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THE EFFECT OF PRISM ADAPTATION THERAPY AND THE PRACTICE IN TREATMENT OF POST-STROKE UNILATERAL SPATIAL NEGLECT



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A thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the Doctor of Philosophy.

Johannesburg, 2022

DECLARATION

I, Chuka Ifeanyi Umeonwuka, hereby declare that the work in this dissertation, unless acknowledged, is mine.

This work is submitted in fulfillment for the degree of Doctor of Philosophy, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or examination at this or any other University.

Signed at the University of the Witwatersrand, Johannesburg on February, 2022



DEDICATION

To my wife Dr Juliet Nwachukwu-Umeonwuka that will always be there. And in the loving memory of my father, the late Nze Godson Umeonwuka.

PUBLICATIONS AND PRESENTATIONS FROM THIS THESIS

PUBLISHED ARTICLES

1. Umeonwuka, C., Roos, R., & Ntsiea, V. (2020). Current trends in the treatment of patients with post-stroke unilateral spatial neglect: a scoping review. In *Disability and Rehabilitation*.

2. Umeonwuka, C., Roos, R., & Ntsiea, V. Knowledge and current practice of post-stroke unilateral spatial neglect rehabilitation: A cross sectional survey of South African Neuro-Physiotherapists. ***Accepted for publication*****:** *South African journal of physiotherapy*.

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2. **Umeonwuka, C.**, Roos, R., & Ntsiea, V. Clinical and demographic predictors of unilateral spatial neglect recovery after prism therapy among stroke survivors in the sub-acute phase of recovery. *Submitted to Neurorehabilitation and neural repair.*

CONGRESS PRESENTATIONS

1. **Umeonwuka, C**., Roos, R., & Ntsiea, V. 2021. Unilateral spatial neglect rehabilitation post-stroke: current treatment options, practice and knowledge of physiotherapists. World Congress of Physiotherapy. 9-11 April. Online. **(Winner of best poster: Africa region)**

2. **Umeonwuka, C.**, Roos, R., & Ntsiea, V. Current trends in the treatment of patients with post-stroke unilateral spatial neglect: A scoping review. In: Advances in Evidence Synthesis: special issue. *Cochrane Database of Systematic Reviews* 2020; (9 Suppl 1): [529] https://doi.org/10.1002/14651858.CD202001
3. **Umeonwuka, C.**, Roos, R., & Ntsiea, V. 2020. Current Practice and Knowledge of post-stroke unilateral spatial neglect rehabilitation: A national survey of Nigerian Physiotherapists. Wits Faculty of Health Sciences Virtual Research day and Postgraduate expo. 15 October, Johannesburg.
4. **Umeonwuka, C**., Roos, R., & Ntsiea, V.2020. Knowledge and current practice of post-stroke unilateral spatial neglect rehabilitation: A survey of Nigerian Physiotherapists. World Congress of Physiotherapy Africa region. July 10-13. Cotonou (postponed due to global COVID-19 pandemic)
5. **Umeonwuka, C**., Roos, R., & Ntsiea V. 2019. Current trends in the treatment of patients with post-stroke unilateral spatial neglect: a scoping review. School of Therapeutic Sciences Biennial Research Day. 29 September. Johannesburg.
6. **Umeonwuka, C.,** Roos, R., & Ntsiea, V. 2021. Clinical and demographic predictors of unilateral spatial neglect recovery after prism therapy among stroke survivors in the sub-acute phase of recovery. *African Stroke Organization conference*. November 3-4th (Virtual conference)

ABSTRACT

Background: Unilateral Spatial Neglect (USN) affects the rehabilitation process and leads to poor functional outcomes after stroke. Knowledge and research about the rehabilitation of USN seem plentiful albeit most studies on interventions for USN treatment seem to present mixed results. Also, physiotherapists' level of uptake of available evidence in USN rehabilitation in their practice and the barriers they encounter are not known in South Africa and Nigeria. Evidence for the treatment of USN in the sub-acute phase of recovery is not conclusive. This thesis aims to bridge the gap.

Objectives and Methodology: The purpose of this thesis is to explore the current trend of USN treatment, to evaluate physiotherapists' knowledge, current practice, barriers and facilitators to USN rehabilitation in South African and Nigerian cohorts and to evaluate the effect of prism adaptation on USN in stroke survivors at the sub-acute phase of recovery.

To achieve these thesis aims, this study was conducted in stages.

Stage I: A scoping review was undertaken using a three-step search strategy guided by the Joanna Briggs Institute's (JBI) guideline for scoping reviews. Databases such as PubMed, CINAHL, The Cochrane Central Register of Controlled Trial, SCOPUS, PROSPERO, JBI, Sport Discus and Google Scholar databases were searched. The searches were limited to publications from January 1, 2008, to May 1, 2020. Critical appraisal was undertaken by two independent reviewers using a standardized critical appraisal instrument from JBI. Non-English articles were excluded, and data were extracted using a study-specific charting table. Findings were categorized and descriptively presented using tables and figures.

Stage II Study: A cross-sectional survey was conducted to evaluate physiotherapists' knowledge of USN, and the current practice of USN management among a cohort of Nigerian physiotherapists. Convenient sampling technique was used to recruit participants registered with the medical rehabilitation and therapist board of Nigeria. A self-developed questionnaire that assessed therapist's knowledge, current practice, barriers and facilitators were sent electronically to therapists. Descriptive statistics and inferential statistics were used to summarise the data using STATA 16.

Stage III: A cross-sectional survey was conducted to evaluate physiotherapists' knowledge of USN, and the current practice of USN, barriers and facilitators to USN rehabilitation among South African neuro-physiotherapists. A total sampling technique was used in this study to recruit all two hundred and seventy-seven members of the neurology special interest group of the South African society of physiotherapists. A self-developed questionnaire that assessed therapist's knowledge, current practice, barriers and facilitators were sent electronically to therapists. Descriptive statistics and inferential statistics were used to summarise the data using STATA 16.

Stage IV study: A single-blinded randomized controlled trial was conducted to evaluate the effect of Prism Adaptation Therapy (PA), as assessed by the Behavioural Inattention Test-conventional sub-test (BIT-C) and Catherine Bergego Scale (CBS). The effect of PA therapy on activities of daily living (ADL), functional mobility, balance abilities and quality of life (QoL) were evaluated with the Barthel index, modified Rivermead mobility index (MRM), Berg balance scale (BBS) and stroke specific quality of life (SSQoL) questionnaire respectively. A total of 74 USN patients who presented with USN following right-brain damage were divided into prism (n = 37) and control (n = 37) groups. The prism group used 20 diopter prism lenses for repeated aiming, five

days a week, 12 days a day, and induced right optical shift every day, while the control group used neutral lenses for similar aiming training.

Results

Stage I results: Out of the 3,648 articles identified**,** 311 full-text papers were screened, and 86 articles were critically appraised, with 83 articles included in the final review. Thirty-seven studies were quasi-experimental, and 46 studies were randomized controlled trials; most interventions targeted stroke patients at the sub-acute phase of recovery. Thirty interventions for post-stroke unilateral spatial neglect symptom amelioration were identified and studies using randomised control trial study design were in majority. Prism Adaptation (PA) was the most investigated intervention while combination therapy appeared to be a new approach.

Stage II results: Two hundred and forty physiotherapists responded to the Nigerian survey. The total knowledge score was 12.6±4.75 on a scale of twenty-five. Nineteen Physiotherapists (7.92%) demonstrated good knowledge of USN, while the majority had moderate knowledge (N=154; 64.17%). There was no significant association between USN knowledge and physiotherapist's gender (t=0.25; p=0.801), Cadre (F=1.94; p=0.470), settlement setting of facility (F=0.26; p=0.855) and physiotherapist's educational level (F=1.94; p=0.125). However, having a postgraduate certification in neurorehabilitation (t=-3.780; p=0.001), clinical practice setting (F=3.51; p=0.008), and working full time in neurorehabilitation (t=-2.158; p=0.033) were significantly associated with therapist's knowledge of USN. There was also a non-significant minimal positive correlation between duration of practice in neurorehabilitation setting (r=0.02; p=0.854), with USN knowledge. Further, there was a non-significant minimal negative correlation between practice as a physiotherapist

(r=-0.02; p=0.772) with USN knowledge. Age of physiotherapists showed no linear relationship with therapist's knowledge of USN (r=-0.00; p=0.992).

Constraint-induced movement therapy (CIMT) (86.47%) was the most common used USN treatment while Albert's test (49.37%) was the most utilized screening tool for USN. When therapists were asked about enablers to USN rehabilitation "Specialized training in USN management" was reported by a majority (83.56%) of a physiotherapist as an enabler to post-stroke USN treatment; "Presence of multidisciplinary stroke team in clinical practice" (83.56%) and "Availability of relevant equipment at clinical practice" (84.25%) were also found to be major enablers. The majority of the respondents indicated that "Lack of relevant equipment for Rehabilitation of USN at clinical practice" (73.72%), "Limited staff capacity" (62.82%), and "lack of hands-on pre-requisite skills needed for post-stroke unilateral spatial neglect rehabilitation" (57.0%) were the major barriers to post-stroke USN rehabilitation.

Stage III results: Twenty-eight physiotherapists completed the South African survey. The overall knowledge score of USN was 14.11±5.23 (on a total scale of 25). Key findings include a significant moderate positive correlation between respondents' age (r=0.46; p=0.016) and years of practice as a physiotherapist (r= 0.43; p= 0.026) and knowledge of USN. Constraint-induced movement therapy and mirror therapy were the two most utilized interventions for USN management by South African physiotherapists while the comb and razor test were the most utilized assessment tools utilised in patient assessment for USN. "Lack of relevant equipment for rehabilitation of unilateral spatial neglect at clinical practice" (38.89%) were identified as major barriers to USN rehabilitation whilst enablers identified by a majority of the

respondents include: “Presence of multidisciplinary stroke team in clinical practice” (83.35%), “availability of adequate staffs” (76.47%).

Study IV results: There was significantly greater improvement of BIT-C in the intervention group post treatment (P= >0.001) and decline in the CBS. Greater clinical recovery (BIT-C score >129) was observed in the intervention group (n=23; 62.16%) vs control group (n=3; 8.11%) post treatment. Similarly, significant improvement, post-treatment, was observed in ADLs (p =0.011), functional mobility (p=0.016), balance (p=>0.001), and QoL (p = 0.004). Cognitive ability (OR =1.52, CI = 1.08- 2.14, p = 0.016) was found to significantly influence recovery following PA treatment. Other socio-demographic and clinical data didn’t show statistically significant influence on recovery post treatment (p>0.05).

Conclusions:

A plethora of intervention studies has been explored to ameliorate neglect symptoms post-stroke. In the treatment of USN after a stroke, no single treatment has the best advantage. Evidence for the selection of treatment at a specific phase of recovery is not conclusive as both improvements and non-improvements on neglect measures were observed across all treatment approaches without specific reference to the phase of recovery**.** The surveys confirmed that only a small number of physiotherapists demonstrated good knowledge of USN. Prism adaptation therapy had a very low usage in USN in both the South African and Nigeria cohorts. Nigerian Physiotherapists with postgraduate qualifications demonstrated better knowledge of USN. Findings emphasize the need for more specific rehabilitation training for post-stroke neglect rehabilitation. The randomised controlled trial in this thesis confirmed that prism adaptation therapy can significantly improve ADL, balance, QoL and functional

mobility in patients with subacute stroke. Good cognitive function is needed in stroke patients to benefit from post-treatment from PA therapy regimen.

Keywords: Stroke; Cross-sectional studies; quality of life, perceptual disorder; activities of daily living; stroke rehabilitation; physiotherapists; cognition; randomised control trial; Unilateral spatial neglect.

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“Though the sorrow may last for the night, joy comes in the Morning”

- ***Psalm 30:5***

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LIST OF ABBREVIATIONS

ACAPN	Association of clinical and academic Physiotherapists of Nigeria
ADLs	Activities of daily living
ANOVA	Analysis of variance
APS	Arm position sense
BAT	Body awareness training
BBS	Berg balance scale
BI	Barthel Index
BIT-C	Behavioural inattention test-conventional sub-test
CAV	Contralesional arm vibration
CBS	Catherine Bergego scale
CIMT	Constraint-induced movement therapy
CINAHL	Cumulative Index of Nursing and Allied Health Literature
COVID-19	Corona virus disease-2019
CPD	Continuing professional development
CPS	Cold pressor stimulation
CT	Computed tomography
cTBS	Continuous theta burst stimulation
EBP	Evidence based practice
EEG	Electroencephalogram
FAC	Functional ambulation categories
FES	Functional electrical stimulation
FIM	Functional independence measure
fMRI	Functional magnetic resonance imaging
GVS	Galvanic vestibular stimulation
HPCSA	Health professions council of South Africa
HRQoL	Health related quality of life

ITT	Intention to treat
JBI	Johanna Briggs institute
LAT	Limb activation treatment
LBT	Line bisection test
LOS	Length of stay
MDT	Multi-disciplinary team
MNT	Music neglect training
MRMI	Modified Rivermead mobility index
MRTBN	Medical rehabilitation and therapist board of Nigeria
MVPT	Motor free visual perception test
NFB	Neuro-feedback
NIH	National Institutes of health
NMV	Neck muscle vibration
NP	Non-Prismatic
NSP	Nigerian society of Physiotherapist
NT	Neglect tests
NV	Neck vibration
OKS	Optokinetic stimulation
PA	Prism adaptation
PEDRO	Physiotherapy evidence database
PNF	Proprioceptive neuromuscular facilitation
QoL	Quality of life
RCT	Randomised control trial
REDCAP	Research electronic data capture
rTMS	Repetitive transcranial magnetic stimulation

SASP	South African society of Physiotherapists
SCT	Star cancellation test
SN	Spatial neglect
SSQoL	Stroke specific quality of life
TENS	Transcutaneous electrical nerve stimulation
TR	Trunk rotation
USN	Unilateral spatial neglect
VFT	Visuomotor feedback training
VR	Virtual reality
VSE	Visual scanning exercise
VST	Visual scanning therapy

LIST OF DEFINITIONS

Cadre	A nucleus or core group especially of trained personnel able to assume control and to train others.
Supratentorial	Supratentorial region of the brain is the area located above the tentorium cerebelli. The supratentorial region contains the cerebrum, lateral ventricle and third ventricle (with cerebrospinal fluid shown in blue), choroid plexus, pineal gland, hypothalamus, pituitary gland, and optic nerve.
Infratentorial	The area of the brain below the tentorium cerebelli is the Infratentorial region. The infratentorial region contains the cerebellum, tectum, fourth ventricle, and brain stem.
Sub-Saharan Africa	Sub-Saharan Africa is, geographically and ethnoculturally,thearea of the continent of Africa that lies south of the Sahara. it consists of all African countries and territories that are fully or partially south of the Sahara.

Educational level	Educational levels are subdivisions of formal learning, typically covering early childhood education, primary education, secondary education and tertiary education.
Rural settlement	Rural area or countryside is a geographic area that is located outside towns and cities.
Semi-rural settlement	A semi-rural settlement is partly rural, between rural and urban; an out-of-town suburb.
Urban settlement	Urban settlement is a settlement with a high population.
Clinicians	A clinician is a health care professional who works as a caregiver of a patient in a hospital, skilled nursing facility, clinic, or patient's home. Clinicians work directly with patients rather than in a laboratory or as a researcher. A clinician may diagnose, treat, and otherwise care for patients.
Policy makers	A person responsible for or involved in formulating policies.
Dioptre	A dioptre is a unit of measurement of the optical power of a lens or curved mirror, which is equal to the reciprocal of the focal length measured in metres.
Therapists	A healthcare professional who helps people recover from an illness or injury and return to daily life.

1. CHAPTER 1: INTRODUCTION

1.1. INTRODUCTION TO CHAPTER

This chapter explains the need and the justification for this study: The current trends in the rehabilitation of USN. The need for research to be done locally to understand physiotherapist's knowledge and the current practice of physiotherapists is also outlined. This chapter outlines the background of the research, problem statement, research question, aim, objectives, and significance of the study, theoretical and conceptual framework of the research as well as the methodological process of the research is presented in this chapter.

1.2. BACKGROUND AND NEED

Unilateral spatial neglect (USN) is defined as the "*inability to report, respond or orient to meaningful stimuli presented to the side opposite the brain lesion*" (Watson & Heilman, 1979). USN affects approximately 50-70% of post-stroke survivors with right hemispheric damage (Buxbaum et al., 2004b; Nijboer et al., 2013; Paolucci et al., 2001) and is a better predictor of post-stroke recovery than paralysis or communication disability (Nys et al., 2005; Robertson et al., 1997). It is established in the literature that USN is a leading cause of disability and handicap in stroke survivors affecting recovery in function and is correlated with negative rehabilitation results (Jehkonen et al., 2000; Kalra et al., 1997a; Katz et al., 1999; Paolucci et al., 2001; Riestra & Barrett, 2013).

Several researchers (Jacquin-Courtois et al., 2013; Mizuno et al., 2011a; Nijboer et al., 2014; Pisella et al., 2002; Revol et al., 2020; Turton et al., 2010; Vaes et al., 2016; Watanabe & Amimoto, 2010b) have explored the utilization of prism adaptation (PA) in the management of USN among patients that had survived a stroke. However,

previous USN rehabilitation studies utilising prism have explored patients in the chronic phase, while fewer in the sub-acute phase (Mizuno et al., 2011a). There is inconsistent information from research studies on prism adaptation efficacy in the rehabilitation of stroke survivors with USN symptoms (Bowen & Lincoln, 2007b).

Although USN is highly prevalent and the negative results correlated with the syndrome (Luauté et al., 2006), a recent review showed no single intervention has shown superior efficacy in reducing the disability associated with USN (Umeonwuka et al., 2020) For clinicians to be effective at reducing spatial neglect-related disability, it is important to examine additional interventions targeting USN. There is also a need to assess physiotherapists' knowledge, practice, barriers and enablers to USN rehabilitation to decipher the evidence utilization level for USN rehabilitation for better rehabilitation outcomes.

1.3. STATEMENT OF PROBLEM

In stroke-related injuries that lead to clinical deficits, the existence of USN has always been correlated with slow functional progress and decreased ADL function during rehabilitation (Chen et al., 2015a; Nijboer et al., 2013), poor functional recovery, (Di Monaco et al., 2011a) reduced HRQoL (Sobrinho et al., 2018a), reduced functional mobility and poor gait (Oh-Park et al., 2014) and all these results in increased costs for health care systems.

In the last 60 years, varying rehabilitation approaches or treatment methods have been proposed to reduce neglect of the left visual space (Azouvi et al, 2017; Luauté et al., 2006). Treatment for unilateral spatial neglect has been broadly classified into strategies that utilize top-down mechanisms and bottom-up mechanisms (Adair & Barrett, 2008). With the top-down approach, the patient is actively engaged in the

process through external cues and guidance. Therapy based on the top-down approach involves continuous feedback, encouragement, training, and encouragement provided by a therapist. Among the treatment options after such an approach are visual scanning training (VST), sustained attention training, and mental imagery training (Marshall, 2009).

Treatment based on the bottom-up mechanism involves manipulating endogenous components of the neural axis, mainly sensory input, at the preconscious level of perception. The idea behind this method is that an unbalanced perception and attentional system can be corrected without the patient's conscious involvement. Prism glasses, trunk rotation, and eye patches are all examples of bottom-up interventions. Other interventions alter the somatosensory system, such as limb activation, muscle vibration, and optokinetic stimulation.

Despite the plethora of available evidence, there seems to exist a translational gap, with a low uptake rate of evidence-based practice and integrating clinical skills into decision-making for post-stroke rehabilitation (McEvoy et al., 2011). Physiotherapists are no exception despite the significant increase in knowledge and skills in the physiotherapy profession both in the academic syllabus and in clinical practice (Manns et al., 2015).

Physiotherapists are trained health care professionals who can provide rehabilitation care under various disability conditions to restore, maintain, and promote the functions of people with limited activities and limited participation (American Physical Therapy Association, 2011). Successful rehabilitation of stroke survivors requires adequate knowledge, receptivity and an interest in caring for individuals like these. Poor knowledge and skills about a specific condition, however, pose a strong barrier to

implementing effective stroke rehabilitation (Menon et al., 2010; Petzold et al., 2014a; Pollock et al., 2000). Identification of practice barriers is fundamental in the process of translating knowledge into practice (McCluskey & Middleton, 2010). Sadly, there is a considerable gap between real-life and current practice in stroke management (Menon et al., 2010).

Evidence-practice gaps can be caused by poor organizational and personal barriers to change, such as outdated attitudes, inefficient policies and inefficient systems, leading to inefficient processes (Petzold et al., 2012; Pollock et al., 2000).

Survey studies in the United Kingdom, Australia and the United States of America have explored theoretical beliefs underpinning USN and the current practice of stroke rehabilitation (Carr et al., 1994; DeGangi & Royeen, 1994; Lennon et al., 2001; Lennon, 2003; Natarajan et al., 2008; Nilsson & Nordholm, 1992). Studies that evaluate USN specific knowledge and practice specific to unilateral spatial neglect.

The use of PA therapy in the management of stroke survivors still has some questions unanswered. First, empirical review studies showed that research on long term effects of prism adaptation did not include proper control conditions (Bowen & Lincoln, 2007a). Secondly, there are inconsistent results from reported published studies on the extended efficacy of prism adaptation in the management of unilateral spatial neglect (Rossetti et al., 1998) and most previous studies used a small population size. Thirdly, previous studies have explored stroke survivors in the chronic phase, i.e. stroke survivors with a duration of more than three months after stroke onset, with few studies exploring the effect of prism adaptation in the sub-acute phase (Mizuno et al., 2011a). Also, the characteristics of patients most likely to benefit from prism adaptation therapy were still not established in the literature.

With the foregoing in mind, this study sought to bridge the research gap on the effect of prism adaptation therapy on USN rehabilitation, current trends in the management of USN, and Physiotherapists' knowledge, practice and barriers in the practice of USN rehabilitation.

1.4. RESEARCH QUESTION

1.4.1. Research question one: What is the current trend in the treatment of USN in stroke survivors?

1.4.2. Research question two: What is the current physiotherapists' knowledge, practice, enablers and barriers to the practice of USN rehabilitation in stroke survivors in Nigeria and South Africa?

1.4.3. Research question three: What is the effect of PA therapy on USN in stroke survivors during the sub-acute phase of stroke recovery?

1.5. HYPOTHESIS

1.5.1. Hypothesis (H_1): Prism Adaptation therapy will improve USN in stroke survivors during the sub-acute phase of recovery.

1.5.2. Null Hypothesis (H_0): Prism Adaptation therapy will not improve USN in stroke survivors.

1.6. AIMS OF THE STUDY

The aim of this thesis was to:

1. Explore current trends in treatment of post-stroke USN.
2. Evaluate knowledge, current practice enablers and barriers in the management of USN among physiotherapists in Nigeria and South Africa.

3. Investigate the effect of PA therapy on USN among patients that had a stroke during the sub-acute phase of recovery. To achieve this, the study was carried out in three stages.

1.7. OBJECTIVES OF THE STUDY

1.7.1. Study 1:

To explore recent trends in the treatment of USN for stroke survivors.

1.7.2. Study 2:

To evaluate knowledge, practice enablers and barriers to the practice of USN management in stroke survivors among physiotherapists in Nigeria and South Africa.

1.7.3. Study 3

Primary Objective: To establish the effect of PA therapy on USN in stroke survivors at the sub-acute phase of recovery after twelve sessions of PA.

Secondary Objectives:

1. To identify demographic and clinical profile characteristics (age, gender, educational level, Stroke duration, type of stroke, site of stroke and handedness) of post-stroke USN patients in the sub-acute phase of recovery.
2. To identify predictive factors which are predictive of the outcome of PA therapy of stroke survivors with USN in the sub-acute phase of recovery after twelve sessions of PA.
3. To establish the effect of PA therapy on hospital length of stay of stroke survivors with USN during the sub-acute recovery phase after twelve sessions of PA.

4. To establish the effect of PA therapy on balance of post-stroke survivors with USN in the sub-acute phase of recovery after twelve sessions of PA
5. To establish the effect of PA therapy on functional mobility of stroke survivors with USN during the sub-acute recovery phase after twelve sessions of PA
6. To establish the effect of PA therapy on the quality of life of stroke survivors with USN in the sub-acute phase of recovery after twelve sessions of PA
7. To establish the effect of PA therapy on activities of daily living, of stroke survivors with USN during the sub-acute recovery phase after twelve sessions of PA.

1.8. SIGNIFICANCE OF THE STUDY

Relevant evidence base that can inform clinical practice in the selection of specific intervention for USN was elucidated in the scoping review of this study.

Prism Adaptation therapy is effective in the management of USN in stroke survivors in this study it could be integrated into post-stroke management and this may assist patients who had suffered a stroke to regain function early and be re-integrated into the community.

Health professionals involved in stroke rehabilitation can benefit from an evidence-based technique for the management of USN among post-stroke survivors. Physiotherapists' knowledge about post-stroke USN rehabilitation, clinical current practice and the barrier and enablers they encounter in practice may assist health policy makers and clinicians to formulate the best strategy in conducting continuing education programs and inform health policy and budget planning for implementation and improvement of post-stroke rehabilitation.

1.9. THEORETICAL FRAMEWORK OF THE STUDY

The theory underpinning the entire thesis is the knowledge to action (KTA) framework developed by Ian Graham and colleagues (Graham et al., 2006). The KTA Framework adds a knowledge creation component to planned-action theories (which make up the action cycle). The KTA Framework consists of two parts: (i) Knowledge Creation, and (ii) the Action Cycle. Since KT is iterative, components of the Action Cycle will feed back into the Knowledge Creation process and inform practice. The funnel represents the production and synthesis of knowledge. Three phases constitute this inner component: (1) knowledge inquiry, (2) knowledge synthesis, and (3) the creation of knowledge products and tools.

Knowledge inquiry refers to primary studies and constitutes the majority of research conducted. Individual studies at this stage are just not ready to be applied to practice on a wide scale, but are necessary to inform future research.

Knowledge synthesis involves synthesizing results from individual research studies and interpreting them within the context of global evidence. Knowledge syntheses take the form of studies that fall into the categories of systematic reviews, scoping reviews, and meta-analyses. Lastly, knowledge tools and products are the most refined form of knowledge, based on earlier stages of the funnel. Knowledge tools and products present evidence in a concise and user-friendly manner based on synthesized knowledge.

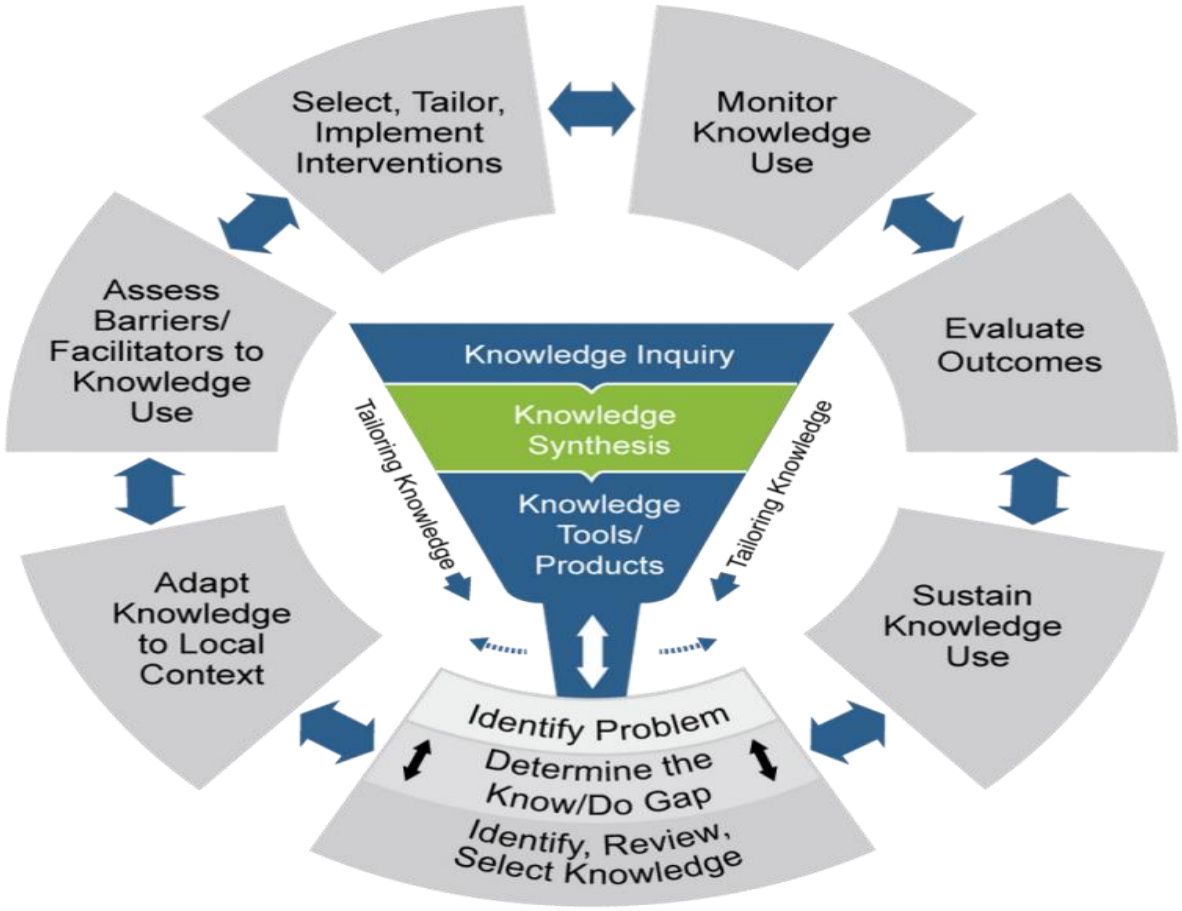


Figure 1. 1: Knowledge to action framework (Graham et al., 2006)

The theory underpinning the effectiveness of PA in USN rehabilitation follows a bottom-up mechanism that uses sensory stimulation (manipulation of the sensory environment) to enhance the representation of contralesional space (Adair & Barrett, 2008). These methods are based on manipulating the sensory environment of the patient.

Spatial references are modulated by sensory stimuli by acting on the sensory afferents. Since the 1960s, PA has been used to study sensorimotor plasticity by artificially manipulating the spatiotemporal reference system (Azouvi et al, 2017). Figure 1.2 shows the theoretical framework for the use of prism in USN rehabilitation.

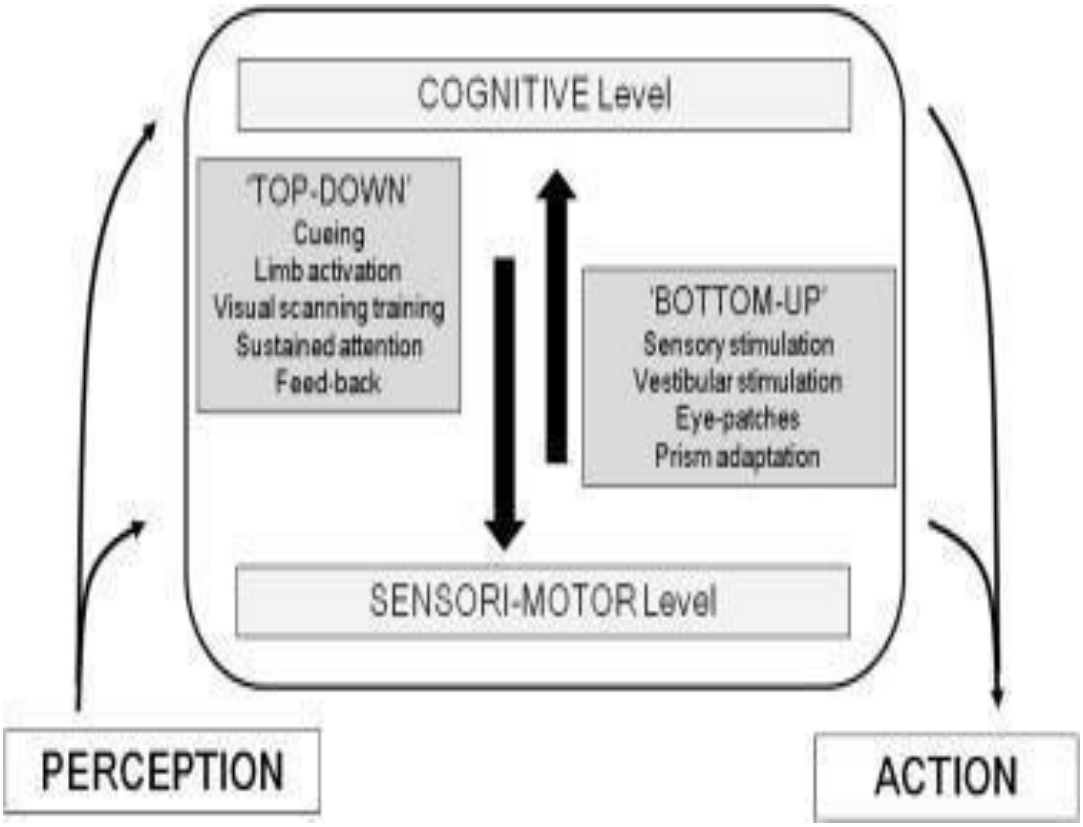


Figure 1. 2: Theoretical framework for the use of Prism in USN rehabilitation (Dintén-Fernández et al., 2019a)

1.10. CONCEPTUAL FRAMEWORK OF THE STUDY

Unilateral spatial neglecthas been correlated with significant and persistent motor deficits. Each of these injuries is related to severe long-term disability (Azouvi et al, 2017).

Through a closer look at these links, one may discover new insights into the causes of disability and possible recovery mechanisms. A proposal that inattention to disability can be mediated directly (by biological mechanisms) and indirectly (by behavioural mechanisms) was advanced by the researcher. Figure 1.3 shows the link between inattention and disability.

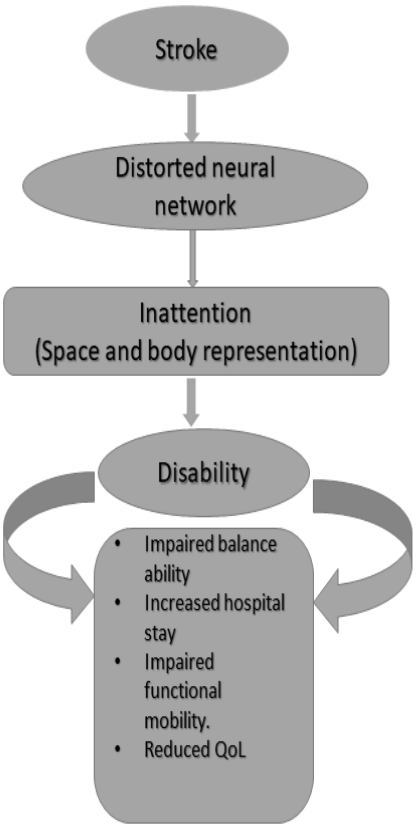


Figure 1. 3: Link between Unilateral spatial neglect, disability and study variables (Corbetta & Shulman, 2011).

Unilateral spatial neglect is associated with both cortical and subcortical lesions post-stroke (Bartolomeo, De Schotten, & Doricchi, 2007). It was hypothesized that sessions of PA may improve spatial attention (primary outcome) with resultant reduction in disability in post-stroke survivors. These gains in disability reduction and spatial symptoms may extend to the quality of life, balance, hospital length of stay, functional mobility, and ADLs (secondary outcome). Figure 1.4 shows the linkage between prism adaptation and USN.

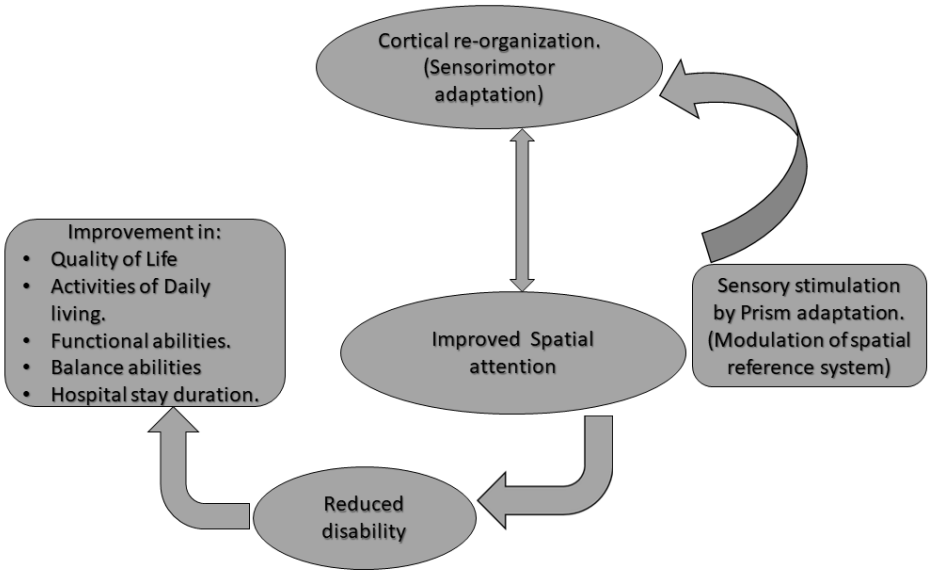


Figure 1. 4: Link between prism adaptation therapy and USN

1.11. METHODOLOGICAL OUTLINE OF THE STUDY

This research study was divided into three stages. The first stage of the study was a scoping review of the current trend in the treatment of USN in stroke survivors. The second stage evaluated the physiotherapist's knowledge, practice, enablers and barriers in the practice of unilateral spatial neglect rehabilitation in stroke survivors in Nigeria and South Africa. The third stage evaluated the effect of PA therapy on USN among post-stroke survivors during the early phase of stroke recovery. Figure 1.5 outlines the flow in this thesis.

The first stage is evidence synthesis using a scoping review. The purpose of a scoping review is to provide an overview and a map of the available research evidence without producing a summary answer to a discrete research question (Arksey & O'Malley, 2005). For this thesis, the rationale to choose a scoping review in the first stage of this

study is pinned to the fact that a scoping review is best designed for knowledge synthesis when a body of literature has not yet been comprehensively reviewed, or exhibits a large, complex, or heterogeneous nature not amenable to a more precise systematic review (Peters et al., 2015). In this instance, preliminary literature searches have revealed a large, complex and heterogeneous nature of approaches relevant for the treatment of unilateral spatial neglect (Luauté et al., 2009). Information from the scoping review in the first stage was used to evaluate physiotherapist knowledge and current practice of unilateral spatial neglect in Nigeria and South Africa in the second stage of this thesis to ascertain the level of evidence-based practice in these countries. The second phase of this study used a cross-sectional survey methodology. The rationale for selecting a cross sectional survey for the second phase of the study is hinged on the fact that cross sectional surveys are cost effective, less time consuming and allows the researcher to study the variables of interest about the population at the current time (Sedgwick, 2014). In this study, an online questionnaire was used to obtain data from physiotherapists. Physiotherapists are quite busy with patient care and anecdotally they tend to not devote time to other activities. Hence this mode of administration of data capturing tool (online) questionnaire was selected as it presents the participants with flexibility to respond to the questionnaire. The rationale to conduct these surveys (stage II) in Nigeria and South Africa is related to the disparities in scope of physiotherapy practice, physiotherapy training in both countries. For instance, In Nigeria, physiotherapy practice is not first contact with patients (Ganiyu, 2008; Mbada et al., 2015). While in South Africa, physiotherapy first contact is practised (Bury & Stokes, 2013). Similarly, physiotherapy training in Nigeria is a five-year training program with current advocacy for a 6-year Doctor of Physiotherapy (DPT) training program. In South Africa however, physiotherapy training is a 4-year training program.

This mentioned disparity is of interest and necessitated the need to evaluate both countries as these might reflect on clinical practice in these countries.

The final stage of this thesis was a randomised control trial to evaluate the effect of PA therapy on USN in post-stroke survivors at the sub-acute phase of recovery. The RCT is the gold standard for evaluating effectiveness of an intervention hence it was a research design of choice for this stage of the thesis (Hariton & Locascio, 2018). Figure 1.5 outlines the flow in the thesis.

Though this thesis is presented in three studies, the central theme of the thesis is improving post-stroke USN treatment. Figure 1.6 illustrates the inter-link between all three stages in this thesis. The thesis is presented in ABCD fashion as each chapter does not necessarily inform the next chapter albeit they are related but not the sequential format of A-B-C-D. Each objective of the studies does not inform the next rather are discrete objectives to fill identified research gaps.

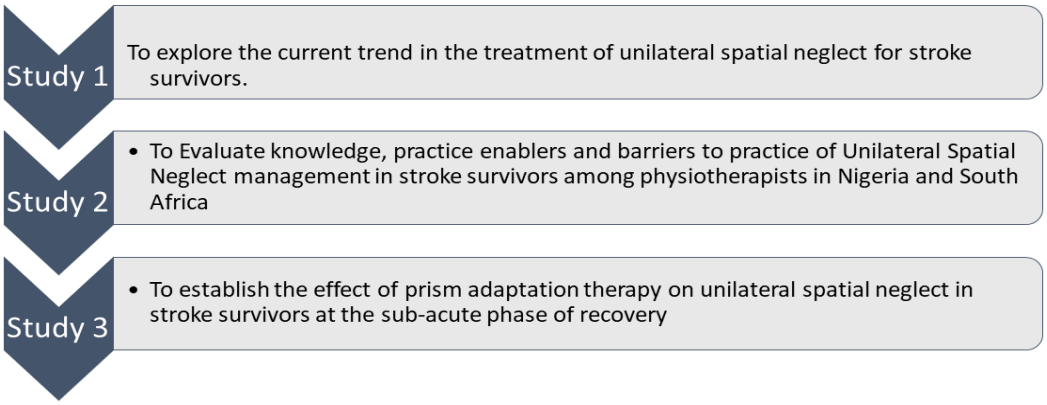


Figure 1. 5: Flowchart of the research process.

Below is the summary of the general outline of the thesis:

Chapter 1: Background and the need for study

Chapter 2: Literature review

Chapter 3: Instrumentation and outcome measures

Chapter 4: Study 1: Current trends in the treatment of patients with post-stroke unilateral spatial neglect: A scoping review.

Chapter 5: Study 2: Current Practice and Knowledge of post-stroke unilateral spatial neglect rehabilitation: A national survey of Nigerian and South African Physiotherapists.

Chapter 6: Study 3: The effect of prism adaptation therapy on unilateral spatial neglect in stroke survivors at the sub-acute phase of recovery: A Randomized control trial.

Chapter 7: Integrative discussion

Chapter 8: Conclusion and recommendation

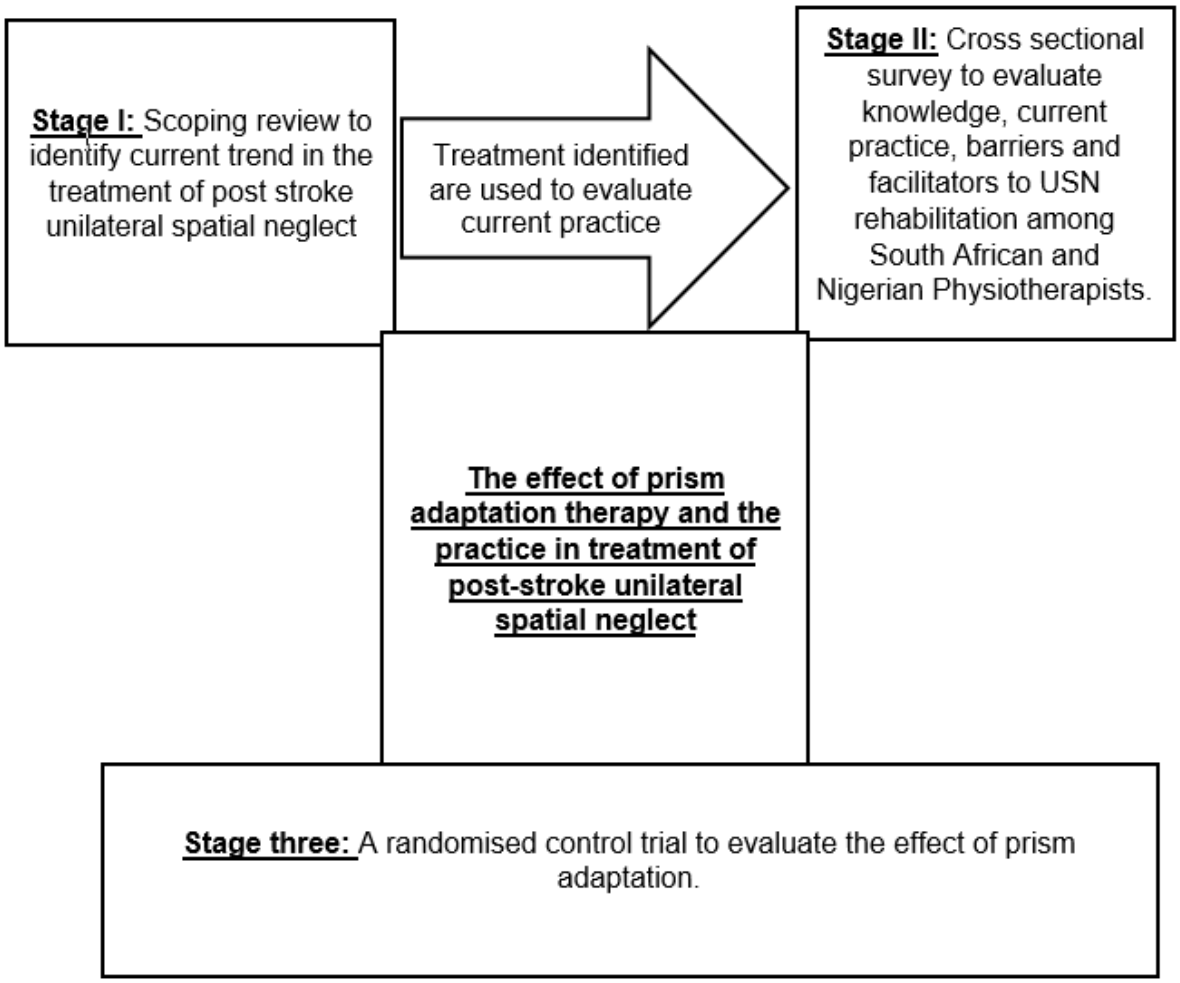


Figure 1. 6: Linkage between all three stages in this thesis.

2. CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION TO CHAPTER

This chapter focuses on the review of the literature supporting the overall rationale and objectives of the study. The chapter is divided into two major sections. The first section is the review of literature based on study 2: Knowledge, current practice, barriers, and facilitators to USN rehabilitation. This section includes reviews on rehabilitation experts' knowledge of USN, factors affecting knowledge of rehabilitation experts on USN, current practice and gaps in post-stroke USN rehabilitation, and Identified barriers and facilitators to USN rehabilitation.

The second section deals with study 3 (the effect of prism adaptation therapy on USN in stroke survivors at the sub-acute phase of recovery). The types, presentation, anatomy, prevalence of neglect and the identified risk factors that predispose stroke survivors to USN were reviewed. This section also includes the review of previous studies on the pathophysiology of neglect, the impact of USN on rehabilitation outcome, mechanism of action of PA in ameliorating USN symptoms post-stroke, interventions for USN, factors that are predictive of outcome in USN management, benefits of PA in USN rehabilitation and factors that influence PA outcome.

Study one was a scoping review, hence the literature supporting the study is presented in Chapter four.

2.2. THE METHODOLOGY OF THE LITERATURE REVIEW

Related topics of interest were accessed using databases which included: Google Scholar, PubMed, PEDro, Science Direct, CINAHL, and Cochrane reviews. The flowchart of the literature review is outlined in Figure 2.1.

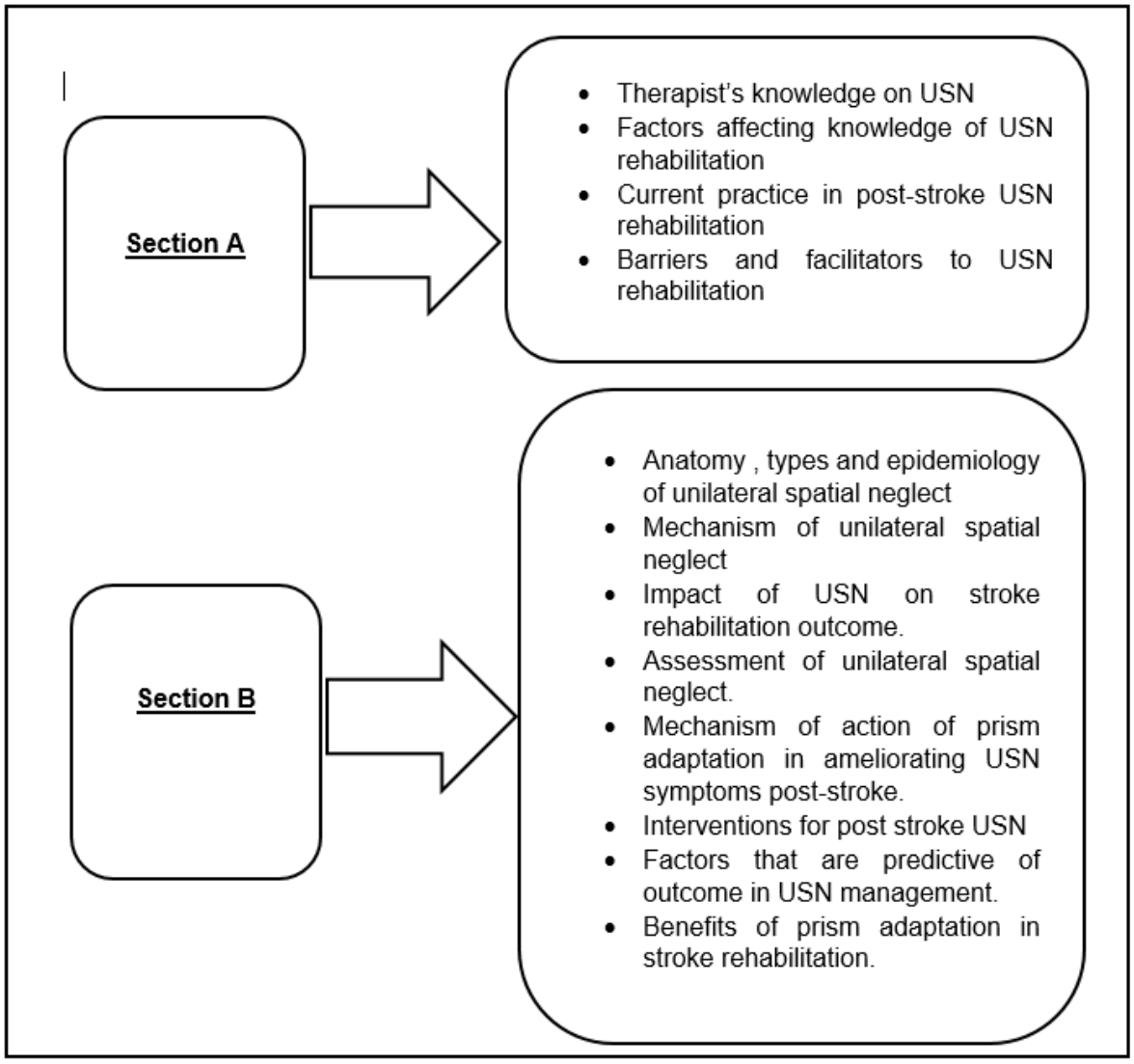


Figure 2. 1: The flowchart of the literature review.

2.3. SECTION A

2.3.1. Therapist's knowledge on unilateral spatial neglect

Manns and colleagues (Manns et al., 2015) showed that the content of evidence-based practice, proficiency and expertise in physiotherapy, both in education syllabus and in clinical practice, has increased over the past ten years, but the research up-take is minimal. As a result, knowledge and practice are still far apart. The conjecture was that physiotherapists would use this knowledge set in adopting evidence-based practices.

From extensive literature search, studies that have explored rehabilitation experts' knowledge of USN rehabilitation after stroke appears to be modest. Only one study by Petzold and colleagues in Canada (Petzold et al., 2012) explored the occupational therapist's knowledge on USN using a multimodal knowledge translation intervention. Their study reported that occupational therapists in Canada and most clinicians were unaware that USN can be categorized into three types before the knowledge translation intervention. Furthermore, therapists with a higher level of education in physiotherapy and those who superintend physiotherapy students had a greater understanding of EBP specific to stroke (Petzold et al., 2012).

Studies investigating physiotherapists' USN specific knowledge are unavailable for referencing, the few studies examined in this review on the occupational therapists (major players in the rehabilitation team) showed that they have a modest USN specific knowledge).

From extensive literature search, there seem to be unavailable studies that evaluated physiotherapist's knowledge of post-stroke unilateral spatial neglect rehabilitation. The only available study conducted by Petzold and colleagues ((Petzold et al., 2012) was

conducted on occupational therapists using a pre-post repeated measure design. Even though occupational therapists are member of the rehabilitation team, the scope of practice between physiotherapy and occupational therapy differs, hence the body of knowledge needed for practice. Also, no study has evaluated knowledge of post-stroke USN in an African setting.

2.3.2. Factors affecting therapists' knowledge of unilateral spatial neglect rehabilitation

According to Menon-Nair and colleagues' study on occupational therapists in Canada, there is a 7% to 19% variability in the identification, assessment, and treatment of USN (Menon-Nair et al., 2007). In their research, they found that working in the stroke unit and being young was one of the variables that explained between 7% and 19% of the variability in USN problem identification, assessment, and intervention. A Canadian study by Petzold and colleagues examined the possibility of providing a multi-modal knowledge translation intervention for acute USN management (Petzold et al., 2012). Their study found that three of seven potential independent variables significantly correlated with greater mean change in scores on the Knowledge Questionnaire on USN. These include bachelor's vs master's degree, supervising student's vs not supervising students and being a member of a stroke team vs not being part of a stroke team (Petzold et al., 2012).

This sub-section explored the factors affecting rehabilitation expert's knowledge of USN rehabilitation. Even though no study has investigated physiotherapists' knowledge of USN and factors affecting it, studies on occupational therapists identified factors such as working in a stroke unit, younger age, higher qualification and supervising students in training as influencing knowledge of occupational therapists.

2.3.3. Current practice in unilateral spatial neglect rehabilitation

Several guidelines on stroke treatment propose an extensive and timeous evaluation and identification of USN as a crucial part of post-stroke clinical care planning (Hebert et al., 2016a; National Stroke Foundation, 2010; Reidy, 2020; Royal College of Physicians, 2012; Winstein et al., 2016a). Clinical assessment tools are broadly classified into four categories which include: functional assessments, neuroimaging/neuromodulation assessments, neurological assessments, and cognitive/neuropsychological assessments (Checketts et al., 2020).

Currently, clinical rehabilitation professional groups have not stated how they screen, assess, or diagnose neglect. For instance, a survey of two hundred and fifty-three occupational therapists in Canada conducted by Menon-Nair and colleagues (Menon-Nair et al., 2007) reported that diagnosis of neglect-related symptoms was very high while utilization of factual, standardized assessment is modest. An earlier retrospective study of medical records found that standard neglect assessments among rehabilitation experts in Canada were not standard practice (Menon-Nair et al., 2006).

Evald and colleagues (Evald et al., 2020) reported that the most frequently used treatments for USN were occupational and physiotherapy, according to a Danish survey. Most treatments entail training to perform daily living activities (ADL), sensory stimulation, and cueing (Evald et al., 2020). Less often reported were evidence-based methods such as prism adaptation and visual scanning (Evald et al., 2020). In South Africa, interventions such as saccadic eye movement training and visual scanning exercises (VSEs) integrated with task-specific activities have been suggested in the treatment of post-stroke USN (Ntsiea, 2019). However, there seem to be no studies

that have evaluated actual USN specific practice of post-stroke rehabilitation in sub-Saharan Africa among physiotherapists.

A multidisciplinary international survey study by Checketts and colleagues evaluated 12 professions from 33 countries' assessment of USN. Their study majority reported using cognitive assessment (82%) (Particularly psychologists); 80% used functional assessments (physiotherapists majorly), twenty per cent (physicians are the majority, from Italy) used neuroimaging/ neuromodulation (Checketts et al., 2020). Additionally, there are reports of informal assessment of spatial neglect by clinicians vis-à-vis none use of standardized tests (Silver & Callahan, 2001). Research studies use a variety of neglect assessments (Chen et al., 2018) which may have arisen as a result of different operational definitions of the syndrome and how they present (Verdon et al., 2010).

Chapters five and six of this thesis dealt with the evaluation of physiotherapists' knowledge and current practice of post-stroke USN. From a search of published data, in this subsection, despite a plethora of interventions suggested by researchers for ameliorating USN symptoms, there seem not to be adequate studies that have evaluated the current practice of unilateral spatial neglect rehabilitation practice.

Available studies that shed light on assessments of USN suggests that physiotherapists employ functional assessments, other professionals also utilized other forms of assessments such as cognitive and neuroimaging tools. Also, the use of non-standardized tools was reported as being used in the assessment of USN patients.

2.3.4. Barriers and Facilitators to unilateral spatial neglect rehabilitation

Poor knowledge and skills about a specific condition pose a strong barrier to implementing a guideline for effective stroke rehabilitation (Menon et al., 2010; Petzold

et al., 2014a; Pollock et al., 2000). Identification of practice barriers is fundamental in the process of translating knowledge into practice (McCluskey & Middleton, 2010).

Graham and colleagues believe that by identifying specific enablers and barriers for patient populations, clinicians, and work settings, you optimize interventions aimed at increasing EBP use (Graham et al., 2006). Several barriers and facilitators have been identified for stroke rehabilitation. A Canadian study reported lack of time as the principal barrier to stroke rehabilitation, followed by lack of staff, unreliable equipment, team functioning and communication (Bayley et al., 2012). Several barriers to stroke rehabilitation were also identified in an Australian study, including the social influence of stroke survivors and their relatives, professionals' beliefs about their competency, knowledge, skills and role identification, and availability of resources (McCluskey & Middleton, 2010). In a Ghanaian study, failure to establish a clear mission, inadequate time, insufficient information resources and lack of understanding of statistics were identified as the top five barriers to stroke rehabilitation (Quartey & Kwakye, 2018). These reported barriers have profound adverse outcomes on rehabilitation in stroke settings and ultimately on USN rehabilitation.

Few studies have investigated barriers and facilitators to post-stroke USN specific rehabilitation (Ogourtsova et al., 2019a; Petzold et al., 2014b). Petzold and colleagues identified several barriers which impede the implementation of USN specific approaches in the rehabilitation of stroke patients among Canadian occupational therapists. Among the key barriers were an inadequate knowledge of evidence-based practices applicable to the treatment of USN and a lack of individual inspiration to alter practices currently in place. Recent graduation, being a member of an interdisciplinary

stroke team, availability of learning time, and learning resources created an environment where learning could thrive (Petzold et al., 2014a).

Similarly, Ogourtsova and colleagues in Canada explored the rehabilitation expert's perceived barriers and enablers to the use of virtual reality (VR) in USN evaluation. Identified barriers include personal factors such as lack of expertise, institutional factors such as support, a person with expertise in the field, and built-in help facility while identified key facilitators were expectations regarding performance and effort, positivity at work, no fear/anxiety towards VR, and intention of use (Ogourtsova et al., 2015).

This sub-section examined the perceived barriers and enablers to USN specific treatment. Although no study has examined physiotherapists' perceived barriers and facilitators to USN specific treatment, studies exploring these barriers in other rehabilitation professionals identified barriers such as lack of basic understanding of EBP for USN management, individual inspiration to alter practices currently implemented and entrenched habits, lack of support or built-in help facility and lack of resource persons while identified key facilitators were effort and performance expectations, positive attitude, and absence of fear/anxiety. However, no studies in Africa have explored barriers and facilitators to USN specific treatment. The majority of the studies identified were North American studies.

2.4. SECTION B

2.4.1. Anatomy, types, and epidemiology of unilateral spatial neglect.

2.4.1.1. Anatomy of neglect

Unilateral spatial neglect is the fallout from damage to the right cerebral hemisphere. Although USN is conventionally correlated with lesions in the parietal region of the brain, most strokes affecting the middle cerebral artery are diverse in affectation and many patients clinically manifest a varying combination of parietal, temporal, and frontal damage (Verdon et al., 2010). Neglect may be as a result of subcortical stroke as well, which may be due to hypo perfusion or dysfunction in the overlying cortex (Fruhmann Berger et al., 2009; Hillis et al., 2002; Verdon et al., 2010).

At a functional level, unilateral spatial neglect could emanate due to inter-hemispheric imbalance in patients with stroke, culminating in an overactive left hemisphere after a right hemispheric stroke and this could cause a rightward bias in attention and eye movements experienced in USN patients (Corbetta et al., 2005; Kinsbourne, 1970). Karnath proposed that the dense neural interconnection called the "perisylvian neural network", which is composed of the upper/medial temporal lobe, inferior parietal lobe, and ventrolateral frontal cortex of the right hemisphere, represents the anatomy of the process involved in spatial orientation (Karnath, 2010). Neurons domiciled in these areas provide superfluous data about the motion and position of the body in space and is also key in body position adjustment relative to external space (Karnath & Dieterich, 2006).

Also, USN can be described following an injury that is streamlined to subcortical regions more precisely, lesions affecting the caudate nucleus, (Caplan et al., 1990;

Kumral et al., 1999) the putamen (Karnath et al., 2002) and the thalamic pulvinar (Karnath et al., 2002).

Perfusion weighted infusion (PWI) study by Karnath and colleagues reported that dense strokes on the right basal ganglia that elicit spatial neglect induce abnormal perfusion in areas of the intact cortex that typically involves those regions (the superior/middle temporal cortex, the inferior parietal lobule, and the ventrolateral prefrontal cortex) (Karnath et al., 2005). As a result, spatial neglect may result from (partial) dysfunction of the cortical perisylvian neural network after right basal ganglia injuries.

Several studies recommended that impairments on different types of tasks were more likely to localize to different regions (Medina et al., 2009; Rorden et al., 2006; Verdon et al., 2010). The impairment of white matter tracts involved in attention and in particular the superior longitudinal fasciculus, as well as individual cortical and subcortical regions, appears to be the cause of attention deficits. (Bartolomeo et al., 2007; Lunven et al., 2015).

The anatomical basis of spatial neglect was discussed in this subsection. From the literature search, injury (due to infarct) to areas responsible for spatial processing are responsible for spatial neglect. Such areas implicated are thus: the superior/middle temporal cortex, the inferior parietal lobule, and the ventrolateral prefrontal cortex. There has been a strong debate concerning the precise anatomy of neglect. Although a plethora of brain areas have been correlated with USN, there seems to be no consensus regarding the central anatomy of USN. This could be related to the different imaging methodologies and timing at which patients have been tested (Golay et al., 2008; Karnath et al., 2011).

2.4.1.2. Epidemiology of unilateral spatial neglect post-stroke

The prevalence of USN is widely varied among the population (Bowen et al., 1999). However, several regional prevalence of post-stroke USN has been reported. Variability for this observation in the occurrence of USN has been explored by Bowen et al. (1999) and could be due to patient selection, lesion localization, and the nature and timing of assessment (Bowen et al., 1999).

Studies have reported varying incidences of neglect, ranging from 10 to 82%, and it occurs more often following right cerebral lesions than left. (Stone et al., 1993; Sunderland et al., 1987; Zoccolotti et al., 1989). Also, patients having left cerebral lesions are not· always included in studies due to challenges in testing patients with communication problems, and these categories of a patient may be under-reported. Hamzat and colleagues in a Nigerian study reported that USN was observed in less than half of stroke patients living in community settings and is distributed almost equally in both rights and left hemispheric stroke (Hamzat et al., 2012). Study results by Ringman et al. (2004) out of 1,282 patients who had recently had a stroke, it was shown that forty-three per cent of patients with right-side lesions experienced USN symptoms.

There was an incongruent range of USN reported in the Copenhagen Stroke Study, but sample selection, defining unilateral spatial neglect and assessing USN differences resulted in inconsistent results (Pedersen et al., 1997). Also, according to Appelros and colleagues, 23% of patients with strokes displayed visual-spatial neglect, while 8% showed personal neglect (Appelros et al., 2002).

Previous researchers have reported that severe neglect is infrequently seen 6 months after a stroke (Gammeri et al., 2020; Stefano Paolucci et al., 1996; Sunderland et al., 1987). Age is a significant factor associated with increased odds of USN in patients with acute strokes of the right hemisphere as well as the severity of the neglect (Gottesman et al., 2008), but not with gender (Kleinman et al., 2008; Ringman et al., 2004), previous stroke, handedness or comorbidities (Pedersen et al., 1997; Ringman et al., 2004).

This discrepancy in reported prevalence of USN could be as a result of screening tools used (diagnostic methods) in the identification of USN in these studies. Also, the study population and lesion localization may have affected the results of the studies. For instance, the stage of stroke (or time since stroke) recovery at which the study participants were screened for USN may account for discrepancies in reported prevalence as USN is more common at the acute phase of stroke than in the chronic phase (Esposito et al., 2021).

In summary, occurrences of USN post-stroke were appraised in this subsection. The range of reported prevalence of USN varied within studies. Increasing age is a significant factor associated with increased odds of unilateral neglect in patients with acute strokes of the right hemisphere as well as the severity of the neglect. However, gender, prior stroke, comorbidities or handedness were reported not to be associated with the incidence of USN. It is however not clear if race is associated with the incidence of USN.

2.4.1.3. Types of unilateral spatial neglect

There are two classification systems for USN. In the USN's first classification system, hemineglect is divided into different types based on how the resulting behaviour is carried out. In this classification, hemineglect could be sensory, motor or representational neglect (Heilman et al., 2000). The second classification is based on the area of distribution of abnormal behaviour. These categories differentiate neglect as being either personal or spatial (Heilman et al., 2000).

2.4.1.3.1. Classification of Neglect based on the mode of the resulting behaviour

Subtypes of neglect based on this classification include sensory, motor, or representational neglect.

Sensory Neglect: Sensory neglect is distinguished by an obliviousness of the body to sensory information from the environment. This inability to perceive sensation often occurs on the contralesional side of the patient (Bowen et al., 1999). Diverse sensory abilities can be affected in this form of neglect including visual, somatosensory, and auditory faculties. In visual neglect, patients will be unable to identify any visual input on the symptomatic side of their visual field. Such neglect will cause the patient to be unable to completely reproduce the image based on the model image and ignore the details of the image on the affected side (Heilman et al., 2000). *Somatosensory* neglect is distinguished by inattention to sensory input originating in the body of the patient not inattention to transduction of stimuli from the outside world (Heilman et al., 2000). Sensory neglect patients will also show neglect of their auditory senses. Patients who suffer from auditory neglect show no sensitivity to voices or other

sounds that come from their left side. In other words, patients might ignore anyone speaking in their symptomatic ear (Heilman et al., 2000).

Motor neglect or output neglect: This is the decreased capability to commence movement in reaction to stimuli notwithstanding, the patient is aware of the presence of the stimuli. There is no evidence to suggest muscle weakness or primary motor impairments are to blame for this inability (Heilman et al., 2000). This type of neglect includes several more specifically defined disorders, including hypometria, hypokinesia, and bradykinesia. Hypometria is a disorder of motor neglect in which a patient produces a movement that does not reach the intended object or goal (Heilman et al., 2000). Bradykinesia is a disorder of motor neglect that is distinguished by slowness in the performance of a movement (Berardelli et al., 2001).

Representational Neglect: Representational neglect is the incapacity to process the contralesional side of visual mental images (Bisiach & Luzzatti, 1978). This is hinged on the mode of resulting behaviour and is characterized by inattention to portions of internally generated images (Bisiach & Luzzatti, 1978) which includes images visualizations including memories, dreams and hallucinations.

2.4.1.3.2. Classification Based on the Area of Distribution of the Abnormal Behaviour

The two main categories into which the types of neglect are classified are personal neglect and spatial neglect.

***Personal Neglect*:** This type of neglect is typified by a lack of orientation of the side of the body opposite to the damage. For instance, a patient with personal neglect may deny ownership of a limb, ignoring its presence and claiming that it belongs to another individual. Additionally, patients with personal neglect pay no attention to one side of

the body during activities such as shaving, combing hair, or applying makeup (Bisiach & Luzzatti, 1978).

Spatial Neglect: In this type of neglect, the patient is unable to respond to stimuli on the contralesional side of the body. Spatial neglect is classified into two type types viz: peripersonal neglect and extra personal neglect. Peripersonal neglect is characterized by a patient's inability to pay attention to activities or items within reaching distance while extra personal neglect refers to the inability to pay attention or recognize items that are farther away (Li & Malhotra, 2015).

Unilateral neglect is a multimodal syndrome, hence various types of dysfunctions vary between patients (Yantis & Serences, 2003). Interventions used to improve neglect fall into two categories. One category of treatments aims at improving patients' awareness of neglected spaces, while the other focuses on correcting proprioceptive and kinesthetic dysfunctions. Most intervention suggested for the management of USN is generalist, with none of the approaches tailored or specific to the varying types of neglect (Azouvi et al.,2017; Dintén-Fernández et al., 2019b; Hjaltason & Saevarsson, 2007; Luauté et al., 2006a; Umeonwuka et al., 2020).

Identification of USN and its categorization into disparate sub-types may aid clinicians and researchers select management approaches. Neglect, for example, affects functional independence and stroke recovery in different ways (Bickerton et al., 2011; Chechlacz et al., 2010) and may serve as a template for selecting treatment options.

However, the intervention of interest in this study: prism adaptation therapy, has been evaluated for its efficacies by earlier researchers on different aspects of neglect such as representational neglect (Rode et al., 2001), spatial neglect (Rusconi & Carelli,

2012), visual-motor, visual-verbal, behavioural, and spatial cognitive tasks (Frassinetti et al., 2002). Generalizing these effects of PA across all levels of hemineglect suggests that the prism adaptation process may be able to integrate multisensory information as well as facilitate higher spatial representations. (Rode et al., 2003).

The classification system for USN was identified in this section and the basis for classification was discussed. It was also highlighted that different types of hemineglect confer diverse impedance on functional recovery of stroke patients.

2.4.2. Mechanism of unilateral spatial neglect

Reduced stimulation of the contralesional side of the visual cortex due to lack of stimulation in the ipsilesional part of the visual cortex, increasing inhibition of the contralesional side, results in hemineglect (Brandt et al., 2012). Scientists have debated if hemineglect is a disorder of spatial attention or of spatial representation for a long time (Bradshaw & Mattingley, 2013).

Several models and theories have been put forward to explain the underlying mechanism of USN. In one model, neglect is viewed as the result of an attention gradient biased away from contralesional elements (Smania et al., 1998; Wallace, 1996). Another model considers hemineglect to be a result of an impairment in the capability to disengage attention and shift it contralesional (Posner et al., 1984). Researchers speculate that different combinations of these components may contribute to the perplexing array of behavioural dissociations observed in neglect patients (Baker, 2012; Hallіean, 1994).

In spatial attention theory, hemineglect is considered a disorder of attention and orientation due to disruptions of the visual cortex area (Corbetta & Shulman, 2011). It

is not uncommon for patients with these disorders to ignore stimuli from the contralesional side, despite their intact visual fields, and to focus on the ipsilesional side instead. Thus, the unaffected side of the visual system is rendered more sensitive to visual input (Brandt et al., 2012). As a result, the patient is unable to disengage attention from the ipsilateral side (Bisiach, 1996).

Spatial representations theory holds that neglect stems from an incapacity to make contralateral spatial representations (Long, 2003). In this theory, patients who suffer from neglect are unable to accurately recall information about the opposite side of a familiar scene. The phenomenon of spatial lateralization is also evident in the deterioration of spatially lateralized mechanisms of neglect patients as they perform everyday activities and specialized tasks such as visual search cancellation (Wansard et al., 2014). Theoretically, the hemineglect behaviour of patients on spatial clinical tests could be elucidated by spatially biased sensory, motor, representational or attentional accounts, none of which are mutually incompatible (Bisiach, 1993). According to sensory accounts, patients with right-hemisphere damage cannot perceive leftward objects because they are in an area of the body that the patient is not perceptive to (Diano et al., 2017).

According to directional motor models of neglect (Heilman et al., 1985), perception of stimuli by patients with right hemispheric injury is altered so that they perceive stimuli originating from their left but have challenges initiating eye or limb movement in that direction. It is important to note, however, that this type of motor deficit alone cannot adequately describe the behaviour of neglect patients (Husain et al., 2000; Mattingley et al., 1998).

These models represent a step toward understanding neural representations of spatial information and their functions in the control of behaviour. Also, these models form the

basis of classification and subsequent assessment and treatment of hemineglect. Some aspects of the syndrome cannot be easily explained in psychological terms but by understanding neural representations of spatial relationships.

From the foregoing models of hemineglect, a better account for the mechanism of hemineglect will be a one that combines both classical models of attention with anatomical constraint on the distribution of neurons. Further investigations need to be conducted on the mechanism of neglect, which will unify these theorems for better understanding of the neglect mechanism.

2.4.3. Impact of unilateral spatial neglect on stroke rehabilitation outcome.

USN can have a negative effect on functional recovery, rehabilitation length, and the need for post-discharge assistance after stroke (Di Monaco et al., 2011b; Nijboer et al., 2013). In the case of post-stroke unilateral neglect, recovery is usually within three months; however, the majority of patients with the most serious case have the worst outcome on initial presentation (Diamond, 2001). Paolucci and colleagues (2001) demonstrated USN to be a negative predictor of recovery after stroke (Paolucci et al., 2001).

In the subsequent subsections literature on the impact of USN on postural balance, functional mobility, ADLs, and quality of life, as these forms a key component of stroke rehabilitation outcome, is presented.

2.4.3.1. Impact of Unilateral spatial neglect on postural balance

The association between unilateral spatial neglect and postural control is key to differentiating between the postural reactions evoked via a massive disturbance of the centre of gravity. The proprioceptive system and vestibular system are also dependent

on visual input to maintain balance. In consequence, postural sway increases at great heights whenever the visual frame is not available, and a tilted visual frame can make it more difficult to judge the vertical (Blake & Howard, 1982; Brouwer & Heeger, 2011; Fang et al., 2005). Impaired visual information has been shown to have a negative influence on postural control (Dornan et al., 1978; Seidel & Brauer, 1979).

Unilateral cerebral damage affects one's discernment of the upright (Yelnik et al., 2002), and USN may also override and rotate the visual frame of reference away from the affected side (Tomomitsu et al., 2013).

Unilateral spatial neglectaffects the performance of tasks requiring bilateral simultaneous sensory input in postural control. There may be unequal effects resulting from motions across the retina caused by postural sway, depending on either the direction of motion or the direction away from the neglecting side (Tomomitsu et al., 2013).

Several studies have reported a negative link between hemineglect and balance in posture (Gottlieb & Levine, 1992; Pérennou, 2006; Taylor et al., 1994; Van Nes et al., 2009). Distorted balance can lead to significant problems in daily life functioning leading to poor rehabilitation outcomes (Suzuki et al., 2002).

Previous researchers (Gottlieb & Levine, 1992; Perry, 1969) observed that patients with USN are insufficient in the acquisition of the postural adjustments required to requite hemiparesis to recover a functional sitting or standing balance. This is as a result of unilateral weakness after a stroke that alters the body's biomechanical equilibrium. This alteration in body equilibrium by the presence of USN culminates in a lateral shift of the centre of gravity by activating muscles in the non-affected side of the body, in particular the leg and trunk abductors (Cavanaugh et al., 2005). The more

severe the loss of strength and control on the affected side, the more positive posture adjustments are required on the unaffected side to restore balance (Henley et al., 1985; Jung et al., 2020; Karthikbabu & Verheyden, 2020; Keenan et al., 1984; Nayak & Shetty, 2015).

Perennou and colleagues (Pérennou, 2006) showed that patients with neglect show a dramatic postural disability in body orientation concerning gravity and impairment and in-body stabilization. Also, another study, (Gottlieb & Levine, 1992) showed that unilateral neglect has an independent inimical impact on the post-stroke postural adjustments needed to perform ADL and spatial tasks.

Also, Van Nes and colleagues in their study reported that visuospatial hemineglect is significantly associated with balance evaluated using the Berg's balance scale (BBS) and Functional Ambulation Categories (FAC) and is an independent covariate that is longitudinally associated with postural imbalance after stroke (Van Nes et al., 2009).

The relationship between balance and unilateral spatial neglect was scrutinized in this subsection. A negative impact of USN on balance was shown in the section. Literature review of this subject suggests that hemineglect is a key element for static and dynamic standing balance control in the first month post stroke.

2.4.3.2. Impact of Unilateral spatial neglect on Hospital Length of stay

There are modest facts on specific patient characteristics that can prognosticate a home versus institution disposition from inpatient rehabilitation and hospital length of stay (Brauer et al., 2008; Kwakkel & Kollen, 2013; Veerbeek et al., 2011). The more severely an affected side loses strength and control, the more positive adjustment is needed to restore balance on the unaffected side, and this postural adjustment is

crucial to most other functional activities, and poor balance is one of the more consistently poor prognostic signs in recovery from stroke (Brauer et al., 2008; Ifejika-Jones et al., 2013; Tinl et al., 2014) and this may influence length of hospital stay.

Several factors such as age, being separated or divorced, health insurance, dysphagia, cognitive deficits, and higher motor functional independence measure (FIM) score have been shown to affect length of in-hospital stay after stroke (Nguyen et al., 2015).

Also, reports from previous studies indicate that apart from demographic attributes of patients, clinical factors also impede discharge of patients thereby increasing hospital length of stay (LOS) (Chen et al., 2016, 2015b; Edmans et al., 1991; Hammerbeck et al., 2019; Spaccavento et al., 2017; Wee & Hopman, 2008; Wilkinson et al., 2012).

Chen and colleagues reported in their study that stroke survivors with spatial neglect stayed ten days longer in hospital than the non-spatial neglect patients. A lower likelihood of discharge from hospital was also predicted by the severity of spatial neglect (Chen et al., 2015b). Similarly, Hammerbeck and colleagues reported that stroke patients with neglect had an increased length of stay (27 vs. 10 days) (Hammerbeck et al., 2019). A study by Wee and Hopman, 2008 confirmed that the existence of USN increases the length of hospital stays among stroke survivors by eight days as compared to non-neglect patients (Wee & Hopman, 2008). The reason for this consensus on the negative impact of post-stroke USN on hospital length of stay may be due to the fact that survivors of mild stroke were far less likely to present with neglect than those with severe stroke.

Summarily, from a literature search on the impact of USN on hospital length of stay, it can be deduced that the presence of unilateral spatial neglect prolongs hospital stay.

Although the exact mechanism for this observation is not explicitly reported, it might be connected with the negative effect the presence of USN has on functional recovery, which might translate to longer hospital stay duration. For instance, survivors of mild stroke are less likely to present with neglect than those with severe stroke (Hammerbeck et al., 2019). Also, USN has been associated with worst clinical outcome (Hammerbeck et al., 2019).

2.4.3.3. Impact of unilateral spatial neglect on functional mobility

The recuperation of mobility function at the community level is fundamental for stroke survivors' positive rehabilitation outcomes (Davis et al., 2016). The ability to move around in the community is multi-faceted, reflecting not only physical function but also cognitive ability, integration within the social context, and community participation.

During ambulation, an individual quantifies the area around his or her body to reach the desired location. Post-stroke USN survivors make errors in spatial perception of a location target and are likely to derail or fall when walking (Berti et al., 2002). Patients with spatial neglect showed three times more collisions during walking through doorways, even though their gait velocity was like those of patients without neglect (Tromp et al., 1995).

For wheelchair navigation, neglect patients experience challenges avoiding objects in their environment (furniture or a wall), especially on the left side, compared with those without neglect (Huitema et al., 2006; Tromp et al., 1995). Additionally, spatial neglect has been associated with poor physical fitness to drive among stroke survivors, inhibiting community-based travel (Akinwuntan et al., 2006).

Summarily, there seems to be modest studies that have investigated the relationship between USN and functional mobility. Available studies reviewed showed that patients with USN are more at risk to fall and usually have lower functional ability than those without USN.

2.4.3.4. Impact of unilateral spatial neglect on quality of life

The physical, social, and psychological sequelae of stroke are devastating. Ninety per cent of survivors of stroke have some form of disability (Baumann et al., 2014). The impact of stroke is a huge challenge for society. In addition to being an emergency, a stroke can also affect individuals and families which are usually not prepared to face the disability caused by the rehabilitation process or the stroke (Pinedo et al., 2017; Rangel et al., 2013).

The world health organisation (WHO) defines quality of life as an '*individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns*' (WHO, 1995). The evaluation of the quality of life (QoL) of stroke patients has become a more and more relevant component of the assessment of life, which can be catastrophic as stroke affects multiple areas of life (Ramos-Lima et al., 2018).

Quality of life is important for assessing the influence of an individual's life on society. Stroke has been shown to affect various domains of quality of life, including functional abilities (Fróes et al., 2011; Rangel et al., 2013). However, few studies are focusing on the impact of USN on the quality of life of stroke survivors (Franceschini et al., 2010; Sobrinho et al., 2018a).

Results from previous researchers have suggested a negative correlation between the quality-of-life scores and the behavioural inattention test (Sobrinho et al., 2018a). Following a stroke, USN severity is associated with lower scores in domains (of EUROQOL) such as personal care, usual activities, and pain or discomfort, but mobility domain is not associated with USN severity (Franceschini et al., 2010; Sobrinho et al., 2018a).

Patients with USN tend to present with extended muscular flaccidity following a stroke (Formisano et al., 1993), post-stroke shoulder pain (Pomeroy et al., 2000), environment and obstacle collisions, as well as poorer functional capacity and a high incidence of falls (Chen et al., 2015b), which may have a negative impact on the QoL on stroke survivors.

In a study by Franceschini and colleagues, the presence of neglect at discharge was correlated with a lower health-related quality of life (HRQoL) in the "self-care domain (Franceschini et al., 2010). Sobrinho and colleagues in 2018 reported that a higher behavioural inattention test value indicated a higher score in the personal care items, usual activity, pain or discomfort, anxiety and depression and total EuroQoL score. There was no association between USN and the mobility component of QoL measure (Sobrinho et al., 2018b).

The articles presented in this section on the impact of USN even though modest seems to have a consensus; USN has a negative correlation with HRQoL. This could be because USN interferes negatively with the perceptual processing of motor control and in the daily task execution.

2.4.3.5. Impact of unilateral spatial neglect on activities of daily living

Several authors have found a negative prognostic effect of neglect on the function of neglect recovery (Cherney et al., 2001; Jehkonen et al., 2000, 2001; Vossel et al., 2013). In a study by Nijboer and colleagues neglect (Nijboer et al., 2013), stroke survivors who exhibited neglect symptoms patients scored remarkably lower in self-care, transfer, and exercise compared with non-neglect patients. Self-care and transfers scores were remarkably lower for patients with more severe neglect than for patients with mild neglect (Nijboer et al., 2013).

Also, Vossel and colleagues reported in their study that deficits observed in USN were the most prime predictor for performance in standardized ADLs. Additionally, motor-intentional and perceptual-attentional neglect, extinction, and tasks involving cancellations were significant predictors of ADL performance (Vossel et al., 2013). Similarly, another study found that neglect is linked with lower performance on impairment measurement, as well as on measures of disability in ADLs (Katz et al., 1999). These results further underscore the impact of USN in neglect rehabilitation.

This section summarizes the impact of USN on ADLs, quality of life, functional mobility, balance and hospital length of stay. Unilateral spatial neglect has shown negative impact on these outcomes which are germane for patient recovery post-stroke. This subsection further highlights the rationale for the inclusion of these outcomes in this thesis.

2.4.4. Assessment of unilateral spatial neglect.

Different standardized screening tools of neglect, or of functions affected in USN, are available. Assessment of USN by clinicians is broadly categorized into four distinct

categories namely cognitive/neuropsychological assessment, functional assessment, neurological assessment and neuroimaging/neuromodulation (Checketts et al., 2020).

The purpose of cognitive assessment is to assess abilities like attention and memory using standard testing. The Behavioural Inattention test is one example of a cognitive evaluation for neglect (Wilson et al., 1987). The Catherine Bergego Scale (Bergego et al., 1995; Chen et al., 2012) measures personal space as well as the performance of daily living activities (ADLs) in extra-personal space.

A neurologic evaluation is the clinical evaluation of symptoms and signs including, but not limited to, those of hemineglect. The findings of neuroimaging can also assist in predicting cognitive and functional deficits by identifying lesion locations and damage to distributed neural networks (Vuilleumier, 2013) albeit it is not known whether neuroimaging is commonly used in clinical practice for screening or diagnosis. Table 2.1 highlights the various tests used in the assessment of unilateral spatial neglect.

Table 2. 1: Summary of assessment tools for unilateral spatial neglect

S/No.	Name of Test	Description
1.	Behavioural Inattention test (Wilson et al., 1987).	Two subtests comprise the BIT: Conventional and Behavioural. In BIT Conventional subtest (BIT-C), there are six items to be completed, including line crossings, letter cancellations, star cancellations, copying of figures and shapes, and line bisections. There are nine items in the behavioural subtest (BIT-B) of the BIT: article reading, pre-scanning, telling and setting the time, phone dialling menu reading, coin-sorting, address and sentence copying, map navigation, and card sorting. The test-retest reliability of the BIT in 28 clients with stroke and 14 healthy individuals. Participants were re-assessed within 1 week. The test-retest reliability for the BIT, as calculated using Pearson Correlation Coefficient, was excellent (r = 0.83) (Wilson et al., 1987).

2.	Bell’s Test (Gauthier et al., 1989).	It involves a cancellation task that quantifies visual neglect. On a sheet with 7 columns, subjects are supposed to cross out all the target stimuli (bells, for example). One can examine the pattern of scanning and, in addition, the distribution of targets omitted by the subject. The distribution of targets the subject leaves out as well as the pattern of scanning can be evaluated Clinically, a Bell's test is suitable for detecting USN. It only takes five minutes to complete and is simple to use. Apraxia can interfere with test results. Test-retest reliability for Bells test is substantially better than line bisection, according to a review (Azouvi et al., 2002).
3.	Baking Tray Task (Tham & Tegnér, 1996).	Testing unilateral neglect with the Baking Tray Task is straightforward. This tool involves asking patients to spread out 16 cubes over a 75 × 100 cm board as uniformly as possible.
4.	Comb and Razor Test (Beschin & Robertson, 1997).	USN is evaluated in the client's personal space in the Comb and Razor Test by observing their execution in functional activities such as comb-use and makeup application. The Comb and Razor Test does not include any actual items. Two familiar objects are to be used by the patient for 30 seconds each. Each object is placed at the patient’s midline.
5.	Coin Sorting	This test of neglect involves placing coins of varying values on the left, in front, and on the right of the patient according to an established order. Then they must list all the coins that have a certain value.
6.	Cued Detection Task (Posner Cueing Task) (Posner, 1980).	This test is frequently used to assess attention. On each side of the fixation point lies a target area, on either side of which patients are asked to look at a fixed point. Upon detecting the stimuli in one of the targets, the participant is instructed to respond. In the test, the participants will be given visual cues before the stimuli, either indicating the correct direction of the stimuli appearance or incorrectly indicating one.
7.	Dichotic Listening Task (Broadbent, 1956).	The purpose of this tool is to assess lateralized auditory perception. Participants are presented with two pairs of stimuli, one in each ear. Both stimuli must be focused on, and repeated after the presentation, by the participant. Results are calculated by recording the percentage of stimuli rightly identified in both the right and left ears of the patient
8	Extinction Task	This assessment tool measures visual memory and hemineglect. Images are shown at the right or left hemisphere, and recall is assessed separately for each hemisphere. Any prejudice in visual memory to a side might indicate a USN.

9	Fluff Test (Cocchini et al., 2001).	Personal domain in neglect syndrome is measured by this tool. Twenty-four targets are placed on the participant's body while blindfolded. During the placement of targets (to prevent counting), they are kept distracted and then asked to remove all their pads. Left-side targets are omitted to determine to score.
10.	Functional Neglect Index (Kerkhoff et al., 2014).	It entails a reaching/finding object task, a picture search task, a stick bisection (line bisection) and a gaze orientation task. An overall score of 0-3 indicates a more severe impairment, whereas a score of 0-3 indicates no impairment.
11.	Grey Scales task (Tant et al., 2002).	The objective of this measure is to assess how visual attention is oriented. 26 items are provided to participants. Two A4 sheets of paper are on each item, both of which have rectangles that range in shade from black to white. The two rectangles are similar, albeit the mirror opposite of one another. Thus the items on the scale have two grey scales lying parallel, one on top of the other.
12.	Hand Judgement Test (Cooper et al. 1975; Reinhart et al. 2012).	The purpose of this test is to determine whether an individual can distinguish between left and right hands using mental transformations. During this test, participants are presented with line drawings of hands in six different planes in the form of palms and backs of hands. Next, the participants are asked to decide if the image is of a right hand or a left hand. During the task, their own hands are hidden from view.
13	Harrington-Flocks Visual Screener (Harrington & Flocks, 1954).	This screening assessment assesses for any visual field deficits. Each of the 9 patterns on the test is designed to identify a visual field problem in various locations. The patient stares at a fixation point, a black light is shone on the card for 0.2-0.3 seconds before being turned off. At this point, the participant reports what they have seen. Scoring is dependent on missed targets within the affected field.
14.	Joint Position Sense Test (JPST):	The JPST measures stroke survivors' perception of their joints' positions while they are moving and still. The measurement involves repeating a single functional task over and over. The patient holds 2 different shaped objects of different weights and are then asked to identify which object is heavier and has a stranger shape. The number of times the patient (s) identifies the heavier than the better the outcome.
15.	Judgement of Drawing of Two Houses (Marshall et al. 1998; Rusconi et al. 2002).	Tests such as these are highly useful for examining blind sight, insight, and cases of visual neglect. Participants are shown two identical house drawings that are only disparate by the existence of red flames on the left side of one of the houses. The patient is then asked to make the same different judgement.

16.	King Devick Test	The King Devick test is made up of 3 subtests. It is often carried out to quickly assess for the presence of a concussion in an individual. Nevertheless, the first three tasks involve visual perception and processing. There are three tasks on the first page, each having a different pattern that becomes more complex as the tasks progress. As quickly as possible, the participant must read the numbers aloud leftward through to the right. Assessment of task performance is based on time and errors made.
17.	Landmark Test (Harvey et al., 1995)	Landmark tests are used to differentiate between motor and perceptual errors made by spatial neglect patients during line bisection tests. As part of this test, participants are presented with pre-bisected lines asymmetrically or symmetrically (with the landmark). The participant is presented with three lines in three locations about his or her midline (right, middle, left). No lines were bisected in the middle, and they were asked to point to the line end closest to the landmark. Scores are calculated by comparing left and right decisions, especially for central landmarks.
18.	Lane Tracking Task	In this driving simulation, patients are directed to keep their position as a 'side wind' blows them off course. The patient must maintain proper position on the road by counteracting these disturbances in either direction. The mean lateral position and standard deviation are used to determine their position relative to the track and their degree of oscillation.
19.	Mobility Assessment Course (Ten Brink et al., 2018)	An active approach is taken to assessing neglect using this tool. Walking or steering a wheelchair down a corridor with no halts is required. While navigating the corridor, patients have to point out marked targets set long their path. There is no time curtailment, and scores are calculated as the difference between left and right exclusion.
20.	Motor-Free Visual Perception Test (MVPT) (Brown & Peres, 2018)	In this measure, visual perception is measured without reference to motor ability. In addition to spatial relationships, we test visual discrimination, ground figure, visual closure, and memory for visual information. By taking the raw score, standard score, percentile rank, and age-equivalent score, the total raw score can be calculated.
21.	Munich Reading Texts (Kerkhoff et al., 1992)	This is a standardized version of the reading task. Each of the six paragraphs contains 180 words. All of the sentences are short and the linguistic structure is simple. The task requires reading text aloud speedily and accurately. To score, the right or left side of the paragraphs with errors or omissions are considered.
22.	Neale Analysis of Reading Ability	It measures the accuracy and comprehension of reading a text by listening to it aloud. Participants read a text

	(Neale et al., 1986)	appropriate for the patient's reading level and correctness. Scores are determined by the number of errors made during the reading. Participants are then asked to respond to comprehension questions regarding the text they read.
23.	Ogden Figure Copying Task (Ogden, 1985)	This is a visuomotor figure copying task used to screen for neglect. It consists of a small line drawing scene that includes a tree, a fence, a house, and a different tree. During the assessment process, patients are requested to copy a drawing and to notice any flaws or distortions arising from the left and right sides of the picture.
24.	Orientation Lines Test (Benton et al., 1978)	This test tool is designed to evaluate visuospatial judgement. There are two lines on the test card that appear in multiple locations with different orientations. A reference card displaying eleven numbered lines is provided, all with distinct orientations. By using the reference line numbered according to the same angle on the test card, the patient must determine the angle of the test lines.
25.	Ota's Task (Ota et al., 2001)	The purpose of this assessment is to differentiate between object-centred and body-centred types of neglect. This task consists of two homogeneous tests. There are two parts to this exercise: the first requires you to distribute 40 circles randomly on a piece of paper. The circles contain incomplete sections on either the left or right side. In the second task, 40 triangles are shown on a page, but some of the triangles lack sections either on the right or on the left. Participants are requested to circle completed and also cross out incomplete shapes. To score, the number of shapes wrongly chosen on each side of the paper, and the number of shapes wrongly chosen which were incomplete on the left side, versus those incomplete on the right are computed.
26.	Quadruplet Detection Task (Lucas et al., 2013)	This assessment tool is utilized to evaluate visual detection across hemi fields, this measure requires participants to decipher a coloured shape in one of four quadrants from 3 black shapes. It measures visual neglect by the response times and/or rate of detection in regions of the visual field.
27.	Real Objects Test	The Line Bisection Test is a visual neglect measurement based on everyday objects. An everyday object (rolling pin, towel rail) must be reached for during the test at the centre. Divergence from the middle is employed to quantify the presence of visual neglect.
28.	Rey-Osterrieth Complex Figure Test (Osterrieth, 1944)	Visuospatial abilities and visual memory are measured with this test. In the test, the subject is required to duplicate a geometrical figure from memory, then replicate it from memory after an interval. The Osterrieth method, which uses 18 units of a figure to calculate a 36-

		point summary score, is the method most often utilized for scoring the test.
29.	Rivermead Perceptual Assessment Battery(Jesshope et al., 1991)	A total of sixteen subtests can be found in this test, which can be split into eight different categories (form constancy, body image, cube copying, sequencing, object copying, figure-ground, inattention, and spatial awareness).
30	Semi-structured Scale for the Functional Evaluation of Hemi-attention (Zoccolotti & Judica, 1991).	This test is used to evaluate functional aspect hemineglect and includes two subscales corresponding to extra-personal space and personal space. Serving tea, dealing cards to four people sitting around a square table, describing three complex pictures, and describing a room are examples of tasks performed in extra-personal space. In the personal space, objects such as a razor or make-up, a comb, and eyeglasses are used. Items are judged from 0 (normal) -3 (severe).
31	Sentence Reading Test	Participants are required to read six sentences aloud as a measure of visual-spatial neglect. The number of sentences reads without omissions determines the score.
32.	Tangent Screen Exam	This is an extensive evaluation of an individual's visual field. It involves focusing the patient's attention at the mid-point of a screen while presenting them with targets that are located on the perimeter. Each participant is instructed to inform the assessor once the target is visible. It is possible to produce a detailed map of the visual field with this information, and identify any deficits.
33.	Testing Battery for Attentional Performance (Zimmermann & Fimm, 2002).	This is a computerized test that entails 13 sub-tests (e.g. Alertness, Eye Movements, Working Memory etc.) that evaluates various components of cognition and behaviour related to attention.
34.	Catherine Bergego Scale (Azouvi et al., 1996)	This is a ten-item measure of functionality used in evaluating USN in stroke patients and anosognosia. A trained assessor will grade the patient on a 4-point scale (0 = no neglect, 3 = severe neglect) for each of the items, for example, “Forgets to groom or shave left part of his/her face” (Item 1). The total score amounts to 30, with higher scores translating to greater levels of impairment.
35.	Subjective Neglect Questionnaire (Towle & Lincoln, 1991).	This is a questionnaire for distinguishing everyday problems classic of individuals with USN. Participants are asked to rate the recurrence of 19- neglect related issues, such as bumping into furniture, telling time or navigating a wheelchair, occurring within the past month.
36.	Wundt- Jaslow Illusion Test (Massironi et al., 1988)	This is used for the detection of USN, it has forty differing stimuli consisting of two fans similar in shape and surface. Each of the pairs of fans has one of two orientations.

Traditionally, the evaluation of USN in the clinical setting entails the use of “pen-and-paper” tests such as line bisection, cancellation tasks, copying, and drawing. They are widely used in clinical settings due to their simplicity and ease of administration. Generally, screening for USN could be achieved using a “conventional paper and pencil test” or through a functional assessment method. More recently, computer-based assessment for USN has been suggested (Bonato & Deouell, 2013). Compared to paper and pencil tests, more sensitivity and flexibility is offered by computerized tests (Appelros et al., 2003; Schendel & Robertson, 2002).

2.4.5. Overview of prism adaptation therapy

‘The prism adaptation (PA) is the result of an artificial shift of the visual field laterally or vertically ‘(Fernández-Ruiz & Díaz, 1999). As a form of procedural learning, it involves adapting the motor system to new visuospatial coordinates by substituting a horizontal prism for the visual field (Fernández-Ruiz & Díaz, 1999). PA was first described by Hermann Von Helmholtz late in the 19th century (Helmholtz, 1866). Rossetti and colleagues first demonstrated its efficacy in neurorehabilitation of spatial neglect patients in 1998 (Rossetti et al., 1998).

During prism adaptation, a patient puts on prismatic goggles that shift the visual field laterally or vertically. Usually, a patient's visual field is repositioned either leftward or rightward. When the goggles are on, the individual performs a perceptual-motor task, such as pointing directly at a target. Prism adaptation sessions encompass three components: the pre-test, prism exposure, and post-test.

Pre-test phase: The pre-test evaluates the individual’s *capacity* to point to the visual target directly in front of them before prism exposure. This task can be accomplished accurately and easily by normal, healthy individuals.

Prism Exposure phase: When pointing to a target during prism exposure, the early attempts veer off target due to the lateral shift of the observer's field of view. During prism exposure, pointing errors occur correspondingly to the direction of the visual shift. The fledgling pointing errors instigated by the prismatic goggles are brought about by the deviation of the observer's motor and proprioceptive maps. When the error is exposed, the observer attempts to correct it by strategic recalibration as quickly as possible. Reducing error is also aided by an unconscious process called spatial realignment.

Post-test: In the post-test phase, prismatic goggles are taken off. A negative aftereffect of prism exposure results from the direct adaptation observed as a consequence of prism exposure. When the visual shift is reversed, the initial attempt to point at the visual target during the post-test is in the opposite direction. Figure 2.2 depicts the procedure or prismatic adaptation.

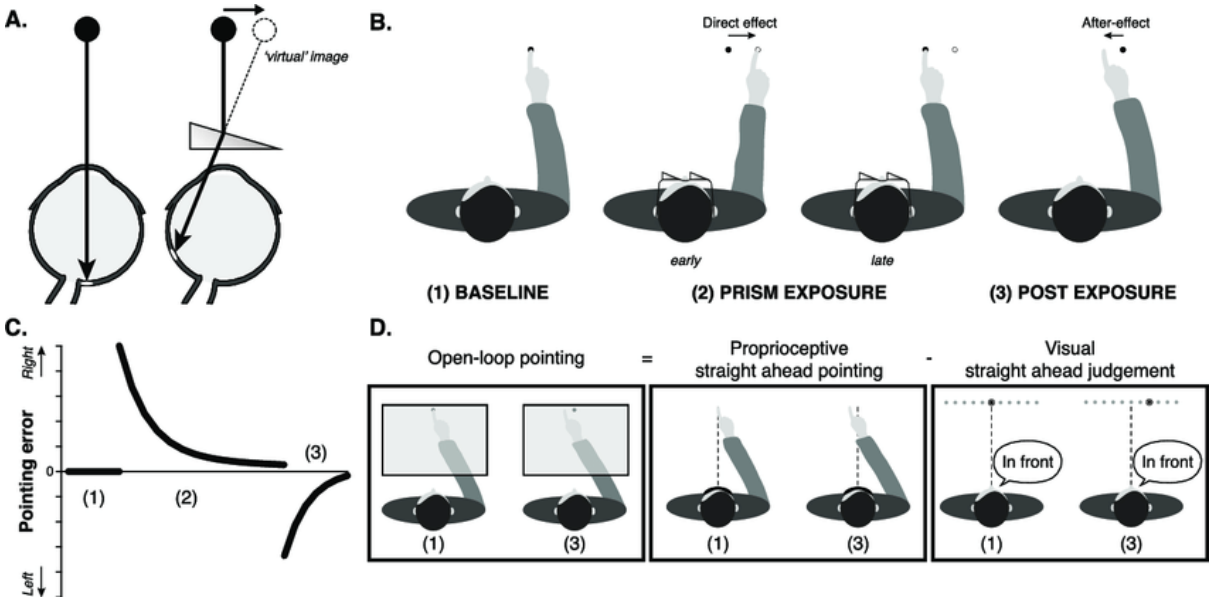


Figure 2. 2: Prism adaptation procedure (culled from Petitet et al., 2018)

2.4.5. Mechanism of action of prism adaptation in ameliorating USN symptoms post-stroke

Prism adaptation has been introduced in neuro-rehabilitation to ameliorate the symptoms of USN in stroke survivors (Luauté et al., 2006; Rossetti et al., 1998) and has been an interest among researchers. PA has been identified as the most investigated approach to ameliorate USN in stroke survivors for the last twelve years (Umeonwuka et al., 2020).

It is still unclear how prism adaptation works and what neuronal mechanisms are involved (Block & Bastian, 2012; Shadmehr & Wise, 2005). Several studies using neuroimaging and neuro-stimulation method has described a sensory-motor mechanism at work during PA (Bracco et al., 2018; Clarke & Crottaz-Herbette, 2016; Redding, 2013; Redding & Wallace, 1997, 2002; Saj et al., 2013; Serino et al., 2006).

Two mechanisms that come into play in a patient's behaviour during prism adaptation include the process of re-calibration and re-alignment. As a consequence of the recalibration process, one's motor commands need to be adjusted while reaching objects (Prablanc et al., 2020) and represents an immediate response to prism-induced deviation by a strategic cognitive alteration of the motor plan to reduce error (O'Shea et al., 2014). Patients utilize sensory information emanating from the result of each movement to plan an updated movement, putting into cognizance the behavioural consequence of visual shift. The re-calibration process consists of conscious and voluntary approaches such as pointing off-target or mental rotation (Rossetti et al., 1993). The second mechanism involved in Prism adaptation is spatial re-alignment which is important for the alignment of visuomotor and proprioceptive

motor actions (Jeannerod & Rossetti, 1993). The spatial re-alignment process re-aligns the sensory maps that were unsettled by the prism shift culminating in a correction of motor planning (Prablanc et al., 2020).

Several brain regions are activated during exposure to PA and have been demonstrated to add to the reduced error rates when aiming at a visual target. Research conducted by Luaute and colleagues (Luauté et al., 2009) on functional magnetic resonance imaging examined the neural activation patterns linked with the error correction phase of PA and reported that the left anterior intraparietal sulcus was activated proportional to pointing deviation and its activation gradually decreased with adaptation. According to a review by Panico and colleagues, sensory-motor effects of PA are mediated by activation of the cerebellum-parietal network, whereas effects on spatial cognition are mediated by bottom-up activation of prefrontal and temporal regions (Panico et al., 2020).

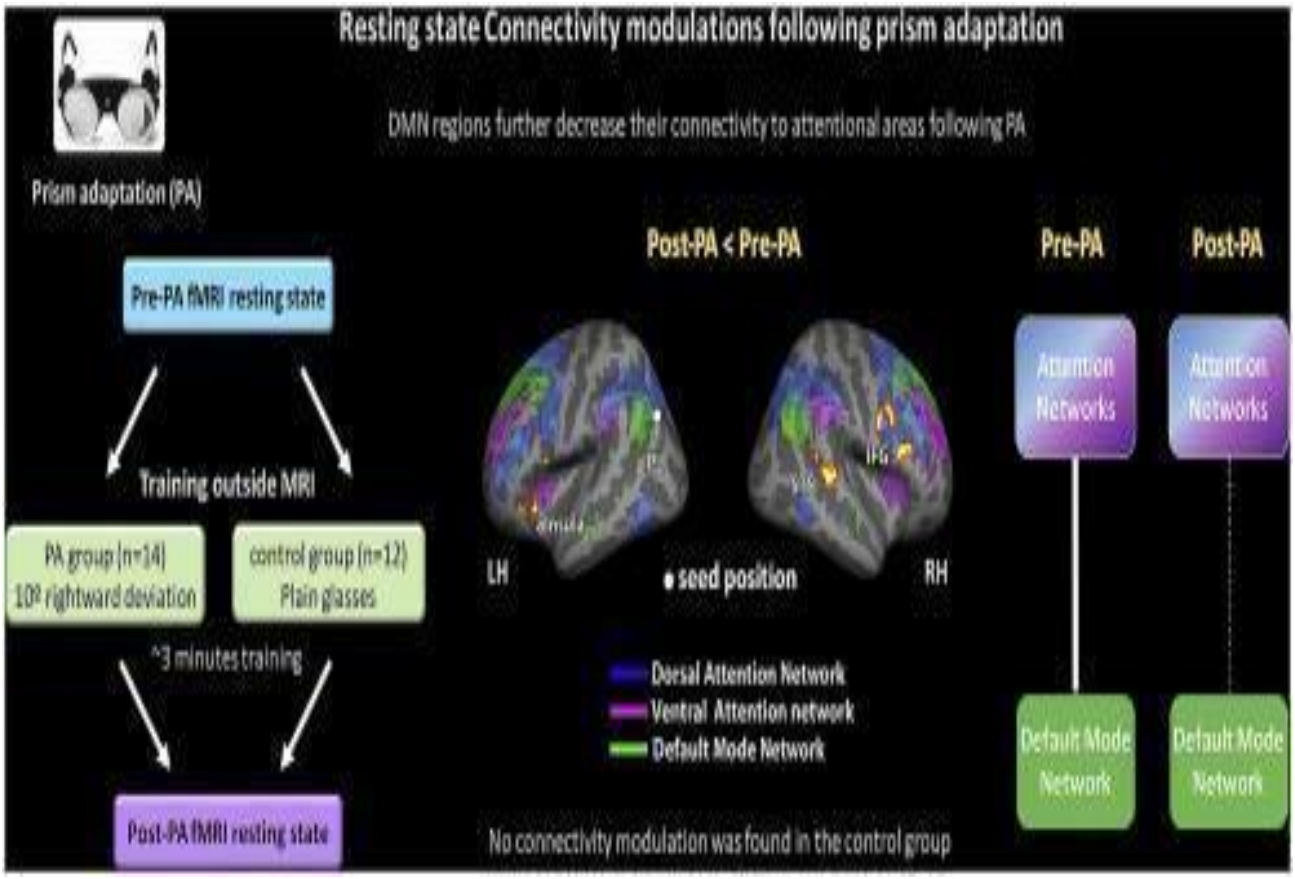


Figure 2. 3: Resting state connectivity modulations following Prism adaptation (culled from Wilf et al., 2019).

2.4.6. Benefits of prism adaptation in stroke rehabilitation

In addition to rehabilitation procedures, PA also impacts daily activities. Several researchers have reported positive gains in activities of daily living (Anelli et al., 2019; Mizuno et al., 2011a; Shiraishi et al., 2008), postural balance (Nijboer et al., 2014), reading (Angeli et al., 2004; Farnè et al., 2002a), wheelchair driving (Jacquin-Courtois et al., 2008; Watanabe & Amimoto, 2010a) or reward-based learning (Schintu et al., 2018). Despite this, there is also evidence that PA has only a partial effect on neglect rehabilitation. (Nys et al., 2008; Rousseaux et al., 2006; Turton et al., 2010). Insufficient control of adaptation is responsible for most of the negative

results (Rousseaux et al., 2006), insufficient prismatic shift magnitude (Turton et al., 2010) or insufficient PA sessions (Rode et al., 2017).

2.4.7. Current treatment for post stroke unilateral spatial neglect

To treat USN after stroke, a variety of interventions have been identified (Umeonwuka et al., 2020). A detailed scoping review of current interventions for USN is presented in chapter four.

2.4.8. Factors predictive of unilateral spatial neglect recovery

Although recovery from unilateral stroke neglect may differ between reports, about one out of every three patients exhibits chronic visuospatial problems several months following the stroke (Cherney et al., 2001; Denes et al., 1982). Studies have shown that several factors can influence recovery from neglect, including deficit severity, visual field defects, age and age-related brain atrophy, as well as the size and location of lesions (Cherney & Halper, 2001; Farnè et al., 2004; Gottesman et al., 2008; Stone et al., 1992).

There is also evidence suggesting that neuroanatomical data can predict neglect recovery (Farnè et al., 2004; Karnath et al., 2011; Maguire & Ogden, 2002; Saj et al., 2012; Samuelsson et al., 1997). Evidence suggests that long-standing neglect is linked with lesions involving the cortical lobes and basal ganglia, but not with parietal lesions (Maguire & Ogden, 2002). Additionally, evidence suggests that the temporal cortex (including the superior and middle temporal gyri), and the basal ganglia lesions play an important role in the prediction of chronic neglect (Karnath et al., 2011). Conversely, recovery has been connected to white matter damage in a study by Samuelsson and colleagues (Samuelsson et al., 1997). Their study linked chronic

neglect with damage to periventricular white matter within the temporal lobe (Samuelsson et al., 1997).

None of these reports, however, discusses the complex relationship between neglect deficits and chronic spatial disorders or the interplay between brain damage and neglect after stroke (Saj et al., 2012). Also, the type of tests utilized in the assessment of neglect when examining recovery from neglect is of import as neglect examinations that do not pick up divergent cognitive constituents of the syndrome may impede understanding not only of the neural substrates of neglect but also the mechanisms of recovery (Saj et al., 2012).

Researchers have proposed a wide range of intervention strategies to alleviate USN symptoms following a stroke. This is changing the rehabilitation process of USN after stroke (Umeonwuka et al., 2020). Prism adaptation therapy, the intervention of interest in this study, has been investigated. However, factors predictive of a successful outcome of prism exposure for USN treat is modest. One study (Lunven et al., 2019) investigated predictors of successful prism adaptation in USN. Their result depicts that thicker cortex in temporo-parietal, prefrontal and cingulate areas of the left, less duration time intervals from the stroke, higher fractional anisotropy value, and genu of the corpus callosum may refine patients' response to PA.

2.5. CONCLUSION OF LITERATURE REVIEW

Unilateral spatial neglect is a complex occurrence that affects stroke survivors. Though it is well researched, it is not fully understood. Knowledge on post-stroke unilateral spatial neglect among physiotherapists in Africa has not been evaluated. Identifying knowledge levels and gaps are germane to better understanding and applying such

knowledge in practice. There is therefore a need to evaluate knowledge levels and practice of USN rehabilitation as it guides implementation of known intervention. Factors that affect rehabilitation professionals' (occupational therapist) knowledge of USN include having a postgraduate degree, working in a stroke unit, younger age and supervising students.

Current practice of USN rehabilitation post-stroke which encompasses USN assessment and treatment was reviewed in this chapter. Identified assessment methods include functional assessment, neuro-imaging and cognitive assessment. No particular assessment has been shown to be superior to any method. Although traditional assessment of USN using a pencil and paper test has been in use in assessment of USN, an emerging approach to assessment of the USN is the use of computer-based tests for USN assessment. In practice, different approaches have been identified for the treatment of USN including treatment to perform ADLs, sensory stimulation and visual scanning. Other rehabilitation professionals (Occupational therapists) indicated that use of standardized USN assessment tools in practice is not standard practice. Reported barriers to USN practice include inadequate knowledge of EBP related to treatment of USN and lack of inspiration to alter practice in place, while availability of learning time, learning resources and recent graduation and being a member of an interdisciplinary stroke team were reported to be facilitators in the treatment of stroke survivors with USN. This highlights the need to evaluate knowledge, practice, barriers and facilitator to USN rehabilitation among physiotherapists that are major players in stroke rehabilitation as knowledge attitudes and practice guides the implementation of public health interventions.

Prevalence of neglect was shown to be varied. Several reasons for this variability include patient selection, lesion localization and the nature and timing of assessment for neglect. The implication of this is that physiotherapists need to scrutinize and re-evaluate all stroke patients in rehabilitation for potential occurrence of USN. Furthermore, USN was shown to have a negative impact on indices of rehabilitation outcomes such as balance, hospital length of stay, quality of life, and ADLs. Various interventions for USN amelioration were pointed out in this. However, further discussions on intervention are presented in chapter four of this thesis.

Approaches for USN amelioration of particular interest is the prism adaptation therapy. The benefits of prism adaptation therapy in USN showed some positive gains extending to other aspects of rehabilitation as revealed in this chapter. These gains include ADLs, balance, reading, and wheelchair driving. However, there seems not to be a consensus on outcomes of treatment regimen on USN. Reasons for these disparate outcomes of interventions for USN were put forward to include insufficient control of adaptation, insufficient prismatic magnitude, and insufficient PA sessions. Also, studies targeting stroke survivors' recovery from USN using PA at the sub-acute phase of recovery are modest. The acute - sub-acute phase has been identified as the phase when USN is more common. It is therefore extremely important to evaluate an intervention for USN in the sub-acute phase.

The next chapter (Chapter 3) consists of the literature related to the overall methodology, instrumentation and outcome measures used in this research project.

CHAPTER 3: METHODS

3.1. INTRODUCTION TO CHAPTER

The outcome measures and instruments used for data collection are discussed in this chapter. The research methodology was divided into three studies. The study design, aim and outcome measures of each study are outlined below. Outcome measures require the use of valid, reliable and responsive measurement procedures and in this chapter, the validity and reliability of the various instruments used were also discussed.

3.2. OVERALL METHODOLOGY

In this thesis, a mixed-method approach was employed in achieving the overall aim of the study. The research was conducted in three main stages. The aim and methodology (including the rationale for choosing the study design) used for each study are explained in detail in the following chapters.

3.2.1. Study one: Current trends in the treatment of patients with post-stroke unilateral spatial neglect.

This study was a scoping review. The rationale to choose a scoping review in the first stage of this study is pinned to the fact that a scoping review is best designed for knowledge synthesis when a body of literature has not yet been comprehensively reviewed or exhibits a large, complex, or heterogeneous nature not amenable to a more precise systematic review (Peters et al., 2015). The study aimed to explore the literature on current trends in USN among stroke survivors in the past twelve years. The overall methodology is presented in chapter four and in a manuscript format.

3.2.2. Study two: Knowledge, practice, enablers and barriers to the practice of unilateral spatial neglect management.

A cross-sectional methodology was utilized for this study. The rationale for selecting a cross-sectional survey for the second phase of the study is hinged on the fact that cross-sectional surveys are cost effective, less time consuming and allow the researcher to study variables of interest about the population at the current time (Sedgwick, 2014). In this study, an online questionnaire was used to obtain data from physiotherapists. Physiotherapists are quite busy with patient care and anecdotally they tend to not devote time to other activities. Hence this mode of administration of data capturing tool (online) questionnaire was selected as it presents the participants with flexibility to respond to the questionnaire.

The study objective was to evaluate physiotherapists' knowledge, current practice, enablers and barriers to unilateral spatial neglect management. Physiotherapists in two African countries (Nigeria and South Africa) were surveyed. The study on the Nigerian and South African cohort is presented in chapter 5 while the South African study is presented in chapter 6 of this thesis.

3.2.2.1. Outcome measures, validity and reliability of the instruments

To evaluate physiotherapist's knowledge, current practice, enablers, and barriers to unilateral spatial neglect management in this study, a self-administered questionnaire was developed.

The data collection tool for this study was a developed questionnaire on knowledge, current practice, barriers and enablers to unilateral spatial neglect (see Appendix I for

the questionnaire on knowledge, current practice, barriers and enablers to unilateral spatial neglect**)**.

3.2.2.2. Content validity of the questionnaire and pilot study

The questionnaire was validated by three experts for content by design and experts in stroke rehabilitation and was also pilot tested on eight consenting clinicians in stroke rehabilitation. Recommendations and changes were made to items in the questionnaire to reflect the specific aims of the questions/items in the questionnaire. The survey questionnaire took about 15-20 minutes to complete and is made up of four sections (Section A to D). Section A elicits questions on the respondent's demographic characteristics. Section B contains 25 items for assessing the knowledge on USN that was developed for this study with guidance from a previous study by Petzold and colleagues (Petzold et al., 2012). The section comprises questions on (i) USN problem identification, (ii) USN assessment use, (iii) USN intervention use, and (iv) knowledge of USN and best practice recommendations including the anatomy of neglect. Each item has three responses ("Agree", "Disagree" or "Undecided"). The highest attainable score is 25 and the lease score is 0. An "Agree" response to a right statement is graded 1, a "Disagree" response to a wrong statement is also scored 1, and a "Disagree" response to a correct statement is scored 0. An "Agree" response to a wrong statement is scored 0 and an "Undecided" response is disregarded. A knowledge score of <10 indicated poor knowledge, 10-19 indicated moderate knowledge while 20-25 represented good knowledge. It was primarily for the determination of the level of participants' knowledge, not as an inferential measure.

Section C assessed the physiotherapist's current practice of USN. The questions are structured to decipher the current assessment strategy, treatment approach, referral

or teamwork in the treatment of post-stroke USN. Lastly, section D contains multiple-choice questions on enablers and barriers already identified in the literature on stroke rehabilitation (Ogourtsova et al., 2019b; Petzold et al., 2014a). The questions on barriers consist of, therapist, institutional, client suitability, and equipment factors.

It was important to present both the item by item responses and the summed knowledge scores so that readers could examine the results in both ways. Similarly, therapists were requested to rate barriers or enablers to the treatments of post-stroke USN; on a scale of 1-5 with 1 the greatest barrier or enabler and 5 least barrier or enabler. The scoring was done so that 1-2=major barrier or facilitator; 3= moderate barrier; 4-5 = Minor barrier. The intraclass correlation of this questionnaire (α) yielded 0.93 (excellent reliability), 0.72 (moderate reliability) and 0.64 (moderate reliability) for sections B, C, and D respectively. An ICC value less than 0.5 indicates poor reliability, a value between 0.5 and 0.75 indicates moderate reliability, a value between 0.75 and 0.9 indicates good reliability, and a value greater than 0.90 indicates excellent reliability (Koo & Li, 2016).

3.2.3. Study three: Effect of prism adaptation therapy on unilateral spatial neglect in stroke survivors at the sub-acute phase of recovery

This study was a randomised controlled methodology. The RCT is the gold standard for evaluating effectiveness of an intervention hence it was a research design of choice for this stage of the thesis (Hariton & Locascio, 2018).

A detailed account of the methodology is presented in chapter seven.

3.2.3.1. Outcome measures, validity and reliability of the instruments

Objective 1.2.3.1. To establish the effect of prism adaptation therapy on USN in stroke survivors at the sub-acute phase of recovery.

The conventional subset of the behavioural inattention test was used for the assessment of neglect symptoms pre and post-intervention. Behavioural Inattention Test (BIT) is a standardized collection of 15 items used to test single-sided spatial neglect (Wilson et al., 1987). There are two main sections to the BIT, each with its own set of subtests. There are six subtests in the conventional section of the BIT (BIT-C): line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection, and representational drawing. The behavioural section of BIT (BIT-B) is comprised of the following nine subtests: picture scanning, phone dialling, menu reading, article reading, telling and setting the time, coin-sorting, address and sentence copying, map navigation, and card sorting (Wilson et al., 1987).

The total score for BIT is 227, with lower scores signifying greater degrees of USN (Teasell *et al,* 2014). The total cut-off, as well as individual cut-offs for each sub-section of the BIT, have been established such that a diagnosis of USN is suggested if the patient's scores are below the cut-off (Cherney et al., 2001; Di Monaco et al., 2011b). For the total BIT, the minimum cut-off is 196 out of 227, for the BIT-C it's 129 out of 146, and for the BIT-B it's 67 out of 81. (Menon & Korner-Bitensky, 2004). The severity of USN can also be ranged as severe (BIT-C score 1–65) and less severe (BIT-C score 66–128) (Teasell *et al,* 2014). The BIT-C demonstrated an excellent test-retest reliability (r=0.89); inter-rater reliability (r=0.99) and excellent to adequate convergent validity with Barthel index (r =0.64), Occupational therapist checklist (r = -0.65) and the Rivermead activity of daily living assessment (r=0.55) when tested on acute stroke patients (Halligan et al., 1991) (See Appendix II for the Conventional behavioural

inattention test). The BIT is available in English language and takes about 30- 40 minutes to administer. BIT-C was used to screen for USN because it demonstrated an excellent reliability when tested on acute and sub-acute stroke patients, it is easy to administer and is available in English which is understood by a vast majority of South Africans.

Also, the Catherine Bergego scale (CBS) was utilised for the assessment of the functional aspect of neglect. The CBS is a short scale designed to measure whether and how much USN is present in a patient during an examination. It includes an observation of the therapist's perspective and an evaluation of the patient's awareness of the same items. The CBS consists of ten items which is scored from 0-3; 0 = No neglect, 3 = severe neglect. The minimum total score is 0 (indicating no neglect) and the maximum total score is 30 (indicating severe neglect) and it takes 30 minutes to complete and is freely available at no financial cost (Azouvi et al., 1996). The CBS showed an excellent predictive validity post-stroke (acute stroke) at predicting deficits in day-to-day activities as assessed by the functional independent measure (FIM) (r=-0.70) (Goedert et al., 2012). Also, excellent inter-rater reliability (ICC=0.96) was found for acute stroke (Marques et al., 2019). See Appendix III for the Catherine Bergego scale. The rationale for choosing the CBS in this study is due to its availability (at no cost), less time consuming to administer, and its functional evaluation of USN perspective.

Objective 1.2.3.2.1. To identify demographic and clinical profile characteristics (age, gender, educational level, Stroke duration, type of stroke, site of stroke and handedness) of post-stroke USN patients in the sub-acute phase of recovery.

A demographic questionnaire, attached (Appendix IV) with the BIT test battery was used to provide information on the characteristics (clinical and demographic) of all stroke survivors recruited in the RCT.

Objective 1.2.3.2.2.: To identify factors that are predictive of the outcome of prism adaptation therapy of stroke survivors with USN in the sub-acute phase of recovery. Demographic and clinical questionnaire from the BIT was used as described in objective two above.

Objective 1.2.3.2.3. To establish the effect of PA therapy on hospital length of stay of stroke survivors with USN in the sub-acute phase of recovery after twelve sessions of PA. The demographic and clinical questionnaire was used as described in the objective above.

Objective 1.2.3.2.4. To establish the effect of PA therapy on balance of stroke survivors with unilateral spatial neglect in the sub-acute phase of recovery after twelve sessions of PA.

The Berg balance Scale (BBS) was used to assess balance function in this study pre and post-intervention.

Berg balance Scale (Appendix V) was developed to evaluate balance function in older people and stroke survivors with impairments of balance function by assessing their performance of functional tasks (Berg et al., 1989). This is a valid instrument that is used to assess interventions and quantify function in clinical practice and research. The BBS is a 14-item scale designed to measure the balance of the older adult in a

clinical setting. The BBS has an excellent internal consistency with Cronbach alpha> 0.83 for older adults and 0.97 for patients with stroke (Berg et al., 1995)

Each item of the BBS is scored along a 5-point scale. There are four levels of function, with zero being the lowest and 4 being the highest. The total score of the BBS ranges from 0 to 56, with 56 indicating functional balance, and less than 45 indicating a greater risk of falling (Berg et al., 1992). The rationale for selecting the BBS in this research project for the assessment of balance is due to the fact that the BBS is specific for patients with stroke and older adults.

Objective 1.2.3.2.5. To establish the effect of prism adaptation therapy on functional mobility of stroke survivors with unilateral spatial neglect in the sub-acute phase of recovery.

The Modified Rivermead Mobility Index (MRMI) (Appendix VI) was used to assess the participant's functional mobility level in this study. Some training was required before using the MRMI (Johnson & Selfe, 2004). There are eight tasks, ranging from turning over in bed to walking. It was developed for all categories of stroke patients, and is not demanding to dispense, requires no equipment, and can be administered in any setting. In cases where the patient cannot perform the mobility aspect, they receive a zero; in cases where they can do it independently, they receive a five. The original Rivermead Mobility Index (RMI) was shown to be valid and reliable in a study by Chen et al. (2007). Using the standard error of measurement and the smallest real differences, the RMI was rated as having absolute reliability of 0.8 and 2.2, respectively (Chen et al., 2007). According to the MRMI, patients are coded either 0 or 1, depending on their ability to perform a task according to the instructions. Items receive a score of 0 for a "No" response and 1 for a "Yes" response, total scores are

determined by summing the points for all items. A maximum of 15 points is possible; higher scores indicate better mobility performance. A score of "0" indicates an inability to perform any of the activities on the measure (see Appendix VI for the Rivermead Mobility Index). For there to be significant change in the patient's mobility level, there has to be a greater than 4.5 change in the score (Lennon & Johnson, 2000). This study considered the MRMI for use since it is able to detect clinically significant changes in mobility.

Objective 1.2.3.2.6. To establish the effect of prism adaptation therapy on quality of life of stroke survivors with unilateral spatial neglect in the sub-acute phase of recovery.

Stroke Specific Quality of Life Scale (SSQoL) (Appendix VII) was used to assess the QOL of participants in this study. SSQoL is an outcome measure aimed at assessing quality of life for stroke survivors (Salter et al., 2008). It consists of 49 items in 12 domains: energy, family roles, language, mobility, mood, personality, self-care, social roles, thinking, upper extremity function, vision and work/productivity. Higher scores indicate better function. Domains of the SSQoL have an internal reliability ≥ 0.73 and most domains are reactive to change with a standardized effect size >0.4 (Williams et al, 1999). In addition to domain scores, SSQoL yields an overall summary score (Williams et al, 1999). Items are rated on a 5-point Likert scale and higher scores indicate better functioning. The domain scores are unweighted averages of the associated items while the summary score is an unweighted average of all twelve domain scores (Williams et al, 1999) (See Appendix VII for the Stroke Specific Quality of Life Scale). SSQoL was selected as the outcome measure for the current study, since it is a patient-focused outcome measure, includes scores from all 12 domains, and does not require proxy data.

Objective 1.2.3.2.7. To establish the effect of prism adaptation therapy on activities of daily living, of stroke survivors with USN in the sub-acute phase of recovery

Functional level (ADLs) was assessed for all study participants with the Barthel Index (BI) (Appendix VIII). The BI is quite simple, consisting of 10 common functional ADLs and administered via direct observation. Eight of the ten items represent activities related to personal care: feeding, bathing, grooming, dressing, bowels continent, bladder continent, toilet use and transfer (bed to chair and back). The remaining 2 are related to mobility on level surfaces and stairs. There are many versions of the BI, but the 10 item BI with a total score of 20 (Collin et al., 1988) was used in this study. This choice was based on the high reliability coefficient of this version (0.99) when compared with the original BI (0.87), Modified BI (0.95) and the Modified scoring (0.90) (Shah et al., 1989). Each domain score is summed, the score ranges from 0-20 with a lower score indicating disability. The BI is easy to apply and has been well validated for use with stroke survivors (Green & Young, 2001) Non-medical personnel can use the BI reliably, as established by Schlote et al., (2004).

3.3. CHAPTER SUMMARY

This chapter presented the methodology for this research project. The rationale for choosing each research design and for outcome measure was also presented. The psychometric properties and suitability for use in this research project was justified in this chapter.

The next chapter is a scoping review on current trends in the treatment of unilateral spatial neglect using a scoping review methodology.

CHAPTER 4: CURRENT TRENDS IN THE TREATMENT OF PATIENTS WITH POST-STROKE UNILATERAL SPATIAL NEGLECT: A SCOPING REVIEW.

4.1. INTRODUCTION TO CHAPTER

This chapter is a scoping review of literature on the treatment of post-stroke unilateral spatial neglect. This chapter is aimed at reviewing interventions for the treatment of post-stroke USN in order to identify gaps and research direction in post-stroke USN management.

The background, aims, methodology and the specific management identified are reported in this chapter.

4.2. INTRODUCTION

Stroke over the years has been a major cause of morbidity globally, and about 70% of stroke survivors have a residual disability (Bonita, 1992). The consequence of stroke is immense and includes an array of impairments of body function, restrictions in activities of daily living, and participation restrictions (Hartman-Maeir et al., 2007; Vincent-Onabajo et al., 2014). These important consequences of stroke have varying impacts on stroke survivors. However, survivors of stroke do suffer not only physical and sensory loss but also perceptual deficit, which includes unilateral spatial neglect. Unilateral spatial neglect (USN) is the *"inability to report, respond or orient to meaningful stimuli presented to the side opposite the brain lesion"* (Adair et al., 1998). This condition affects about half of all acute stroke survivors and is usually accompanied by functional disability (Buxbaum et al., 2004b; Zijlstra et al., 2015).

Unilateral spatial neglect affects 50–70% of patients surviving right hemispheric stroke (Buxbaum et al., 2004c; Damasio et al., 1980; Heilman et al., 2000; Heilman & Valenstein, 1972; Nijboer et al., 2013; Paolucci et al., 2001; Zijlstra et al., 2015) and

is an important predictor of post-stroke recovery over paralysis and communication (Robertson et al., 1997). It is established in the literature that USN is a leading cause of the disability among stroke survivors, affecting functional recovery and is associated with poor rehabilitation outcome (Jehkonen et al., 2006; Kalra et al., 1997b; Paolucci et al., 2001).

There have been a variety of rehabilitation techniques or treatments introduced during the past 60 years aimed at alleviating, reducing or resolving left relative visuospatial dysfunction (Luaute et al., 2006). Treatment for USN has been broadly classified into strategies that utilize top-down mechanisms or a bottom-up approach (Adair & Barrett, 2008). Treatment methods for USN include constraint-induced therapy, limb activation, neck muscle vibration, functional electrical stimulation (FES), trunk rotation, transcutaneous electrical nerve stimulation (TENS), ipsilateral eye patching, spatial cueing, and visual scanning. (Luaute et al., 2006). However, an effective treatment approach for USN has been elusive with conflicting reports existing in the literature.

Nevertheless, most of the existing reviews included selective appraisals of specific treatment approaches (Klinke et al., 2015; Luaute et al., 2006; Paci et al., 2010; Pierce & Buxbaum, 2002). Luaute and colleagues in their review study recommended the following interventions for rehabilitation of patients with left spatial neglect: visual scanning training (VST); trunk rotation (TR) or repeated neck muscle vibrations (NMV) mental imagery training, video feedback training and prism adaptation (PA) (Luaute et al., 2006). In the context of stroke rehabilitation, the rationale for this review is different from previous reviews as this study aims to provide an encompassing and up-to-date mapping of current interventions for USN reported in the literature.

The last attempt to systematically map out interventions for USN rehabilitation was published over ten years ago (Luaute et al., 2006), hence the need to explore and map-out current interventions in USN treatment. Given the significance of post-stroke unilateral spatial neglect treatment in stroke rehabilitation and the need for health care practitioners to utilize an up-to-date knowledge of interventions options in USN treatment, it is relevant to map out the diverse treatments for post-stroke USN treatment. Ultimately, results of this scoping review will illuminate on the current treatment options in the management of patients with post-stroke unilateral spatial neglect and give insight into the current direction of research in USN treatment over the last twelve years. Also, in this study, a systematic and methodological evaluation of studies for unilateral spatial neglect rehabilitation will be conducted. This review may serve as a guide for and evidence for rehabilitation experts in choosing treatment options for post-stroke patients with USN.

With the foregoing in mind, this study was conducted to explore current treatment options in the management of patients with post-stroke unilateral spatial neglect.

4.3. REVIEW QUESTION AND OBJECTIVE

The specific review question for this scoping review was: What are the current treatment options in the management of patients with post-stroke USN?

The objective of this scoping review was: To map the current treatment options of patients with post-stroke USN.

4.4. INCLUSION AND EXCLUSION CRITERIA

4.4.1. Participants

This scoping review considered published studies or reports on interventions conducted in adult patients (≥ 18 years of age) diagnosed with post-stroke USN.

4.4.2. Concept

This scoping review explored a variety of intervention for patients diagnosed with post-stroke USN.

4.4.3. Context

This scoping review considered studies conducted in in-hospital care; either acute care, long-term care or community care, including the home. Studies not conducted and published in the English language were excluded.

4.4.4. Types of study

This scoping review considered both experimental and quasi-experimental study designs including randomized controlled trials, non-randomized controlled trials, before and after studies, interrupted time-series studies and case-control studies. The searches were limited to publications from January 1, 2008, to May 1, 2020. The rationale for this time frame was selected as it is frequently opined by implementation scientists that it takes an average of 17 years for evidence to reach clinical practice. The researchers believe that a twelve-year time frame of evidence will provide a new direction in evidence-based practice stroke rehabilitation.

4.5. MATERIALS & METHODS

4.5.1. Search strategy

A comprehensive search of relevant electronic databases (PubMed, CINAHIL, The Cochrane Central Register of Controlled Trial, SCOPUS, PROSPERO, Johanna Briggs Institute Database of Systematic Reviews and Implementation Reports, Sport

discus, Google scholar) was conducted. The search included all experimental and quasi-experimental studies that explored the therapeutic interventions available for post-stroke USN. The search of electronic databases was conducted using a combination of related terms; the first step was an initial limited search of all the included databases. This initial search was then followed by an analysis of the text words contained in the title and abstract of retrieved papers, and of the index terms used to describe the articles. A second search using all identified keywords and index terms was then undertaken across all included databases. Thirdly, the reference lists of all identified reports and articles were searched for further studies. Authors of studies or reviews were contacted for clarification if the need arose. Table 4.1 shows the search strategy.

Table 4. 1: Search strategy

S/No.	Source	Query/search string	Results
1.	PubMed	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	648
2.	JBISRIR	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	38
3.	Scopus	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	1539
4.	CINAHL	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	255
5.	COCHRANE	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	129
6.	GOOGLE SCHOLAR	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	982
7.	Sport Discus	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	28
8.	PROSPERO	(unilateral spatial neglect OR hemineglect) AND (Stroke OR cerebrovascular accident OR cerebrovascular incident)	0

4.5.2. Study selection

All searches were imported into Mendeley and then into a Microsoft Excel spreadsheet. Two independent reviewers reviewed all titles and abstracts that are relevant to the aim of the scoping review being conducted. Full-text of studies were then retrieved and reviewed by two reviewers independently. All discrepancies in selection were resolved through discussion.

4.5.3. Extraction of results

Data extraction was conducted using a charting table that was developed by the researcher using the JBI guidelines (Peters et al., 2015). (See Appendix IX for the chart table)

4.5.4. Data Mapping

The extracted data are presented in both diagrammatic and tabular forms as per scoping review. A narrative summary accompanies the tabulated and diagrammatic results.

4.5.5. Assessment of methodological quality

The eighty-six articles that met inclusion criteria were critically appraised for methodology quality by two independent reviewers utilizing the JBI Reviewer's Manual using either the quasi-experimental (non-randomized) or the RCT critical appraisal checklist (Tufanaru et al 2017), (See Appendix X) as appropriate to the study design. Following the critical appraisal, studies that did not meet a critical appraisal score of ≥ 50% were excluded for both quasi-experimental (non-randomized) or the RCT.

Table 4. 2: Critical appraisal result for quasi-experimental studies.

S/NO	Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score
Included articles											
1.	Serino et al., (2009)	Y	Y	Y	Y	N	Y	Y	N	Y	78%
2.	Fortis et al., (2011)	Y	Y	N	N	N	Y	Y	Y	Y	67%
3.	Yoneda et al., (2011)	Y	Y	Y	Y	N	Y	Y	N	Y	78%
4.	Gossmann et al., (2013)	Y	Y	Y	N	Y	Y	Y	Y	Y	89%
5.	Fortis et al., (2020)	Y	Y	Y	N	Y	Y	Y	Y	Y	89%
6.	Fortis et al., (2010)	Y	Y	Y	N	Y	Y	Y	Y	Y	89%
7.	Rusconi & Carelli, (2012)	Y	Y	N	N	N	Y	Y	Y	Y	67%
8.	Wang et al., (2015)	Y	Y	Y	N	N	Y	Y	N	Y	67%
9.	Pitteri et al., (2013)	Y	Y	N	N	N	Y	Y	Y	Y	67%
10.	Oh et al., (2015)	Y	Y	N	N	N	Y	Y	Y	Y	67%
11.	Lucas et al., (2013)	Y	Y	Y	N	N	Y	Y	Y	Y	78%

12.	Varalta et al., (2019)	Y	Y	Y	N	N	Y	Y	Y	Y	78%
13.	Harding & Riddoch, (2009)	Y	Y	Y	N	Y	Y	Y	Y	Y	89%
14.	Kim et al., (2013)	Y	Y	Y	Y	N	Y	Y	Y	Y	89%
15.	Nyffeler et al., (2009)	Y	Y	Y	Y	N	Y	Y	N	Y	78%
16.	Hegarty, (2011),	Y	Y	N	N	Y	Y	Y	Y	Y	78%
17.	Woods et al., (2012)	Y	Y	N	N	N	Y	Y	N	Y	56%
18.	Guilbert et al., (2017)	Y	Y	N	N	Y	Y	Y	Y	Y	78%
19.	Bernardi et al., (2017).	Y	Y	N	Y	N	Y	Y	Y	Y	78%
20.	Tsai et al., (2013)	Y	Y	N	N	N	Y	Y	Y	Y	67%
21.	Oren et al., (2013)	N	Y	N	Y	N	Y	Y	Y	Y	67%
22.	Trejo-Gabriel-Galan et al., (2016)	Y	Y	N	N	N	Y	Y	Y	Y	67%
23.	Bang et al., (2015)	Y	Y	N	Y	N	Y	Y	Y	Y	78%
24.	Sato et al., (2010)	Y	Y	N	N	N	Y	Y	Y	Y	67%
25.	Funk et al., (2013)	Y	Y	N	N	Y	Y	Y	Y	Y	78%
26.	Yoshihiro & Ito,(2017),	Y	Y	N	N	Y	Y	Y	Y	Y	78%
27.	Schaadt et al., (2016)	N	Y	Y	Y	Y	Y	Y	Y	Y	89%
28.	Khurshid et al., (2009)	Y	Y	Y	N	N	Y	Y	Y	Y	78%
29.	Shiraishi et al., (2015)	Y	Y	N	N	Y	Y	Y	Y	Y	78%
30.	Schmidt et al., (2013)	Y	Y	N	Y	Y	Y	Y	Y	Y	89%
31.	Nakamura et al., (2015)	Y	Y	Y	N	Y	Y	Y	Y	Y	89%
32.	Zubko et al., (2013)	Y	Y	N	N	N	Y	Y	Y	Y	67%
33.	Saj et al., (2018)	Y	Y	N	N	N	Y	Y	Y	Y	67%
34.	Kang & Thaut, (2019)	Y	Y	N	N	Y	Y	Y	Y	Y	78%
35.	Revol et al., (2020)	Y	Y	N	Y	Y	U	Y	Y	Y	78%
36.	Abbruzzese et al.,(2019)	Y	Y	Y	N	N	N	Y	Y	Y	67%
37.	Abdou et al., (2020)	Y	Y	Y	N	N	Y	Y	Y	Y	78%

TOTAL		95%	100%	43%	27%	38%	95%	100%	87%	100%	

4.6. RESULTS

4.6.1. Methodological quality

Thirty-seven studies were quasi-experimental, and forty-six studies were RCTs. Three articles were excluded for poor methodology quality with scores between 31% and 46% which was below the 50% cut-off as per the protocol (Table 4.2 and 4.3 shows the critical appraisal result for quasi-experimental and randomised control trials respectively).

Table 4. 3: Critical appraisal result for Randomised control trial studies.

	Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	SCORE
	Included articles														
1	Turton et al., (2010)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	92%
2	Nys et al., (2008)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
3	Mancuso et al., (2012)	Y	Y	Y	Y	U	U	Y	U	Y	Y	Y	Y	Y	77%
4	Rode et al., (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
5	Làdavas et al., (2011)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	Y	85%
6	Mizuno et al., (2011b)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	92%
7	Van Wyk et al., (2014)	N	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	77%
8	Van Kessel et al., (2013)	N	N	Y	U	U	U	Y	Y	Y	Y	Y	Y	Y	62%
9	Park & Lee, (2015)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	92%
10	Welfringer et al., (2011)	Y	Y	Y	U	U	Y	Y	Y	Y	Y	Y	Y	Y	85%
11	Pandian et al., (2014).	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	92%
12	Aparicio-López et al., (2016)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	85%
13	Fong et al., (2013)	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	85%
14	Wu et al., (2013)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	92%
15	Yang et al., (2017)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	92%

16	Polanowska et al., (2009)	Y	N	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	55%
17	Luauté et al., (2014)	Y	Y	Y	Y	N	U	N	Y	Y	Y	Y	Y	Y	77%
18	Saevarsson et al., (2010)	Y	N	Y	U	U	U	Y	Y	Y	Y	Y	Y	Y	69%
19	Schröder et al., (2008)	Y	U	Y	U	U	U	Y	U	U	Y	Y	Y	Y	54%
20	Jacques Luauté et al., (2018)	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	92%
21	Kim et al., (2018)	Y	U	Y	U	U	U	Y	Y	Y	Y	Y	Y	Y	69%
22	Vatanparasti et al., (2019)	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	77%
23	Luukkainen-Markkula et al., (2009).	Y	Y	Y	U	U	U	Y	Y	Y	Y	Y	Y	Y	77%
24	Cha, (2017)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
25	Gorgoraptis et al., (2012)	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	92%
26	Dalmaijer et al., (2018)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
27	Chieffo et al., (2019)	Y	Y	Y	Y	U	U	Y	Y	Y	Y	Y	Y	Y	85%
28	Karner et al., (2019)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	92%
29	Nyffeler T et al., (2019)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
30	Cha & Kim, (2016)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
31	Fu et al., (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
32	Cha & Kim, (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
33	Cazzoli et al., (2012)	Y	U	Y	U	N	N	Y	Y	Y	Y	Y	Y	Y	69%
34	Kim et al., (2011)	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	85%
35	Tsang et al., (2009)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	92%
36	Ianes et al., (2012)	Y	N	Y	Y	N	Y	N	U	Y	Y	Y	Y	Y	69%
37	Turgut, Möller, et al., (2018)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	92%
38	Varalta et al., (2019)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
39	Wen et al., (2019)	Y	U	Y	U	U	U	Y	Y	Y	Y	Y	Y	Y	69%
40	Kutlay et al., (2018)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
41	Svaerke et al., (2019)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%

42	Tramontano et al., (2019)	Y	N	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	Y	85%
43	Paolucci et al.,(n.d.)	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	85%
44	Iwański et al., (2018)	Y	Y	Y	Y	N	N	U	N	Y	Y	Y	Y	Y	69%
45	Kang & Kim, (2019)	Y	U	Y	U	U	U	Y	Y	Y	Y	Y	Y	Y	69%
46	Rossit et al., (2019)	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	85%
	Excluded articles														
47	Nijboer et al., (2014)	N	N	Y	U	U	N	N	U	U	Y	Y	Y	U	31%
48	Turgut et al., (2018)	N	U	Y	U	U	U	Y	U	U	Y	Y	Y	Y	46%
49	Cao et al., (bv 2016)	U	U	Y	U	U	U	Y	U	Y	Y	U	Y	Y	46%
		88 %	63 %	10 0%	72 %	35 %	63 %	90 %	84 %	96 %	100 %	98%	98%	98%	

4.6.2. Description of studies

A database search identified a total of 3619 records. Other sources which primarily include reference lists of included studies provided a further 29 records. After duplicate removal and screening of study abstracts and titles based on study eligibility criteria, 311 studies were retrieved in full text, and 225 articles were excluded based on the inclusion criteria of the study. Three studies were excluded for methodological reasons. A total of eighty-three studies were reviewed for this study. Figure 4.1 consists of the PRISMA diagram that describes the flow of decisions for the inclusion of studies. Appendix XI summarizes the review finding.

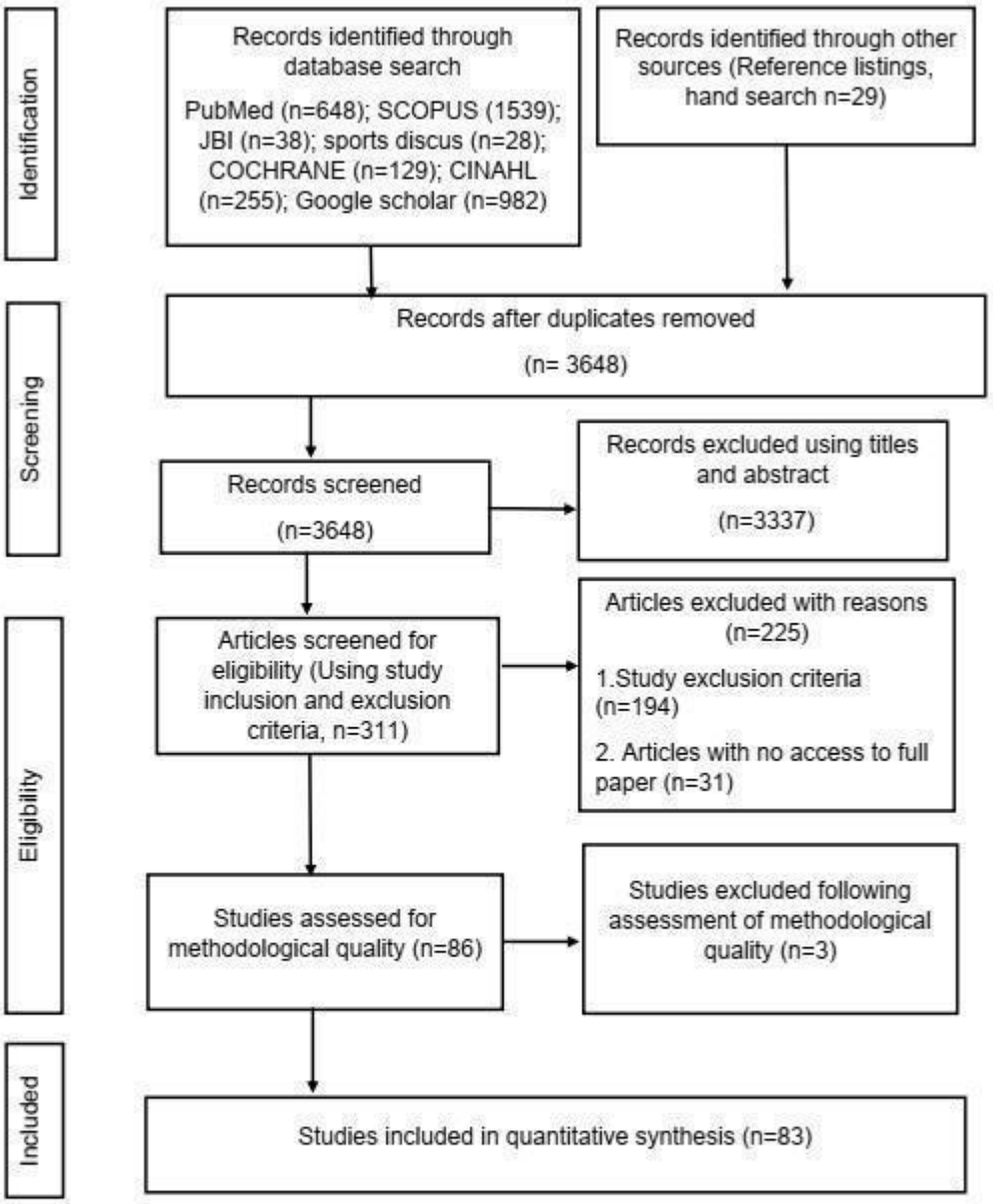


Figure 4. 1: PRISMA diagram describing the flow of decision.

4.6.3. Characteristics of included studies

All studies were conducted in acute, long term community care, outpatient and hospital rehabilitation ward. Analysis of the geographical origin of the studies showed that the majority of the studies were conducted in Italy (n=16) (figure 4.2). Majority of the studies included in this review were randomized controlled trial (N=46) (figure 4.3). Also, most of the studies were published in the year 2013. Figure 4.4 shows the evolution of included studies along the ten years of review.

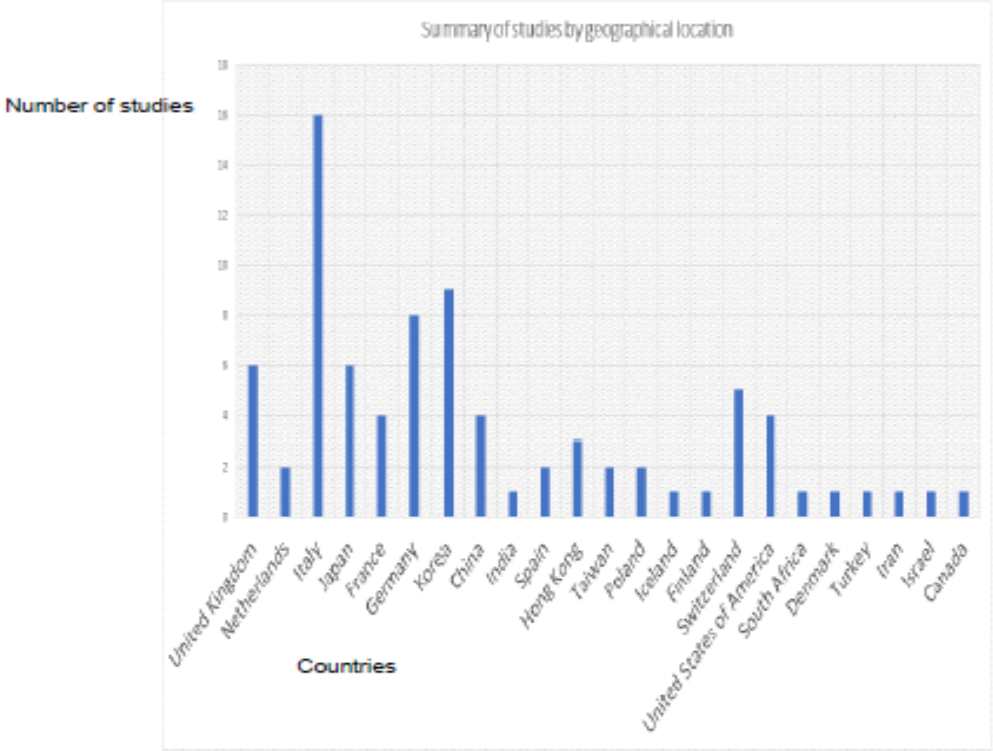


Figure 4. 2: Geographical distribution of included studies.

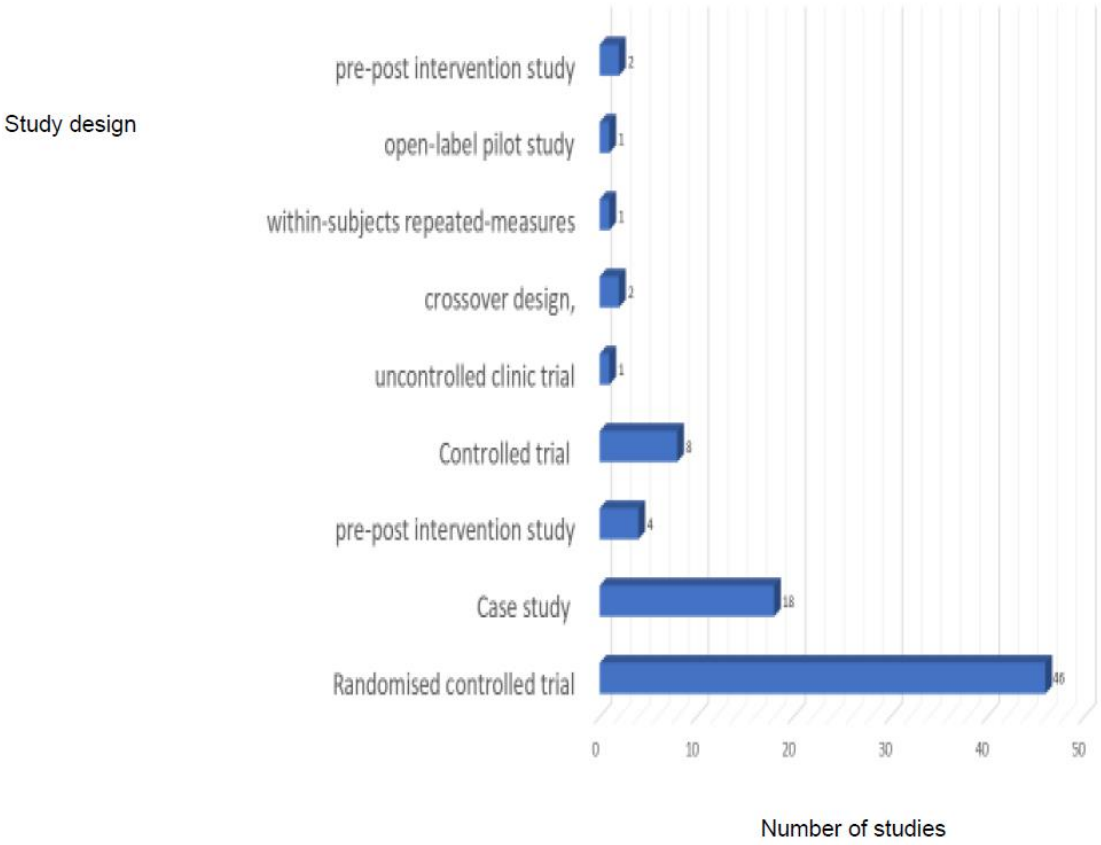


Figure 4. 3: Summary of included article study designs.

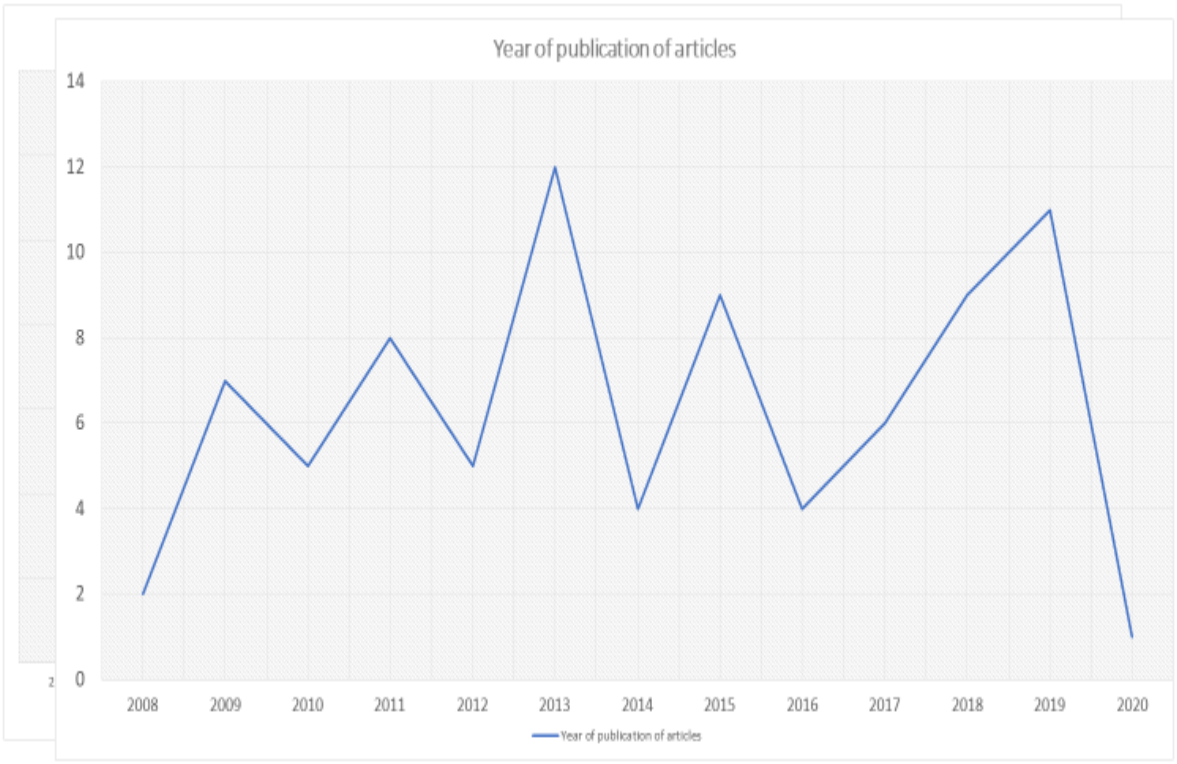


Figure 4. 4: Evolution of relevant studies in hemi-neglect management identified along the 12 years reviewed

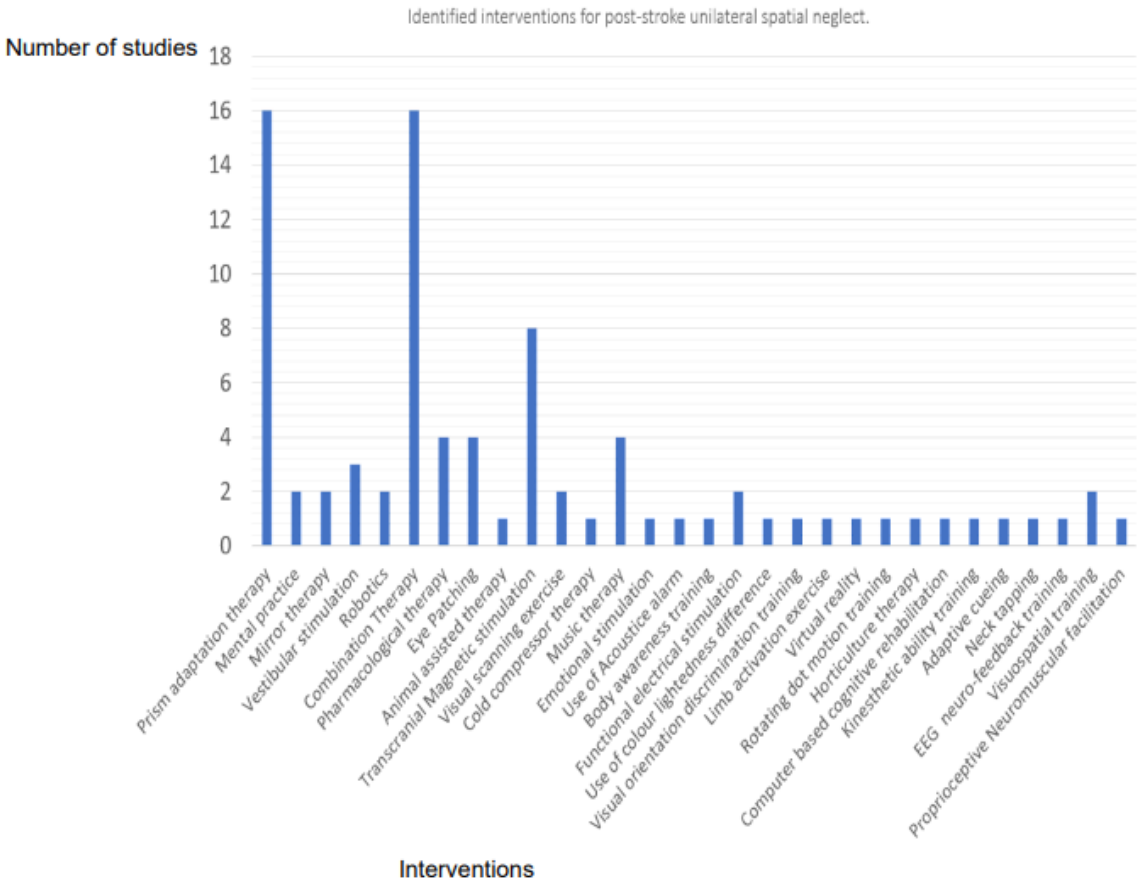


Figure 4. 5: Identified interventions for hemineglect

4.7. REVIEW FINDINGS

4.7.1. Current treatment options of patients with post-stroke unilateral spatial neglect

Thirty interventions for post-stroke unilateral spatial neglect were identified from the included studies for this review. Most of the interventions were conducted in the chronic phase of recovery from stroke. Sixteen studies explored the use of prism adaptation (PA) in post-stroke USN rehabilitation (Abbruzzese et al., 2019; Abdou et al., 2020; Fortis et al., 2010, 2011, 2020; Gossmann et al., 2013; Làdavas et al., 2011; Mancuso et al., 2012; Mizuno et al., 2011b; Nys et al., 2008; Revol et al., 2020; G.

Rode et al., 2015; Rusconi & Carelli, 2012; Serino et al., 2009; Turton et al., 2010; Yoneda et al., 2011). Also, sixteen studies explored combination therapy (Aparicio-López et al., 2016; Fong et al., 2013; Gyu Cha, 2017; Iwański et al., 2018; S. B. Kim et al., 2018; Luauté et al., 2014; Luauté et al., 2018; Luukkainen-Markkula et al., 2009; Oh et al., 2015; Pitteri et al., 2013; Polanowska et al., 2009; Saevarsson et al., 2010; Schröder et al., 2008; Vatanparasti et al., 2019; Wu et al., 2013; N. Y. Yang et al., 2017).Three studies investigated use of prism together with other intervention modalities for post-stroke USN (Oh et al., 2015, Luauté et al., 2014 and Vatanparasti et al., 2019).

Eight studies investigated the use of transcranial magnetic stimulation (Cazzoli et al., 2012; Cha & Kim, 2015, 2016; Chieffo et al., 2019; Fu et al., 2015; Kim et al., 2013; Nyffeler et al., 2009; Nyffeler T et al., 2019) while four studies investigated the effectiveness of eye patching (Ianes et al., 2012; Khurshid et al., 2009; Shiraishi et al., 2015; Tsang et al., 2009). Based on the similarity of the mechanism of action and for clarity of the various interventions identified in this study, the thirty interventions were categorised into six broad categories /intervention groups that include prism adaptation and visual scanning, mental practice and mirror therapy, electrical stimulation and robotics, combination therapy, pharmacological therapy and other interventions. Figure 4.5 shows a broad mapping of identified interventions for USN.

Majority of the studies target intervention for neglect treatment at the sub-acute phase of stroke recovery (Figure 4.6). The initial phase post-stroke is referred to as the acute phase and lasts for about 2 weeks. The second phase is the subacute phase, and this usually lasts up to 6 months after onset. The chronic phase begins months to years after stroke, and it may continue for the remainder of the person's life (Kiran, 2012)

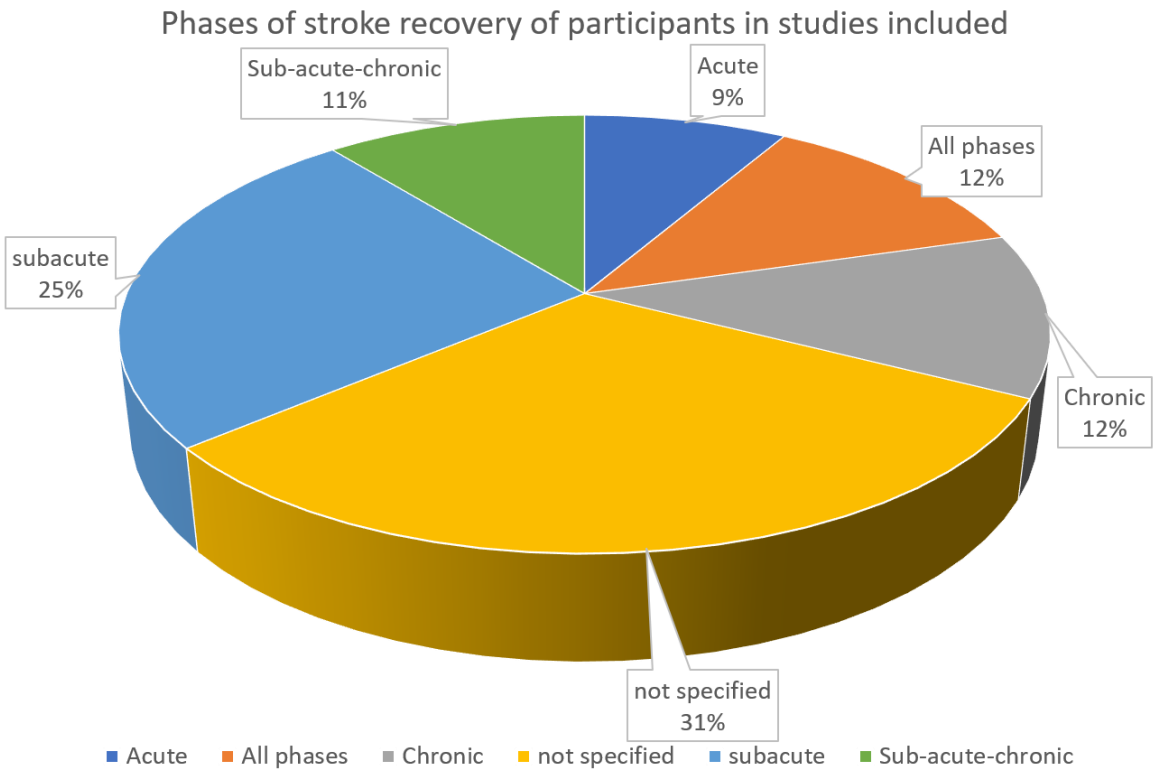


Figure 4. 6: Summary of phases of stroke recovery studies targeted.

4.7.2. Prism adaptation and visual scanning

From this scoping review study, sixteen studies (Abbruzzese et al., 2019; Abdou et al., 2020; Fortis et al., 2010, 2011, 2020; Gossmann et al., 2013; Làdavas et al., 2011; Mancuso et al., 2012; Mizuno et al., 2011b; Nys et al., 2008; Revol et al., 2020; G. Rode et al., 2015; Rusconi & Carelli, 2012; Serino et al., 2009; Turton et al., 2010; Yoneda et al., 2011) investigated use of PA in unilateral spatial neglect symptoms treatment. Several studies showed PA had a positive outcome across different measures including activities of daily living (ADL) (Fortis et al., 2010, 2011; Mancuso et al., 2012; Mizuno et al., 2011b; Rode et al., 2015; Serino et al., 2009; Yoneda et al., 2011) reduction in hospital stay (Mizuno et al., 2011b), neurological severity and disability (Fortis et al., 2011, 2020; Mizuno et al., 2011b).

In a study utilising a blinded randomised control design by Turton and colleagues, four sessions of prismatic lens training did not elicit improvement gains on self-care in a cohort of sub-acute stroke survivors (Turton et al., 2010). Yoneda et al (2011), investigated the effects of prism directionality and active movement adaptation on the symptoms of unilateral spatial neglect. Improvement was observed after prism training in most subtests of the outcome measures for assessment of unilateral spatial neglect (Behavioural inattention test) with long-lasting effects reported during the follow-up evaluation. Mizuno et al (Mizuno et al., 2011b) reported significant improvement in functional independence and spatial symptoms as assessed by the behavioural inattention test in sub-acute stroke patients after ten sessions of prism training using a randomised control trial methodology. Conversely, Nys et al., (2008) utilising a randomized placebo-controlled trial, examined the effectiveness of repetitive PA in ameliorating neglect symptoms in the acute phase of stroke recovery. Their results showed that four daily sessions of prism training showed significant improvement in USN symptoms and on activities of daily living, albeit the improvements were short-termed.

Abdou et al., (2020) in their study utilizing a case study methodology reported that one session of PA therapy improved balance and postural stability in both the anterior-posterior and medial-lateral directions. Revol and colleague (Revol et al., 2020) investigated the effect of PA therapy on haptic object discrimination in neglect patients. They reported that following two sessions of PA training, the left bias error rates in neglect patients were substantially reduced. Abbruzzese et al., (2019) examined the effects of PA on Reference Systems for extra personal Space in neglect patients. In terms of the egocentric–allocentric distinction, the training was effective in reducing

omissions in the left part of space in Apple's Cancellation test both for patients with egocentric neglect and mixed neglect.

Serino et al., (2009) showed using a randomised control trial, that ten daily sessions of prism training over two weeks showed improvements in neglect symptoms among stroke survivors in any phase of recovery. These gains in neglect amelioration were sustained through one month. Mancuso et al., (2012) in their study reported prism to goggle power might also influence the outcome of PA on USN; they reported that five degrees of prismatic lens did not contribute to the variation in performance in spatial tasks after five sessions of PA therapy.

Gossmann et al., (2013) investigated the effect of PA on ego centred neglect in early rehabilitation patients. Findings from their study showed that patients improved in cued body orientation and the cancellation task after four sessions of PA therapy. Fortis and colleagues (Fortis et al., 2011) in their study using a case study design reported that five sessions of PA therapy reduce motor intentional aiming bias in post-stroke neglect patients. Another interesting finding by Fortis et al., (2020) reported that a twenty session home-based PA therapy of ecological PA training proved to be able to significantly improve performance in neuropsychological tests (Behavioural inattention test, Cancellation tasks), a neurological scale (NIH), and functional abilities (Catherine Bergego Scale), when compared to both the baseline and the neutral control treatment, with improvements being maintained over six months.

Rode et al., (2015) investigated long-term sensorimotor, cognitive and functional effects of PA using a randomized control trial design. Their findings suggest that a weekly session of PA therapy over four-week PA therapy was not sufficient to produce long-term functional benefit in post-stroke neglect patients. Lavadas and colleagues

in their study in 2011 (Làdavas et al., 2011) suggested that PA is effective for the recovery of USN when conducted with a procedure stressing correction of vasomotor eye-hand coordination.

Although PA therapy produced some improvement in a wide range of neglect symptoms especially spatial tasks (Fortis et al., 2010, 2011, 2020; Gossmann et al., 2013; Làdavas et al., 2011; Mizuno et al., 2011b; Nys et al., 2008; Rusconi & Carelli, 2012; Serino et al., 2009) some contradictory result was also reported (Mancuso et al., 2012; Rode et al., 2015). Also, our study identified two studies (van Kessel et al., 2013; van Wyk et al., 2014) that attempt to utilise visual scanning to ameliorate USN symptoms. Van Wyk and colleagues (van Wyk et al., 2014) in their study provided some promising evidence of an improvement in spatial tasks and on activities of daily living following thirty sessions of saccadic eye movement training with visual scanning exercises. In a similar study, Van Kessel et al (van Kessel et al., 2013) evaluated the effect of visual scanning training (VST) on unilateral spatial neglect symptoms and reported no significant group and interaction effects after dual-task training.

4.7.3. Mental practice and mirror therapy

Two studies were identified in our study that investigated the use of mental practice in USN (Park & Lee, 2015; Welfringer et al., 2011). Park & Lee, (2015) investigated the effects of mental practice on chronic USN in stroke patients using a randomised control design. Their findings suggest that qualitatively different tasks may evoke different spatial processing mechanisms after twenty sessions of mental practice. Welfringer et al., (2011) reported high subjective gains in a spatial task, reduction in the severity of neglect in drawing/copying tasks as well as enhancing sensation in the affected arm.

In this study, we included one case study and a randomized controlled trial that investigated mirror therapy utilization in the treatment of USN (Pandian et al., 2014; Wang et al., 2015). Pandian et al., (2014) in their study showed mirror therapy provided amelioration in USN symptoms and these therapeutic gains was sustained over 6 months. Another study by Wang and colleagues found that one-week training, which entails watching hand action videos of daily movement with no direction preference, was sufficient to improve the visual-spatial perception in post-stroke neglect patients (Wang et al., 2015).

4.7.4. Electrical stimulations and Robotics training

In our review, only one single subject experimental study design by Harding & Riddoch (Harding & Riddoch, 2009) explored if functional electrical stimulation (FES) of the upper limb alleviates unilateral neglect. They investigated the effect of functional electrical stimulation (FES) on alleviation of post-stroke neglect patients using a single-subject experimental design. Their result showed that three of the four patients tested responded to the FES, showing good amelioration of neglect and also making a good physical and functional recovery. Also, eight studies included in our review (Cazzoli et al., 2012; Cha & Kim, 2015, 2016; Chieffo et al., 2019; Fu et al., 2015; Kim et al., 2013; Nyffeler et al., 2009; Nyffeler et al., 2019) investigated the use of transcranial magnetic stimulation in neglect rehabilitation reported reductions with neglect.

Kim et al., (2013) using a controlled trial demonstrated that high-frequency repetitive transcranial magnetic stimulation (rTMS) is effective in the treatment of visuospatial neglect in patients with acute stroke and again in ADLs after ten sessions of high-frequency rTMS. Similarly, Cha and Kim in a randomised controlled demonstrated that twenty sessions of rTMS yielded a significant difference in the post-training gains in

line bisection Albert, box and block, and grip strength tests in sub-acute neglect patients (Cha & Kim, 2016).

Nyffeler et al., (2009) reported that two trains of transcranial magnetic stimulation (TMS) produced an eight-hour amelioration in neglect symptoms while four trains of TMS reduced neglect symptoms for thirty-two hours. Cazzoli et al., (2012) investigated the repeated application of continuous theta-burst stimulation trains could ameliorate spatial neglect. Results from that study showed a 37% improvement in the spontaneous everyday behaviour of the neglect patients. Varalta et al (Varalta et al., 2014) using a case study design investigated whether robot-assisted left-hand activation alone could lead to an improvement in hemispatial neglect following in sub-acute to chronic stroke survivors. Their study revealed that ten sessions of robot-assisted hand training ameliorated neglect symptoms in stroke survivors. Similarly, Karner et al., (2019) evaluated the effects of an intervention using the robot device PARO on visuospatial hemineglect and activities of daily living, and its acceptance during stroke rehabilitation. In their study, they demonstrated that six sessions of robotics training elicited improvements in neglect symptoms and functional independence.

4.7.5. Combination therapy

Sixteen studies met the inclusion criteria of this review. Rehabilitation approaches combining two or more treatment options were investigated (Aparicio-López et al., 2016; Fong et al., 2013; Cha, 2017; Iwański et al., 2018; Kim et al., 2018; Luauté et al., 2014; Luauté et al., 2018; Luukkainen-Markkula et al., 2009; Oh et al., 2015; Pitteri et al., 2013; Polanowska et al., 2009; Saevarsson et al., 2010; Schröder et al., 2008; Vatanparasti et al., 2019; Wu et al., 2013; Yang et al., 2017)

All the studies except for two studies (Aparicio-López et al., 2016; Fong et al., 2013) showed that a combination of two or more treatment intervention produced a significant reduction of neglect symptoms. Also, therapeutic gains were reported in areas such as motor function (Cha, 2017), activities of daily living (Oh et al., 2015), reading and writing performance (Schröder et al., 2008) and functional independence (Luauté et al., 2014). However, beneficial long-term effect was reported in two studies (Luukkainen-Markkula et al., 2009; Yang et al., 2017). Aparicio-López et al., (2016) investigated the combined use of computer-based cognitive rehabilitation and right hemifield eye patching in sub-acute neglect patients using a randomised control design. Their study revealed that a fifteen of session combination of computer-based cognitive rehabilitation and right hemifield eye patching treatment was not more effective than rehabilitation applied in isolation.

Fong et al., (2013) compared the effects of contralesional sensory cueing and limb activation with that of sham control in the treatment of unilateral at the subacute phase of stroke recovery. Their results did not confirm that sensory cueing and limb activation treatment is effective when compared with those receiving placebo to reduce unilateral neglect. Conversely, Wu and colleagues (Wu et al., 2013) demonstrated in a randomised control trial that fifteen sessions of constraint-induced therapy combined with eye patching on stroke patients in the chronic phase of recovery yielded larger improvements in functional performance.

Yang et al., (2017) investigated the effects of repetitive transcranial magnetic stimulation (rTMS) combined with sensory cueing, and conventional rehabilitation on unilateral neglect, hemiplegic arm functions and performance of activities of daily living. Results showed that rTMS combined with sensory cueing and rTMS alone (88.2±28.7) significantly reduced unilateral neglect than conventional rehabilitation.

ADLs improved in all patients across groups but no significant differences were found between the groups.

Pitteri et al., (2013) tested the effect of simultaneous use of Limb activation treatment (LAT) combined with contralesional arm vibration (CAV) to ameliorate signs of left neglect The results showed an improvement of performance on the Bells test following the combined application of LAT and CAV. (LAT alone had no significant effects of treatment on Line bisection and Picture scanning).

Also, Polanowska et al., (2009) in a randomised double-blind study investigated the therapeutic effectiveness of left-hand electrical stimulation combined with visual scanning was a more effective treatment for hemineglect rehabilitation than scanning training. Luauté et al., (2018) assessed the utility to combine PA and methylphenidate in the treatment of neglect. There was a significant improvement in the functional independence measure in the experimental group. Neglects tests did not change differently in the two groups (control and case). Saevarsson et al., (2010) explored possible additive benefits of neck vibration and PA in chronic stroke patients using a randomised control trial study design. Patients that underwent the combined intervention of neck vibration and prism adaptation therapy (NVPA) showed clear improvements in visual search, unlike the Neck vibration NV, the only group.

Schröder et al., (2008) compared the efficacy of exploration training alone and in combination with transcutaneous electrical nerve stimulation (TENS) or optokinetic stimulation (OKS). It was found that exploration training alone resulted in no improvement on both standard neglect tests (NTs) and everyday-relevant measures of reading and writing performance. In contrast, the group receiving TENS or OKS showed significant improvements in both sets of measures with the difference that for the TENS group the improvement in NT scores at the end of therapy had disappeared

1-week later. However, both treatments resulted in significant improvements in reading and writing which were still present upon retesting 1-week after the end of therapy.

Kim et al., (2018) in their study investigated the effect of upper limb rehabilitation combining robotic training with low frequency repetitive transcranial magnetic stimulation on neglect in stroke patients. They showed that two weeks after the therapy, combining robotic training with low frequency repetitive transcranial magnetic stimulation all groups showed significant improvement in Motor-Free Visual Perception Test-3 (MVPT-3), line bisection test, star cancellation test, Catherine Bergego scale, mini-mental scale, and Barthel index. However, changes in measurements showed no significant differences among groups.

Iwański et al., (2018) investigated using a randomised control trial the therapeutic effect of 1 Hz repetitive transcutaneous magnetic stimulation applied over the left angular gyrus, combined with visual scanning training in patients with post-stroke USN. No differences were detected after fifteen sessions of intervention in any outcome measure between the real rTMS group and the sham group after completion of therapy. Also, Vatanparasti et al (Vatanparasti et al., 2019) in their study investigated the effect of PA combined with continuous theta-burst transcranial magnetic stimulation (cTBS) on post-stroke neglect patients. Their results showed that both groups (Prism adaptation alone and + cTBS) showed improvement in their neglected symptoms (measured by SCT, LBT, Figure Copying Test, and Clock Drawing Task), and in their disability in the neurological function (measured by MRS) ($P<0.05$).

Oh et al., (2015) examined the effects of visual field with prism glasses and intensive upper limb functional training on the reduction of hemineglect and improvement in upper limb function and activities of daily living using a case study design. Subjects'

hemineglect decreased and upper limb function on the paretic side improved after the intervention, which enhanced activities of daily living. Cha & Kim, (2016) using a randomised control trial investigated the effect of rTMS combined with task-oriented training upper limb dysfunction and hemineglect in sub-acute stroke. A significant difference in the post-training gains in Fugyl Meyer assessment, Albert test, and grip strength test was observed between the experimental group and the control group ($p < 0.05$) after twenty sessions of rTMS combined with task-oriented training upper.

4.7.6. Pharmacological therapy

Four studies investigating the effect of drugs on neglect symptoms met the inclusion (Dalmaijer et al., 2018; Gorgoraptis et al., 2012; Lucas et al., 2013; Paolucci et al., 2010) of the review. Paolucci and colleagues demonstrated that 3mg of Rivastigmine twice a day for eight days as an add-on to specific cognitive therapy improved and accelerated recovery on spatial tasks (Paolucci et al., 2010). However, their intervention regimen failed to sustain the therapeutic gains at follow-up. Similarly, Lucas et al., (2013) demonstrated in their study that a single dose of transdermal Nicotine showed a significant improvement of attention and arousal but not on other spatial mechanisms impaired in neglect. Gorgoraptis et al., (2012) in their study showed transdermal Rotigotine significantly improved spatial bias and visual search in neglect patients.

Dalmaijer et al., (2018) conducted a study aimed to test the effects of guanfacine, a noradrenergic alpha-2A agonist, on ameliorating aspects of neglect. Their results showed that after a single dose of guanfacine, there was a statistically significant improvement in the total number of targets found on the cancellation task when compared with placebo (mean improvement of 5, out of a possible 64).

4.7.7. Other interventions

Several other promising interventions to ameliorate neglect symptoms were suggested and researchers investigated its efficacy. Interventions identified by this scoping review include eye patching (Ianes et al., 2012; Khurshid et al., 2009; Shiraishi et al., 2015; Tsang et al., 2009) use of animal-assisted therapy (Hegarty, 2011), cold pressor stimulation(Woods et al., 2012), music therapy (Bernardi et al., 2017; Guilbert et al., 2017; Kang & Thaut, 2019; Tsai et al., 2013), emotional stimulation (Oren et al., 2013), visual acoustic alarm (Trejo-Gabriel-Galan et al., 2016), body awareness training (Bang et al., 2015), use of colour lightness difference (Sato et al., 2010), visual line orientation discrimination training (Funk et al., 2013), limb activation (Yoshihiro & Ito, 2017) , virtual reality (Kim et al., 2011) , vestibular stimulation (Nakamura et al., 2015; Schmidt et al., 2013; Zubko et al., 2013) and rotating random-dot motion (Schaadt et al., 2016) , Kinesthetic ability training (Kutlay et al., 2018), Computer-based cognitive rehabilitation (Svaerke et al., 2019), Horticultural therapy(Wen et al., 2019) , Neck tapping (Varalta et al., 2019) , adaptive cueing(Turgut, et al., 2018) , Neuro-feedback training(Saj et al., 2018), Visuospatial training (Rossit et al., 2019; Tramontano et al., 2019), Proprioceptive neuromuscular facilitation (Kang & Kim, 2019).

A study by Bernardi et al., (2017) assessed if auditory reference provided by a music scale improve spatial exploration of a standard musical instrument, keyboard in right-brain damaged patients with left spatial neglect. Using a counterbalanced design, they demonstrated that a two-session provided by the music scale improves exploration of the left side of space, contralateral to the right hemisphere, damaged in patients with left neglect. Similarly, Tsai et al., (2013) demonstrated that listening to classical music ameliorates unilateral neglect after stroke. Participants generally had the highest

scores on the outcome measures under the classical music condition and the lowest scores under the silence condition.

Also, the effect of musical neglect training (MNT) for chronic persistent unilateral visual neglect post-stroke was evaluated by Kang et al (Kang & Thaut, 2019) using a case study design. According to their results, Participant 1 (26 months' post-stroke) benefitted from MNT training as evidenced by Albert's test with statistical significance and showed small but non-significant improvements on the Line Bisection.

Similarly, Gilbert conducted a study to underline how a multisensory music practice could lead to long-term efficiency in activities of daily living. An Improvement of USN was found on paper-pencil tests but also in everyday activities. Benefits subsisted 4 months after rehabilitation

Oren et al., (2013) using a controlled trial investigated the immediate effects of exposure to positive and negative emotional stimuli on visual search characteristics in patients with unilateral neglect. Neglect subjects, but not controls, were slower and more variable in their reaction time for left compared to right-sided targets. In the USN group, detecting left-sided was significantly slower in trials that followed the presentation of negative pictures as compared to positive pictures.

Trejo-Gabriel-Galan et al., (2016) conducted a study to determine if a visual, acoustic alarm in the hemineglect arm activated by a certain discrepancy in the movement of both hands may enhance neglect arm use in five tasks of daily living. Their results showed that both motion and function of the neglected hand improved during the seven days of training when visual, acoustic alarms were active, but a worsening to baseline values occurred on day 8 and day 30 when alarms were switched off. Improvement was limited to vision dependent tasks.

Bang et al., (2015) evaluated using a randomised control design, the effects of body awareness training on mild visuospatial neglect in patients with acute stroke. The results of their study suggest the feasibility and suitability of body awareness training (BAT) with task-oriented training for mild visuospatial neglect in patients with acute stroke. Sato et al., (2010) assessed the effects of colour lightness differences in patients with USN. In their study, they showed that letter cancellation test consisting of black letters with a yellow background showed favourable effects of colour lightness differences with mild left USN, but not in those with severe left USN. Kim et al., (2011) investigated the effect of virtual reality (VR) on post-stroke USN in the acute phase of recovery. The changes in star cancellation test results and Catherine Bagego scale in the VR group were significantly higher than those of the control group after treatment. Changes in line bisection test score and the Barthel index in the VR group were not statistically significant. Schaadt et al., (2016) investigated using a controlled trial whether rotational random dot motion modulates judgements in oblique line tasks among post-stroke survivors exhibiting USN. The result from their study showed that in baseline condition with stroke background, the impaired patient group showed a significant counter clockwise tilt. Using a case study methodology Khurshid et al., (2009) investigated the effects of eye patching on perseveration versus omission errors. Their study showed that contralesional patching did not affect the omissions ($p=0.871$), whereas ipsilesional patching reduced left-sided omissions on line cancellation tests compared with the unpatched condition ($p=0.016$)

Tsang et al., (2009) also investigated the treatment of neglect in stroke patients at the sub-acute phase of recovery using right half-field eye patching. In their study, patients treated after twenty sessions of right half-field eye patching had significantly higher behavioural inattention test gain than those treated with the conventional treatment.

No significant difference in functional independence measure gain between patients in both groups.

Similarly, Shiraishi et al., (2015) investigated using a case study design whether right half-field eye-patched glasses are an effective intervention for USN patients over a year of stroke onset. They reported that after eight weeks of intervention, letter and star cancellation tests were improved in both cases. Line bisection test showed improvement in one patient. However, line cancellation and line bisection tests were worsened in the other. Ianes et al., (2012) evaluated the effectiveness of the right half-field eye patch in the early phases of stroke using an RCT design. Both groups significantly improved their performance in all outcome measures. No difference in the amount of improvement between the two groups was found.

Schmidt et al., (2013) investigated the immediate effects and after-effects of sub-sensory bipolar galvanic vestibular stimulation (GVS). Results from that study showed that left-cathodal/right anodal GVS improved left arm position sense (APS) significantly, which further improved into the normal range 20 minutes' post-stimulation. GVS had no effect in patients without neglect but right-cathodal/left anodal GVS worsened left arm position sense.

Nakamura et al., (2015) in a single-blind, sham control experiment explored the influence of the stimulus parameters of galvanic vestibular stimulation on USN. In their study, after three sessions of galvanic vestibular stimulation, the cancellation scores were significantly increased after 10 and 20 min L-GVS, with a greater increase observed after the latter ($P < 0.0001$). There was a significant positive correlation between the change in the increase in the cancellation score with L-GVS and the total charge ($r = 0.81$, $P = 0.0004$).

Zubko et al., (2013) assessed whether repeated sessions of galvanic vestibular stimulation induce longer carry-over effects in neglect patients. In their study, Improvement was observed in hemineglect amelioration and this improvement was still evident at follow-up three days after baseline. Varalta et al., (2019) assessed using a randomised control design, the effect of therapeutic neck taping on visuospatial abilities, neck motion, and kinaesthetic sensibility in chronic stroke patients. Results from their study indicated that after thirty sessions of treatment, between-group comparison showed significant differences only for the Cervical Joint Position Error Test after treatment ($p = 0.009$). Saj et al., (2018) investigated the effect of a single early EEG neuro-feedback (NFB) training on remediation of spatial neglect in the acute phase. Results from their study revealed that visuospatial tasks showed decreased error rates (mean neglect score 18%) as compared with before NFB (56%; $P = 0.01$) and 1 week after (42%; $P = 0.02$). The difference in error rates between before NFB and 1 week after was not significant ($P= 0.18$). Wen et al., (2019) in their study observed the influence of rehabilitation using the intervention of adjuvant horticultural therapy on stroke-induced USN. Using a randomised control trial design, they demonstrated that after two groups received horticultural therapy, Fugyl Meyer assessment modified Barthel Index was of significant difference. Kutlay et al., (2018) investigated the effects of kinaesthetic ability training on unilateral neglect and functional outcomes in stroke patients. Both control and intervention groups showed significant improvements in all subscales of the behavioural inattention test (conventional and behavioural) ($p < 0.001$) and the functional independence measure motor scale ($p < 0.001$) after therapy. Kang & Kim, (2019) examined the effects of the chopping pattern of proprioceptive neuromuscular facilitation (PNF) on the neglect, balance ability, and activities of daily living in stroke patients with hemispatial neglect.

Significant differences were observed between the experimental and Control group in terms of neglect, balance, and activities of daily living ($p<.05$). Both groups showed significant improvement in neglect, balance, and activities of daily living ($p<.05$).

The effect of a home-based visuomotor feedback training (VFT) in chronic stroke patients with hemineglect was investigated by Rossit et al., (2019); significantly greater short and long-term improvements were obtained after VFT when compared to control training in line bisection and spatial bias in cancellation. VFT also produced improvements on activities of daily living.

Hegarty, (2011) examined the effects of limb-activating strategy using either a rote activity or a meaningful activity (animal-assisted therapy) using a case study methodology in the treatment of an individual with USN. Participants' baking tray task and line bisection score showed improvements from baseline during both the meaningful and rote activity phases, the Star Cancellation Test showed minimal changes. Woods et al., (2012) in a case study, examined the effects of cold pressor stimulation (CPS) on contralesional neglect, perception of stimulus intensity, reaction time and on an electrophysiological correlate of ascending reticular activating system in neglect stroke patients in the chronic phase of recovery. After CPS treatment, measures that normalized from baseline following CPS included contralesional neglect on a clock drawing test, perception of stimulus magnitude.

4.8. DISCUSSION

This scoping review provides an up-to-date review of published studies relating to interventions for post-stroke USN. We aimed to map the current treatment options of patients with post-stroke USN. Studies included in this review were subjected to

methodological quality assessment and we attempted to address the effectiveness of the intervention aimed at ameliorating USN symptoms in post-stroke adult survivors. Eighty-three studies with moderate to high methodological quality were included in our study.

Our study identified thirty intervention options for the amelioration of USN. This finding can be compared with a previous study by Luaute and colleagues (Luaute et al., 2006) that identified eighteen approaches exploring interventions targeted at ameliorating USN symptoms. This shows research interest in post-stroke USN as there is a progression in empirical studies aimed at ameliorating USN.

The variety of interventions for the treatment of post-stroke USN identified in this review study targets training or restoration of activities of daily living, functional independence, arm position sense, visuospatial perception, reading and writing performance, motor function, arm position sense, regional cerebral blood flow and wheelchair driving and balance. These outcomes are critical in neglect rehabilitation as they are impeded in neglect patients (Luaute et al., 2006). Outcomes relating to the quality of life and ADLs are very important in the rehabilitation context as they allow one to communicate the benefit of the intervention on the patient's lifestyle (Smith et al., 2016).

Despite the plethora of studies identified that explored treatment of USN, outcomes relating to the quality of life and activities of daily living does not show a consensus on the studies included in our review as some studies reported benefits in these aspects after the intervention while some failed to show improvements across all the interventions identified in the included studies in our review. The inconsistencies in results may be due to differences which include non-harmonisation of treatment

apparatus, the severity of the stroke, treatment duration, and phase of stroke recovery of patients included in this study and relatively.

Combination therapy and PA therapy in the treatment of post-stroke USN was identified as the most commonly investigated intervention for post-stroke USN. This finding is different from the previous study that identified visual scanning technique as the most explored intervention in the literature for unilateral spatial neglect treatment (Luaute et al., 2006) and it's in tandem with a previous study by Yang and colleagues (Yang et al., 2013) that identified prism adaptation therapy as the most explored intervention in the literature for unilateral spatial neglect treatment This paradigm shift in research interest and output on USN rehabilitation may be because combination therapy shows promises to be cost-effective, lower treatment failure rate and fewer side-effects than monotherapy (Takeuchi & Izumi, 2015). Similarly, PA therapy also appears to be a much simpler, low-risk, low-cost approach and more amenable to standardization for in-hospital use hence researchers find it more exciting to explore in contemporary times (Takeuchi & Izumi, 2015). It is, however, also not daunting, as a previous study by Chen and colleagues (Chen et al., 2018) had surveyed experts' opinions in addressing spatial neglect by scenario (ideal vs. reality) and by recovery phase (earliest, acute, subacute, and chronic). In their study, PA was identified in the top-five selections in the ideal scenario, while in the real scenario, it was in the top-five in all phases except for the earliest phase where it was the sixth most selected.

However, despite the plethora of studies that reported a positive outcome on the effect of prism adaptation in neglect rehabilitation, it is not certain if these positive gains observed in non-randomised studies included in They showed that two weeks our review were due to chance as without adequate controls these gains could be attributed to spontaneous recovery. Although no study is likely on its own to prove

causality, randomization studies reduce bias and provide a rigorous tool to examine cause-effect relationships between an intervention and outcome. This is because, the act of randomization balances participant characteristics (both observed and unobserved) between the groups allowing attribution of any differences in outcome to the study intervention (Hariton & Locascio, 2018). Hence, inferences can be drawn from such research methodology that can be translated into practice. It is therefore pertinent to note that interpretation of case studies and non-randomised control trials should be approached with caution as improvements observed may be due to spontaneous recovery.

Several PA studies (Mancuso et al., 2012; Mizuno et al., 2011b; Nys et al., 2008; Rode et al., 2015; Serino et al., 2009; Turton et al., 2010; Yoneda et al., 2011) in our review utilized randomised control methodology and reported positive and negative outcomes on neglect measures, activities of daily living, and functional independence which are important in communicating neurorehabilitation gains. However, there appears to be no single neglect measure that is reliably affected by PA as most of the studies utilized several outcome measures (Such as the Catherine Bergego scale, Behavioural inattention test, line bisection test and the line bisection ion test). Also, protocols for these RCTs were not homogenous; for instance: duration of intervention and phase of stroke recovery varied widely and we did not conduct a pooled analysis of intervention. Therefore, we can't conclusively infer that these gains observed in PA studies were superior to gains observed in other intervention studies. Even though PA studies were in preponderance, evidence on the long-term effect of PA in the rehabilitation of USN appears to be modest as only one study by Serino et al (Serino et al., 2009) utilized an RCT methodology to elucidate a long-term positive gain in neglect measures.

Although several other studies in our review demonstrated amelioration in neglect symptom and other rehabilitation outcomes, evidence for long lasting beneficial effect was elusive in most studies. For instance, Nys et al (Nys et al., 2008) showed improvement in USN symptoms that were short termed. Similarly, a study by Rode et al (Rode et al., 2015) reported that PA session over 4 weeks was not sufficient to produce long-term functional benefit. A study by Turton and colleagues, however, reported no improvement in neglect symptoms personal care after prism adaptation. A possible explanation for the lack of any differences between groups in self-care behaviour or impairment level test performance by Turton and colleagues (Turton et al., 2010) may include: outcome measures were measured four days after the end of treatment and so it may be that any effects were short and may have worn off by the time of the assessment. The pointing bias data showed a partial lapse in adaptation over the weekends when treatment was not delivered. Also, prism power and repetition of pointing tasks might have a role as 10 dioptres with 6 degrees shift prism goggles was utilized in their study. However, there are very few studies that have investigated the effect of prism strength in USN outcome. Mancuso et al (Mancuso et al., 2012) reported that prism that produced 5 degrees' deviation, did not contribute to the variation in performance.

Combination therapy or polytherapy is an exciting treatment approach that uses more than one medication or modality has been suggested in pharmacotherapy, electrotherapy and in neuro-rehabilitation (Takeuchi & Izumi, 2015). Combining therapeutic approaches for cortical reorganization and maximal functional gain in patients with stroke is based on the processes of Hebbian plasticity and homeostatic metaplasticity has been suggested by Takeuchi & Izumi, (2015). Also, another theory suggests that the underlying mechanism for combination strategies in ameliorating

neurological deficits in stroke survivors is interhemispheric competition model; however, applying this theory to all patients with stroke is oversimplified or even untrue (Pino et al., 2014). The concept of priming has also shed more light to understand the interaction between different neurorehabilitation processes when interventions are performed simultaneously. Behavioural, environmental, pharmacological, or electrophysiological stimulation have been utilized as priming strategies that modify the effects of a subsequent intervention. Prime cortical stimulation because there is strong evidence that this can change cortical excitability (Takeuchi & Izumi, 2015)

Nevertheless, combination techniques identified in our study have shown mixed results. There is heterogeneity in the combined neurorehabilitation protocols that are used, for example, interventions concerning factors such as the number of sessions, intensity, type and timing of, time after stroke, lesion site, the severity of motor function, gender, pathology, which adds complexity to this field.

In our study, six studies investigated the use of combination therapy in the treatment of Neglect the sub-acute phase of stroke recovery (Aparicio-López et al., 2016; Fong et al., 2013; Luauté et al., 2014; Polanowska et al., 2009; Schröder et al., 2008; N. Y. Yang et al., 2017), only one study by Aparicio-Lopez (Aparicio-López et al., 2016) did not show improvement at that phase of stroke recovery. However, two studies investigated the rehabilitation of chronic post-stroke neglect (Saevarsson et al., 2010; Wu et al., 2013). Even though combination therapy seems to show more promise at the sub-acute phase, it is, however, difficult for us to make a conclusive inference on what phase of recovery of stroke combination will be more useful in the rehabilitation process. This could be due to the heterogeneity of studies included, as most of the spontaneous recovery after a stroke occurs in the first month following a stroke (Kerkhoff & Schenk, 2012b). Hence subsequent more focused research is required to

decipher the phase or appropriate commence time for selection of the respective interventions for hemineglect rehabilitation in stroke.

Also, interventions such as visual acoustic alarm virtual reality, cold pressors stimulation, music therapy, robotics, vestibular stimulation, rotating random-dot motion and electrical stimulations identified in our review appears to be in tandem with the contemporary research direction that emphasises the use of technologies in stroke treatment and rehabilitation. For instance, over the last ten years, many devices for robotic-assisted training have been proposed to allow patients to perform task-oriented exercises (Hesse et al., 2012; Huang & Krakauer, 2009) and wearable devices for an objective assessment of human movements have been developed for substituting in clinical settings the expensive and difficult to use sophisticated systems of research gait laboratories (Iosa et al., 2012).

Similarly, the majority of the included studies were randomised controlled trials (RCT). This finding is not astonishing as a well-conducted RCT is known to provide the best evidence for decision making about the clinical effectiveness of interventions and are regarded as the *gold standard* for answering questions of effectiveness in evidence-based practice (Sacks et al., 1982). Studies on intervention for post-stroke USN included in our review were conducted majorly on stroke patients in the chronic phase of recovery. This is in tandem with previous studies (Luaute et al., 2006; Mizuno et al., 2011b) which reported that majority of investigations aimed at ameliorating USN symptoms in stroke survivors were majorly conducted in stroke patients at the chronic phase of recovery with very few studies focusing on the acute phase. This has clinical implications as it might inform the selection of intervention appropriate at each phase of stroke recovery. However, with relatively little evidence for treatment of acute neglect, it will be difficult to appropriately choose interventions at this stage. Also, it

has been reported that the severity of USN in acute stroke worsens the degree of long-term disability and functional independence (Luvizutto et al., 2018) hence it is imperative to commence rehabilitation early, targeting the acute stage of neglect to give a better prognosis.

Lastly, the adverse effect of interventions was not reported and dosage of various studies such as treatment using prism is not conclusive. Ethical issues still exist on the use of some interventions such as deep brain stimulation (Schermer, 2011). Hence there is a need for further studies to elucidate on these aforementioned controversies observed and caution taken when translating to a clinical practice setting. One could assume that the lack of adverse effects being reported could be because periodization models of treatment regimen are progressed on an individualized basis, which prevents the aspect of overtraining.

4.9. STRENGTHS AND LIMITATIONS

The strength of this review is the utilization of a meticulous and standardized recommended approach for conducting scoping reviews and the use of broad search terms across several databases which increased the likelihood of including all the available research articles needed for this review.

Also, the large information eligible for extraction from articles by the two independent reviewers means some relevant studies could have been missed. Exclusion of non-English studies may have led the authors to miss out on some relevant studies published in other languages which are not English.

4.10. CONCLUSION

This review aimed to map the current interventions for USN in people with stroke. The last 12 years have witnessed a relative increase in the study of potential interventions for USN rehabilitation. Although optimal protocols still need to be defined, prism adaptation and combination therapy were the most commonly investigated interventions for the treatment of USN. Both positive and negative outcomes were observed across all measures of neglect.

The results of the study are critical for understanding the extent to which current evidence is relevant in clinical practice and the current direction in research for post-stroke treatment of USN. The result of this review may form a road-map for a more focused systematic review (with meta-analysis) on current interventions and efficacy of interventions for USN in stroke survivors.

Veronica Ntsiea: Reviewing, supervision, editing, validation and methodology formulation

Ronel Roos: Reviewing, supervision, editing

Chuka Umeonwuka: Conceptualization, data collection, preliminary data analysis, manuscript drafting, methodology formulation

5. CHAPTER 5: CURRENT PRACTICE AND KNOWLEDGE OF POST-STROKE UNILATERAL SPATIAL NEGLECT REHABILITATION: CROSS-SECTIONAL SURVEYS OF NIGERIAN AND SOUTH AFRICAN PHYSIOTHERAPISTS

This chapter presents the current practice and knowledge of post-stroke unilateral spatial neglect among a cohort of physiotherapists in South Africa and Nigeria. The study population for the South-Africa cohorts were delimited to physiotherapists with neuro-rehabilitation interests and are members of the South African society of physiotherapy neurology interest group while the Nigerian cohort were registrants of the medical rehabilitation and therapist's board.

The reasons for choosing South Africa and Nigeria for my survey studies are not ambiguous. Aside suitability as mentioned by the examiner. It is encouraged for researchers to improve scholarship in his immediate milieu.

Previous studies have reported that Nigeria and South Africa should be focus of stroke research in Africa as Akinyemi et al (2021) reported the annual incidence rate of stroke in Africa is up to 316 per 100,000 individuals, which is within the highest incidence rates in the world, and the prevalence rate of 1,460 per 100,000 reported in one region of Nigeria, western Africa, is clearly among the highest in the world(Akinyemi et al., 2021).

The reports for the two cohorts were presented distinctly in sub-sections 5.1 and 5.2 in manuscript format submitted to the international journal of therapy and rehabilitation (In review) and South African journal of physiotherapy (accepted for publication). results from both cohorts were discussed in chapter 7 (integrative discussion).

5.1. CURRENT PRACTICE AND KNOWLEDGE OF POST-STROKE UNILATERAL SPATIAL NEGLECT REHABILITATION: A NATIONAL SURVEY OF NIGERIAN PHYSIOTHERAPISTS.

5.1.1. INTRODUCTION

About 50–70% of patients surviving right hemispheric stroke will experience a perceptual disorder known as post-stroke USN (Buxbaum et al., 2004c; Nijboer et al., 2013; Paolucci et al., 2001). '*USN is the inability to report, respond or orient to meaningful stimuli presented to the side opposite the brain lesion*' (Heilman et al., 2000, abstract section). It is associated with poor rehabilitation outcomes (Jehkonen et al., 2000; Kalra et al., 1997b; Katz et al., 1999; Paolucci et al., 2001) and is a strong predictor of post-stroke recovery (Aarts et al., 2004).

A variety of rehabilitation techniques for USN rehabilitation has been explored in the past (Luaute et al., 2006). However, despite the plethora of available evidence, there seems to exist a knowledge-to-practice translation gap, with a lack of uptake of evidence-based practice skills into clinical decision-making for post-stroke rehabilitation (McEvoy et al., 2011). Physiotherapists are no exception despite the significant increase in knowledge and skills in the physiotherapy profession both in academic curricula and in clinical practice (Manns et al., 2015).

Physiotherapists are health-care professionals trained to provide rehabilitative care in a wide range of disabling conditions with the aim of restoring, maintaining and promoting function in persons with activity limitations and participation restrictions (American Physical Therapy Association, 2011). However, poor knowledge and skills about a specific condition pose a strong barrier to implementing a guideline for

effective stroke rehabilitation (Menon et al., 2010; Petzold et al., 2014a; Pollock et al., 2000). Identification of practice barriers is fundamental in the process of translating knowledge into practice (McCluskey & Middleton, 2010). Sadly, there is a significant gap between actual and current practice in stroke rehabilitation (Menon et al., 2010). It is possible that the evidence-practice gap occurs because of systemic barriers, team or individual barriers. These barriers may include lack of knowledge and skills, negative or out-dated attitudes, or inefficient systems which as a consequence affects practice (Petzold et al., 2012; Pollock et al., 2000). Practice guidelines for stroke rehabilitation, and thus for USN treatment, are available globally (Bryer et al., 2010; Hebert et al., 2016b; Ringleb et al., 2008; Winstein et al., 2016b). Treatment for USN is unclear given USN's impact on stroke and brain injury survivors. There is however, a dearth of empirical or anecdotal studies investigating adherence of practice guidelines for USN treatment in stroke survivors attending rehabilitation clinics. The certitude that USN is underdiagnosed in clinical settings (Chen et al., 2013; Punt & Riddoch, 2006) portrays that not all clinicians who provide care to patients with stroke have sufficient knowledge or rarely assess patients for USN. In these cases, those with SN may not have had the potential benefit of undergoing treatment for SN.

Survey studies in the United Kingdom, Australia and the United States of America have explored the theoretical beliefs underpinning current practice of stroke rehabilitation (Carr et al., 1994; DeGangi & Royeen, 1994; Lennon et al., 2001; Lennon, 2003; Natarajan et al., 2008; Nilsson & Nordholm, 1992). However, two studies in the United States of America by Chen et al., (2018) and Menon-Nair et al., (2007) evaluated treatment approaches specific to post-stroke unilateral spatial neglect.

In Nigeria, stroke rehabilitation practices involve conventional approaches consisting mostly of the Bobath and Brunnstrom techniques (Abdullahi et al., 2016). Hamzat and colleagues (Hamzat et al., 2012) in a regional survey reported that neglect was observed in thirty-seven percent of stroke patients. Although Nigerian Physiotherapy training has evolved, it is targeted at producing generalist physiotherapists and not specialist physiotherapists. Although post-graduate programs in physiotherapy abound, albeit these programs aimed at reinforcing clinical critical reasoning and research competencies. Despite the plethora of treatment options suggested for treatment of stroke specific perceptual disorder such as unilateral spatial neglect, it is unclear if this evidence is available and integrated in clinical practice.

Physiotherapists' knowledge about post-stroke USN rehabilitation, clinical current practice and the barrier and enablers they encounter in practice are very important when planning treatment, informing health policies and conducting continued education programs. To the best of our knowledge, no study has evaluated physiotherapists' knowledge, current practice, barriers and enablers to post-stroke USN rehabilitation. Also, physiotherapist's knowledge and current practice of USN may provide prospective answers to questions that have not been answered by research and insights into the gap between research and clinical practices.

Therefore, with the foregoing in mind, this study was conceptualized to evaluate physiotherapist's knowledge, current self-reported practice, barriers and enablers to post-stroke USN rehabilitation amongst Nigerian Physiotherapists.

5.1.2. MATERIALS AND METHODS

5.1.2.1. Study Design

A cross-sectional national survey of physiotherapists who provide services to stroke survivors in neurological units in Nigeria was conducted from November 2018 to June 2019. The exclusion criteria to this survey were the following: i) Intern physiotherapists, ii) physiotherapists who were not licensed by the medical rehabilitation and therapist board of Nigeria, iii) Physiotherapists who are not members of any of the two physiotherapy professional associations in Nigeria, iv) physiotherapists not currently working neurology units.

5.1.2.2. Sample size

A sample size of 153 physiotherapists was calculated statistically using an 80% power and a 5% confidence limit, 50% hypothesized frequency of outcome (estimated at 50% to reflect the assumption that 50% of the population would have a good knowledge of USN) (Suresh & Chandrashekara, 2012) and it was based on the 2,038 physiotherapists listed in the MRTB register.

5.1.2.3. Study setting

Participants

The study participants were Nigerian physiotherapists currently providing stroke rehabilitation services in neurology units either in the private or the public health sector. One thousand five hundred physiotherapists were contacted through the medical rehabilitation and therapist board database (MRTB). In Nigeria, MRTB is a federal agency that regulates rehabilitation specialists and physiotherapists. Although this number is in contrast with the bulletin of the Medical Rehabilitation Therapist Board (MRTB) of Nigeria published in 2013, which listed 2,038 licensed physiotherapists in Nigeria (Medical Rehabilitation Therapist Board of Nigeria., 2012). A sample size of 153 physiotherapists was calculated statistically using an 80% power

and a 5% confidence limit, 50% hypothesized frequency of outcome (estimated at 50% to reflect the assumption that 50% of the population would have a good knowledge of USN) (Suresh & Chandrashekara, 2012) and it was based on the 2,038 physiotherapists listed in the MRTB register. However, current evidence has indicated that about half of the licensed physiotherapists in Nigeria are likely to immigrate to another country (Oyeyemi et al., 2012). More so, the MRTB's list did not state whether the physiotherapists in their list were practicing in Nigeria or providing stroke rehabilitation services in neurology units. As a result, the researcher could not completely rely on the MRTB list to determine how many physiotherapists were currently practicing in the country. Hence, we approached the two physiotherapy associations; The Nigerian Society of Physiotherapists (NSP) and the Association of Clinical and Academic Physiotherapists of Nigeria (ACAPN) to grant us access to the database of their members with a special interest in neurological physiotherapy and they were contacted to compliment the MRTB list.

5.1.3. DATA COLLECTION TOOL

The data collection tool for study was a questionnaire on knowledge, current practice, barriers and enablers to unilateral spatial neglect (see Appendix I). The aim of the pilot study was to test the developed questionnaire; after the pilot study the following was achieved: Redundant questions were removed to avoid ambiguity; the reliability of the questionnaire (subsections) was established and data capturing procedure using the online platform (REDcap) was understood.

The questionnaire was validated by experts in questionnaire design and experts in stroke rehabilitation and was also pilot tested on eight consenting clinicians in stroke rehabilitation. The questionnaire took approximately 15-20 minutes to complete and

consists of four sections (Section A to D). Section A elicits questions on respondent's demographic characteristics.

Section B contains 25 items for assessing the knowledge on USN developed for this study adopted from a previous study by Petzold and colleagues (Petzold et al., 2012). The knowledge questions are adapted from Petzold et al., (2012) which comprises questions on (i) USN problem identification, (ii) USN assessment use, (iii) USN intervention use, and (iv) knowledge of USN and best practice recommendations including the anatomy of neglect. Each item has three responses ("Agree", "Disagree" or "Undecided") with a maximum score of 25 and a minimum score of 0. An "Agree" response to a correct statement was scored 1, a "Disagree" response to a wrong statement was also scored 1, and a "Disagree" response to a correct statement was scored 0. An "Agree" response to a wrong statement was scored 0 and an "Undecided" response was disregarded. A knowledge score of <10 indicated poor knowledge; 10-19 indicated moderate knowledge while 20-25 represented good knowledge. This ranking was essentially for the determination of level of knowledge among the participants and was not for inferential statistics.

Section C assessed the physiotherapist's current practice of USN. The questions are structured to decipher the current assessment strategy, treatment approach, referral or teamwork in the treatment of post-stroke USN.

Lastly, section D contains multiple-choice questions on enablers and barriers already identified in the literature on stroke rehabilitation (Ogourtsova et al., 2019b; Petzold et al., 2014a). The questions on barriers consist of, therapist, institutional, client suitability, and equipment factors. Item by item responses as well as the summed scores for knowledge was presented to allow readers to examine the data in both

ways. Similarly, therapists were asked to rate barriers or enablers to the treatments of post-stroke USN; on a scale of 1-5 with 1 the greatest barrier or enabler and 5 least barrier or enabler. The scoring was done so that 1-2=major barrier or facilitator; 3= moderate barrier; 4-5 = Minor barrier. The intraclass correlation of this questionnaire (α) yielded 0.93, 0.72 and 0.64 for sections B, C, and D respectively. ICC coefficient less than 0.5= poor reliability, between 0.5 and 0.75 =moderate reliability, between 0.75 and 0.9 = Good reliability, greater than 0.9 =excellent reliability.

5.1.3.1. DATA COLLECTION PROCEDURE

Study data were captured and managed using Research Electronic Data Capture, an electronic data capture tool hosted at the University of Witwatersrand (Harris et al., 2009). A survey link containing the study questionnaire was sent to physiotherapists' telephone numbers (n=1500) by the Medical Rehabilitation and Therapist's Board of Nigeria (MRTBN). Similarly, interest groups (Neurology) of the Nigerian Society of Physiotherapists (n=97) and the Association of Clinical and Academic Physiotherapists of Nigeria (ACAPN), (n=49). Also, a hardcopy of the questionnaire (n=46) was distributed at the 2018 neuro-rehabilitation congress in Ibadan, Nigeria. Reminders were sent to the respondents every three weeks while the data collection for this study was from November 2018-August 2020.

Consent was obtained electronically, question seeking for participant's consent was presented at the beginning of the electronic version of the questionnaire. An explanation was presented detailing that by continuing with the completion of the questionnaire they consent to the study.

5.1.4. SURVEY ANALYSIS

The data were analysed using IBM SPSS Statistics for Macintosh, Version 25.0. (IBM, 2017). Means and standard deviations were used to summarize continuous data, while frequencies and percentages were used to summarize categorical data. To explore relationships between demographic characteristics of the main outcome measure (Knowledge of USN), inferential statistics was used. Spearman rank correlation was used to compare the medians of continuous variables (age, years of practice) that were not normally distributed while student t-test was used to compare the means of continuous normally distributed data. The Shapiro-Wilk test was used to test for normality of data. ANOVA test was employed to establish the relationship between categorical variables. *Incomplete questionnaire (that has missing fields) were treated as defective survey and were excluded from analysis* (Leung & Qin, 2006)

The significance level of .05 was used. Item by item responses as well as the summed scores for knowledge was presented to allow readers to examine the data in both ways.

5.1.5. ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the University of the Witwatersrand Committee for Research on Human subjects (Approval Number M180155) (See approval letter attached: appendix XII). Also, permission to conduct this study was obtained from the National Research Ethics committee of Nigeria (Approval Number NHREC/01/01/2007-30/07/2018) and the medical rehabilitation and therapist board of Nigeria. See approval letter attached: Appendix XIII).

5.1.6. RESULTS

Out of the total 1692 physiotherapists invited to participate in the survey, 498 responded, yielding a response rate of 29.43%. Two hundred and forty (48.19%) out of the 498 respondents completed the questionnaire and one hundred and seventy (70.83%) respondents indicated they provided stroke rehabilitation services in neurology units. Figure 1 shows the flow of respondents.

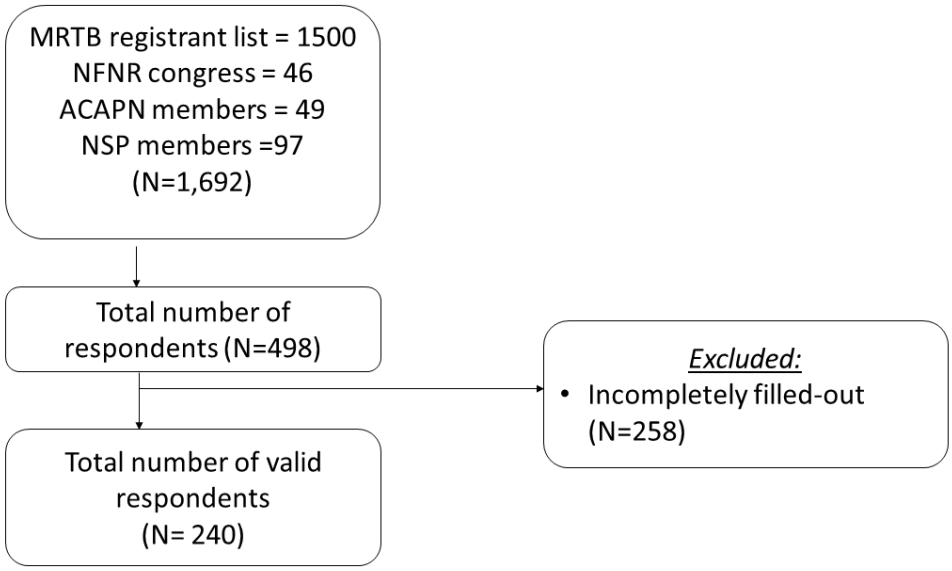


Figure 5. 1: Flow diagram illustrating respondents' selection process.

(** ACAPN = Association of Clinical and Academic Physiotherapists of Nigeria NSP = Nigeria society of physiotherapist; MRTB= Medical rehabilitation and therapist board; NFNR = Nigerian federation of Neurorehabilitation)

5.1.6.1. Respondents' characteristics

The majority of respondents were male (n=145, 60.66%) with a median age of 32 years (range 23 - 68). One hundred and fifteen (48.12%) of the respondents had an entry-level bachelor's degree while one hundred and sixty-four (68.62%) worked mostly in a hospital setting and sixty-two (26.16%) had post-graduate certification in

neurological physiotherapy. The respondents' characteristics are presented in Table 5.1

Table 5. 1: Socio-demographic characteristics of responders (N=240)

Variable	Value
Age	
Median (range) in years	32(23 - 68)
Gender, n (%)	
Male	145(60.66)
Female	92(38.49)
Preferred not to say	2(0.84)
Settlement setting, n (%)	
Rural	2(0.84)
Semi-rural	8(3.35)
Semi-urban	60(25.10)
Urban	169(70.71)
Years of Practice as a Physiotherapist, Median (range) in years	7 (1 - 43)
Educational level, n (%)	
Bachelors	115(48.12)
Post-graduate diploma	4(1.67)
Master's Degree	98(41.00)
Doctorate	22(9.21)
Clinical practice setting, n (%)	
Hospital	164(68.62)
Rehabilitation centre	14(5.86)
Out-patient Department	30(112.56)
Domiciliary/Home health	26(10.88)
Others (Academics)	5(2.10)
Postgraduate certification in Neurological rehabilitation, n (%)	
Yes	62(26.16)
No	175(73.84)
Work Full time in neuro-rehabilitation, n (%)	
Yes	81(53.29)
No	71(46.71)
Duration of Practice in Neuro-rehabilitation unit, Median (IQR) in years	5 (1 - 28)
Cadre, n (%)	
Physiotherapist	105 (43.93)
Senior Physiotherapist	50 (20.92)
Principal Physiotherapist	23 (9.62)
Chief Physiotherapist	16 (6.69)

Assistant Director of Physiotherapy	21 (8.79)
Director of physiotherapy`	10 (4.18)
Others	14 (5.86)

IQR: Interquartile range

5.1.6.2. Physiotherapists' knowledge of unilateral spatial neglect

The total knowledge score was 12.6±4.75 on a scale of twenty-five. Seven Physiotherapists (7.92%) demonstrated good knowledge of USN, while the majority had moderate knowledge (N=154; 64.17%). (See table 5.2).

Table 5. 2: Ranking of scores on physiotherapists' knowledge of post-stroke USN

Variable	**Value**
Overall knowledge about unilateral spatial neglect	
Mean *(SD)*	12.6 (4.75)
Maximum Knowledge score	25
Minimum Knowledge score	0
Categories of USN knowledge score	
< 10 Poor knowledge *n (%)*	67 (27.92)
10-19 Moderate knowledge *n (%)*	154 (64.17)
20-25 Good knowledge n (%)	7 (7.92)

Having a postgraduate certification (t=-3.780; p=0.001), clinical practice setting (F=3.51; p=0.008), and working full time in neurorehabilitation (t=-2.158; p=0.033), were significantly associated with therapist's knowledge of USN. However, there was no significant association between USN knowledge and physiotherapist's gender (t=0.25; p=0.801), Cadre (F=1.94; p=0.470), settlement setting of facility (F=0.26; p=0.855) and physiotherapist's educational level (F=1.94; p=0.125). There was also a non-significant minimal positive correlation between duration of practice in neuro-rehabilitation setting (r=0.02; p=0.854), with USN knowledge. Also, there was a non-significant minimal negative correlation between of practice as a physiotherapist (r=-0.02; p=0.772) with USN knowledge, Age of physiotherapists showed no linear

relationship with therapist's Knowledge on USN (r=-0.00; p=0.992). Table 5.3 shows a summary of inferential statistics of the relationship between physiotherapist's knowledge score of USN and their sociodemographic characteristics.

Table 5. 3: Relationship between physiotherapists' knowledge score of USN and demographics

Variable	Mean knowledge score	SD	Statistic	p-value
Age	12.60	4.75	0.00†	0.992
Gender				
Male	12.68	4.76	0.25††	0.801
Female	12.52	4.80		
Settlement setting of facility				
Rural	10.50	0.71	0.26 †††	0.855
Semi-rural	12.13	3.87		
Semi-urban	12.95	5.23		
Urban	12.60	4.56		
Educational level				
Bachelors	12.54	4.81	1.94†††	0.125
Post-graduate diploma	10.75	3.10		
Master's Degree	12.38	4.62		
Doctorate	14.82	4.16		
Clinical practice setting.				
Hospital	13.30	4.54	3.51 †††	0.008**
Rehabilitation centre	13.00	3.86		
Out-patient Department	11.00	3.90		
Domiciliary/Home health	11.12	5.53		
Other	8.6	6.43		
Postgraduate certification in Neurological rehabilitation.				
Yes	14.53	4.21	-3.780 ††	0.000**
No	11.98	4.69		
Work Full time in neuro-rehabilitation.				
Yes	13.43	4.03	-2.158 ††	0.033**
No	11.97	4.30		
Duration of Practice in Neuro-rehabilitation unit.	12.60	4.75	0.02†	0.854
Years of Practice as a Physiotherapist	12.60	4.75	-0.02 †	0.772
Cadre				
Physiotherapist	12.65	4.26	0.94 †††	0.470
Senior Physiotherapist	13.02	4.98		

Principal Physiotherapist	13.47	4.82		
Chief Physiotherapist	13.62	4.27		
Assistant Director of Physiotherapy	12.33	5.17		
Director of physiotherapy	11.00	3.40		
Others (Academics that are honorary consultants)	10.64	6.65		

† = Spearman's rank correlation. †† = ttest ††† = ANOVA** = statistical significance @ p<0.05

In addition, item by item analysis of the questions on knowledge of post-stroke USN showed that two hundred and twenty-six (94.96%) of physiotherapists agreed that 'Constraint-induced movement therapy is a rehabilitation option for USN'. Also, Albert's Test was identified as standardized screening tool for USN (Table 5.4).

Table 5. 4: Item by item Frequency distribution of responses of physiotherapists to questions on knowledge on unilateral spatial neglect.

		Responses N (%)	
S/No.	**Statement**	**Agree**	**Disagree/ Undecided**
1.	Unilateral spatial neglect is the inability to orient or respond to stimuli appearing on the contralateral side of a brain lesion	228(95.40)	11(4.60)
2.	Unilateral spatial neglect in stroke patients is more common in left hemispheric stroke than in right hemispheric stroke	115(348.12)	124(51.88)
3.	Unilateral spatial neglect in stroke is commonly associated with a lesion in the inferior parietal lobe.	124(52.32)	113(47.68)
4.	Unilateral spatial neglect in stroke is commonly associated with cognitive dysfunction.	156(65.55)	82(34.45)
5.	Brain tumours can result in unilateral spatial neglect symptoms.	200(83.68)	39(16.32)
6.	Traumatic brain injury cannot result in unilateral spatial neglect symptoms	47(19.67)	192(80.33)
7.	Unilateral spatial neglect in stroke is more common in younger patients than in older individuals.	23(9.66)	215(90.34)
8.	Most stroke patients with unilateral spatial neglect symptoms show recovery within the first week	62(25.94)	177(74.06)

9.	Unilateral spatial neglect in stroke is associated with a longer hospital stay.	132(55.46)	106(44.54)
10.	Unilateral spatial neglect in stroke predicts poor rehabilitation outcome.	154(64.44)	85(35.56)
11.	Albert's Test is a standardized screening tool for unilateral spatial neglect	94(39.50)	144(60.50)
12.	The Crovitz-zener scale can be used to screen for unilateral spatial neglect	75(31.51)	163(68.49)
13.	Spinal cord injury is a condition to consider for differential diagnosis of spatial neglect.	76(31.93)	162(68.07)
14.	The best possible time for assessment of Unilateral spatial neglect in stroke patients is at the chronic stage.	57(23.95)	181(76.05)
15.	Unilateral spatial neglect symptoms can be treated using pharmacological agents	84(35.29)	154(64.71)
16.	The drug rivastigmine can be used in the management of Unilateral spatial neglect symptoms.	81(34.18)	156(65.82)
17.	Mirror therapy is a rehabilitation option for unilateral spatial neglect	223(93.70)	15(6.30)
18.	Eye patching is a rehabilitation option for unilateral spatial neglect	170(71.43)	68(28.57)
19	Functional electrical stimulation and transcutaneous electrical stimulation are rehabilitation options for unilateral spatial neglect	148(62.18)	90(37.82)
20.	Constraint-induced movement therapy is a rehabilitation option for unilateral spatial neglect.	226(94.96)	12(5.04)
21.	Line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection, and representational drawing can be used as an assessment tool to establish the presence of unilateral spatial neglect	197(82.77)	41(17.23)
22.	Use of yoked prism is a treatment option for unilateral spatial neglect that its benefits extend to dressing, postural stability, walking, sit-to-stand transfers and wheelchair driving	157(66.24)	80(33.76)
23.	Visual scanning exercise is not an effective technique in the treatment of unilateral spatial neglect.	67(28.15)	171(71.85)

24.	Listening to music scale will not ameliorate unilateral spatial neglect symptoms	76(32.07)	161(67.93)
25.	Mental practice cannot improve unilateral spatial neglect symptoms	53(22.46)	183(77.54)

The shaded portion represents the correct option for each question

5.1.6.3. Physiotherapists' practice of post-stroke unilateral spatial neglect

One hundred and seventy (71.4 %) physiotherapists indicated that they provide treatment to stroke survivors who exhibit spatial neglect symptoms.

On the assessment of patients with neglect, the majority of the respondents (n= 77; 45.5%) indicated that on average, they identified 1-2 patients of that exhibit USN symptom every 3 months. Also, the majority of the respondents (n=51;30%) indicated that the average duration before performing an evaluation to identify USN in stroke patients was 3 to 5 days after admission into rehabilitation. Similarly, less than half of physiotherapist (n=79; 46.75%) reported using a specific standardized tool in assessing patients for USN (Table 5.5).

Among the therapists that indicated they use specific assessment tool for screening USN in practice, Albert test (n=39; 49.37%) was the most utilized assessment tool (Figure 5.2).

When asked treatment used in practice, majority of the physiotherapists (86.47%) indicated that constraint induced movement therapy was the most utilized intervention for patients with post-stroke USN while and Transcranial stimulation was the least utilized intervention (3.53%) (Figure 5.3)

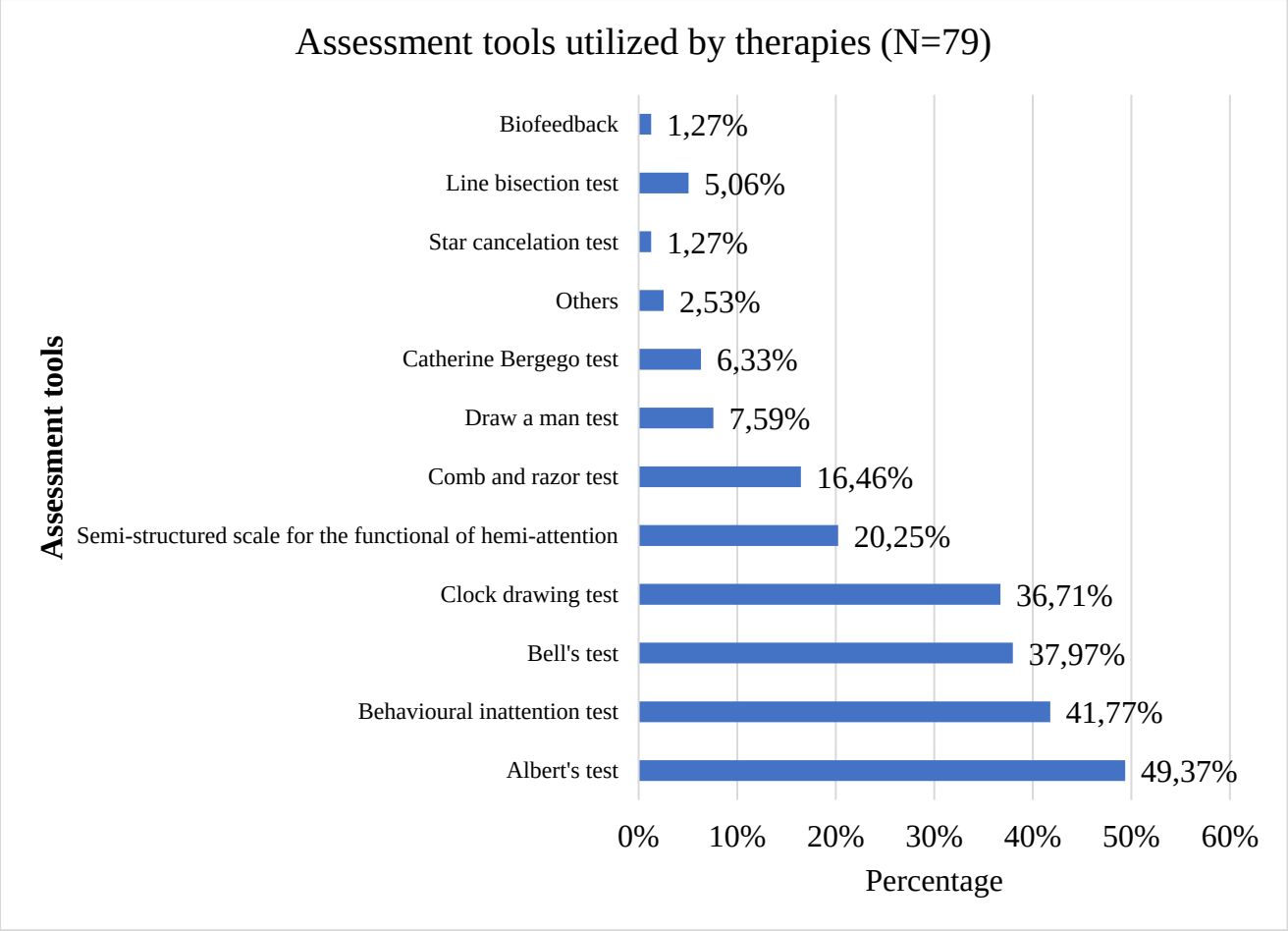


Figure 5. 2: Assessment tools utilized by physiotherapists in identifying post stroke USN.

Table 5. 5: Physiotherapist's practice in post-stroke unilateral spatial neglect management.

Statement	Frequency	%
Do you provide treatment to stroke survivors who exhibit spatial neglect symptoms?		
Yes	170	71.43
No	68	28.57
Number of cases of stroke patients with unilateral spatial neglect do you identify every 3 month period		
1 – 2	77	45.56
>2-5	53	31.36
>5-10	27	15.98
>10-15	7	4.14
>15-20	4	2.37
>20-30	1	0.59
Duration before performing initial evaluation to identify unilateral spatial neglect in stroke patients (days)		
1 – 2	45	26.47
>2-5	51	30.0
>5-10	42	24.71
>10-15	17	10.0
>15-20	5	2.94
>20-30	2	1.18
>30	8	4.71
Do you re-evaluate a patient for unilateral spatial neglect after you have performed an initial evaluation		
Yes	144	85.71
No	24	14.29
How soon do you re-evaluate a patient for unilateral spatial neglect after you have performed an initial evaluation (in days)		
1 – 2	12	8.33
>2-5	26	18.06
>5-10	44	30.56
>10-15	31	29.85
>15-20	9	6.25
>20-30	14	9.72
>30	8	5.56
Specific screening tool in assessing of your patients for unilateral spatial neglect		
Yes	79	46.75
No	90	53.25

Do you refer patients with post-stroke to other members of the healthcare team?		
Yes	156	92.31
No	13	7.69

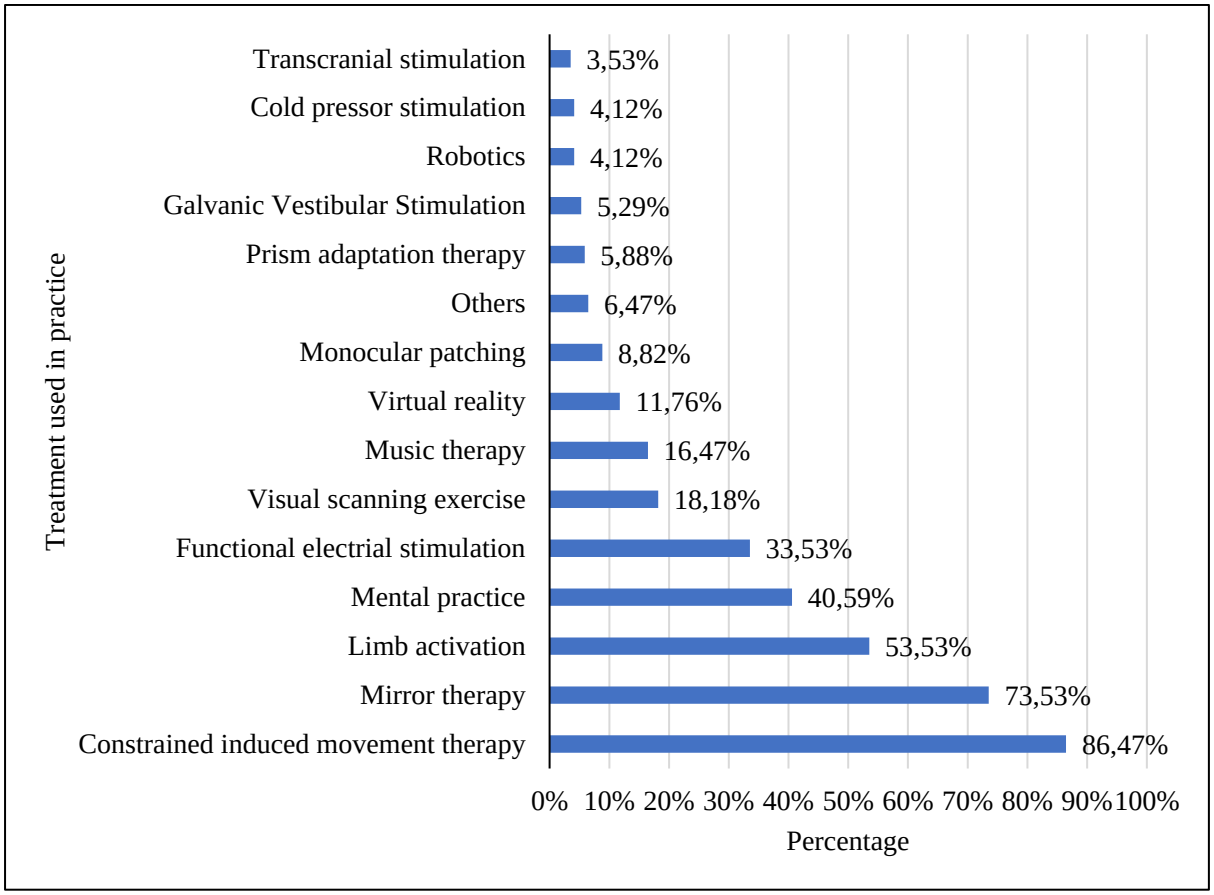


Figure 5. 3: Treatment utilized by Physiotherapists in the treatment of post-stroke USN in practice (N=170)

One hundred and fifty-six physiotherapists indicated they referred their patients to other members of the health team. Neuropsychologists (91.03%) followed by occupational therapists (60.90%) were reported to receive the majority of referrals (Figure 5.4).

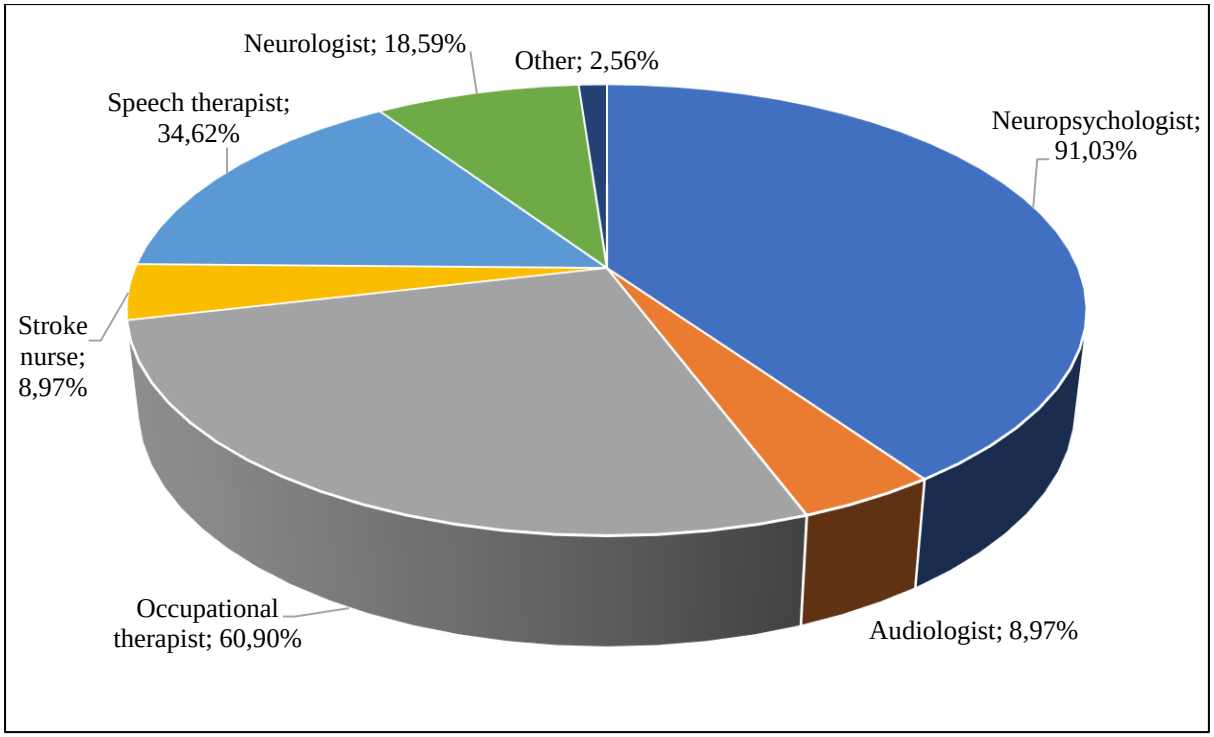


Figure 5. 4: Referral system for post-stroke unilateral spatial neglect (N=156)

5.1.6.4. Physiotherapists' perceived barriers and enablers to treatment of post-stroke unilateral spatial neglect

Majority of the respondents indicated that "*Lack of relevant equipment for Rehabilitation of USN at clinical practice"* (73.72%), "*Limited staff capacity*" (62.82%) and "*lack of hands-on pre-requisite skills needed for post-stroke unilateral spatial neglect rehabilitation*" (57.0%) were major barriers to post-stroke USN rehabilitation.

Conversely, about half (49.36%) of the respondents reported that therapists believe that therapy for patients with USN made no difference was a minor barrier to USN

rehabilitation

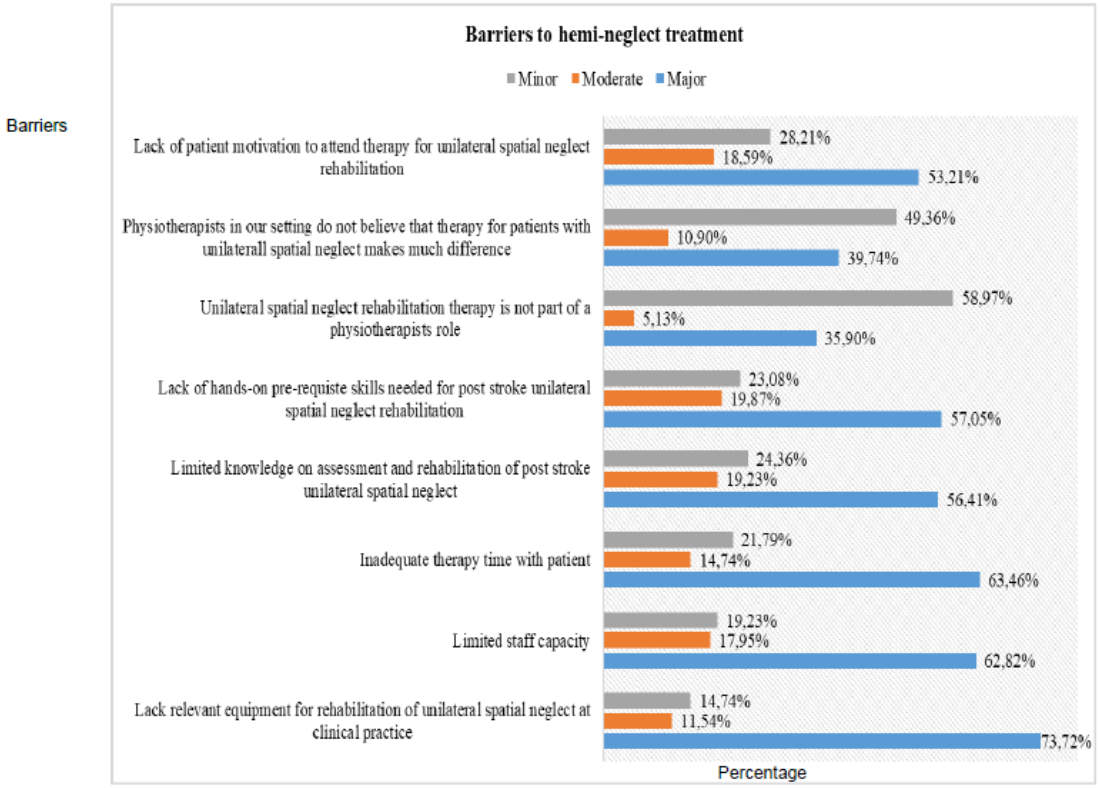


Figure 5. 5: Physiotherapist's perceived barriers to unilateral spatial neglect management (N= 170)

When therapists were asked about enablers to USN rehabilitation *'Specialized training in USN management'* was reported by majority (83.56%) of physiotherapist as a major enabler to post-stroke USN treatment in addition to "*Presence of multidisciplinary stroke team in clinical practice*" (83.56%) and "*Availability of relevant equipment at clinical practice* (84.25%). (Figure 5.6)

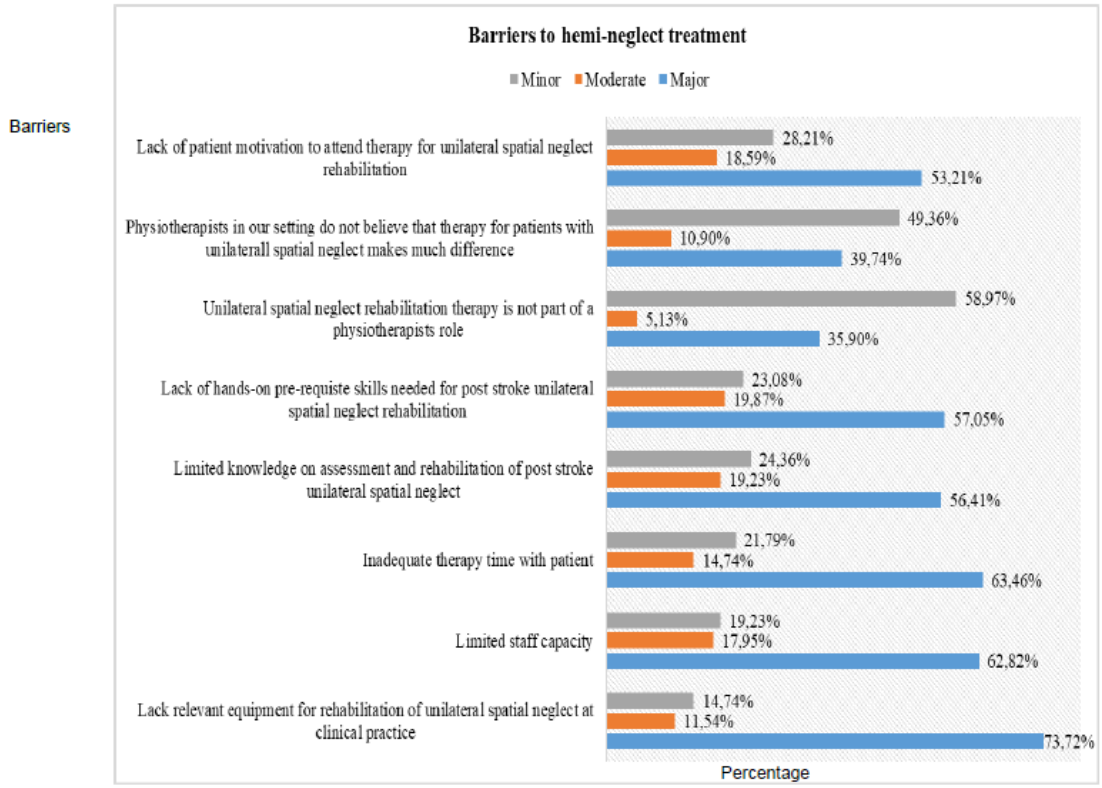


Figure 5. 6: Physiotherapist's perceived barriers to unilateral spatial neglect management (N=170)

5.1.7. DISCUSSION

This study evaluated physiotherapists' knowledge, current practice, barriers and enablers to post-stroke USN rehabilitation in Nigeria. To the best of our knowledge, this is the first nationally representative study to evaluate the physiotherapists' knowledge, current practice, barriers and enablers to post-stroke USN rehabilitation in Nigeria. Physiotherapists' understanding of post-stroke USN is important for the holistic management of stroke patients.

This study showed that a vast majority of physiotherapists surveyed demonstrated moderate knowledge while fewer physiotherapists demonstrated good knowledge of

post-stroke USN. This implies that physiotherapists in Nigeria had a decent knowledge of USN. This is in tandem with the study by Kalu and colleagues that reported a moderate level of knowledge about multiple medications as a risk factor for falls (Kalu et al., 2019).

Although fewer therapists demonstrated good knowledge of the subject, it is not surprising as previous studies reported Nigerian Physiotherapists demonstrated good knowledge on health promotion in Nigeria (Abaraogu et al., 2019). However, our finding is in contrast with previous studies that reported poor knowledge of physiotherapists on topical pharmacotherapy (Onigbinde et al., 2012), leprosy (Ayanniyi et al., 2013) and use of stroke assessment scale (Okafor et al., 2010). This moderate knowledge on post-stroke USN reported by the therapist in this study could be ascribed to the fact that physiotherapists based on the nature of their training are skilled in stroke management as succinctly identified by Bernhardt et al that asserted that physiotherapists are active drivers in stroke rehabilitation (Bernhardt et al., 2004).

The presence of a neurological physiotherapy team may also have played a pivotal role in the high preponderance of moderate knowledge in our study as our population are physiotherapists working with stroke patients and it could be presumed these therapists seized the learning opportunity in form of stroke-specific continuing education that the worksite presents. However, an item-by-item analysis of the knowledge questionnaire depicts that physiotherapist in Nigeria had poor knowledge on standardized outcome measures used in post-stroke USN. Petzold and colleagues had reported in a previous study that being part of a stroke team significantly correlated with greater mean change in scores on the knowledge questionnaire of best practices for occupational therapists treating post-stroke USN (Petzold et al., 2012). This finding is not surprising as previous studies (Odole et al., 2018; Okafor et al., 2010) identified

poor knowledge of stroke assessment scale among Nigerian physiotherapists. Although our study did not take into cognizance the reasons for this occurrence, Udoka and colleagues (Okafor et al., 2010) reported that the reason physiotherapists did not utilize standard outcome measures was that therapists were not taught the use of stroke assessment in their undergraduate training. The physiotherapy training curriculum in Nigeria has evolved over the years with changes to meet the current demands of professionalism in physiotherapy. Hence, we cannot categorically affirm that Udoka and colleagues report ten years are still valid as a reason for the non-utilization of standardized outcome measures in practice in our study (Okafor et al., 2010). Although practicality, clinical relevance, cost, lack of resources, lack of time, lack of availability, lack of management support, and a lack of training and proficiency with measurement instruments have also been identified as factors that hinder the use of standardized outcome measures (Duncan & Murray, 2012; Meadows et al., 1998).

Furthermore, possession of a certification in neuro-rehabilitation, working full time in neurology and therapist's practice setting were statistically associated with knowledge of physiotherapists on post-stroke USN. This finding corroborates previous studies that showed that rehabilitation professionals who had higher qualifications had a higher knowledge of the stroke-specific evidence-based practice (EBP) (Menon-Nair et al., 2007b; Petzold et al., 2012). This might not be unconnected to the content of advanced condition-specific training and critical reasoning received in advanced training. Similarly, workplace enablement such as working full-time in a neuro-rehabilitation unit presents ample time and stroke -specific learning opportunity to the therapist to continually participate in patient care and also participate in continuing medical education that the worksite presents which may influence their knowledge on the subject. Why the clinician's duration of work in neuro-rehabilitation was not

statistically associated with knowledge scores is an interesting query. It may be that the therapist is not fully stationed at the unit for a significant amount of time as most health facilities operate such that physiotherapists rotate between various units available in that facility. Interestingly, more than half of the physiotherapists in our study indicated that they do not work full time in neurorehabilitation units. This is not surprising as Nigerian physiotherapists working in tertiary facilities are posted to several sub-speciality units such as orthopaedics, neurology, paediatrics and cardiopulmonary physiotherapy. This observation however underscores the importance of a clinical based residency training program so therapists will have more focused and specific competencies in specific speciality areas.

Conversely, Physiotherapist's gender, the settlement setting (whether urban or rural setting) of the facility and the cadre of physiotherapists were not statistically associated with knowledge. Although these characteristics are institutional factors and were not significantly associated with the physiotherapist's knowledge score on post-stroke USN, some interesting findings were observed. Firstly, these physiotherapists working in urban and semi-urban settings had a better knowledge score than therapists working in other settings. Likewise, chief physiotherapists had better knowledge scores. Anecdotally, it might be that physiotherapists practising in an urban and semi-urban setting have more access to learning facilities and access to internet resources at their disposal to engage in continuing education programs than their counterparts in the rural setting. Furthermore, it is not surprising that the Chief physiotherapist cadre had the highest post-stroke USN knowledge. This could be attributed to institutional practices and administration in Nigeria. Firstly, Chief physiotherapy cadres in many settings are heads of various units and are involved in day-to-day clinical operations which is in sharp contrast to their assistant director's cadre counterpart in

most tertiary health facilities in Nigeria that are mostly in administrative and managerial duties. Secondly, they, in most instances, have more access and funding to CPDs in the form of workshops and in-service training which exposes them to current trends in the treatment approach. Thirdly, they must have worked longer in a unit (Including neurological unit) than most other lower cadres hence most have acquired more clinical skills and exposure as they ascend the ranks.

Also, our study evaluated the current practice of physiotherapists in post-stroke USN treatment. Findings from our study revealed a vast majority of our respondents provided treatment with USN symptoms whereas less than half of clinicians indicated the use of some form of a standardized assessment tool. A comparably low prevalence has been reported in Canada where only thirteen percent of post-stroke survivors were assessed with a standardized USN assessment tool (Menon-Nair et al., 2006). A divergent finding has been documented, also in Canada, where 67% reported using standardized USN assessment tools (Menon-Nair et al., 2006). This is not surprising as Odole and colleagues (Odole et al., 2018) in a previous study in Nigeria reported the poor usage of standard account measures among Nigerian physiotherapists in practice. This observation might not be unconnected to training received as Okafor and colleagues (Okafor et al., 2010) reported that a low number of physiotherapists (28%) reported the use of outcome measures due to training received. Interestingly, our study corroborates this finding as it was observed that physiotherapists demonstrated poor knowledge in the identification of standard outcome measures used as shown in the item by item analysis of knowledge on post-stroke USN. A lack of identification of post-stroke USNs is serious for both the patient and society, as most patients return to their daily lives before being informed about the potential risks of such activities in relation to community mobility or driving. The rate of recovery from

neglect is highest within the first month hence the importance of repeat assessment. Sadly, the initial identification of neglect was quite low in our study. A similar finding was reported by Menon-Nair and colleagues (Menon-Nair et al., 2006) though a prevalence of USN of 37.0% has been reported by Hamzat et al in a Nigerian population (Hamzat et al., 2012). Interestingly, re-evaluation practice among therapists was good and conforms to clinical practice guidelines for stroke which emphasized timely and multidisciplinary patient assessment using a formal protocol in documented form and carried out within 72 hours of patient admission after stroke (*Clinical guidelines for stroke rehabilitation and recovery*, 2005).

Albert test and the behavioural inattention test were indicated as the most utilized USN assessment tools by physiotherapists. Similarly, the majority of clinicians indicated using a USN intervention, with the three most common being Constraint-induced movement therapy (CIMT), Mirror therapy and limb activation exercise. This finding is not daunting as a vast majority of respondents were knowledgeable on the therapeutic effects of these treatment options. However, Menon-Nair and colleagues (Menon-Nair et al., 2006) reported perceptual training and Bells test as the most utilized intervention and assessment of USN with constraint-induced movement therapy as the least reported utilised intervention for USN in their study. Similarly, Checketts and colleagues in an interdisciplinary, multinational survey reported that Cognitive tests were used in USN evaluation by 82% of respondents (particularly by psychologists, cancellation and drawing were most popular). 80% used functional assessments (physiotherapists were most likely) while 20% (mainly physicians, from Italy) used neuroimaging/ neuromodulation (Checketts et al., 2020).

Even though CIMT has been investigated in neglect treatment and considerable evidence on its efficacy is available (Luaute et al., 2006). However, an interesting

finding is that the reported intervention for amelioration of post-stroke USN in this study is not in tandem with the current evidence trend in USN treatment. Umeonwuka and colleagues (Umeonwuka et al., 2020) in a scoping review study reported a combination of two or more approaches and Prism adaptation therapy as the most investigated and promising rehabilitation intervention for post-stroke USN.

Lastly, we also explored barriers and facilitators physiotherapists encounter in the course of treating patients with post-stroke USN. In our study, the three most reported barriers to post-stroke USN treatment by Nigerian physiotherapists include: i) lack of relevant equipment for rehabilitation of USN ii) Limited staff capacity iii) Lack of hands-on prerequisite skills needed for USN management. This finding corroborates a study in Canada by Petzold et al. (Petzold et al., 2014a) that indicated a lack of basic skills specific to USN treatment as one of the key barriers to the management of post-stroke unilateral neglect. Similarly, Baatiema et al., (2017) identified poor staff number, inadequate staff development opportunities and limited knowledge of stroke care interventions as a barrier to evidence-based acute stroke care in Ghana. This is understandable as strokes generally need specialized skills. More so, Nigeria is a developing country and physiotherapy practice in Nigeria, like in many developing nations, is fraught with some challenges such as unwholesome work settings, understaffing and lack of appropriate equipment. To address the issue of limited staff numbers, an immediate short-term measure would be to consider task-shifting approaches, as opined by Akinyemi and colleagues (Akinyemi et al., 2015) which have been shown to improve knowledge of health-workers in acute stroke care, thus potentially translating into improved patient outcomes. It is however not astonishing as the majority of physiotherapists surveyed in our study identified specialized training in USN and practising in an environment with access to learning time about USN

treatment as enablers to post-stroke USN treatment. This finding is consistent with previous studies (Petzold et al., 2014a). The findings of the present study present practical implications. First, the identified barriers and facilitators to best practice for post-stroke USN assessment and treatment could be a reference point for future research on priorities for effective outcomes in stroke rehabilitation and for the planning of training programs specific for stroke care.

In conclusion, our study evaluated physiotherapists' knowledge, current practice, barriers and enablers to post-stroke USN using a quantitative methodology. Findings show that the majority of Nigerian physiotherapists who provide stroke rehabilitation services have good knowledge of post-stroke USN. This finding is crucial as it can inform policy for specialist entry level of practice in Nigeria as there is a growing paradigm shift from generalist to specialist care. Clinicians need to be educated on effective treatments and how to implement them, based on these data. It's also imperative that therapists monitor their beliefs and update their practice as new evidence emerges.

It is crucial that clinicians actively read professional literature so that they can make use of the updated evidence base. The uncertainty revealed in some sections of the survey indicates that further evidence of clinical approaches is necessary. There is a need to develop a comprehensive treatment program based on basic and clinical scientific research, using current therapeutic practices that are supported by the literature. It would be beneficial to investigate the components of treatment methods and prioritize them further

5.1.8. LIMITATION OF STUDY

Using an online knowledge test may have a limitation in that clinicians may turn to outside sources for answers. An attempt was made to reduce this potential by reducing the amount of time that the clinician had to complete the questionnaire.

Also, the small sample size in this study could affect the reliability of the survey results. A probable reason for the low response rate in this study may be that physiotherapists may have missed the emails (as the emails may have been delivered to their spam folders in their emails since the questionnaire was sent in bulk to all MRTB members). Another possible reason for the low response rate may be because physiotherapists as a result of their workload spend minimal time at their desk or in front of a computer or smart devices and have also missed emails containing the survey questionnaire for this study. In addition, most of the respondents that completed this survey practice in urban areas. This limits the generalizability of the study findings to semi-urban and rural settings.

The next chapter presents findings from the survey of the current practice and knowledge of post stroke USN rehabilitation among South African Physiotherapists as well as the barriers and facilitators to USN rehabilitation in this context. The South African Cohort was drawn from the neurology special interest group and as such differ from the Nigerian cohort that was drawn from the general pool of Physiotherapists.

Veronica Ntsiea: Reviewing, supervision, editing, validation and methodology formulation

Ronel Roos: Reviewing, supervision, editing

Chuka Umeonwuka: Conceptualization, data collection, preliminary data analysis, manuscript drafting, methodology formulation

5.2. CURRENT PRACTICE AND KNOWLEDGE OF POST-STROKE UNILATERAL SPATIAL NEGLECT REHABILITATION: A CROSS-SECTIONAL SURVEY OF SOUTH AFRICAN PHYSIOTHERAPISTS.

5.2.1. INTRODUCTION

Unilateral spatial neglect (USN) is "*a failure to report, respond or orient to stimuli presented in the side of space contralateral to the injured cerebral hemisphere, which cannot be explained by primary sensory or motor deficit*" (Heilman et al. 2000, abstract section). Spatial neglect occurs after stroke, or degenerative diseases and is a multifaceted and disabling condition (Andrade et al., 2010). Incidence of neglect differs extensively in reported studies and this variability is between 12% and 95% (Robertson & Halligan, 1999). This variability of USN incidence is due to a plethora of factors such as operational definition of USN, assessment type to identify USN and heterogeneity of USN presentation (Ting et al., 2011). In many post-stroke patients, the severity of neglect symptoms persists chronically (Farnè et al. 2004; Katz et al. 1999) with a negative affectation in almost every activity that contributes to daily living and rehabilitation outcome such as postural balance (Gottlieb & Levine, 1992; Pérennou, 2006; Taylor et al., 1994; Van Nes et al., 2009), functional mobility (Berti et al., 2002; Tromp et al., 1995), quality of life (Franceschini et al., 2010; Sobrinho et al., 2018), ADLs (Cherney et al. 2001; Jehkonen et al. 2000, 2001; Vossel et al. 2013) and hospital stay duration (Chen et al. 2015; Hammerbeck et al. 2019; Wee & Hopman, 2008). Several interventions to ameliorate USN have been proposed by researchers (Luauté et al. 2006a; Umeonwuka et al. 2020). Strategies for USN symptom amelioration are broadly classified into bottom-up or top-down methods (Marshall, 2009). Treatment options have metamorphosed in the last decades from a

more conventional and conservative approach to the use of technology combining more than one treatment approach (Umeonwuka et al., 2020) and they include prism adaptation, combination therapy, constraint induced movement therapy (CIMT), transcutaneous electrical nerve stimulation (TENS), transcranial magnetic stimulation, virtual reality, visual scanning exercise and trunk rotation exercise. Current stroke treatment guidelines recommend the all-inclusive and timeous screening and diagnosis of USN as a critical part of post-stroke care (Bryer et al., 2010; National Stroke Foundation, 2010; Royal College of Physicians, 2012; Winstein et al., 2016). However strict adherence to these protocols is not guaranteed and translational gaps exist between theory and practice in the management of post-stroke USN (Checketts et al., 2020). Identified assessments currently utilized by rehabilitation experts in clinical practice include; cognitive, functional and neuro-imaging (Checketts et al., 2020). In South Africa, a study by Ntsiea (2019), that collated South African physiotherapy stroke rehabilitation services and research identified saccadic eye movement priming with visual scanning exercise as an effective physiotherapy intervention for USN. However, no study had examined the uptake of intervention identified as effective in the treatment of USN by South African neuro-rehabilitation physiotherapists. With the foregoing in mind, this study was conceptualized to evaluate physiotherapists' knowledge, current practice, and barriers and facilitators to the rehabilitation of USN in South Africa. An understanding of the physiotherapists' knowledge, practice and barriers they encounter in the treatment of USN will enable the neuro-rehabilitation team including the physiotherapy educators to better strategize and plan to achieve better outcomes in USN specific treatment post-stroke.

5.2.3. METHODS

5.2.3.1. Study Design

A cross-sectional national survey of physiotherapists who are members of the South African society neurology special interest group was conducted from November 2018 to June 2019.

5.2.3.2. Sample size

Total sampling technique was employed in the recruitment of participants in this study. There was no sample size calculation for this survey study as all two hundred and seventy-seven physiotherapists on the list of the SASP were invited to participate in this study.

5.2.3.3. Study setting

Participants

The study participants were South African physiotherapists that are members of the South African Society Neurology Special Interest group currently providing stroke rehabilitation services in the neurology unit either in the privately owned or government owned facilities. Two hundred and seventy-seven physiotherapists were contacted through the SASP (neurology speciality interest group). These physiotherapists provide neurological services to patients.

Inclusion and exclusion criteria

The exclusion criteria to this survey were the following: i) community service physiotherapists, ii) physiotherapists who were not registered with the Health Professions Council of South Africa (HPCSA) iii) Physiotherapists who are not

members of the neurology speciality interest group of the South African Society of Physiotherapists (SASP). iv) Physiotherapists not currently working in neurology units.

5.2.3.4. Data Collection Tool

The data collection tool used for this study was a questionnaire on knowledge, current practice, barriers and enablers to USN (see Appendix I). The questionnaire has been described in detail in chapter three of this thesis.

5.2.3.5. Data collection procedure

Study data were collected and managed using Redcap (Research Electronic Data Capture), an electronic data capture tool hosted at the University of Witwatersrand (Harris et al., 2009). The REDCap application is developed to capture data for research studies in a secure, web-based environment. A survey link containing the study questionnaire was sent to physiotherapists' (that are members of the neurology interest group of the SASP) telephone numbers and emails by South African Society of Physiotherapists. (n=277). Consent was obtained electronically: question seeking for participant's consent was presented at the beginning of the electronic version of the questionnaire. An explanation was presented detailing that by continuing with the completion of the questionnaire they consent to the study.

5.2.3.6. Survey Analysis

A version 25.0 of IBM SPSS Statistics for Macintosh was used for the analysis of the data (IBM, 2017). Means and standard deviations were used to summarize continuous data, while frequencies and percentages were used to summarize categorical data. To explore relationships between demographic characteristics of the main outcome measure (Knowledge of USN), inferential statistics were used. Spearman rank

correlation was used to compare the medians of continuous variables that were not normally distributed while student t-test was used to compare the means of continuous normally distributed data. The Shapiro-Wilk test was used to test for normality of data. ANOVA test was employed to establish the relationship between categorical variables. Incomplete questionnaire (that has missing fields) were treated as defective survey and were excluded from analysis (Leung & Qin, 2006)

The significance level of .05 was used. Item by item responses as well as the summed scores for knowledge was presented to allow readers to examine the data in both ways.

5.2.4. ETHICAL CONSIDERATIONS

The Ethics Board for Human Research at the University of the Witwatersrand approved the study (Approval Number M180155) (See approval letter attached: Appendix XII).

5.2.5. RESULTS

5.2.5.1. Respondents' characteristics

Table 5.6. Outlines the characteristics of the respondents.

A total of 28 physiotherapists completed the questionnaires. Female respondents were in preponderance (n=25; 89.29%) while the median age was 34.5 (22 – 61) years. Physiotherapists working in the urban settlement were in the majority (n =23; 82.14%). Most of the respondents had a bachelors' degree as the highest educational level (n =14; 50%), whereas seven respondents (25%) possessed a master's degree and six (21.43%) possessed a doctorate (PhD). However, only nine (32.14%) of the therapists

had a postgraduate degree certification in neurological rehabilitation and the majority of the respondents work full time in neurorehabilitation (n= 16; 76.19%). The median years of practice of the respondents were 12 (0-40) years while the median duration of practice in the neuro-rehabilitation unit of the respondents was 10.5 (1-30) years.

Table 5. 6: Socio demographic characteristics of participants (South African population)

Variable	**Value**
Age **Median (Range) in years**	34.5(22 - 61)
Gender, n (%)	
Male	3(10.71)
Female	25(89.29)
Preferred not to say	0(0.00)
Settlement setting, n (%)	
Semi-urban	5(17.86)
Urban	23(82.14)
Years of Practice as a Physiotherapist, **Median (Range) in years**	12 (0 - 40)
Educational level, n (%)	
Bachelors	14(50.00)
Post-graduate diploma	1(3.57)
Master's Degree	7(25.00)
Doctorate	6(21.43)
Clinical practice setting, n (%)	
Hospital	9(32.14)
Rehabilitation centre	13(46.43)
Out-patient Department	4(14.29)
Domiciliary/Home health	2(7.14)
Postgraduate certification in Neurological rehabilitation, n (%)	
Yes	9(32.14)
No	19(67.86)
Work Full time in neuro-rehabilitation, n (%)	
Yes	16(76.19)
No	5(23.81)
Duration of Practice in Neuro-rehabilitation unit, Median (IQR) in years	10.5(1 - 30)
Cadre, n (%)	
Production Physiotherapist	19(67.86)

Chief Physiotherapist	5(17.86)
Others (Academics that are honorary consultants)	4(14.29)

5.2.5.2. Physiotherapists' knowledge of unilateral spatial neglect

Table 5.7 highlights the ranking of the score on physiotherapist's knowledge of post-stroke USN. The overall knowledge score on USN was 14.11±5.23 (on a total scale of 25). Twenty-two (81.48%) physiotherapists had a moderate knowledge (score between 10 and 19) while only two (7.41%) had a good knowledge score (score of 20-25) on unilateral spatial neglect.

Table 5. 7: Ranking of scores on physiotherapists' knowledge of post-stroke USN (South African population)

Variable	**Value**
Overall knowledge about unilateral spatial neglect	
Mean *(SD)*	14.11 (5.23)
Maximum Knowledge score	22
Minimum Knowledge score	0
Categories of USN knowledge score	
< 10 Poor knowledge *n (%)*	3 (11.11)
10-19 Moderate knowledge *n (%)*	22 (81.48)
20-25 Good knowledge n (%)	2 (7.41)

Analysis of the relationship of respondent's demographics and USN knowledge showed that there was a significant moderate positive correlation between respondents age (r=0.46; p=0.016) and years of practice as a physiotherapist (r= 0.43; p= 0.026) and knowledge of USN. Conversely, respondent's cadre (p =0.066), working full time in neuro-rehabilitation (p=0.918), possession of post-graduate certification in neurological rehabilitation (p=0.126), clinical practice setting (p=0.051), educational level (p=0.651), gender (p=0.595) and settlement setting of facility (p=0.967) were not

significantly associated with USN knowledge score of respondents. Table 5.8 shows the relationship between physiotherapists USN knowledge score and demographics of respondents.

Table 5. 8: Relationship between physiotherapist's USN knowledge demographics

Variable	Mean knowledge score	SD	Statistic	p-value
Age	14.11	5.23	0.46†	0.016**
Gender				
Male	15.67	3.79	0.54††	0.595
Female	13.92	5.41		
Settlement setting of facility				
Semi-urban	14.2	5.97	0.04 ††	0.967
Urban	14.09	5.20		
Educational level				
Bachelors	12.43	5.65	0.86†††	0.651
Post-graduate diploma	0			
Master's Degree	16.71	4.11		
Doctorate	15.00	4.52		
Clinical practice setting.				
Hospital	10.00	5.79	7.77 †††	0.051
Rehabilitation centre	15.42	4.08		
Out-patient Department	18.00	0.82		
Domiciliary/Home health	17.00	2.83		
Post graduate certification in Neurological rehabilitation.				
Yes	16.50	4.38	-1.58 ††	0.126
No	13.11	5.33		
Work Full time in neuro-rehabilitation.				
Yes	15.80	3.82	-0.10 ††	0.918
No	15.60	3.21		
Duration of Practice in Neuro-rehabilitation unit.	14.11	5.23	0.25 †	0.377
Years of Practice as a Physiotherapist	14.11	5.23	0.43 †	0.026*
Cadre				
Production Physiotherapist	7.25	8.38	5.44 †††	0.066
Chief Physiotherapist	16.20	2.77		
Others (Academics that are honorary consultants)	15.06	3.78		

† = Spearman's rank correlation †† = ttest ††† = ANOVA

Also, item by item analysis showed that the respondents (as a pool data) demonstrated a good knowledge in questions related to definitions of unilateral spatial neglect 92.86% of respondents agreed to the question 1 (which is the correct response obtainable) (see table 6.4). Similarly, respondents demonstrated a moderate knowledge on questions about incidences and occurrence of USN (questions 2 & 7), causes of USN (question 5 & 6), anatomy of neglect (questions 3), prognosis (question 8, 9 & 10), screening and diagnosis (questions 11, 12, 13, 14). However, respondents showed poor knowledge in pharmacological approach to management of USN (questions 15 and 16). Table 5.9. Shows the item-by-item response to questions on USN neglect.

Table 5. 9: Item by item Frequency distribution of responses of physiotherapists to questions on knowledge on unilateral spatial neglect.

		Responses N (%)	
S/No.	Statement	Agree	Disagree/ Undecided
1.	Unilateral spatial neglect is the inability to orient or respond to stimuli appearing on the contralateral side of a brain lesion	26(92.86)	2(7.14)
2.	Unilateral spatial neglect in stroke patients is more common in left hemispheric stroke than in right hemispheric stroke	19(67.86)	9(32.14)
3.	Unilateral spatial neglect in stroke is commonly associated with a lesion in the inferior parietal lobe.	13(48.15)	14(51.85)
4.	Unilateral spatial neglect in stroke is commonly associated with cognitive dysfunction.	15(55.56)	12(44.44)
5.	Brain tumours can result in unilateral spatial neglect symptoms.	23(85.19)	4(14.81)
6.	Traumatic brain injury cannot result in unilateral spatial neglect symptoms	23(85.19)	4(14.81)
7.	Unilateral spatial neglect in stroke is more common in younger patients than in older individuals.	16(59.26)	11(40.74)

8.	Most stroke patients with unilateral spatial neglect symptoms show recovery within the first week	1(3.70)	26(96.30)
9.	Unilateral spatial neglect in stroke is associated with a longer hospital stay.	19(70.37)	8(29.63)
10.	Unilateral spatial neglect in stroke predicts poor rehabilitation outcome.	19(70.37)	8(29.63)
11.	Albert's Test is a standardized screening tool for unilateral spatial neglect	12(44.44)	15(55.56)
12.	The Crovitz-zener scale can be used to screen for unilateral spatial neglect	7(25.93)	20(74.07)
13.	Spinal cord injury is a condition to consider for differential diagnosis of spatial neglect.	23(85.19)	4(14.81)
14.	The best possible time for assessment of Unilateral spatial neglect in stroke patients is at the chronic stage.	19(70.37)	8(29.63)
15.	Unilateral spatial neglect symptoms can be treated using pharmacological agents	2(7.41)	25(92.59)
16.	The drug rivastigmine can be used in the management of Unilateral spatial neglect symptoms.	4(14.81)	23(85.19)
17.	Mirror therapy, is a rehabilitation option for unilateral spatial neglect	20(74.07)	7(25.93)
18.	Eye patching is a rehabilitation option for unilateral spatial neglect	14(51.85)	13(48.15)
19	Functional electrical stimulation and transcutaneous electrical stimulation are rehabilitation options for unilateral spatial neglect	14(51.85)	13(48.15)
20.	Constraint induced movement therapy is a rehabilitation option for unilateral spatial neglect.	20(74.07)	7(25.93)
21.	Line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection, and representational drawing can be used as an assessment tool to establish the presence of unilateral spatial neglect	24(88.89)	3(11.11)
22.	Use of yoked prism is a treatment option for unilateral spatial neglect that its benefits extend to dressing, postural stability, walking, sit-to-stand transfers and wheel chair driving	13(48.15)	14(51.85)

23.	Visual scanning exercise is not an effective technique in the treatment of unilateral spatial neglect.	13(48.15)	14(51.85)
24.	Listening to music scale will not ameliorate unilateral spatial neglect symptoms	7 (25.93)	20(74.07)
25.	Mental practice cannot improve unilateral spatial neglect symptoms	16(59.26)	11(40.74)

The shaded parts represent the correct answers for each statement.

5.2.5.3. Physiotherapists' practice of post-stroke unilateral spatial neglect rehabilitation

The majority of the respondents (n= 20;71.43%) provides treatment to stroke survivors who exhibit spatial neglect symptoms. On average, nine (45%) respondents reported they identified a maximum of two post-stroke USN patients every three months while four respondents reported identifying about 16 to 20 post-stroke USN patients within the same time frame. Duration before initial evaluation to identify unilateral spatial neglect was also assessed, the majority (n=9;45%) of the respondents reported that they took about one to two days on average before evaluating to identify USN in stroke patients. Similarly, nineteen (95%) respondents reported performing re-evaluation for USN after initial evaluation to identify USN and six (31.58%) respondents reported that they performed re-evaluation about six to ten days after they had performed an initial evaluation for USN (Table 5.10). On screening for USN, half of the respondents reported using specific standard tools in screening for USN. The comb and razor test (n= 8; 28.57%) was reported as the most utilized assessment tool for USN screening among the respondents while constraint-induced movement therapy (n=14; 50%) and mirror therapy (n=14; 50%) were reported to be the two most utilized treatment options for USN among the respondents (Figure 5.7 and 5.8 shows the treatment and screening tool utilized by Physiotherapists in the

treatment of post-stroke USN in practice). All the respondents reported referring stroke survivors with USN to other member of the health care multidisciplinary team (MDT) of which occupational therapist (n=19;67.86%) and speech therapist (n=13; 46.43%) were MDT members with the most referrals from physiotherapists. (See Figure 5.9).

Table 5. 10: Physiotherapist's practice in post-stroke unilateral spatial neglect management (N=28)

Statement	Frequency	Percentages
Do you provide treatment to stroke survivors who exhibit spatial neglect symptoms?		
Yes	20	71.43
No	8	28.57
Number of cases of stroke patients with unilateral spatial neglect do you identify every 3 month period		
1 – 2	9	45.00
>2-5	9	45.00
>5-10	1	5.00
>10-15	1	5.00
>15-20	4	25.00
Duration before performing initial evaluation to identify unilateral spatial neglect in stroke patients (days)		
1 – 2	9	45.00
>2-5	3	15.00
>5-10	3	15.00
>10-15	2	10.0
>15-20	1	5.00
>20-30	2	10.00
Do you re-evaluate a patient for unilateral spatial neglect after you have performed an initial evaluation		
Yes	19	95.00
No	1	5.00
How soon do you re-evaluate a patient for unilateral spatial neglect after you have performed an initial evaluation (in days)		
1 – 2	4	21.05
>2-5	5	26.32
>5-10	6	31.58
>10-15	3	15.79
>15-20	0	0
>20-30	1	5.26

Specific screening tool in assessing of your patients for unilateral spatial neglect		
Yes	10	50.00
No	10	50.00
Do you refer patients with post-stroke to other members of the healthcare team?		
Yes	20	100.00
No	0	0.00

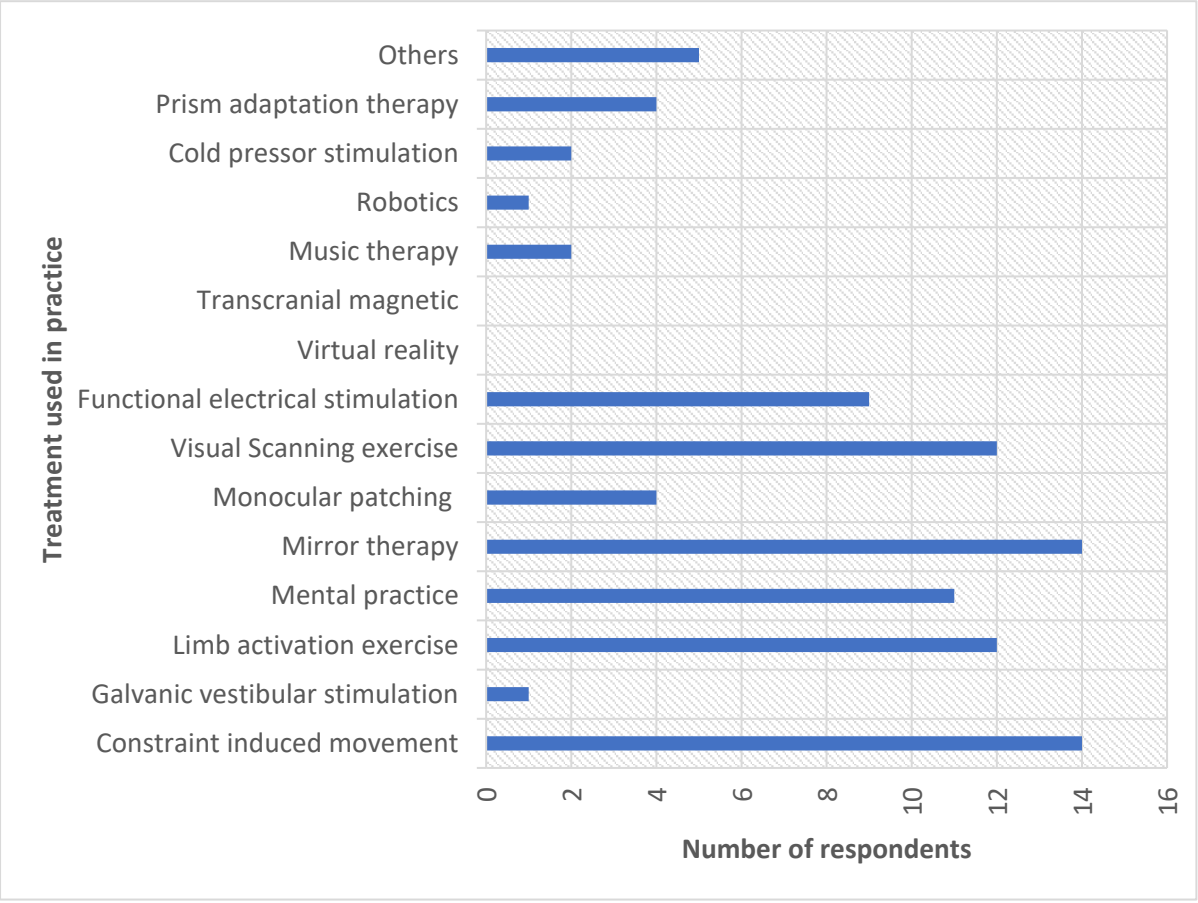


Figure 5. 7: Treatment utilized by Physiotherapists in the treatment of post-stroke USN in practice (N=28)

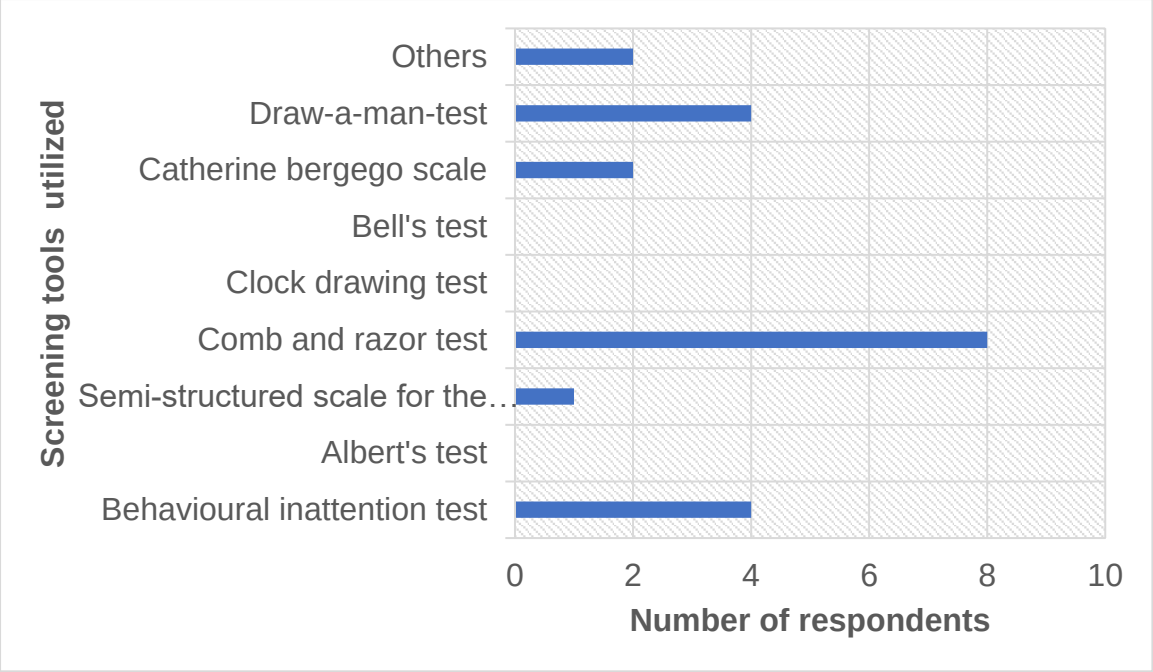


Figure 5. 8: Screening tools utilized by Physiotherapists in the treatment of post-stroke USN in practice (N=28)

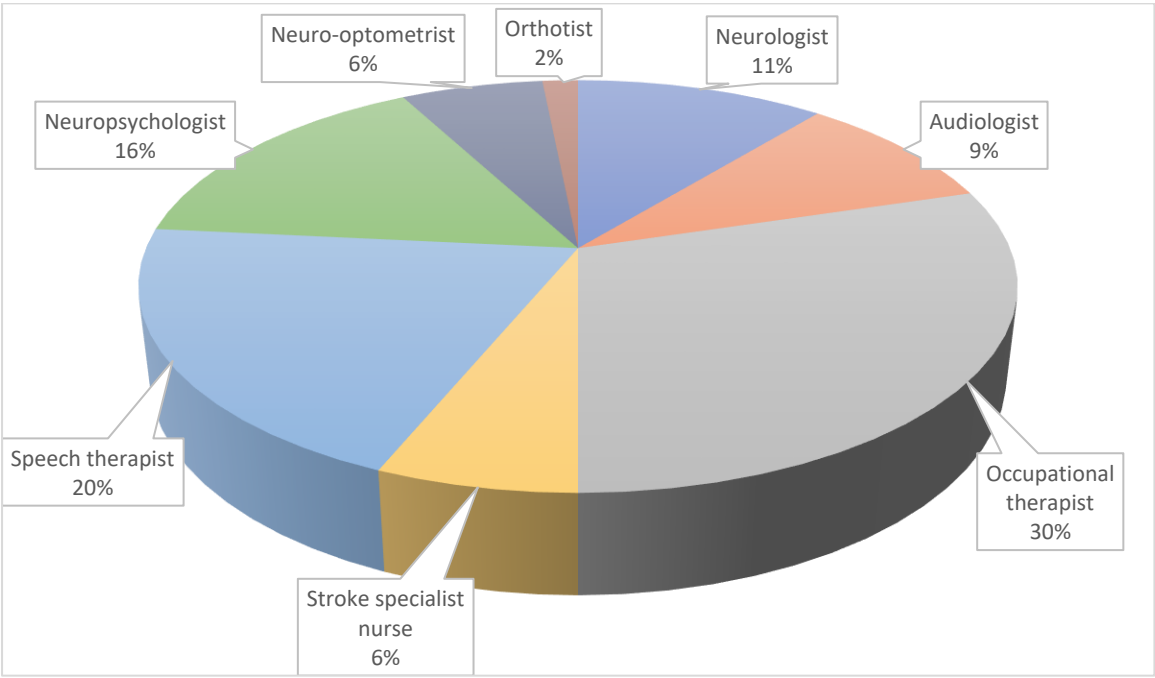


Figure 5. 9: Referral system for post-stroke unilateral spatial neglect (N=28)

5.2.5.4. Physiotherapists' perceived barriers and enablers to treatment of post-stroke unilateral spatial neglect

When asked to identify barriers to USN rehabilitation, the majority of the physiotherapists (83.33%) reported that "physiotherapists in our setting do not believe that therapy for patients with unilateral spatial neglect makes much difference" was a minor barrier to USN rehabilitation. Also, another minor barrier to USN identification identified by a majority (72.22%) of the respondents was that "Unilateral spatial neglect rehabilitation therapy is not part of physiotherapist's role". Conversely, "Inadequate therapy time" (55.56%), "lack of relevant equipment for rehabilitation of unilateral spatial neglect at clinical practice" (38.89%) were identified as major barriers to USN rehabilitation (Figure 5.10).

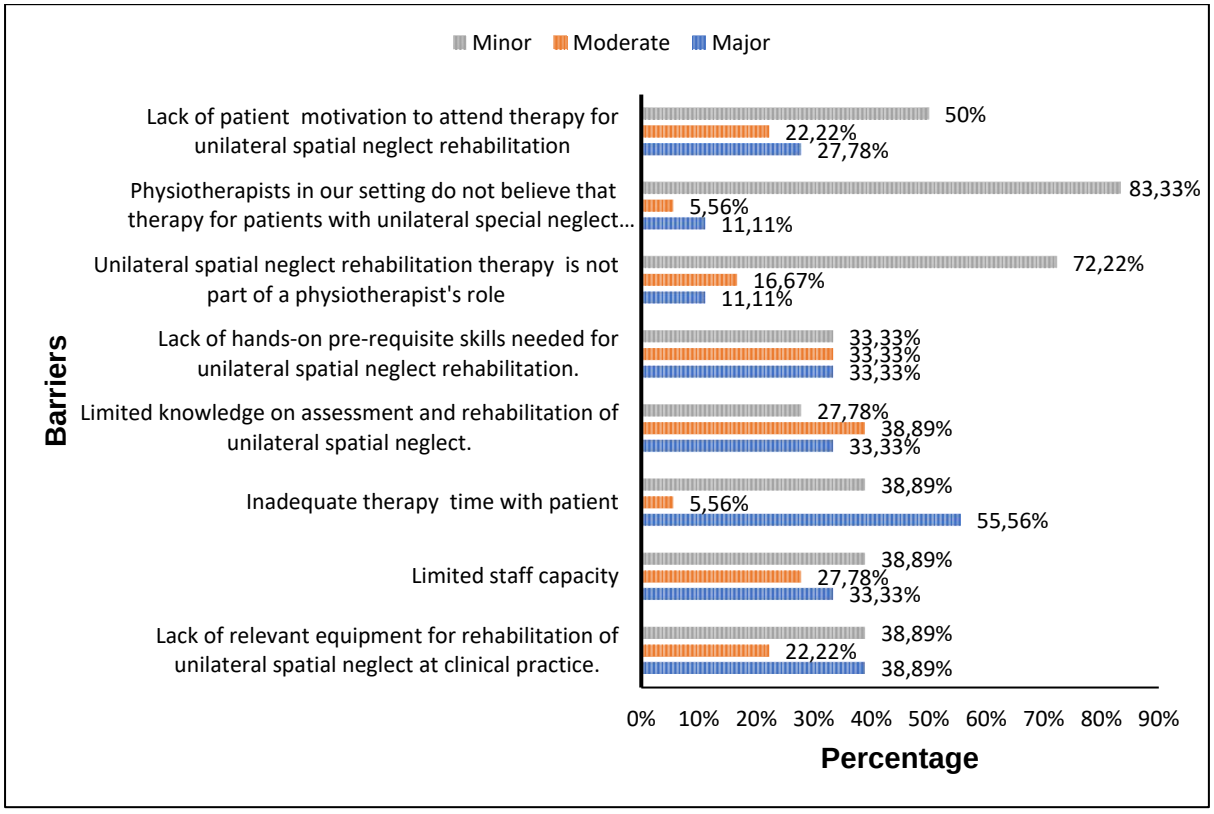


Figure 5. 10: Physiotherapist's perceived barriers to unilateral spatial neglect management (N=28)

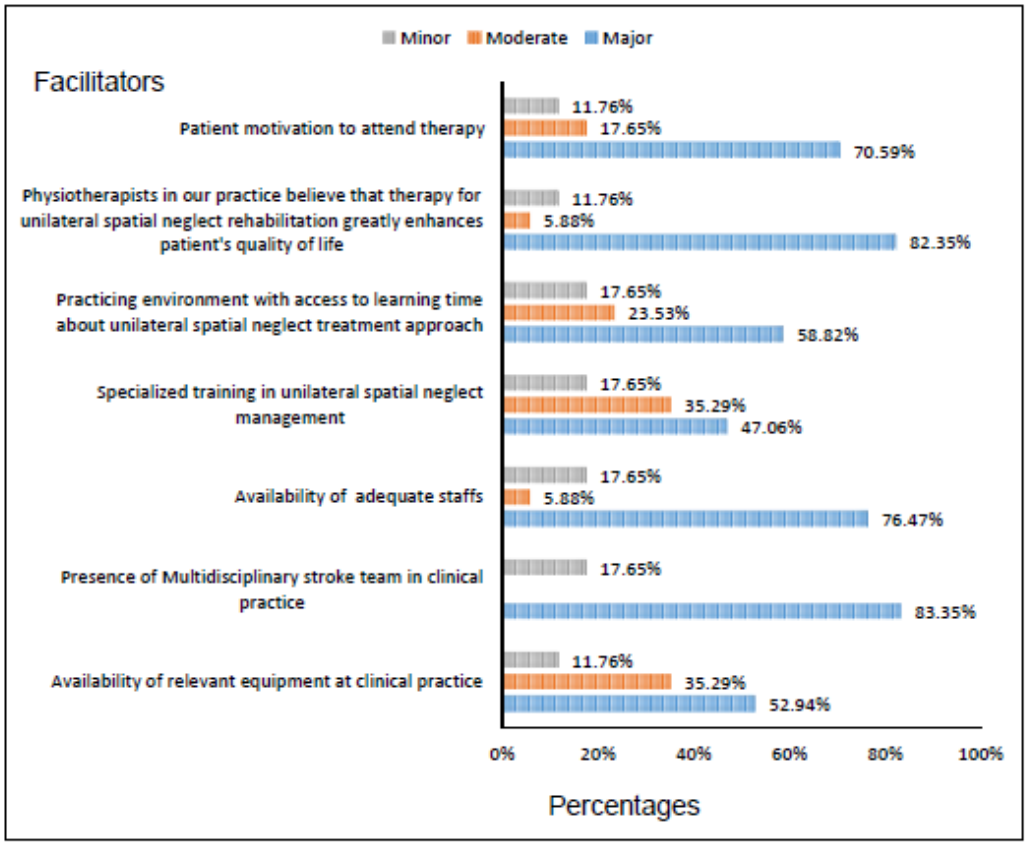


Figure 5. 11: Physiotherapist's perceived enablers to unilateral spatial neglect management (N=28)

Enablers identified by majority of the respondents include: *Presence of multidisciplinary stroke team in clinical practice*" (83.35%), "*availability of adequate staffs*" (76.47%) and the belief *"that therapy for unilateral spatial neglect rehabilitation greatly enhances patient's quality of life"* (See figure 5.11)

5.2.6. DISCUSSION

Physiotherapy is recognized as an autonomous profession in South Africa, accepting patients directly and as self-referrals (Bury & Stokes, 2013). As such, physiotherapists practising in the South African healthcare sector are required to possess a sound theoretical, clinical and evidence-based knowledge of conditions they manage which includes post-stroke USN. This study evaluated the knowledge on USN, current practice in the rehabilitation of USN and the barriers and enablers to USN rehabilitation among physiotherapists with neurology bias in South Africa.

This study is the first to evaluate physiotherapist's knowledge on USN, current practice in the rehabilitation of USN and the barriers and enablers to USN rehabilitation in South Africa. The overall knowledge on the USN score of the respondents in this study was moderate with only very few having poor knowledge of USN. Even though the general pooled knowledge score was adequate, item by item analysis of questions contained in the USN knowledge questionnaire showed some interesting results that might have some implications for training and practice. For instance, questions bordering on pharmacological treatment for USN revealed that physiotherapists in South Africa had modest knowledge on the use of pharmacological agents in USN treatment. This may not be unrelated to the fact that physiotherapy training and legislation prohibits physiotherapy to administer or prescribe medicines. This is further corroborated by a study by Unger & Lochner, (2006) that examined pharmacology practice among South African physiotherapists. In their study, respondents received theoretical training in pharmacology as part of their undergraduate qualification. This

emphasises the need for a more in-depth integration of pharmacology in student training.

Conversely, respondents demonstrated a moderate knowledge on questions about incidences and occurrence of USN, causes of USN and anatomy of neglect. Physiotherapists possess an in-depth understanding of gross anatomy necessary for safe and effective clinical practice. A study by Shead and colleagues in 2018 on anatomy education for South African undergraduate physiotherapy students reported that anatomy is taught in all eight schools that train physiotherapists in South Africa and dissection, prosection, plastinated models, surface anatomy, and e-learning were available across faculties (Shead et al., 2018). These learning environments might have positively influenced physiotherapist's knowledge of the anatomy of neglect.

In South Africa, post-stroke rehabilitation typically commences immediately after the stroke survivor attains medical stability (Krakauer et al., 2012) even though not all stroke survivors have access to rehabilitation service in South Africa due to poor referral pathway, long waiting times and coordination of care (van Niekerk et al., 2021)

The clinical practice for post-stroke USN in South Africa was explored in this study. Identification of post-stroke USN was reported to be modest in this study as less than half of the therapists identified about two post-stroke patients with USN symptoms. This could be as a result of not having a routine assessment for the identification of USN or due to a low prevalence of USN in health facilities across South Africa. However, this is beyond the scope of this present study and could only be substantiated in a future study. Interestingly, reported evaluation from time of admission for post-stroke USN in this study is in tandem with clinical guidelines that recommend screening for visual perception and USN within forty-eight hours of patient

regaining consciousness (National Stroke Foundation, 2010; Robinson, 2009). The association of USN with poor functional outcome has been substantiated by previous authors (Jehkonen et al., 2000), it is, however, imperative to identify USN early in the rehabilitation process to enhance positive decision making such as highlighting the importance for further perceptual assessment and commencing treatment interventions involving cognitive rehabilitation during hospitalization (Bowen & Lincoln, 2007).

This study also showed that half of the physiotherapists reported using standardized outcome measures in the assessment/ screening of post-stroke USN. This is in direct contrast with a Canadian study where a paltry thirteen percent of stroke survivors were assessed using a standardized outcome measure (Menon-Nair et al., 2006). The use of standard outcome measures is a familiar discourse in the South African rehabilitation space. Inglis and colleagues in a cross-sectional survey on awareness of outcome measures among physiotherapists in South Africa reported that 84% of responding therapists reported using standardized outcome measures frequently (Inglis et al., 2008). It is surprising in this study that the use is modest despite the previous report of high utilization of standardized outcome measures by South African physiotherapists. This observation in this current study may be due to time constraints or reduced therapy time and lack of knowledge in the use of condition-specific outcome measures.

The specific test identified for screening for USN was the Comb and razor test, draw-a-man test and the behavioural inattention test. The previous multidisciplinary international survey had identified the line cancellation test as the most popular test used in the screening for USN (Checketts et al., 2020). However, this study did not

investigate the factors that influence the selection of specific screening tools. It might be due to the ease of administration of the comb and razor test, the reduced time spent in administering and no cost implication in obtaining the test as the Comb and razor test takes approximately five minutes to administer (McIntosh et al., 2000). Another probable explanation for the popularity of the comb and razor test among South African Neurological physiotherapists could be institutional preference. Anecdotally, most physiotherapy practice centres in South Africa have a battery of recommended outcome measures institutionalized in those centres. Also, McGinnis et al., (2009) had, in a previous study, reported that patients' medical diagnosis and history could inform the choice of assessment tool selection for balance assessment post-stroke.

Constraint-induced movement therapy, mirror therapy, visual scanning exercise and limb activation were the top four popular interventions for USN identified by South African neurological physiotherapists in the treatment of USN. This observation is in tandem with a previous study by Chen et al, (2018) that identified visual scanning, active limb activation, sustained attention training and prism adaptation therapy as the top four popular interventions for USN. Similarly, a systematic literature review by Luaute et al. (2006) had recommended, based on available evidence, the use of Visual scanning exercise, trunk rotation, mental imagery and muscle neck vibration. Constraint-induced movement therapy was the top intervention of choice by neurological physiotherapists in South Africa. This is not daunting as CIMT is currently considered to be the most effective treatment regimen in physical therapy for improving upper paretic limb rehabilitation outcomes (Langhorne et al., 2011; Marieke Veerbeek et al., 2014). It has been reported that increased mobility of the affected limb, especially in the affected hemispace, could reduce the manifestations of visual-spatial neglect (Robertson & North, 1993). The reasons for selecting these

interventions was not explored in this study. However, physiotherapist preference, patient profile information and alternating to other effective treatment has been pinpointed to be the reason for selection of a particular intervention.

Lastly, this study investigated the enablers and barriers faced by South African neuro-physiotherapists in the treatment of USN. Identified major barriers included inadequate therapy time and lack of relevant equipment for rehabilitation of unilateral spatial neglect at clinical practice. This is similar to reports by Checkett and colleagues that highlighted various barriers to USN rehabilitation as time and equipment shortages, sub-optimal MDT collaboration and lack of knowledge (Checketts et al., 2020). A major challenge in the South African context is that there are few public rehabilitation facilities leading to overcrowding and long waiting times and delays (Sokhela et al., 2013). Treatment for USN is usually tailored to an individual's needs and needs ample time for a one-on-one session with the therapist. The overload may ripple to the shortening of individualized therapy time. Also, the other major barrier identified in this study is not alien to the African region; poor facilities and equipment has been an age-long challenge for the African health landscape (African Development Bank, 2013). On the other hand, perceived major enablers included: Presence of multidisciplinary stroke team, therapists' belief that USN greatly enhances stroke patient's QoL and availability of staff. These identified barriers and enablers are critical in understanding how to plan for better USN rehabilitation outcomes in the South African rehabilitation space.

5.2.7. CONCLUSION

Physiotherapists surveyed demonstrated a fair knowledge of unilateral spatial neglect, although knowledge about pharmacological management of USN appears to be

modest. Current practice in post-stroke USN by a South African neuro-physiotherapist is in tandem with the current evidence base and practice guidelines.

5.2.8. LIMITATION OF STUDY

Using an online knowledge test may have a limitation in that clinicians may turn to outside sources for answers. An attempt was made to reduce this potential by reducing the amount of time that the clinician had to complete the questionnaire.

The small sample size in this study could affect the reliability of the survey results. Physiotherapists have a high workload such that they only spend minimal time at their desk or in front of a computer or smart devices and thus, may miss emails containing the survey questionnaire for this study, resulting in a low response rate. Another probable reason for the low response rate in this study may be that physiotherapists may have missed the emails (as the emails may have been delivered to their spam folders in their emails since the questionnaire was sent in bulk to all SASP neurology interest group members).

In addition, most of the respondents that completed this survey practice in urban areas. This limits the generalization of the study findings to semi-urban and rural settings.

The next chapter is a Randomised Controlled Study on the effect of prism adaptation (PA) therapy on post-stroke unilateral spatial neglect in patients at the sub-acute phase of recovery.

Veronica Ntsiea: Reviewing, supervision, editing, validation and methodology formulation

Ronel Roos: Reviewing, supervision, editing

Chuka Umeonwuka: Conceptualization, data collection, preliminary data analysis, manuscript drafting, methodology formulation

6. CHAPTER 6: EFFECT OF PRISM ADAPTATION THERAPY ON POST-STROKE UNILATERAL SPATIAL NEGLECT IN PATIENTS AT THE SUB-ACUTE PHASE OF RECOVERY: A RANDOMISED CONTROL TRIAL

6.1. INTRODUCTION TO CHAPTER

This chapter was a randomized control trial that evaluated the effect of prism adaptation therapy on USN (primary outcome) and other secondary outcomes such as ADLs, balance, quality of life and functional mobility. Also, predictors of USN recovery after prism treatment were evaluated.

This chapter is presented in a manuscript format.

6.2. INTRODUCTION

USN is observed more with lesions affecting the right side of the brain than with lesions on the left-side and is estimated to occur in 13 to 100 percent of the patient population with right hemispheric affectation (Bowen et al., 1999). In many post-stroke patients, the severity of neglect symptoms persists chronically (Farnè et al., 2004; Katz et al., 1999) with a negative affectation in almost every activity that contributes to daily living and rehabilitation outcome such as postural balance (Gottlieb & Levine, 1992; Pérennou, 2006; Taylor et al., 1994; Van Nes et al., 2009), functional mobility (Berti et al., 2002; Tromp et al., 1995), quality of life (Franceschini et al., 2010; Sobrinho et al., 2018a), ADLs (Cherney et al., 2001; Jehkonen et al., 2000, 2001; Vossel et al., 2013) and hospital stay duration (Chen et al., 2015; Hammerbeck et al., 2019; Wee & Hopman, 2008). Several interventions to ameliorate USN has been proposed by researchers (Luauté et al., 2006a; Umeonwuka et al., 2020). Strategies for USN symptom amelioration is broadly classified into bottom-up or top-down methods

(Marshall, 2009). Specifically, prism adaptation (PA) intervention has been of interest to researchers in recent times because of its propensity to ameliorate neglect symptoms in post-stroke patients (Chokron et al., 2007; Luaute et al., 2006; Umeonwuka et al., 2020).

Prism adaptation (PA) was discovered over 100 years ago (Helmholtz, 1866) and has been introduced in neurorehabilitation. PA entails the patient pointing towards a visible target while wearing prismatic goggles. An induced deviation is brought about by this goggle which ultimately results in leftward compensatory movement.

Studies (Gammeri et al., 2020; Keane et al., 2006) have suggested that neglect symptoms improve with PA and these improvements extend to dressing, postural stability (Tilikete et al., 2001), walking (Keane et al., 2006), sit-to-stand transfers (Shiraishi et al., 2008) and wheelchair driving (Jacquin-Courtois et al., 2008). However, previous randomized control trials investigating the effect of PA on USN showed disparate outcomes (Luauté et al., 2006b; Rossetti et al., 1998; Rousseaux et al., 2006; Umeonwuka et al., 2020). Several reasons for this observation have been highlighted by Vilimovsky and colleagues to include use of weaker power of prism, disparate neglect assessment tool, sample size and the PA procedure itself (Vilimovsky et al., 2021). Thus, it is contentious if amelioration of spatial neglect during inpatient rehabilitation using PA can be attributed to the visuomotor task.

In addition, the majority of the studies examined patients after they had suffered a stroke for over three months. The initial phase following a stroke is referred to as the acute phase and lasts for about 2 weeks. The second phase is the subacute phase, and this usually lasts up to 6 months after onset. The chronic phase begins months to years after stroke, and it may continue for the remainder of the person's life (Kiran,

2012). Studies of USN rehabilitation of patients in the sub-acute phase are few despite the certitude that USN leads to poor functional outcome in the sub-acute phase (Gialanella & Mattioli, 1992; Gialanella & Ferlucci, 2010; Katz et al., 1999; Nys et al., 2005).

Also, there is modest knowledge about the specific effects of prism adaptation therapy on functional mobility, quality of life of stroke survivors with USN at the sub-acute phase of recovery.

This study was conceptualized to assess the effect of prism adaptation on USN symptoms and if these effects extended to other indices of rehabilitation outcome such as functional mobility, hospital length of stay (LOS), ADLs, QoL therapy and postural balance.

It was hypothesized in this study that if visuomotor training is useful intrinsically in leftward sensorimotor system orientation, an improvement of neglect should be found after both the PA and control non-prismatic (NP) treatments. Nonetheless, if the leftward recalibration due to PA is pointedly more helpful in recovering neglect, greater amelioration should be observed in the PA than in the NP group.

6.3. MATERIALS AND METHODS

6.3.1. Study design

This study was a single blinded randomized controlled trial (RCT). Consenting patients were consecutively recruited from the study sites.

6.3.2. Variables

*Dependent variables***:** Unilateral spatial neglect, activities of daily living performance, hospital stay duration, balance, functional mobility and quality of life**.**

Independent variable: Twelve sessions of prism Adaptation Therapy.

6.3.3. Sample selection and size

Patients who had a stroke in the sub-acute phase (≤ 3 months post-stroke) were recruited consecutively from the study sites. Information on the expected effect of prism adaptation on neuropsychological neglect tests or BIT scores were unavailable (Brink et al., 2015). The sample necessary to identify a difference with a power of 80% and alpha .05 (2-sided) was estimated using an effect size of 0.5 for medium effect size (Muller & Cohen, 1989) with non- compliance of 5% and 0.7 standard deviations (Brink et al., 2015): 35 patients per group (70 patients in total) for sufficient statistical power sans inflation; 15% inflation for possible dropouts raised the number to 82.

6.3.4. Randomization and masking

Participants were assigned to either the control or intervention group by block randomization. The investigator placed 82 labelled cards (41 interventions and 41 control) in envelopes before the study began. Following baseline assessment, the research assistant randomly selected an envelope and assigned the patient based on the information written on the card to either the control or the treatment group. The researcher performed the baseline line and post-treatment assessment and was unaware of the group allocation. Also, the patients were ignorant of the treatment arm to which they were assigned. The rationale for choosing block randomisation was that it would ensure balance in sample size in the control and treatment groups, reduce

bias and tend to be uniformly distributed by key outcome related characteristics (Efird, 2011).

6.3.5. Study setting

Patients were screened and recruited from two study centres for this study; Charlotte Maxeke Johannesburg Academic Hospital and South Rand Hospital, both in Gauteng province of South Africa. The South rand Hospital is a 314-bed rehabilitation hospital situated in Rosettenville in the southern part of Johannesburg and is a level 1 district hospital established in 1954. The rationale for choosing South rand hospital as a study centre is that as a rehabilitation centre, it is expected that stroke survivors in the sub-acute phase will be readily recruited from this centre. The centre also receives referral from the southern Johannesburg metropolis for rehabilitation services.

The Charlotte Maxeke Johannesburg Academic Hospital is an accredited hospital opened in 1979 and located in Park Town, Johannesburg with a 1088 bed capacity. It is the main teaching hospital for the University of the Witwatersrand, Faculty of Health sciences. The hospital offers inpatient and specialist outpatient services mainly at level 3 (provincial tertiary Hospital) and level 2 (Regional Hospital). The rationale for choosing this centre (Charlotte Maxeke Johannesburg Academic Hospital) as a study site is that the centre is centrally located and serves a wider population. It is an academic hospital and an in-patient specialist centre hence providing ready access to the category of patients required for this study.

6.3.6. Participants

Stroke patients with a clinical diagnosis of symptomatic stroke (initial or recurrent, haemorrhagic, or ischemic stroke) were screened at the study site consecutively. The diagnosis was made by the physician after a brain Computed tomography

investigation (CT) (Musuka et al., 2015). The inclusion criteria were: First-ever left hemiparetic stroke, admission within 3 months following stroke onset, aged 18 years and above and absence of severe cognitive impairment (Mini-Mental State Examination score>17). Patients were excluded if they were unable to sit on a wheelchair, had very bad eyesight, had severe hearing loss, were unable to reach with upper-extremity, and had amputation of the ipsilesional upper extremity and poor position sense deficits of the fingers because of peripheral neuropathy.

6.3.7. Patient screening

6.3.7.1. Unilateral spatial neglect screening

The standard subtest of the Behavioural inattention test (BIT-C) was used to measure improvement from USN. This comprises six items: figure and shape copying, line crossing, representational drawing, star cancellation, line bisection, and letter cancellation.

Patients that scored below BIT-C Cut-offs scores (less than 129 out of 146) had poor BIT-C score while participants who scored above 146 had good BIT-C (Halligan et al., 1991; Wilson et al., 1987). The BIT-C has been described in chapter three.

The Catherine Bergego Scale (CBS) was also used to evaluate functional aspects of USN. The CBS is a standardized checklist to check presence and degree of neglect during observation of everyday life situations. The CBS consists of day-to-day tasks that the therapist observes patients perform. The CBS uses a 4-point grading scale to show the severity of neglect for each item: 0 = no neglect, 1 = mild neglect (patient always explores the right hemispace first and slowly or hesitantly explores the left side), 2 = moderate neglect (patient demonstrates constant and clear left-sided

omissions or collisions) and 3 = severe neglect (patient is only able to explore the right hemispace). This results in a total score out of 30 (Azouvi et al., 2003).

6.3.7.2. Cognitive screening

The Mini-Mental State Examination (MMSE) was used to assess the patient for any cognitive impairment before recruitment into the study as per the study inclusion criteria. The patient to be recruited for this study must obtain an MMSE score of >17(Tombaugh & McIntyre, 1992).

The MMSE is a screening tool that identifies cognitive ability quantitatively. The mini-mental scale examination is made up of 11 tasks, grouped into seven areas. The usual threshold for cognitive impairment is a score of 23 or less from a total of 30 (Dick et al., 1984). Degrees of impairment have also been categorised as severe (0-17), mild (18-23) and none (24-30) (Tombaugh & McIntyre, 1992) (Appendix XIV shows the mini mental scale).

6.3.7.3. Screening of secondary outcome (Activities of daily living, functional mobility, quality of life and balance)

Functional mobility, quality of life, activities of daily living and balance were assessed via the Modified Rivermead mobility index, stroke-specific quality of life questionnaire, Barthel index and the Berg balance scale respectively. These instruments have been discussed in detail in chapter three.

6.3.8. The prism adaptation Intervention

The prism adaptation intervention procedure for reaching a task was adapted from a similar study by Mizuno et al., (2011). Patients recruited for this study were asked to

sit at a desk on which a wooden table adapted from Bedford, (1989) (height 30 cm) was placed. The semi-circular table top with a radius of 60 cm (see figure 6.1), had 3 targets marked at the centre, right, and left corners of its edge. During each session, patients were seated upright and assisted if needed. Every patient's target distance was adapted according to their arm length. Therapists then instructed patients to point using the fore finger of their opposite hand at the three targets located at the bottom of the table. The three targets were randomly selected by the therapists. The reaching path was made unseen to the patient by the table. It was only possible for patients to see their fingertips at the table's edge. The patients were instructed to reach and return their hands as quickly as possible without being corrected for pointing errors. Initially, the pointing task was repeated 30 times without prism glasses. Then, wearing 20 dioptre prism glasses that shifted their visual field 11.4° to the right (deluxe Prism google; Bernel 1138KIT28+) the task was repeated 90 times. After pointing at targets, the prism glass was taken off and they pointed 60 more times. Each patient undertook a total of 12 training sessions, each lasting about 30 minutes, every weekday. The interventions were provided during regularly scheduled rehabilitation sessions; all other routine interdisciplinary stroke rehabilitation continued as usual. The control and intervention group underwent the same intervention procedure. However, the control group utilized neutral goggles (sham) whilst the intervention group utilized prism glass.

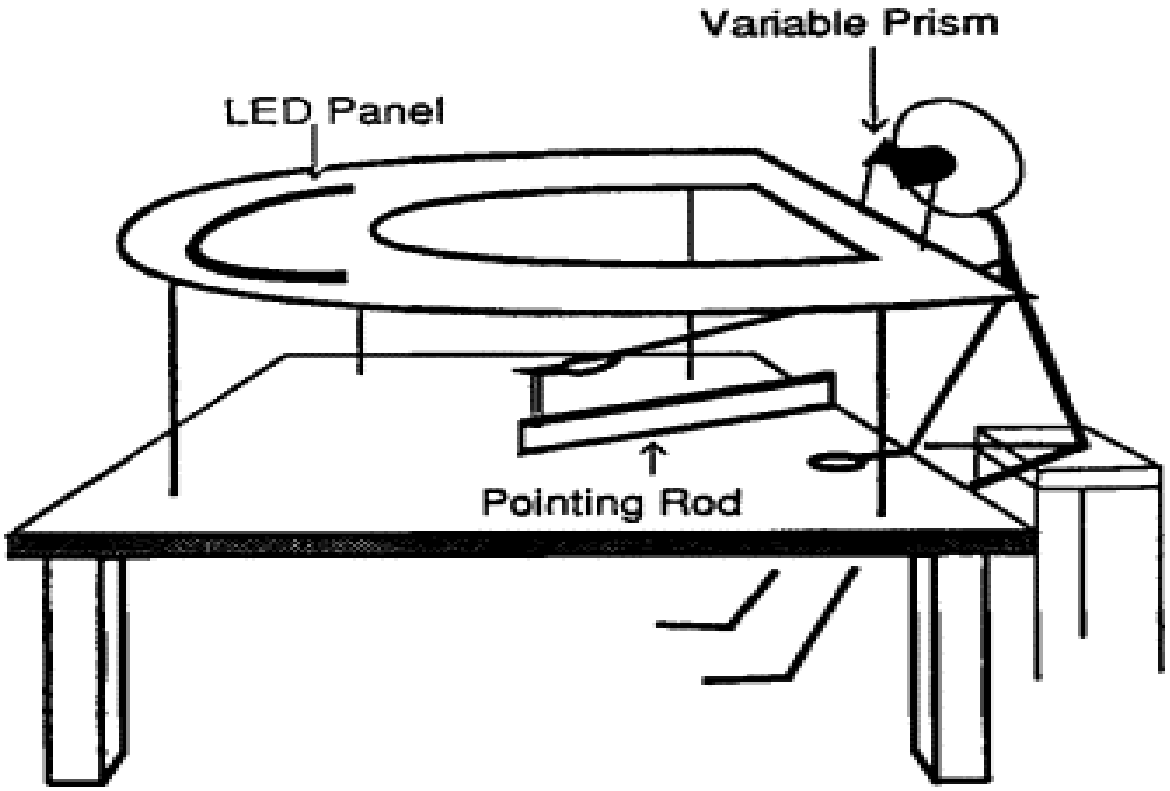


Figure 6. 1: Prototype of the table used for prism adaptation therapy by patients (Bedford, 1989)

6.3.9. Procedure

6.3.9.1. Pilot study

6.3.9.1.1. Introduction

A pilot study was conducted prior to the commencement of the main study. The pilot study was conducted at one of the selected study sites: The Charlotte Maxeke Johannesburg Academic Hospital. This hospital was selected through a random selection process.

This pilot study aimed at gaining an understanding of the outcome measures for this study and:

a) Establish the feasibility of recruiting stroke survivors who will meet the inclusion criteria for the main study.
b) To allow the research assistants familiarize themselves with administering the prism adaptation therapy; determine the amount of time it will take to administer the instruments; and to detect any unexpected problems that might arise during the process of data collection.
c) To enable the researcher to establish an understanding of the demographic form, BI, MRMI, BIT-C sub-test, SSQoL, and the BBS and the CBS.
d) To establish and familiarize with the instrument scoring system and to simulate an analysis plan for the main study.
e) Establish the time needed to administer or assess patients using the outcome measures (BI, MRMI, BIT-C sub-test, SSQoL, and the BBS and the CBS).

6.3.9.1.2. Pilot study methodology

As recommended by Connelly (2008), ten percent of the main study group (seven consecutive patients) who had a stroke for less than three months but more than one week took part in the pilot study. The patients were initially identified by physiotherapists working at the selected study site who then notified the researcher. The researcher screened the patients based on the study's inclusion criteria and obtained consent to participate in the study. The demographic and clinical information of the patient were retrieved from the case notes by the researcher. The researcher also administered the baseline assessment of BIT-C, MMS, CBS, BBS, SSQoL, MRMI and the BI. The research assistants (two physiotherapists and two clinical associates) conducted the randomization procedure as described in sub-section 6.3.4.

The research assistants (Physiotherapists and clinical associates), trained by the researcher on the prism adaptation procedure, administered the prism adaptation intervention as described in sub-section 6.2.10. for five consecutive days to familiarize themselves with the intervention procedure and monitor for any adverse reactions as a result of the prism adaptation intervention.

After the fifth session, the researcher administered a post-treatment assessment of BIT-C, CBS, BBS, SSQoL, MRMI and the BI.

6.3.9.1.3. Pilot study Data Analysis

STATA software version 15 was used in the pilot study of data analysis. Continuous data were summarized using mean and standard deviation and median and interquartile range (IQR). Percentages and frequencies were used to summarize categorical data.

6.3.9.1.4. Pilot study results

The result of the pilot study data is presented in appendix XV.

6.3.9.1.5. Conclusion

The researcher and the research assistants were better prepared to conduct all patient assessments and intervention prism adaptation treatment following completion of the pilot study.

There was no adverse event from prism adaptation therapy and was expected to find patients in the sub-acute phase of stroke with USN for the main study.

6.3.9.2. Main Study procedure

Research assistants were recruited for this study. To provide them with a clear understanding of the study and the prism adaptation therapy intervention, the research

assistants were trained. Four research assistants were recruited consecutively for this study: they include two physiotherapists and two clinical associates. The physiotherapists were postgraduate students at the physiotherapy department of the University of the Witwatersrand. The research assistants were PG students and were recruited one at a time at each instance. Hence it was a continuum and not all research assistants were responsible for randomisation at the same time.

The researcher determined eligibility of patients identified by physiotherapists working at the research sites for the study. Participants that met the inclusion criteria and willingly consented by signing a consent to partake in this study were recruited and randomly assigned to the intervention or the control as described previously.

A demographic form designed by the researcher and clinical characteristics data form were used to capture participants' demographic and clinical profile characteristics (Age, gender, educational level, stroke duration, type of stroke, site of stroke, handedness, hospital admission and discharge dates) (Appendix IX and X).

Baseline assessment for other secondary variables (functional mobility, activities of daily living performance, quality of life, and balance ability) were done at recruitment before the commencement of prism adaptation intervention. Post-treatment assessment of secondary variables was done after 12 sessions of prism adaptation intervention.

The researcher's role in the data collection procedure was:

- Extraction of participant's demographic and the patient's clinical characteristics using a sociodemographic form and the case notes of patients respectively. This was done for all participants in this study.
- Conduction of spatial neglect screening, functional mobility, activities of daily living performance, quality of life, and balance ability, using the behavioural

inattention test, CBS, Barthel index, stroke specific quality of life scale, modified Rivermead Mobility Index, and berg balance scale respectively.

- Obtaining informed consent from prospective participants.

The research assistant's role in the data collection procedure was:

- Conducting the reaching prism adaptation therapy intervention for stroke survivors in this study.
- Conduct randomisation procedure.

6.4. ETHICAL CONSIDERATIONS

I. This trial was registered in the Pan African clinical trial registry. The registry identification number is **PACTR201903732473573** (See appendix XVI for approval letter)

II. Ethical clearance was obtained from the University of the Witwatersrand Committee for research on the human subject with approval number **M180155** (Appendix XII).

III. Patient's consent was sought and obtained from prospective study participants before recruitment into study (Appendix XVIII shows the participant consent form)

IV. Procedure of the entire research process was explained to the patient and an information sheet was given to the patient for further clarification (Appendix XIX shows the participant's information sheet).

V. Participation was voluntary and participants were free to withdraw from the study at any time with no consequences.

VI. Permission of head of units for the various centres was sorted and obtained before commencement of data collection. (See Appendix XVII approval letters from study centres)

VII. Information provided by the participants was treated confidentially. A study code was allocated to each participant to ensure anonymity. Study code was used on the data collection sheets and data analysis documents.

VIII. Information dissemination of data is done as pooled data and not on an individual basis.

IX. Patients' data were stored on google drive which are accessible to the principal investigator and supervisors alone. They will be used for this study alone and will be deleted after three to six years.

6.5. DATA ANALYSIS

STATA version 15 was used for data analysis. Descriptive statistics of percentage, medians and IQR, mean and standard deviation were used to summarise data.

An intention-to-treat analysis approach was utilized to include all participants as originally recruited in the study. The rationale to carry-out intention-to-treat (ITT) analysis in this study is to provide unbiased comparisons among the treatment to forestall the effects of dropout, which may affect the randomization to the treatment groups and to also ensure deviation from the protocol will have not major effect on the findings of this study. Missing data was handled using single imputation methods. Using a single imputation, a missing real value is imputed with a specific value. In this case, we are picking the highest possible answer by analysing other responses. The value is obtained by calculating the mean, median, and mode of the available responses (Khan & Hoque, 2020).

Effect of prism adaptation therapy on the primary outcome (Unilateral Spatial Neglect assessment) in stroke survivors

- Comparison of the means of the BIT-C and CBS scores between the control and intervention group was carried out using t-test to demonstrate significant distinction between the two groups.

Effect of prism adaptation therapy on secondary dependent variables

- The means of continuous variables of secondary dependent variables (BI, MRMI, BBS, SSQoL) were compared using T-test.
- The mean difference of BI, MRMI, BBS, SSQoL at baseline and post-treatment were presented to account for differences between groups.

Factors predictive of the outcome of prism adaptation therapy effect on USN in stroke survivors in the sub-acute phase

- Univariate and stepwise multivariate logistic regression was done to establish sociodemographic and clinical variables that may have significance in the prediction of the outcome of prism adaptation therapy among stroke survivors with USN.
- The outcome variable was *BIT-C score>129: recovery, BIT-C score< 129: No recovery.* Independent variables were demographic and clinical data used in this study.

6.6. RESULTS

6.6.1. Participant's flow through the study

Between October 2018 and December 2020, 221 patients were screened; 74 patients met the eligibility criteria and gave consent to participate in the study and 68 patients completed the study. Six participants dropped out, three in the control and three in the intervention group: two were discharged prematurely; one was deceased before the intervention was complete and another was infected with the COVID-19 and was transferred to the isolation ward. Figure 6.2 shows the flow of participants in the study.

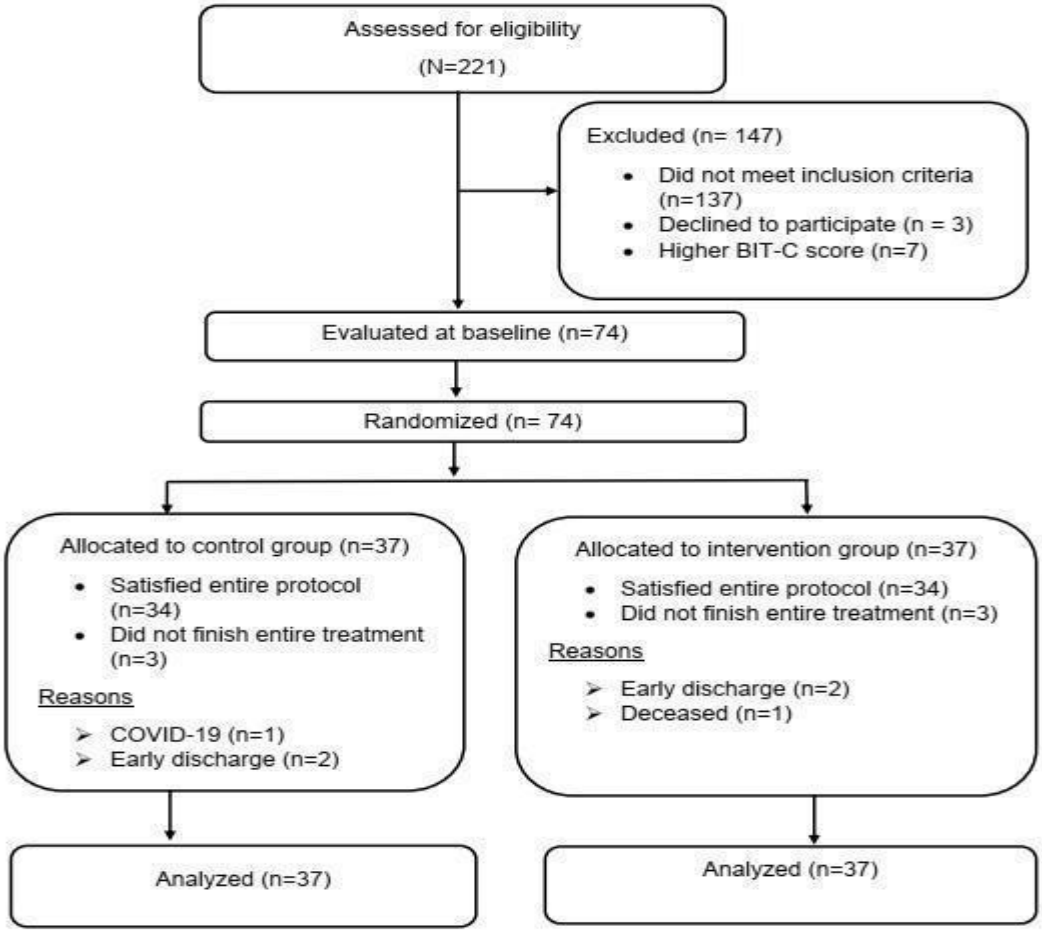


Figure 6. 2: Distribution of the study sample throughout the study

6.6.2. Sociodemographic and clinical characteristics of study participants

Table 6.1 shows the sociodemographic and clinical characteristics of the enrolled study participants. The male to female ratio was 1:1 and the average participant age was 49.15±13.17 years while the median time from stroke onset to study enrolment was 38.5 (28-48) days.

The majority of the patients were right-handed (79.73%), of black race (81.08%), had ischaemic stroke type (78.38%) with supratentorial lesion (90.54%). The differences in demographics and clinical variables between intervention and control groups were not statistically significant.

Table 6. 1: Demographic and clinical characteristics of stroke survivors (N=74)

Variable	Total	Control group (n=37)	Intervention group (n=37)	Comparison	
				Test statistics	p-value
Sex, (n, %)					
Male	37 (50)	20 (45.95)	17 (54.05)	X^2 = 0.487	0.485
Female	37 (50)	17 (54.05)	20 (45.95)		
Age, years Mean ± SD	49.15±13.17	46.51±13.56	51.78±13.06	*t* = 1.69	0.095
Time post-stroke onset *(at baseline), days*	38.5 (28-48)	36 (28-47)	42 (26-56)	*z* = 0.80	0.423
Years of education	10 (5-13)	10(6-13)	9(5-12)	*z* = -1.028	0.304
Employment status					
Employed	33 (44.59)	14 (37.84)	19 (51.35)	X^2 = *1.620*	0.445
Unemployed	29 (39.19)	17(45.95)	12 (32.43)		
Retired	12 (16.22)	6(16.22)	6 (16.22)		
Marital status (%)					
Married	43 (58.11)	20 (54.05)	23 (62.16)	X^2 = 1.019	0.601
Single	24 (32.43)	14 (37.84)	10 (27.03)		
widowed	7 (9.46)	3 (8.11)	4 (10.81)		
Race (%)					
Black	60 (81.08)	30 (81.08)	30 (81.08)	X^2 = 0.311	0.856
Asian	5 (6.76)	2 (5.41)	3 (8.11)		
Caucasian	9 (12.16)	5 (13.51)	4 (10.81)		

Hand preference (%)					
Right	59 (79.73)	30 (81.08)	29 (78.38)	X^2 = 0.084	0.772
Left	15 (20.27)	7 (18.92)	8 (21.62)		
Stroke type (%)					
Ischaemic	58 (78.38)	29 (78.38)	29 (78.38)	X^2 = 0.000	1.000
Haemorrhagic	16 (21.62)	8 (21.62)	8 (21.62)		
Lesion site (%)					
Supratentorial	67 (90.54)	33 (89.19)	34 (9.89)	X^2 = 0.215	P = 0.898
Infratentorial	2 (2.70)	1 (2.70)	1 (2.70)		
Mixed (diffuse)	5 (6.76)	3 (8.11)	2 (5.41)		
Cognitive ability, *(MMSE score)*	21.61±2.27	21.89±2.51	21.32±1.99	*t* = -1.077	P = 0.285

(t= T-test statistics; z= Mann Witney U statistics; X^2=*Chi square statistics)*

6.6.3. Effect of prism adaptation therapy on USN in stroke survivors

Both groups had improved total scores of the BIT-C which generally increased over the study period for both groups at post-treatment (t_1). There were statistically significant differences in BIT-C baseline and post-treatment scores with the intervention group scoring higher than the control group (Table 6.2). Items of the BIT-C had statistically significant between-group difference as thus: **baseline**: Star cancellation test (p =0.024); **post-treatment**: line crossing (p=<0.001), star cancellation test (p=<0.001), letter cancellation test (p=<0.001), figure and shape copying (p=<0.001), line bisection test (p=0.005). Table 6.3 shows the effect size (BIT-C) (main outcome variable) in this study.

Table 6. 2: Comparison of specific test for BIT-C (primary USN outcome) between control and intervention group

Variable (maximum obtainable score)	Baseline Assessment (t_0)		Baseline comparison		Post-intervention assessment (t_1)		Post-intervention comparison	
	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value
BIT-C Total (146)	82.95 ± 20.46	70.59 ± 23.40	-12.35	0.018*	78.08± 33.74	117.68 ± 39.49	39.59	<0.001***
Line crossing (36)	23.38 ± 7.54	20.97 ± 9.60	-2.41	0.235	23.00 ± 7.09	33.44 ± 5.48	10.44	<0.001***
Star cancellation (54)	30.84 ± 11.94	24.70 ± 10.98	-6.14	0.024*	31.71 ±11.90	47.74± 7.52	16.03	<0.001***
Letter cancellation (40)	20.43 ± 7.46	17.03 ± 7.82	-3.41	0.059	20.32 ± 8.89	33.91 ± 6.22	13.59	<0.001***
Figure and shape copying (4)	2.00 ± 1.20	1.76 ± 1.28	-0.24	0.389	3.11 ± 1.34	4.38 ± 1.13	1.26	<0.001***
Line bisection (9)	5.59 ± 1.64	5.03 ± 1.48	-0.57	0.123	6.12 ± 2.10	7.50 ± 1.88	1.38	0.005**
Representational drawing (3)	0.70 ± 1.02	1.11 ± 1.15	0.41	0.114	0.71 ± 1.12	1.09 ± 1.42	0.38	0.222
Catherine Bergego scale	20.24 ± 4.18	21.22 ± 4.02	0.97	0.311	19.5 ± 4.28	13.85 ± 5.73	-5.65	<0.001***

Mean difference=

****= statistically significant @ p<0.05*

Table 6. 3: Effect size of the main outcome variable (The BIT-C)

	Effect size estimate (Cohen's d)	**95% Confidence interval**
BIT-C Total (146)	1.96	1.37 – 2.53
Line crossing (36)	1.65	1.09-2.20
Star cancellation (54)	1.77	1.20-2.30
Letter cancellation (40)	1.61	1.06-2.15
Figure and shape copying (4)	1.02	0.51-1.52
Line bisection (9)	0.69	0.20-1.18
Representational drawing (3)	0.30	-0.18-0.78
Catherine Bergego scale	-1.12	-1.62 - -0.60

Also, clinically relevant improvement was observed more post-treatment, more (n=23; 62.16%) of the patients in the intervention group recovered from USN post-treatment (BIT-C score >129) than patients in the control group (*n*=3;8.11%) and this was statistically significant (p=<0.001) (Table 6.4).

Table 6. 4: Distribution of patients that recovered from Unilateral spatial neglect post-treatment.

Recovery from USN	Control	Intervention	X^2	p-value
No	34(91.89)	14(37.84	23.717	P<0.001**
Yes	3(8.11)	23(62.16)		
Total	37(50.00)	37(50.00)		

*(BIT-C score>129: recovery, BIT-C score< 129: No recovery, ** statistically significant @ p< 0.005)*

6.6.4. Effect of prism adaptation therapy on mobility functional level, activity of daily living functional level, perceived quality of life, balance abilities in stroke survivors.

6.6.4.1. Stroke survivors' mobility functional level

The MRMI items and total score at baseline and post-treatment are presented in Table 6.5 and 6.6 respectively. A significant difference in total MRMI scores was found between the control and intervention groups at baseline (p=0.013) and post-treatment (p=0.016). The MRMI score for the intervention group was lower than the control group at baseline. The mean change of 5.8 from 11.35 at baseline to 17.19 at post-treatment for the intervention group is clinically significant. In order to be considered significant, a change in mobility score must be greater or equal to 4.5 (Lennon & Johnson, 2000).

Table 6. 5: Pre and post-intervention comparison of stroke survivors' mobility functional level: MRMI total score

MRMI total score (Total score, 40)	Baseline Assessment (t_0)		Baseline comparison		Post-intervention assessment (t_1)		Post-intervention comparison	
	Control group	Intervention group	Mean difference	p-value	Control group	Intervention group	Mean difference	p-value
Mean (SD)	13.97±4.50	11.35±4.33	-2.62	0.013*	13.57±5.84	17.19±6.72	3.62	0.016*
Minimum score	4	3			0	0		
Maximum score	30	23			32	27		
Effect size							Estimated 0.58	CI (95%) 0.11-1.04

The mean item score increased for the intervention group post treatment. At post-treatment follow-up all mean item score was below four, indicating mobility with assistance is needed. Statistically significant between group differences were seen in the following items: **baseline**: turning over (p = 0.027), lying to sitting (p = 0.032), walking indoors (p = 0.013): **post-treatment**: turning over (p =<0.001), lying to sitting (p = <0.001), sitting balance (p = <0.001), transfers (p=0.027), stairs climbing (p =0.048).

Table 6. 6: Pre and post-intervention comparison of stroke survivors' mobility functional level: MRMl item score

MRMl item	Baseline Assessment (t_0)		Baseline comparison		Post-intervention assessment (t_1)		Post-intervention comparison	
	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value
Turning over	2.24 ±0.68	1.92 ± 0.55	-0.32	0.027 *	2.24 ± 0.50	2.74 ± 0.57	0.50	<0.001** *
Lying to sitting	2.19 ±0.52	1.89 ± 0.61	-0.30	0.032 *	2.18 ± 0.45	2.74 ± 0.62	0.56	<0.001** *
Siting balance	2.22 ± 0.53	1.92 ±0.80	-0.30	0.063	2.21 ± 0.59	2.88 ± 0.81	0.68	<0.001** *
Sitting to standing	1.97 ± 0.73	1.65 ± 0.72	-0.32	0.057	2.00 ± 0.55	2.62 ± 0.60	0.62	<0.001** *
Standing	1.41 ± 0.80	1.03 ± 0.87	-0.38	0.054	1.59 ± 0.78	1.97 ± 0.83	0.38	0.056

Transfers	2.43 ± 0.84	2.11 ± 0.94	-0.32	0.120	2.62 ± 0.65	3.00 ± 0.74	0.38	0.027*
Walking indoors	1.11 ± 0.90	0.59 ± 0.76	-0.51	0.013*	1.18 ± 1.00	1.56 ± 0.70	0.38	0.073
Stairs	0.41 ± 0.80	0.24 ± 0.49	-0.16	0.297	0.76 ± 0.89	1.21 ± 0.92	0.44	0.048*

*=statistical significance at $p<0.05$

6.6.4.2. Stroke survivors' activity of daily living functional level

The Barthel index (BI) was used to assess stroke survivors' activity of daily living. Table 6.7 and 6.8 displays the average BI total and item scores.

The BI total scores increased for the intervention group while a reduction was observed in the mean BI score for the control group post-treatment. The differences between baseline ($p = 0.016$) and post-treatment ($p=0.011$) follow-up scores were statistically significant with the control group scoring relatively lower than the intervention group. However, post-treatment follow-up of the BI mean score for both control and intervention groups was below 18. A score above 18 indicates that the patient does not require assistance for mobility.

Table 6. 7: Pre and post intervention comparison of stroke survivors' activity of daily living functional level: BI total score

BI total score (Total score, 20)	**Baseline Assessment (t_0)**		**Baseline comparison**		**Post-intervention assessment (t_1)**		**Post-intervention comparison**	
	Control group	Intervention group	Mean difference	p-value	Control group	Intervention group	Mean difference	p-value
Mean (SD)	11.19(3.08)	9.59(2.41)	-1.59	0.016*	9.38(3.62)	11.81(4.32)	2.43	0.011*
Minimum score	5	5			0	0		
Maximum score	19	17			19	19		

Table 6. 8: Pre and post intervention comparison of stroke survivors' activity of daily living functional level: BI item score.

BI item (Maximum score)	Baseline Assessment (t_0)		Baseline comparison		Post-intervention assessment (t_1)		Post-intervention comparison	
	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value
Bowels (2)	1.57 ± 0.65	1.24 ± 0.55	-0.32	0.022*	1.82 ± 0.39	1.94 ± 0.24	0.12	0.136
Bladder (2)	2.59 ± 0.60	2.39 ± 0.76	-0.22	0.178	1.68 ± 0.47	1.91 ± 0.29	0.24	0.016*
Grooming (1)	0.08 ± 0.47	0.08±0.47	0.00	1.000	1.65 ± 0.49	1.97 ± 0.30	0.32	0.002**
Toilet use (2)	0.86 ± 0.42	0.70 ± 0.46	-0.16	0.119	0.85 ± 0.44	1.03 ± 0.39	0.18	0.082
Feeding (2)	1.05 ±0.33	1.05 ±0.33	0.00	1.000	0.94 ± 0.42	1.06 ± 0.34	0.12	0.212
Transfer (3)	1.81 ± 0.52	1.37±0.75	-0.43	0.006**	1.59 ± 0.61	1.82 ± 0.58	0.24	0.106
Mobility (3)	1.27± 0.51	0.97 ± 0.29	-0.30	0.003**	1.15 ± 0.97	1.74 ± 0.51	0.59	<0.001***
Dressing (2)	0.46± 0.61	0.49 ± 0.56	0.03	0.842	0.35 ± 0.49	0.97 ± 0.52	0.62	<0.001***

Stairs (2)	0.16 ± 0.37	0.03 ± 0.16	-0.14	0.048*	0.12 ± 0.33	0.38 ± 0.49	0.26	0.011*
Bathing (1)	1.08 ± 0.36	1.03 ± 0.16	-0.05	0.041*	0.06 ± 0.24	0.03 ± 0.17	-0.03	0.562

(*= statistical significance at *p< 0.005)*

The differences between intervention and control groups were statistically significant in the following item scores: **baseline**: bowels (p=0.022), transfer (p = 0.006), stairs (p =0.048), bathing (p =0.041); **Post-treatment**: bladder (p=0.016), grooming (p = 0.002), mobility (p = <0.001) and dressing (p= < 0.001).

6.6.4.3. Stroke survivors' perceived quality of life

The mean stroke-specific quality of life (SSQoL) questionnaire assesses a patient's perceived quality of life. Table 6.9 and 6.10 shows the Comparison of Stroke survivors' perceived quality of life level total and item scores respectively.

Table 6. 9: Pre and post intervention comparison of stroke survivors' perceived quality of life level: SSQoL total score

SSQoL total score	Baseline Assessment (t_0)		Baseline comparison		Post-intervention assessment (t_1)		Post-intervention comparison	
	Control group	Intervention group	Mean difference	p-value	Control group	Intervention group	Mean difference	p-value
Mean (SD)	84.35 ±23.20)	80.49 (21.70)	-3.86	0.462	80.05(31.47)	103(35.16)	22.95	0.004**
Minimum score	0	0			0	0		
Maximum score	168	124			114	151		
Effect size							0.69	0.22, 1.15

SSQoL total scores were comparable at baseline between control and intervention group (p =0.462); at post-treatment, the mean score between the control and intervention groups were significantly different (p = 0.004).

Table 6. 10: Pre and post intervention comparison of stroke survivors' perceived quality of life level: SSQoL item score

SSQoL item	Baseline Assessment (t_0)		Baseline comparison		Post-intervention assessment (t_1)		Post-intervention comparison	
	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value
Energy	5.33 ± 1.60	4.83 ± 1.48	-0.50	0.174	5.33 ± 1.65	6.56 ± 2.20	1.23	0.012*
Family roles	4.67 ± 1.51	4.75 ± 1.87	0.08	0.836	5.18 ± 2.17	6.79 ± 2.24	1.61	0.004**
Language	16.06± 4.20	15.92± 4.64	-0.28	0.791	19.30 ± 4.67	21.94 ± 3.31	2.64	0.010*
Mobility	7.08 ± 2.66	6.39 ± 2.00	-0.69	0.215	8.18 ± 3.03	11.14 ± 3.02	2.97	<0.001***
Mood	8.36 ± 3.59	9.26 ± 3.02	0.90	0.260	8.61 ± 2.33	10.53 ± 2.31	1.92	0.001**
Personality	5.58 ± 2.35	6.03 ± 2.62	0.45	0.453	4.97 ± 1.40	6.47 ± 2.22	1.50	0.002**
Self-Care	8.58 ± 3.33	7.71 ± 2.40	-0.87	0.212	8.03 ± 2.62	10.68 ± 2.97	2.65	<0.001***
Social roles	8.86± 3.20	8.40 ± 2.57	-0.46	0.506	8.61 ± 2.21	10.65 ± 3.27	2.04	0.004**
Thinking	4.86 ± 2.09	4.86 ± 1.93	0.00	0.993	4.85 ± 1.60	5.82 ± 1.91	0.98	0.027*

Upper extremity function	7.61 ± 3.49	6.77 ± 1.97	-0.84	0.218	8.73 ± 2.71	10.09 ± 2.72	1.36	0.044*
Vision	4.97 ± 2.54	4.91 ± 2.23	-0.06	0.919	3.88 ± 1.43	5.71 ± 2.11	1.83	<0.001***
Work/productivity	4.58 ± 1.93	4.34 ± 1.86	-0.24	0.595	4.09 ± 1.23	5.71 ± 2.46	1.61	0.001**

The mean item score was all comparable for all the items at baseline ($p>0.05$). Conversely, all items score difference between control and intervention groups post-treatment were statistically different ($p < 0.05$) with comparatively higher scores in the intervention group.

6.6.4.4. Stroke survivors' functional balance abilities

The Berg balance scale was used to assess stroke survivors functional balance abilities. Table 6.11 shows the comparison of Stroke survivors' berg balance scale (balance ability) levels.

At baseline and post-treatment, the mean difference between the control and intervention groups were statistically significant ($p=0.047$). Also, the mean BBS score increased in the intervention group post-treatment. However, the mean BBS of the intervention group was less than 45. A BBS score of less than 45 indicates that the individual may be at greater risk of falling.

Table 6. 11: Pre and post intervention comparison of stroke survivors' functional balance abilities: BBS score

	Baseline Assessment (t_0)		**Baseline comparison**		**Post-intervention assessment (t_1)**		**Post-intervention comparison**	
BBS total score (Total score, 56)	Control group	Intervention group	Mean difference	p-value	Control group	Intervention group	Mean difference	p-value
Mean (SD)	9.35(6.98)	6.41(5.48)	-2.95	0.047*	9.97(7.57)	19.97(11.03)	10.00	<0.001***
Minimum score	1	0			0	0		
Maximum score	30	34			38	44		
Effect size							1.06	0.57, 1.54

6.6.5. Factors predictive of the outcome of prism adaptation therapy effect on unilateral spatial neglect in stroke survivors in the sub-acute phase

Table 6.12 and 6.13 shows factors that had an influence on USN recovery after prism adaptation therapy: results of the Univariate and multivariate analysis.

Stroke survivors in the treatment group had **18.62** times more odds of recovery than patients in the control group. This was seen to be overwhelmingly significant ($P < 0.001$).

Although not significant, for every unit increase in age, cognitive ability and time from stroke to enrolment, the odds of USN recovery increases by 1.01, 1.17 and 1.09 respectively. Conversely, females had 0.76 less odds of recovery than the males in this study. Stroke patients who had haemorrhagic stroke had 0.8 less odds of recovery than those with Ischemic stroke. Left-handed participants were 1.3 times more likely to recover than those who were right-handed. Also, Stroke survivors who had infratentorial strokes had 1.79 more odds of recovery while those with mixed type had 0.45 less odds of recovery compared to those who had supratentorial stroke. Asians and Caucasians also 0.40 and 0.46 times less likely to recover than blacks.

Table 6. 12: Factors that influence recovery from post-stroke USN: Univariate analysis

	OR	SE	Z	p-value	95% confidence	
Allocation arm						
Control	Ref					
Treatment	18.62	12.87	4.23	<0.001***	4.80	72.15
Age	1.01	0.02	0.56	0.574	0.97	1.05
Cognitive ability	1.17	0.13	1.41	0.160	0.94	1.45
Time to enrolment	1.09	0.02	0.60	0.550	0.98	1.04
Gender						
Male	Ref					
Female	0.72	0.12	-1.92	0.054	0.52	1.01
Marital status						
Married	Ref					
Single	0.84	0.45	-0.32	0.751	0.30	2.41
Widow	0.68	0.60	-0.44	0.660	0.12	3.89
Years of Education	0.98	0.05	-0.41	0.680	0.88	1.08
Employment status						
Employed	Ref					
Unemployed	2.17	1.17	1.43	0.153	0.75	6.25
Retired	1.33	0.97	0.40	0.692	0.32	5.54
Race						
Black	Ref					
Asian	0.40	0.46	-0.79	0.428	0.04	3.82
Caucasian	0.46	0.39	-0.92	0.357	0.09	2.41
Hand Preference						
Right	Ref					
Left	1.3	0.77	0.44	0.659	0.41	4.17
Type of stroke						
Ischemic	Ref					
Haemorrhagic	0.80	0.48	-0.37	0.71	0.24	2.62
Site of stroke						
Supratentorial	Ref					
Infratentorial	1.79	2.57	0.41	0.685	0.11	29.95
Mixed	0.45	0.51	-0.70	0.484	0.05	4.24

(OR: odd ratio, CI: confidence interval, SE: standard error, ***= statistical significance)

Table 6. 13: Factors that influence recovery from post-stroke USN: Multivariate analysis

	OR	SE	Z	P-value	CI	
Allocation arm						
Control	Ref					
Treatment	63.10	60.30	4.34	<0.001***	9.70	410.59
Cognitive Ability	1.52	0.26	2.41	0.016*	1.08	2.14
Gender						
Male	Ref					
Female	0.70	0.17	-1.48	0.139	0.44	1.12
Age	0.96	0.03	-1.46	0.145	0.90	1.02
Employment Status	2.21	1.21	1.45	0.147	0.76	6.46

The model for the multivariate analysis was selected following backward stepwise logistic regression. Age was locked into the model as literature has shown that age plays a role in stroke recovery (Bagg et al., 2002).

Controlling for other confounding factors, patients in the treatment group had 63.10 greater odds of recovery than patients in the non-treatment group. This finding was overwhelmingly significant with p-value < 0.001 and 95% confidence interval 9.70 – 410.59. Also, for every unit increase in cognitive ability (MMSE score), the odds of recovery increased by 1.52 after controlling for confounders. This finding was also statistically significant (p = 0.016, 95% CI= 1.08-2.14). Females had 0.70 less odds of recovery compared to the males although this did not reach statistical significance (P = 0.139). Likewise, for every unit increase in age, the odds of recovery decreases by 0.96 after adjusting for confounders. This finding was not statistically significant (p = 0.147, CI = 0.90 -1.02).

6.7. DISCUSSION

The objective of this study was to examine the impact of prism adaptation therapy in survivors of sub-acute stroke and to investigate if these PA effects extend to rehabilitation outcomes such as functional mobility, activities of daily living, functional balance, and perceived stroke-specific quality of life. Also, this study investigated socio-demographic and clinical predictors of recovery from USN after prism adaptation therapy.

This study is the first study to conduct an RCT of the effect of prism adaptation therapy on USN post-stroke on the African population using a substantial sample size. At baseline allocation, there was no imbalance in the between-group (control vs intervention) comparison of socio-demographic and clinical characteristics of participants.

This discussion covers key results from the results chapter. Salient results are considered in relation to literature and conclusions are reached centred on the main discussion items.

6.7.1. Characteristics of study participants

In this study, there was a 1:1 ratio of gender distribution; this could be attributed to chance in the recruitment of patients for this study and not a depiction of the gender distribution of stroke incidence. There is existing evidence that stroke incidence is higher in males than in females in all age classes, and females are, on average, several years older than men when they suffer their first stroke. Up until about the age of 80 years, the prevalence of stroke is higher among men, after which it is higher among women (Gibson, 2013; Giralt et al., 2012; Goto et al., 2007; Kes et al., 2016; Wyller, 1999).

The participants averaged 46.51±13.56 years in the control group and 51.78±13.06 years in the intervention group. This is not surprising as the current trend in incidence of stroke supports that stroke against the age-long belief is no longer a disease of the aged. Previous studies (Connor, 2004; Mudzi et al., 2012; Ntsiea et al., 2013; Rhoda & Hendry, 2003; Röding et al., 2003) had reported occurrence of stroke in same age group as this study. This paradigm shift in the age of occurrence of stroke has been attributed to growing poor lifestyle choices such as sedentary

habits, smoking and poor diet intake which leads to stroke risk factors such as dyslipidaemia and hypertension (Maredza et al., 2016; Putaala et al., 2012; Smajlović, 2015).

Right-handed patients were in preponderance in this study, this is in tandem with a meta-analysis by Papadatou-Pastou et al., (2020) that reported a right-handedness preponderance as opposed to left-handedness.

Similarly, ischaemic stroke type was in majority in this study. This is in tandem with a study that put estimates of ischaemic stroke to be 80% in an African population (Walker et al., 2011). Among Caucasians, ischaemic stroke was observed in approximately 80% of all strokes (Ovbiagele & Nguyen-Huynh, 2011; Sudlow & Warlow, 1997). This, however, is in contrast with a study that reported prevalence in West Africa where haemorrhagic stroke occurred at a higher frequency than ischemic stroke among people <50 years old, whilst among people aged ≥50 years, there were significantly more ischemic strokes (Sarfo et al., 2018). In sub-Saharan Africa (SSA), data on stroke subtype is limited. For example, rates of cerebral haemorrhage range from 29-57% (Connor et al., 2007; Kolapo et al., 2006; Ogun et al., 2002; Zenebe et al., 2005). SSA and high-income countries are showing a wide variation in the incidence of stroke sub-types, largely due to low numbers in these studies, lack of availability of computed tomography (CT) scanning equipment, and hospital settings (Walker et al., 2011).

Supratentorial stroke was in majority among the study participants. This is in contrast to results obtained by previous researchers (Kora et al., 2011; Owolabi et al., 2016; Sundar & Mehetre, 2007) that reported infratentorial stroke to be in preponderance. It was reported, however, by Kora et al., (2011) that infratentorial lesions were more prevalent (83%) than supratentorial lesions (16%) in haemorrhagic strokes, however both were equally prevalent in ischemic strokes (40% each). Blacks were in preponderance in this study population. This is not surprising as blacks make up a vast majority of the population in South Africa where this study was conducted (*Community Survey 2016 Statistical release*).

6.7.2. Effect of prism adaptation therapy on unilateral spatial neglect

In this study, an RCT methodology was used to ascertain the effect of a twelve session, once daily dose of 20 dioptre prism adaptation on USN (assessed using a paper and pencil test and a functional test; the BIT-C) therapy among post-stroke survivors in the sub-acute phase of recovery. PA group improved significantly in the spatial abilities (BIT-C score). Additionally, the intervention group had more clinical recovery (BIT-C score >129) than the control/sham group. This indicates that PA enabled motor and cognitive relearning following the twelve sessions of prism treatment. The sample size and comparability of the intervention and control group in this study was relatively good and is compatible with previous studies utilising prisms in USN treatments (AJ et al., 2010; Fortis et al., 2011; Frassinetti et al., 2002; Gossmann et al., 2013; Keane et al., 2006; Maravita et al., 2003; Mizuno et al., 2011b; Nys et al., 2008; G. Rode et al., 2015; Rossetti et al., 1998; Serino et al., 2009; H Shiraishi et al., 2008; Yoneda et al., 2011) and in contrast to studies that found no improvement in unilateral spatial neglect (Mancuso et al., 2012; Rode et al., 2015). The observed therapeutic gains in this study can be attributed to a plethora of reasons: Firstly, a higher prism power (20 dioptres, 11.4° shift) was utilised in this study and is higher than previously reported in studies; 10 dioptres (AJ et al., 2010; Georg Kerkhoff & Schenk, 2012a; Mizuno et al., 2011b) and five dioptres (Mancuso et al., 2012). Secondly, the number of treatment sessions was substantial. Evidence shows that administering higher sessions (ten or more sessions) of prisms treatment produce a large effect (Mizuno et al., 2011b) whilst fewer (four or lesser) sessions of prism treatment has been reported to not produce substantial amelioration of USN in post-stroke survivors (Alessandro Farnè et al., 2002b; Nys et al., 2008).

Similarly, all sub-tests of the BIT-C (*Line crossing, star cancellation test, figure and shape copying and line bisection),* except for the representational drawing, significantly improved. This is a reflection of previous studies (Luauté et al., 2006; Shiraishi et al., 2008) that stated that prism was more useful for cancellation and line bisection task than visuo-construction such as copying and drawing. Testing of line bisections and cancellations is conducted within reaching spaces. These

tests can suggest the presence of neglect in peripersonal space (Plummer et al., 2003), hence a gain in these sub-tests as observed in this study suggests that prism treatment also targets neglect of peripersonal space.

6.7.3. Effect of prism adaptation therapy on mobility functional level, activity of daily living functional level, perceived quality of life, and balance abilities among stroke survivors

This study also evaluated the effect of prism adaptation on rehabilitation outcomes such as mobility functional level, activity of daily living functional level, perceived quality of life and balance abilities among stroke survivors. The rationale for this was that literature has reported direct negative effect of USN on functional mobility (Berti et al., 2002; Tromp et al., 1995), ADLs (Cherney et al., 2001b; Jehkonen et al., 2000; Vossel et al., 2013), perceived QoL (Franceschini et al., 2010; Sobrinho et al., 2018b) and balance abilities (Pérennou, 2006; Taylor et al., 1994). It was therefore hypothesized that PA effect on USN will extend to these rehabilitation outcomes. The effect of prism adaptation therapy on these rehabilitation outcomes is discussed in the subsequent subsections.

6.7.4. Effect of prism adaptation therapy on mobility functional level.

Functional mobility is key in rehabilitation efforts in stroke rehabilitation. In this study, the mean MRMI post-treatment for the intervention group was statistically and clinically significant; as the change in score was greater than a 4.5 (Lennon & Johnson, 2000). The finding of this study is comparable to previous studies that reported improvement following prism treatment in wheelchair driving (Chen et al., 2019; Jacquin-Courtois et al., 2008; Watanabe & Amimoto, 2010c) and navigation in a virtual market space (Glize et al., 2017). However, Ten Brink et al., (2017), using the Mobility Assessment Course (MAC), reported no improvement in functional mobility related to USN after prism treatment in sub-acute stroke survivors.

In this study, functional mobility was assessed using the MRMI. This is the first study to assess functional mobility in stroke patients after prism treatment. The difference in outcome between this study and the study by Ten Brink et al., (2017) may be related to the outcome measure utilized in assessment of mobility related outcome. The items of the MRMI such as turning over, transfers, sitting balance, walking indoors and stairs climbing require midline alignment which is distorted in unilateral spatial neglect. Findings from this study suggest that prism adaptation improves egocentric midline reference observed in USN which extends to gains in functional mobility.

6.7.5. Effect of prism adaptation on activities of daily living functional level

The Barthel index was used to assess ADLs in this study. A plethora of other approaches such as reading/writing, activities of daily living (ADL) direct tests, ADL questionnaires (i.e., therapist or self-rating questionnaires including questions on domains of daily functioning, and navigation (i.e., walking or wheelchair driving)), have been utilised in the assessment of ADLs in stroke survivors (Champod et al., 2018).

In this study, ADLs, as assessed by the BI total scores, increased for the intervention group while a reduction was observed in the mean BI score for the control group post-treatment. The reason for the decline in the BI score of the control group is not clear. However, previous study by Pan et al., (2021) reported decline in BI scores among elderly community dwellers and factors explaining this were socio-demographics (i.e., sex, education, living arrangement, and hobbies) and disease conditions.

Statistically, the intervention group scored higher than the control group at the post-treatment follow-up. However, post-treatment follow-up of the BI mean score was below 18 for both control and intervention groups. When a score is above 18, no assistance is required for activities of daily living (Uyttenboogaart et al., 2005). Previous studies (Fortis et al., 2010; Mizuno et al., 2011b, 2021) using the functional independence measure (FIM) have reported improvements in ADLs following prism adaptation therapy whereas some other studies (Gossmann et al., 2013; G. Rode et al., 2015; H Shiraishi et al., 2008) reported a negative outcome from prism treatment on post-

stroke USN survivors. Several possible causes of diverse outcome of prism treatment effect such as the number of treatment sessions, phase of recovery of patients and severity of USN has been put forward by Champod et al., (2018).

In this study, though there was an improvement in total BI score, the improvement observed did not reach a clinically significant score (BI score less than 18); which translates that patient will need assistance with ADLs. The probable reason for patients not reaching a clinical significance might be due to the following reason: This study did not consider the severity of neglect. Patients with severe neglect might produce an outlier effect skewing the results as severe USN patients are likely to need more prism sessions to reach a clinically significant level (Goedert et al., 2015). Secondly, the items in the BI such as bowel and bladder control are autonomic functions which prism adaptation does not target in action; this may have also affected post-treatment scores of the BI. This is also evident in the improvement seen in the item score of the BI in this study; the bowel function showed no statistically significant difference post-treatment.

6.7.6. Effect of prism adaptation on perceived quality of life

Quality of Life was assessed using the SSQoL in this study. This study is the first to assess the impact of prism adaptation therapy on QoL. Findings from this study showed a positive outcome on QoL after treatment with prism. All items of the SSQoL showed significant improvement. Munce and colleagues, in a systematic review, identified several strategies for quality improvement OF QoL which include: self-management patient education, team changes, and case management (Munce et al., 2018)

Several physiotherapeutic interventions such as aquatic therapy (Pérez-De la Cruz, 2020), pelvic muscle training (Tibaek et al., 2017), Yoga (Immink et al., 2014), horseback riding (Beinotti et al., 2013), CIMT (Kelly et al., 2018) and proprioceptive neuromuscular facilitation (Chitra & Joshi, 2017; Manjula, 2020) have been suggested to improve quality of life in stroke patients.

The improvement observed in this study could be due to the improvement observed in USN after prism therapy. USN impedes performance in midline activities which can affect day-to-day

activities thereby affecting QoL of post-stroke survivors. This is not surprising as QoL has been reported to have a strong positive correlation with activities of daily living (Kim et al., 2014) and these gains in ADL resulting from USN amelioration may have ostensibly extended to the patient's QoL. Also, items of the SSQoL questionnaire include questions that integrate midline adjustments to achieve.

This finding suggests that prism therapy should be considered in the treatment of post-stroke survivors with USN if improving QoL is the aim.

6.7.7. Effect of prism adaptation on balance abilities

Balance ability was assessed in this study using the Berg Balance Scale. Some improvement in the BBS was noted after treatment using prism. Previous studies (Chen et al., 2019; Ha et al., 2019; Tilikete et al., 2001) reported a similar result albeit utilising a smaller sample size. This study is the first to examine the secondary impact of prism therapy in a randomised control methodology using a large sample size.

Though improvements were observed in the BBS, the improvements did not reach clinical significance as the patients in the treatment group post-stroke had a score less than 45; a score of <45 indicates a greater risk of falling for the individual (Berg et al., 1992). It is however unclear why recovery in balance abilities in this study did not reach clinical significance. It could be as a result of diverse reasons such as duration of training might not have been sufficient to bring about the desirable change in balance abilities as assessed using the BBS. Also, general balance measures like the BBS have a high-level balance requirement which may not have been met by the stroke survivors in this study as they were all in the sub-acute phase of recovery.

Integration of other balance treatment approaches such as whole body vibration, virtual reality, mirror therapy and exercise is suggested for optimal balance. Umeonwuka et al., (2020) had observed that combination of two or more intervention approaches is the new trend in USN treatment and is more promising than utilizing single intervention.

6.7.8. Factors predictive of the outcome of prism adaptation therapy effect on unilateral spatial neglect in stroke survivors in the sub-acute phase

This study also evaluated factors that influence recovery from USN following prism treatment among stroke survivors. This will give rehabilitation experts an insight into the category of patients that will most benefit from USN treatment.

Stroke survivors in the treatment group had 18.62 ($p < 0.001$) times more odds of recovery than patients in the control group. No other sociodemographic factor was found to reliably influence the recovery of USN after prism treatment. This implies that all stroke survivors who have USN irrespective of socio-demographics should be considered a candidate for prism adaptation treatment after stroke. Though not statistically significant; age, gender, type of stroke, site of stroke, time from stroke to enrolment in study, handedness and race showed some interesting findings on recovery from USN after prism treatment. For instance, age was shown to have almost no effect on recovery after prism as the odds of recovery for every unit increase in age was 1.01 Previous studies had reported that functional recovery post-stroke increased with decreasing age (Cioncoloni et al., 2013; Jongbloed, 1986; Khan et al., 2014; Protopsaltis et al., 2009; Veerbeek et al., 2011). However, conflicting report of the influence of age on stroke recovery has been highlighted by Jongbloed, (1986). Similarly, Harvey, (2015) reported that the age of a person recovering from a stroke does not predict their functional recovery until several months have passed. However, resulting functional recovery depends much more on the extent of the initial disability.

Also, females had 0.76 less odds of recovery than the males in this study. Previous studies (Cioncoloni et al., 2013; Tei et al., 2011; Tilling et al., 2001) have reported poorer functional outcomes and lower quality of life of females than men even though females have higher incidence of stroke. Stroke differences may be explained by a combination of factors that include coagulation status, sex hormones, genetics, social interactions, and lifestyle, acting individually or jointly (Hiraga, 2017).

Stroke patients who had haemorrhagic stroke had 0.8 less odds of recovery than Ischemic stroke. Left-handed participants were 1.3 times more likely to recover than those who were right-handed. Currently available data do not provide definitive answers to all of the questions regarding recovery on haemorrhagic strokes versus ischemic strokes; however, haemorrhagic stroke patients demonstrated functional gains more rapidly than ischemic patients (Chae et al., 1996; Stefano Paolucci et al., 2003). However, data from this study were in disagreement with those of a prior study (Franke et al., 1992).

Stroke patients who had infratentorial strokes had 1.79 more odds of recovery while those with mixed type had 0.45 less odds of recovery compared to those who had supratentorial stroke.

Supratentorial stroke (STS) and infratentorial stroke (ITS) strokes cause motor deficits that require specific rehabilitative treatment. The main motor deficit for STS is hemiparesis and ataxia for ITS. Very few studies compare the outcome of STS patients with that of ITS patients (De Haan et al., 1995; Bernardo Gialanella et al., 2008). Patients with brainstem infarction (ITS) have a worse prognosis than those with hemispheric infarction (STS) according to Marshali & Kaeser (1961). Turney et al., (1984) showed better recovery and De Haan et al., (1995) showed that ITS had a better quality of life than in STS patients. A possibility is that structures in the supratentorial region are responsible for cognitive and perceptual processing. It is possible that prism adaptation may have altered spatial cognition in the direction of visual displacement by temporarily adjusting sensorimotor mapping.

Cognitive ability was statistically significantly associated ($p = 0.016$, 95% CI= 1.08-2.14) with recovery from USN after prism treatment. Attentional task (BIT) has been reported to be deeply influenced by cognitive function among patients with cerebral infarction on their right cerebral hemisphere (Kato et al., 2012). This finding suggests that higher cognitive ability is a prerequisite for stroke survivors to be able to benefit from prism adaptation in the treatment of USN in stroke survivors.

6.8. CONCLUSION

This study assessed the impact of prism adaptation therapy on USN and the secondary effect on QoL, ADLs, balance and functional mobility. Also, sociodemographic and clinical predictors of recovery from USN after prism treatment were investigated. Improvement was observed in spatial abilities and this improvement extended to QoL, ADLs, functional recovery and balance abilities which is in tandem with previously published data. There was however a decline in CBS that assesses functional aspects of USN. Cognitive ability was found to influence recovery from USN post-stroke. Prism adaptation can improve spatial difficulties following a stroke program for the patients.

Results from this study may form evidence for the incorporation of prism therapy in the rehabilitation of stroke survivors at the sub-acute phase of recovery.

6.9. LIMITATION

I. The non-stratification of USN (as assessed by BIT-C score) by severity made it difficult to infer if gains in spatial abilities could benefit patients with varying degrees of neglect symptoms post-stroke.

II. The block randomisation used may have generated groups that are not comparable in terms of covariates. This may negatively influence the results of the clinical trial. A multivariate model (logistic regression) was employed to mitigate the confounding effects.

III. Some sub-items of the BI such as the bowels and bladder component may have been irrelevant or unrelated to spatial abilities and may have given a picture of recovery. However, the result in this study also presented item scores of the BI.

IV. The follow-up for this was for a single time just after completion of treatment regimen. Multiple follow-up at 3 months and 6 months' post-treatment completion could enable the researcher to establish the lasting effect of prism treatment on USN and if there could be a possible relapse in the gains recorded after prism adaptation therapy.

Impact of the COVID-19 pandemic on the research process

The data collection phase of this study overlapped with the advent of the COVID-19 pandemic which was fraught with overwhelming strain on health institutions, and the government-imposed lockdowns.

One of the study centres for this study due to the massive pressure of the COVID-19 converted the neurological ward to a COVID ward. This translated to reduced admission of neurological cases at the facility for these periods and early discharges leading to loss of potential participants for the study.

Also, a fire accident at the same facility in April 2021 and subsequent closure prevented the researcher from assessing data on Hospital length of stay (LOS).

The next chapter includes the integrative discussion that discusses the three stages of this research project as a single cohesive thesis and recommendation of this thesis.

7. CHAPTER 7: INTEGRATIVE DISCUSSION

7.1. INTRODUCTION TO CHAPTER

This chapter discussed the results of the different stages of study of this research project in the integrative discussion.

7.2. INTEGRATIVE DISCUSSION

Post stroke USN is a major cause of disability among stroke survivors (Paolucci et al., 2001; Riestra & Barrett, 2013). Stroke is the the second leading cause of death and disability globally (Katan & Luft, 2018; *Stroke: A Leading Cause of Death and Disability in the United States | LLUH News*, n.d.).

Although USN has been extensively researched, there are still some unanswered questions. First, there have been conflicting studies in the literature regarding effective treatment for USN. Given the importance of USN treatment in post-stroke rehabilitation, healthcare practitioners should maintain a current knowledge of interventions. Secondly, knowledge uptake of this evidence in clinical practice is not known among physiotherapists. Identifying knowledge gaps between knowledge creation and uptake is extremely important to understanding the subject better. Thirdly, prism adaptation therapy, which is an interesting approach introduced in treatment of USN has not been demonstrated to be effective in post-stroke survivors at the sub-acute phase of recovery.

This research project investigated the evidence base for USN rehabilitation, the knowledge base for USN treatment and the impact of PA therapy on USN in the sub-acute phase of recovery of patients. This multipronged project was conducted in three main stages. First, a scoping review to map current treatment approaches for post-stroke unilateral spatial neglect as presented in the literature. This was followed by a cross-sectional survey evaluating knowledge, current practice, barriers and enablers of USN among physiotherapists in Nigeria and South Africa respectively. Lastly, an RCT to evaluate the effect of a twelve session intervention program of 20 dioptre prism goggle use on USN was conducted in stroke survivors during the sub-acute phase of recovery.

The scoping review identified a plethora of interventions in the literature for the amelioration of USN. Combining more than one approach (combination therapy) and PA therapy were the most investigated interventions for treatment of USN. A total of thirty interventions for the treatment of USN were identified by previous studies (Klinke et al., 2015; Luaute et al., 2006; Paci et al., 2010; Pierce & Buxbaum, 2002). This underscores the fact that there is a growing interest in post-stroke USN among researchers in the field of rehabilitation. Also, there was a trend in the investigated interventions for USN identified in this study. Firstly, combining more than one approach in the treatment of USN was investigated the most and appears to be very promising. This is a shift from mono-therapy approaches previously suggested in the literature. Combination therapy utilises both the top-down approach and the bottom-up approach (Azouvi et al., 2017). Secondly, there seems to be a shift from the more traditional approach such as visual scanning, trunk rotation to more technology-based interventions such as transcranial stimulation, and PA. Ethical issues still exist on the use of some interventions such as deep brain stimulation (Schermer, 2011). This study creates a map of what is known regarding interventions for USN post-stroke.

The second stage of this study investigated physiotherapists' knowledge, current practice, barriers, and facilitators to USN rehabilitation. It is imperative to evaluate how physiotherapists treat post-stroke USN with the aim of identifying and possibly, remediating the disconnection between evidence-based clinical care and real-life practice. Also, identification of practice barriers is fundamental in the process of translating knowledge into practice (McCluskey & Middleton, 2010). Hence the need to identify barriers and facilitators physiotherapists encounter in the treatment of post-stroke survivors exhibiting USN. This phase of the study employed a cross sectional study design and was conducted among cohorts of physiotherapists in Nigeria and South Africa. The rationale to conduct these surveys (stage II) in Nigeria and South Africa is related to the disparities in the context and scope of physiotherapy training and practice in both countries. For instance, in Nigeria, physiotherapy practice is not first contact with patients (Ganiyu, 2008; Mbada et al., 2015) while in South Africa, first contact physiotherapy is practised (Bury & Stokes, 2013). Similarly, physiotherapy training in Nigeria is a five-year training program with a

current advocacy for a 6-year doctor of physiotherapy (DPT) training program (*Nigeria Physiotherapy Network - Physiotherapy Education in Nigeria*, n.d.). In contrast Physiotherapy training is a 4-year training program South Africa. These mentioned disparities are of interest and necessitated the need to evaluate both countries separately as these differences might reflect in clinical practices in these countries. Also, Nigeria and South Africa should be the focus of stroke research in Africa as Akinyemi et al (2021) reported the annual incidence rate of stroke in Africa is up to 316 per 100,000 individuals, which is within the highest incidence rates in the world, and the prevalence rate of 1,460 per 100,000 reported in one region of Nigeria, western Africa, is clearly among the highest in the world (Akinyemi et al., 2021).

In both cohorts (South African and Nigerian physiotherapists), knowledge of USN was reported to be moderate although the average knowledge score was higher among South African physiotherapists (Knowledge score of 14.11 vs 12.6 for South African and Nigerian cohort respectively). The reason for these results was not investigated in this research project. However, anecdotally, this disparity might be explained by differences in the availability of resources (both teaching and learning materials), training curriculum (Scott, 2014), and national education budgetary allocation which is evident in the global ranking of tertiary education institutions of these countries. South Africa's extensive investments in higher education have made a significant impact in the region which places their institutions among global top 200 Universities (*World University Rankings*, 2022) . Nigerian universities, on the other hand, face a number of challenges including a lack of funding, decaying infrastructure, outdated textbooks, obsolete equipment, and inadequate student services (Olatunji, 2021). Another reason might be due to the population surveyed. The South African cohort were physiotherapists with special interest in neurology, while the Nigerian cohort were physiotherapists with interests in different specialties.

Factors that influenced Physiotherapist's knowledge on post-stroke USN identified in this research project include: post-graduate certification in neurorehabilitation ($p=0.001$), working full time in neurorehabilitation ($p=0.033$) and clinical practice setting ($p=0.008$) for the Nigerian cohort while for the South African cohorts, respondents' age ($r=0.46$; $p=0.016$) and years of practice as a

physiotherapist (r= 0.43; p= 0.026) had a significant moderate positive correlation with knowledge of USN. The reason for the disparate relationship between USN knowledge scores and physiotherapists' characteristics in the two populations may be related to the disparities in the demographic characteristics and sample size in both cohorts. However, previous studies showed that rehabilitation professionals who had higher qualifications had a higher knowledge of the stroke-specific evidence-based practice (EBP) (Menon-Nair et al., 2007b; Petzold et al., 2012). This might not be unconnected to the content of advanced condition-specific training and critical reasoning received in advanced training. Constraint induced movement therapy and mirror therapy were reported to be the treatment of choice among Nigerian physiotherapists. In comparison with results from the South African cohort that reported constraint induced movement therapy (CIMT), mirror therapy and visual scanning as treatment of choice for post-stroke USN, there seem to be similarities in the reported treatment approach for USN. Constraint induced movement therapy has been investigated in neglect treatment and considerable evidence on its efficacy is available (Luaute et al., 2006). However, an interesting finding is that the reported intervention for amelioration of post-stroke USN in this study is not in tandem with the current evidence trend in USN treatment identified in the scoping of this research (Umeonwuka et al., 2020) that reported a combination of two or more approaches and PA therapy as the most investigated and promising rehabilitation intervention for post-stroke USN. The reasons for selecting these interventions was not explored in this study. However, physiotherapist preference, what was taught at initial training, prior experience with patient, profile information and alternating to other effective treatment has been pinpointed to be the reason for selection of a particular intervention (Turner & Whitfield, 1999). On assessment of patients, nearly half of Nigerian physiotherapists reported not using standardized assessment tools for USN identification. This is similar with reports from South African physiotherapists that reported standardized assessment tools are utilized in practice by half of the physiotherapists. This is in direct contrast with a Canadian study where a paltry thirteen percent of stroke survivors were assessed using a standardized outcome measure (Menon-Nair et al., 2006). The use of standard outcome

measures is a familiar discourse in the South African rehabilitation space. Inglis and colleagues in a cross-sectional survey of physiotherapists on awareness of outcome measures among physiotherapists in South Africa reported that 84% of responding therapists reported using standardized outcome measures frequently (Inglis et al., 2008).

This study investigated the enablers and barriers faced by South African and Nigerian physiotherapists in the treatment of USN. The major barriers identified by the South African physiotherapists were an insufficient amount of therapy time and a lack of appropriate equipment for rehabilitation of unilateral spatial neglect. For the Nigerian cohort, the three most reported barriers to post-stroke USN treatment included: lack of relevant equipment for rehabilitation of USN, limited staff capacity and lack of hands-on prerequisite skills needed for USN management. Lack of relevant equipment for rehabilitation of USN was a common barrier to USN treatment to both cohorts. This is similar to reports by Checketts and colleagues that highlighted various barriers to USN rehabilitation as time and equipment shortages, sub-optimal MDT collaboration, and lack of knowledge (Checketts et al., 2020).

Nigeria and South Africa, like many developing nations, face a number of challenges, including unwholesome working conditions, understaffing, and inadequate equipment. Considering task-shifting approaches would be an immediate short-term measure to solve the issue of limited staff numbers, as opined by Akinyemi and colleagues (Akinyemi et al., 2015).

The results of this stage of the research project had some interesting findings which have implications for physiotherapy practice. Firstly, current treatment options reported in the study 1 (scoping review) of this research project were not co-opted into treatment choice for post-stroke USN. This calls for the development of comprehensive stroke treatment guidelines that are evidence-based in both countries. In the case of an existing guideline (for South Africa), an update to reflect current evidence in stroke rehabilitation may be necessary (Bryer et al., 2010). Secondly, the identified barriers and facilitators to best practice for post-stroke USN assessment and treatment could be a reference point for future research on priorities for effective outcomes in

stroke rehabilitation and the planning of training programs specific for stroke care. Further, resource constraint was a common barrier for both cohorts and this could be a reference point in the allocation of funds and resources for stroke management especially in the early phases.

The last study was an RCT that evaluated the primary effect of twelve sessions of prismatic training. The secondary effect on other indices of rehabilitation such as QoL, ADLs, functional mobility and balance abilities was also investigated. In addition, predictors of recovery from USN after prismatic treatment was investigated. The rationale to investigate PA therapy in this research project is thus: stage 1 (scoping review) that mapped out interventions for post-stroke USN identified both PA therapy and combination therapy as the most investigated and promising intervention for post-stroke USN. However, stage two of this research project that surveyed physiotherapist's knowledge and current practice of USN rehabilitation identified low use of prism for treatment of post-stroke USN. Thus the gap between theory and practice is of interest and an informed decision to investigate the effect of PA for post-stroke USN treatment.

The randomised control trial of effect of PA on USN, demonstrated that a 12-week training program using a 20 dioptre prism ameliorated USN symptoms in stroke survivors at the sub-acute phase of recovery. This was the first study on the effect of PA therapy in an African population. This finding corroborated previous studies (Fortis et al., 2010, 2011; Mancuso et al., 2012; Mizuno et al., 2011; Rode et al., 2015; Serino et al., 2009; Yoneda et al., 2011) that reported improvement in USN. However, other studies have less favourable findings (Mancuso et al., 2012; Rode et al., 2015). Several reasons that could explain the discrepancies in outcome include dosage (i.e. strength of prism and treatment sessions), stage of recovery, and methodology used in studies. In this research project, a randomised control methodology was utilized in this study which is the gold standard to establish effect. This study differs from previous study in various ways. First, this is the first study to investigate the effect of USN using a higher prism power (20 dioptre). Secondly, this study was the first to examine the effect of PA in an African population. Furthermore, this study also investigated demographic and clinical predictors of recovery from USN following PA treatment. Cognitive function as assessed by the mini mental scale was the only variable identified

as a factor that predicts recovery from USN after treatment with prism at the sub-acute phase of recovery. This is not surprising as USN is a perceptual disorder and was assessed using a neuropsychological test (the behavioural inattention test). This suggests that to benefit from regimen of PA for USN amelioration, the patient needs to have a higher cognitive function.

7.3. CONCLUSION

Despite the promising effect of PA on USN (in stage 3: RCT study) and the plenteous studies identified in the scoping review of this research project, therapists surveyed in this research project appear not to utilize PA in their management of USN. This highlights the gap between theory and practice in stroke rehabilitation. Strategies that could enhance uptake of evidence into the practice of post-stoke USN rehabilitation in these countries surveyed in this research project are suggested and could improve stroke rehabilitation outcome.

The next chapter presents the conclusions and recommendations drawn from this study on rehabilitation of post-stroke USN.

8. CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1. INTRODUCTION TO CHAPTER

This chapter presents the general conclusions of the thesis, the overall strength and limitations of the research project and recommendations.

8.2. GENERAL CONCLUSION OF THESIS

The summary of the procedure and key findings of each study is outlined below based on the research questions of the study. Figure 8.1 outlines the key findings, of each study to the overall aim of the thesis.

In study one the aim was to map out the current trend in the treatment of post-stroke unilateral spatial neglect. Using a scoping review methodology, it was shown that the trend in research for intervention for post-stroke USN has shifted from monotherapy to combining more than one intervention approach. Other promising interventions for treatment of post-stroke USN include prism adaptation therapy and transcranial stimulation. Additionally, no single treatment approach was found to be optimally superior in the rehabilitation of USN post-stroke.

In study 2 and 3, physiotherapists' knowledge, current practice, barriers and facilitators to USN rehabilitation post-stroke in Nigeria and South Africa were assessed. The knowledge of post-stroke USN was moderate in both cohorts. Factors that influenced physiotherapists' knowledge on post-stroke USN identified in this research project include: post-graduate certification in neuro-rehabilitation, working full time in neurorehabilitation and clinical practice setting for the Nigerian cohort while for the South African cohorts, respondents' age and years of practice as a physiotherapist. Also, both cohorts of physiotherapists' choice of intervention for post stroke USN were similar. Constraint Induced Therapy was the treatment of choice for both cohorts. This thesis found that most physiotherapists in Nigeria and South Africa do not use standardized outcome measures for the screening of USN in practice. There seems to be a gap in the uptake of current evidence in treatment of post-stroke USN.

Lastly, this research project evaluated the effect of PA therapy on USN. Twelve sessions of PA were demonstrated to ameliorate USN symptoms in stroke survivors at the sub-acute phase of recovery. Also, cognitive function was the only factor that was found in the thesis to influence recovery from USN following PA treatment regimen. These improvements in USN extended to ADLs, balance, quality of life and functional mobility.

The information generated in this thesis can be used to improve stroke rehabilitation services both locally and internationally. It is hoped that the result of this research project will contribute in remedying the dearth in the literature on physiotherapists practice in sub-Saharan Africa and in Nigeria and South Africa in particular. This will help in the efforts of finding better ways of rehabilitation and integrating USN treatment guidelines for stroke survivors with USN symptoms into clinical practice in both countries. There is a need for physiotherapists to screen for USN in stroke rehabilitation and focus on USN treatment. The results of this thesis contribute to the body of knowledge in the management of stroke survivors with USN.

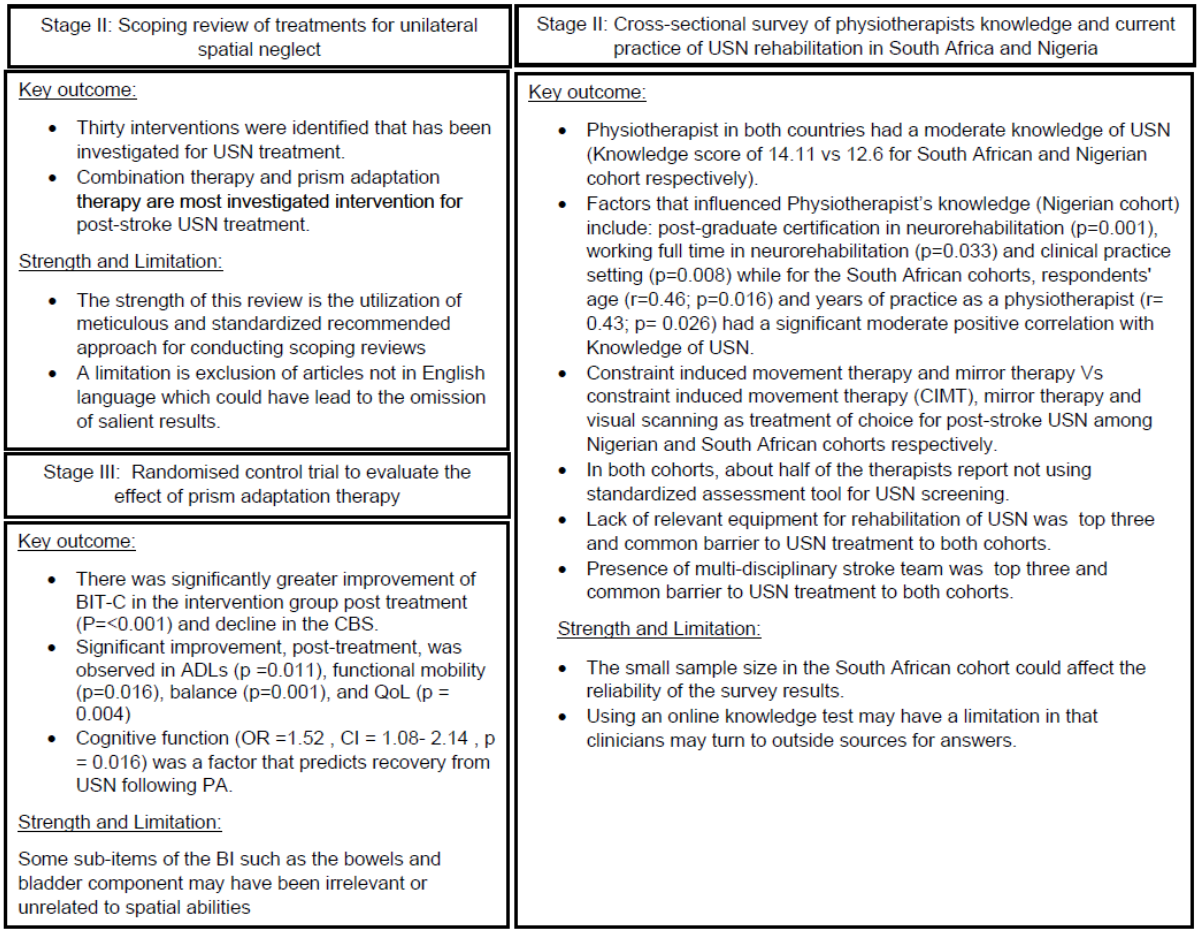


Figure 8. 1: Key findings of the thesis

8.3. STRENGTH AND LIMITATIONS OF THE THESIS

The strength of the scoping review in this thesis is the utilization of a meticulous and standardized recommended approach for conducting scoping reviews and the use of broad search terms across several databases which increased the likelihood of including all the available research articles needed for this review.

However, the large amount of information that was able to be extracted from articles by the two independent reviewers means some relevant studies may have been missed. Exclusion of non-English studies may have led the authors to miss out on some relevant studies published in other languages which are not English.

Results may be limited in their generalizability due to the nonprobability sampling technique used and small sample size, which may have caused selection bias in the cross-sectional study in this

research project. As this study was small, use of more rigorous statistics, like regression analysis, was precluded. Small sample size also leads to higher variability with resultant bias thereby affecting the reliability of the study. A limitation to the use of online knowledge tests is that clinicians may look to outside sources for answers. An attempt was made to decrease this potential by shortening the duration of the questionnaire.

Also, in this thesis the RCT has some limitations: firstly, some of the sub-items such as the bowels and bladder component may have been irrelevant or unrelated to spatial abilities and may have given a picture of recovery. Also, the follow-up for this was for a single time just after completion of treatment regimen. Multiple follow-ups at 3 months and 6 months' post-treatment completion could enable the researcher to establish the lasting effect of prism treatment on USN and if there could be a possible relapse in the gains recorded after prism adaptation therapy.

8.4. CONTRIBUTION TO THE FIELD OF RESEARCH AND REHABILITATION

I. Current trends in USN management highlighting the shift in research interest from conventional approach to technology inclined approach in USN management. This also provides rehabilitation experts a knowledge base on rehabilitation options for USN management. It also provides a template for a future more robust systematic review on interventions for USN management.

II. This thesis is the first to investigate the knowledge, current practice, barriers and facilitators to USN management among Nigerian and South African physiotherapists. The study underscored the need for a specialist training in physiotherapy and highlighted the current state of practice as regards USN treatment post-stroke. The study also identified barriers and facilitators to USN rehabilitation. These findings from this study on the barriers and facilitators therapists encounter in the treatment of post-stroke USN are salient points as they highlight both institutional, therapist and patient factors. This information can be used to improve post-stroke USN rehabilitation outcomes by healthcare administrators, managers and policy makers.

III. The effect of prism adaptation in the sub-acute phase of stroke recovery was first demonstrated in an African population in this thesis. This adds to the evidence base on treatment options for USN management. The profile of stroke patients that is likely to benefit from prism adaptation regimen was demonstrated; cognitive ability (higher) was the only implicated prerequisite for a successful PA treatment.

8.5. RECOMMENDATIONS FOR FUTURE RESEARCH AND REHABILITATION PRACTICE

I. A more robust systematic and meta-analysis on interventions for post-stroke unilateral spatial neglect treatment is suggested.

II. Post-stroke USN treatment should be integrated in stroke treatment guidelines in Nigeria and South Africa.

III. Continuing education in form of workshops, refresher courses and seminars should be conducted in these countries (Nigeria and South Africa) to improve uptake of current evidence in stroke management.

IV. Strategies on how to surmount barriers and strengthen facilitators of post-stroke USN should be formulated to improve stroke care services in Nigeria and South Africa.

V. An RCT on the effect of prism in post-stroke survivors should be conducted with follow up at a longer interval post intervention to check for relapse of gains recorded. Also, dosage finding studies to demonstrate prismatic lens power that is optimal for therapeutic purposes in USN treatment is recommended.

VI. Feasibility studies on the implementation of PA in clinical practice should be conducted to assess integration of PA into routine or additional treatment for post-stroke USN.

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APPENDIX I: QUESTIONNAIRE ON KNOWLEDGE, CURRENT PRACTICE, BARRIERS AND ENABLERS TO UNILATERAL SPATIAL NEGLECT

Knowledge, current practice, barriers and enablers to rehabilitation of unilateral spatial neglect

My name is Umeonwuka Chuka, a doctoral student at the department of Physiotherapy, faculty of health Science University of Witwatersrand, Johannesburg. As part of my sub-study for my doctoral thesis I am in the process of conducting a study on 'knowledge, current practice, barriers and enablers to rehabilitation of unilateral spatial neglect'

You are invited to participate in this study which requires completion of an electronic questionnaire about your current practice as regards unilateral spatial neglect rehabilitation, knowledge of unilateral spatial neglect rehabilitation and barriers or enablers to effective rehabilitation of unilateral spatial neglect among stroke survivors.

You will not benefit directly from participating in this study, but the findings of this study will contribute towards understanding physiotherapist's knowledge, current practice, barriers and enablers to rehabilitation of unilateral spatial neglect'

Results from the study once it is completed will also be made available to you if you wish to know them. Participation is completely voluntary, there is absolutely no pressure on you to take part in the study.

Every effort will be made to keep all documentation confidential. No answers or personal information will be disclosed to anyone other than the researchers.

If you would like any further information or have any questions, please feel free to contact me on details below. If you have any concern over the way the study is being conducted, please contact the Chairperson of the ethics committee, Professor Clement Penny, who may be contacted on telephone number +2711 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Researcher's contact

Umeonwuka Chuka

E-mail: 1569591@students.wits.ac.za

Mobile number: +27605535722, +2347065492665

I have read the information letter and by completing the questionnaire, I agree to participate in this study.

- ○ Yes
- ○ No

SECTION A
Demographic Information

What is your age (by last birthday)?	_____
What is your gender?	◯ Female ◯ Male ◯ Preferred not to say
How would you describe the settlement setting of your clinical facility? (Urban settlement is a settlement with a high population; A semi-urban area is between urban and rural; rural area or countryside is a geographic area that is located outside towns and cities. A semi-rural area; A semi-rural settlement is a partly rural; between rural and urban; an out-of-town suburb)	◯ Urban ◯ Semi-urban ◯ Rural ◯ Semi-rural
Which of the following best describes your current clinical practice setting?	◯ Hospital ◯ Rehabilitation center ◯ Skilled nursing facility ◯ Out-patient department ◯ Domiciliary / home health ◯ Retirement village / old age home ◯ Others
Please specify	_____
In which country do you practice your profession?	◯ South Africa ◯ Nigeria
What is the name of the province in your country where you practice your profession?	◯ Gauteng ◯ KwaZulu-natal ◯ Free state ◯ Western cape ◯ Eastern cape ◯ Limpopo ◯ Northern cape ◯ Mpumalanga ◯ North west

What is the name of the state in your country where you practice your profession?	◯ Abia ◯ Adamawa ◯ Akwa Ibom ◯ Anambra ◯ Bauchi ◯ Bayelsa ◯ Benue ◯ Borno ◯ Cross river ◯ Delta ◯ Ebonyi ◯ Edo ◯ Ekiti ◯ Enugu ◯ Gombe ◯ Imo ◯ Jigawa ◯ Kaduna ◯ Kano ◯ Katsina ◯ Kebbi ◯ Kogi ◯ Kwara ◯ Lagos ◯ Nasarawa ◯ Niger ◯ Ogun ◯ Ondo ◯ Osun ◯ Oyo ◯ Plateau ◯ Rivers ◯ Sokoto ◯ Taraba ◯ Yobe ◯ Zamfara ◯ FCT
How many years have you been practicing as a physiotherapist?	_____
What is your highest level of qualification?	◯ Diploma ◯ Bachelor's degree ◯ Postgraduate diploma ◯ Master's degree ◯ Post masters diploma ◯ Doctorate ◯ Others
Please specify	_____
Do you have a postgraduate certification in neurological rehabilitation?	◯ Yes ◯ No
Are you currently practicing as a physiotherapist in neurological rehabilitation?	◯ Yes ◯ No
Do you currently work full time in neuro-rehabilitation?	◯ Yes ◯ No

How long have you been practicing as a physiotherapist in neurological rehabilitation (in years)	_____
What is your current physiotherapy rank/cadre?	○ Physiotherapist ○ Senior physiotherapist ○ Principal physiotherapist ○ Chief physiotherapist ○ Assistant director of physiotherapy ○ Director of physiotherapy ○ Others
What is current physiotherapy rank/cadre?	○ Production physio ○ Chief physio ○ Deputy director ○ Others ○ Others
Please specify	_____

SECTION B
In this section, you will be asked a variety of questions to assess your knowledge on unilateral spatial neglect rehabilitation.

		Agree	Disagree	Undecided
1	Unilateral spatial neglect is the inability to orient or respond to stimuli appearing on the contralateral side of brain lesion.	○	○	○
2	Unilateral spatial neglect in stroke patients are more common in left hemispheric stroke than in right hemispheric stroke.	○	○	○
3	Unilateral spatial neglect in stroke is commonly associated with a lesion in the inferior parietal lobe.	○	○	○
4	Unilateral spatial neglect in stroke is commonly associated with cognitive dysfunction.	○	○	○
5	Brain tumors can result in unilateral spatial neglect symptoms.	○	○	○
6	Traumatic brain injury cannot result in unilateral spatial neglect symptoms.	○	○	○
7	Unilateral spatial neglect in stroke is more common in younger patients than in older individuals.	○	○	○
8				

	Most stroke patients with unilateral spatial neglect symptoms show recovery within the first week.	○	○	○
9	Unilateral spatial neglect in stroke is associated with a longer hospital stay.	○	○	○
10	Unilateral spatial neglect in stroke predicts poor rehabilitation outcome.	○	○	○
11	Albert's Test is a standardized screening tool for unilateral spatial neglect.	○	○	○
12	The Crovitz-zener scale can be used to screen for unilateral spatial neglect.	○	○	○
13	Spinal cord injury is maybe a condition to consider for differential diagnosis of spatial neglect	○	○	○
14	The best possible time for assessment of Unilateral spatial neglect in stroke patients is at the chronic stage.	○	○	○
15	Unilateral spatial neglect symptoms can be treated using pharmacological agents.	○	○	○
16	The drug rivastigmine can be used in the management of Unilateral spatial neglect symptoms.	○	○	○
17	Mirror therapy, is a rehabilitation option for unilateral spatial neglect.	○	○	○
18	Eye patching is a rehabilitation option for unilateral spatial neglect.	○	○	○
19	Functional electrical stimulation and transcutaneous electrical stimulation are rehabilitation options for unilateral spatial neglect.	○	○	○
20				

	Constraint induced movement therapy is a rehabilitation options for unilateral spatial neglect.	○	○	○
21	Line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection, and representational drawing can be used as an assessment tool to establish the presence of unilateral spatial neglect.	○	○	○
22	Use of yoked prism is a treatment option for unilateral spatial neglect that its benefits extend to dressing, postural stability, walking, sit-to-stand transfers and wheel chair driving	○	○	○
23	Visual scanning exercise is not an effective technique in the treatment of unilateral spatial neglect.	○	○	○
24	Listening to music scale will not ameliorate unilateral spatial neglect symptoms	○	○	○
25	Mental practice cannot improve unilateral spatial neglect symptoms	○	○	○

SECTION C
In this section, you will be asked a variety of questions to assess your current practice of unilateral spatial neglect rehabilitation.

Do you provide treatment to stroke survivors who exhibit unilateral spatial neglect symptoms?	○ Yes ○ No
On the average, how many new cases of stroke patients with unilateral spatial neglect do you identify/manage every 3 months period?	○ 1-2 stroke patients ○ >2-5 stroke patients ○ >5-10 stroke patients ○ >10-15 stroke patients ○ >15-20 stroke patients ○ >20-30 stroke patients ○ >30 stroke patients
How soon post-stroke do you typically perform initial evaluation to identify unilateral spatial neglect in your patients? (Indicate in days)	○ 1-2 ○ >2-5 ○ >5-10 ○ >10-15 ○ >15-20 ○ >20-30 ○ >30

If you have performed an initial evaluation that identifies unilateral spatial neglect in your patients, do you re-evaluate the patient after few days/weeks?	○ Yes ○ No
How soon do you re-evaluate a patient for unilateral spatial neglect after you have performed an initial evaluation that identifies unilateral spatial neglect? (In days)	○ 1-2 ○ >2-5 ○ >5-10 ○ >10-15 ○ >15-20 ○ >20-30 ○ >30
Do you use any specific screening/assessment tool in the assessment of your patients for unilateral spatial neglect?	○ Yes ○ No
Please state the screening/assessment tool that you typically use in the assessment of your patients for unilateral spatial neglect.	☐ Behavioural inattention test ☐ Alberts test ☐ Bell's test ☐ Semi structured scale for the functional evaluation of hemi-inattention ☐ Comb and razor test ☐ Clock drawing test ☐ Catherine Bergego scale ☐ Draw-A-man test ☐ Others
Please specify	_____
Please state the technique/approach you use in rehabilitation of your patients that exhibit unilateral spatial neglect.	☐ Constrain induced movement therapy. ☐ Galvanic Vestibular stimulation ☐ Limb activation exercise ☐ Mental practice ☐ Mirror therapy ☐ Monocular patching ☐ Visual scanning exercise ☐ Functional electrical stimulation ☐ Virtual reality ☐ Transcranial magnetic stimulation ☐ Music therapy ☐ Robotics ☐ Cold pressor stimulation ☐ Prism Adaptation therapy ☐ Others
Please specify	_____
Do you refer or invite other members of the healthcare team if the need arises in the course of management of your stroke patients with unilateral spatial neglect?	○ Yes ○ No

If you refer to other healthcare team members, to whom do you refer?	☐ Neurologist ☐ Audiologist ☐ Occupational therapist ☐ Stroke specialist nurse ☐ Speech therapist ☐ Neuropsychologist ☐ Others
Please specify	_____

SECTION D

In this section, you will be asked a variety of questions on your perceived barriers and enablers to effective rehabilitation of unilateral spatial neglect among stroke survivors

Consider the following list of factors that may pose a barrier to your effective rehabilitation of a stroke patient with unilateral spatial neglect in clinical practice. Rank these factors, from 1-5 (Greatest barrier=1; least barrier=5) based upon the relative degree to which they are barriers.

		1	2	3	4	5
1	Lack of relevant equipment (technological devices like Virtual reality, electrical stimulators etc.) for rehabilitation of unilateral spatial neglect at clinical practice.	○	○	○	○	○
2	Limited staff capacity	○	○	○	○	○
3	Inadequate therapy time with patient	○	○	○	○	○
4	Limited knowledge on assessment and rehabilitation of unilateral spatial neglect.	○	○	○	○	○
5	Lack of hands-on pre-requisite skills needed for unilateral spatial neglect rehabilitation.	○	○	○	○	○
6	Unilateral spatial neglect rehabilitation therapy is not part of a physiotherapist's role	○	○	○	○	○
7	Physiotherapists in our setting do not believe that therapy for patients with unilateral special neglect makes much difference	○	○	○	○	○
8	Lack of patient motivation to attend therapy for unilateral spatial neglect rehabilitation	○	○	○	○	○

What other factors not listed in question above do you think may pose barriers to the effective rehabilitation of unilateral spatial neglect? _____

Consider the following list of factors that may be an enabler or facilitator to your effective rehabilitation of unilateral spatial neglect in clinical practice.
Rank these factors, from 1-5 (Greatest facilitator=1; least facilitator=5) based upon the relative degree to which they are barriers.

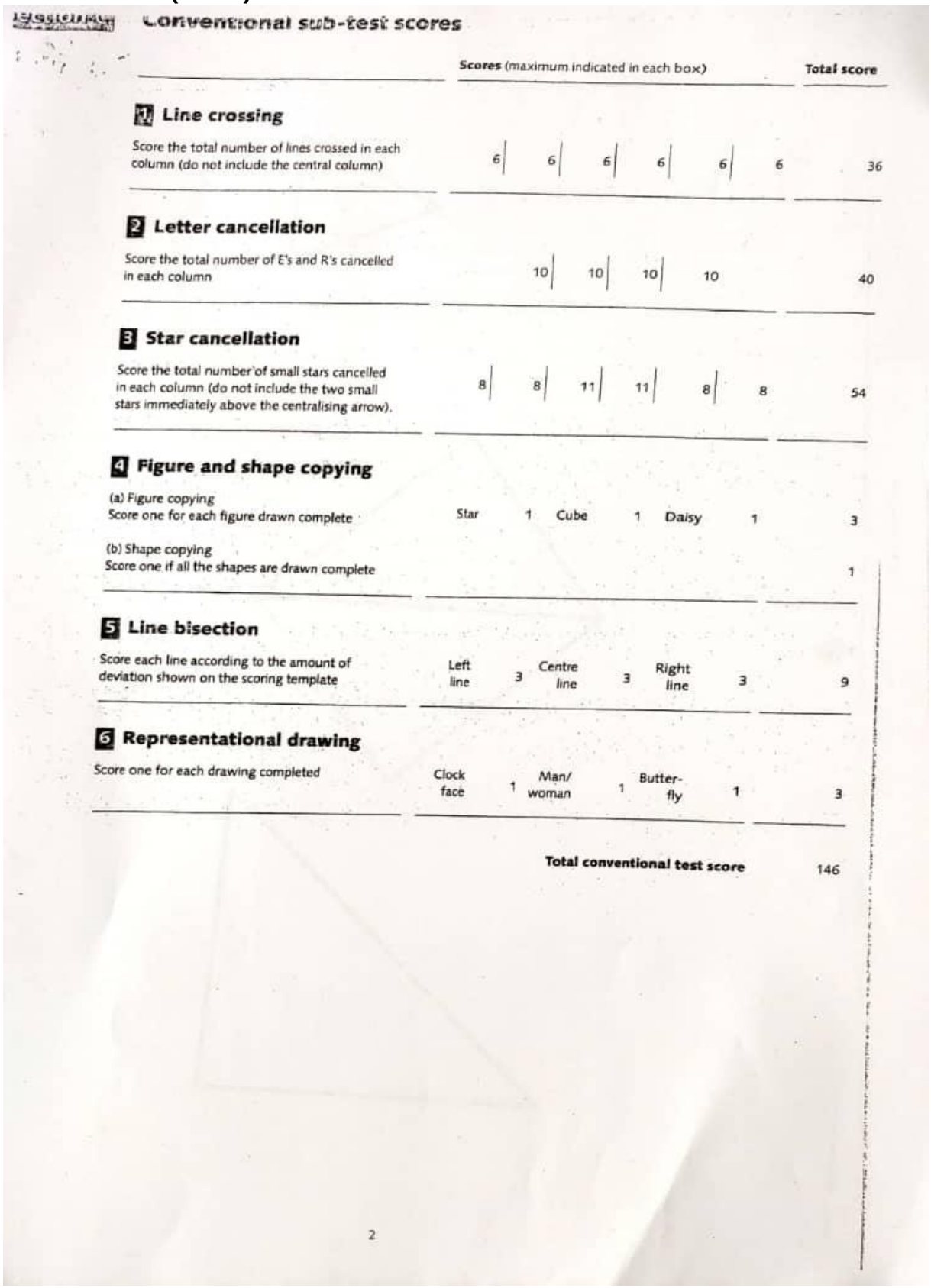
		1	2	3	4	5
1	Availability of relevant equipment at clinical practice	○	○	○	○	○
2	Presence of Multidisciplinary stroke team in clinical practice	○	○	○	○	○
3	Availability of adequate staffs	○	○	○	○	○
4	Specialized training in unilateral spatial neglect management	○	○	○	○	○
5	Practicing environment with access to learning time about unilateral spatial neglect treatment approach	○	○	○	○	○
6	Physiotherapists in our practice believe that therapy for unilateral spatial neglect rehabilitation greatly enhances patient's quality of life	○	○	○	○	○
7	Patient motivation to attend therapy	○	○	○	○	○

What other factors not listed in question above do you think may constitute an enabler/ facilitator to the effective rehabilitation of unilateral spatial neglect? _____

Which channel did you receive this questionnaire?

- ☐ Email
- ☐ WhatsApp
- ☐ Facebook
- ☐ Twitter

APPENDIX II: THE CONVENTIONAL SUB-TEST OF THE BEHAVIOURAL INATTENTION TEST (BIT-C)



Conventional sub-test scores

	Scores (maximum indicated in each box)						Total score
1 Line crossing							
Score the total number of lines crossed in each column (do not include the central column)	6	6	6	6	6	6	36
2 Letter cancellation							
Score the total number of E's and R's cancelled in each column	10	10	10	10			40
3 Star cancellation							
Score the total number of small stars cancelled in each column (do not include the two small stars immediately above the centralising arrow).	8	8	11	11	8	8	54
4 Figure and shape copying							
(a) Figure copying Score one for each figure drawn complete	Star	1	Cube	1	Daisy	1	3
(b) Shape copying Score one if all the shapes are drawn complete							1
5 Line bisection							
Score each line according to the amount of deviation shown on the scoring template	Left line	3	Centre line	3	Right line	3	9
6 Representational drawing							
Score one for each drawing completed	Clock face	1	Man/ woman	1	Butter-fly	1	3
					Total conventional test score		146

2

Figure and shape copying (shape copying)

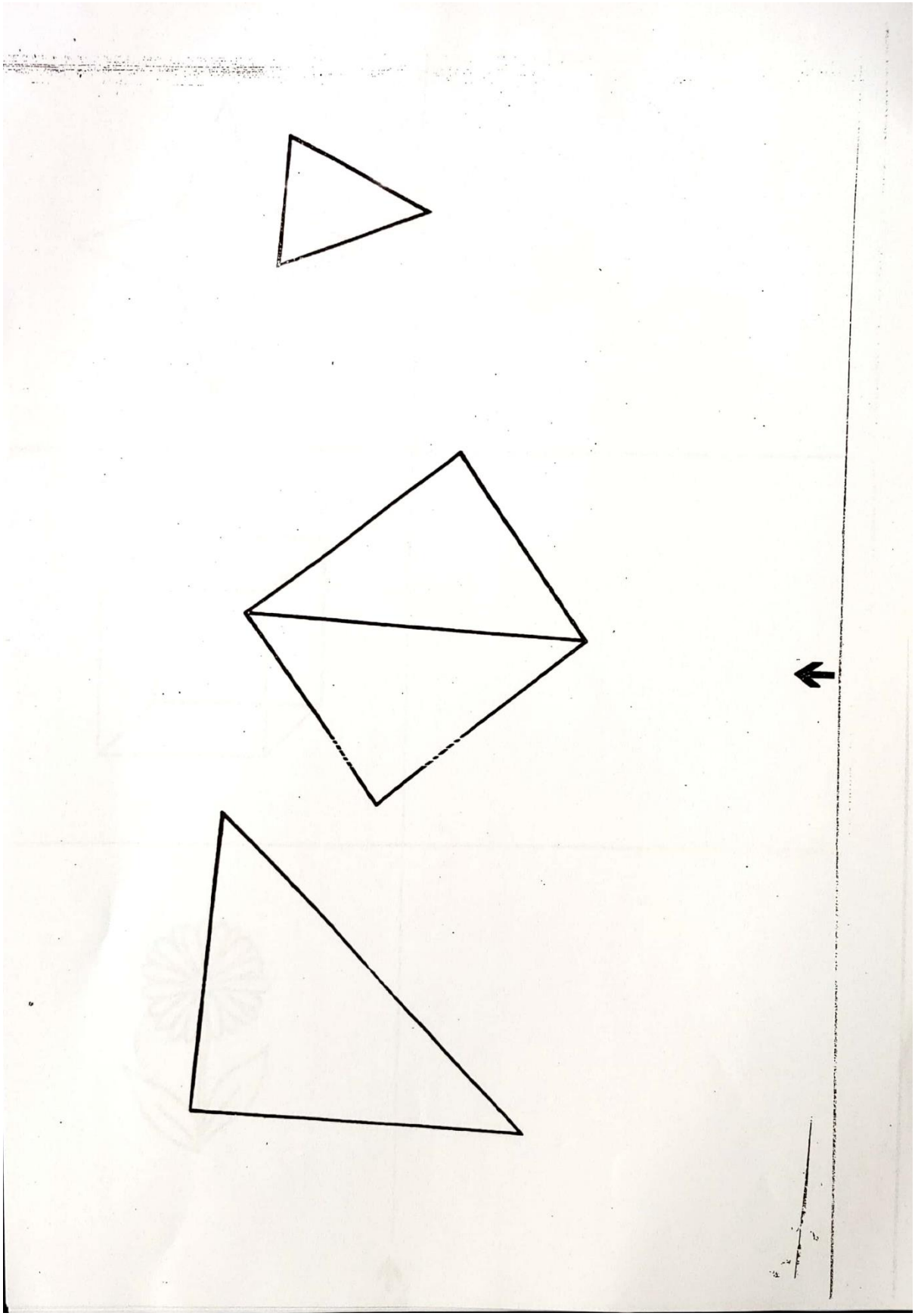
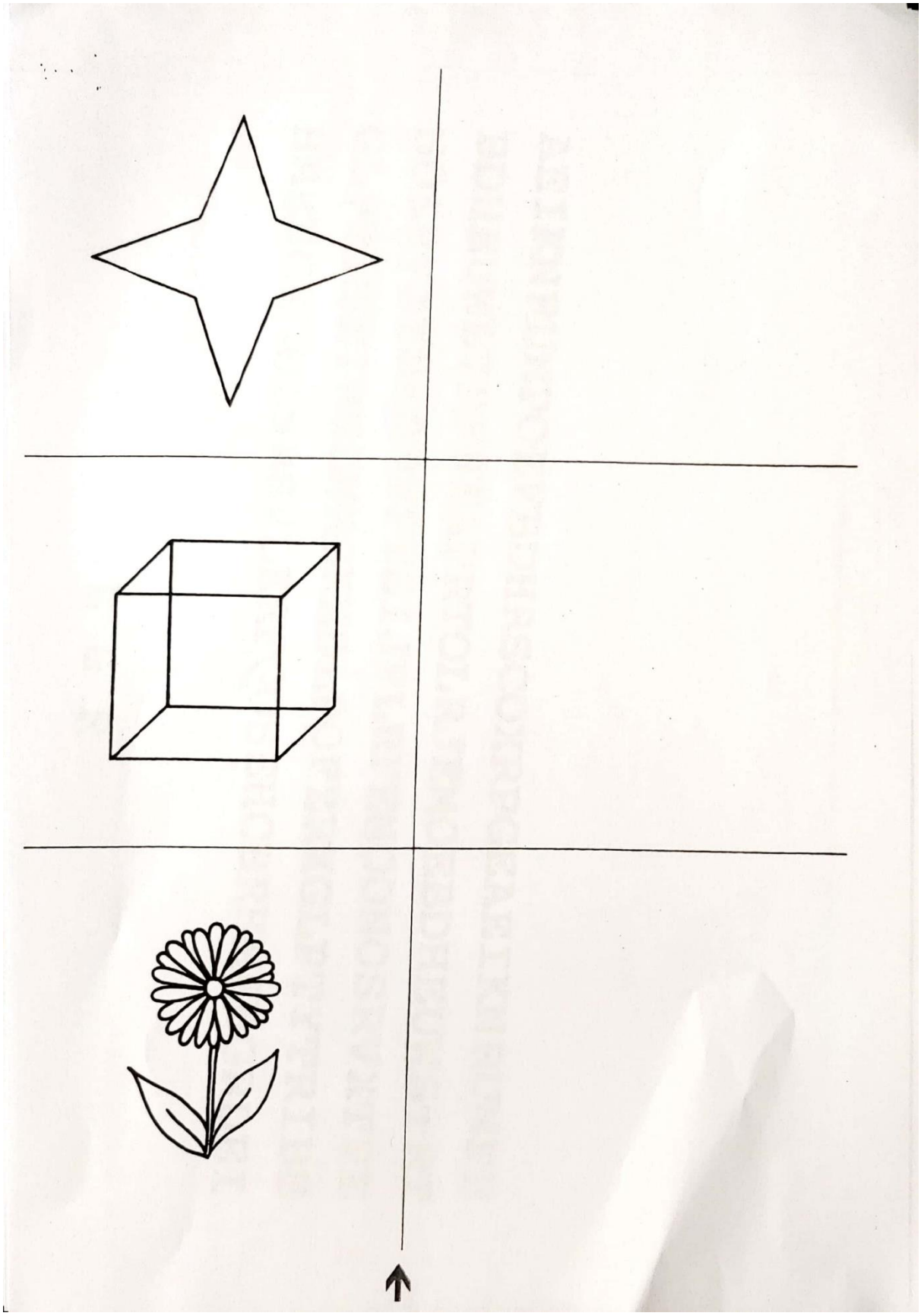
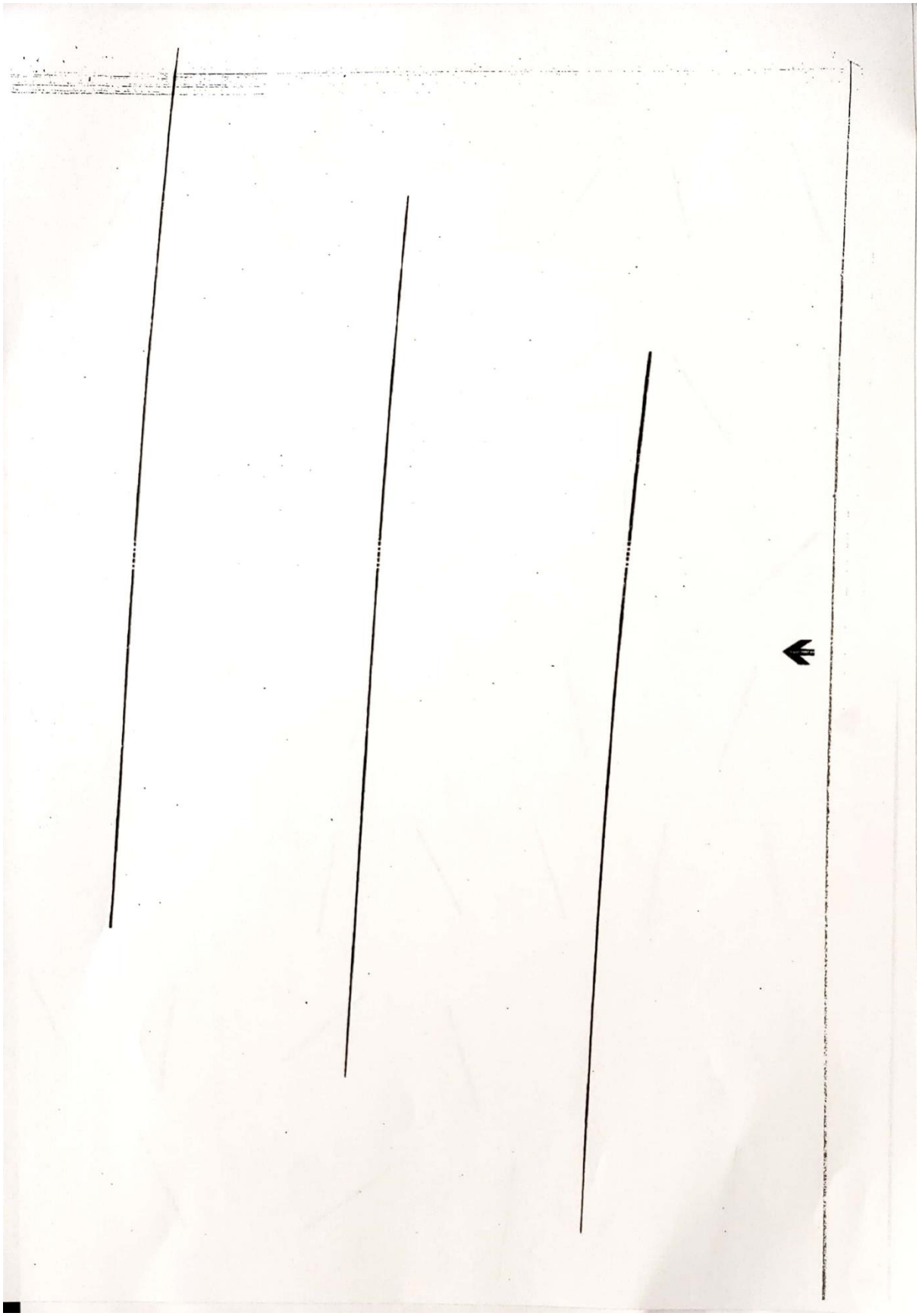


Figure and shape copying (Figure copying)

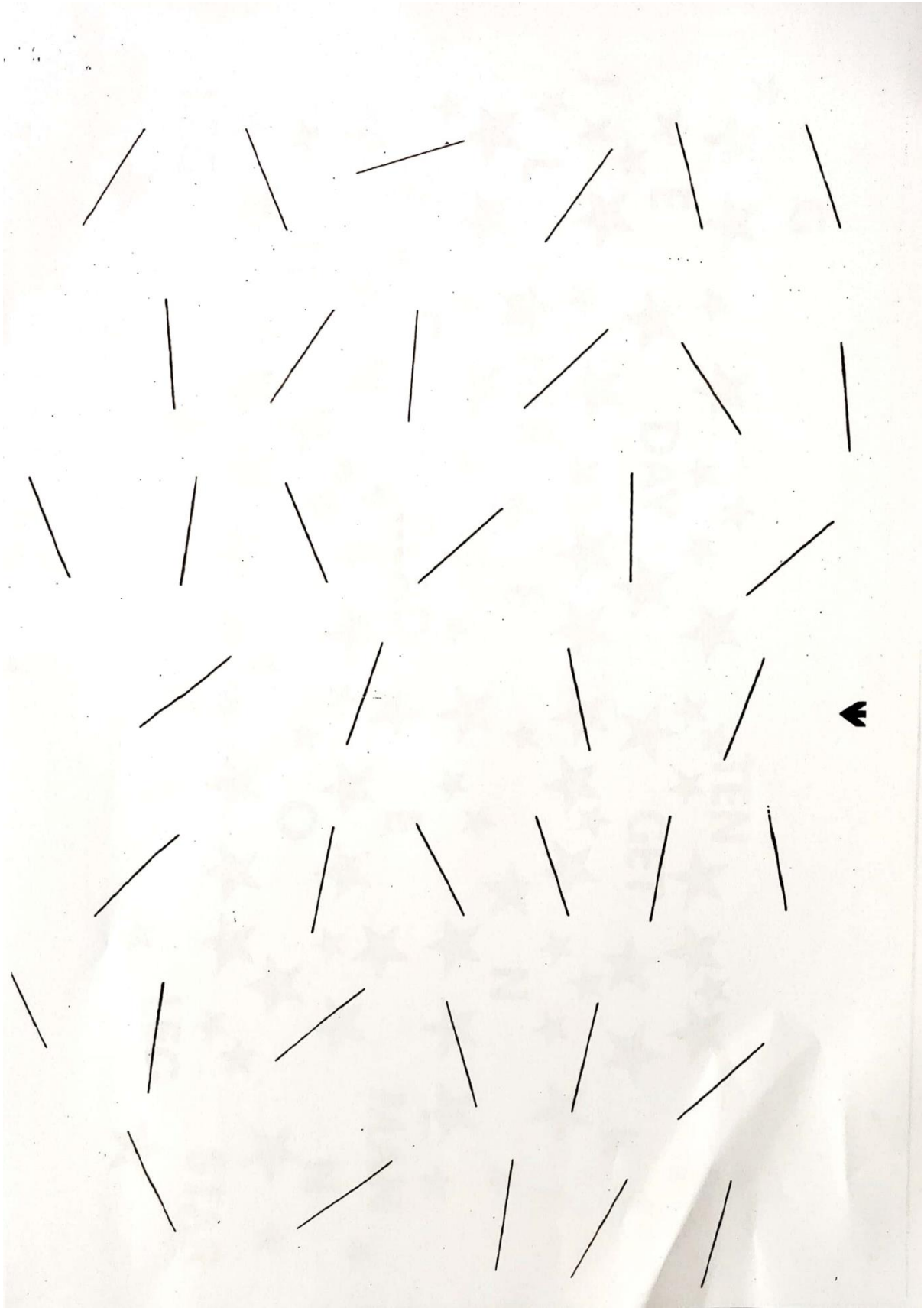


Letter cancellation

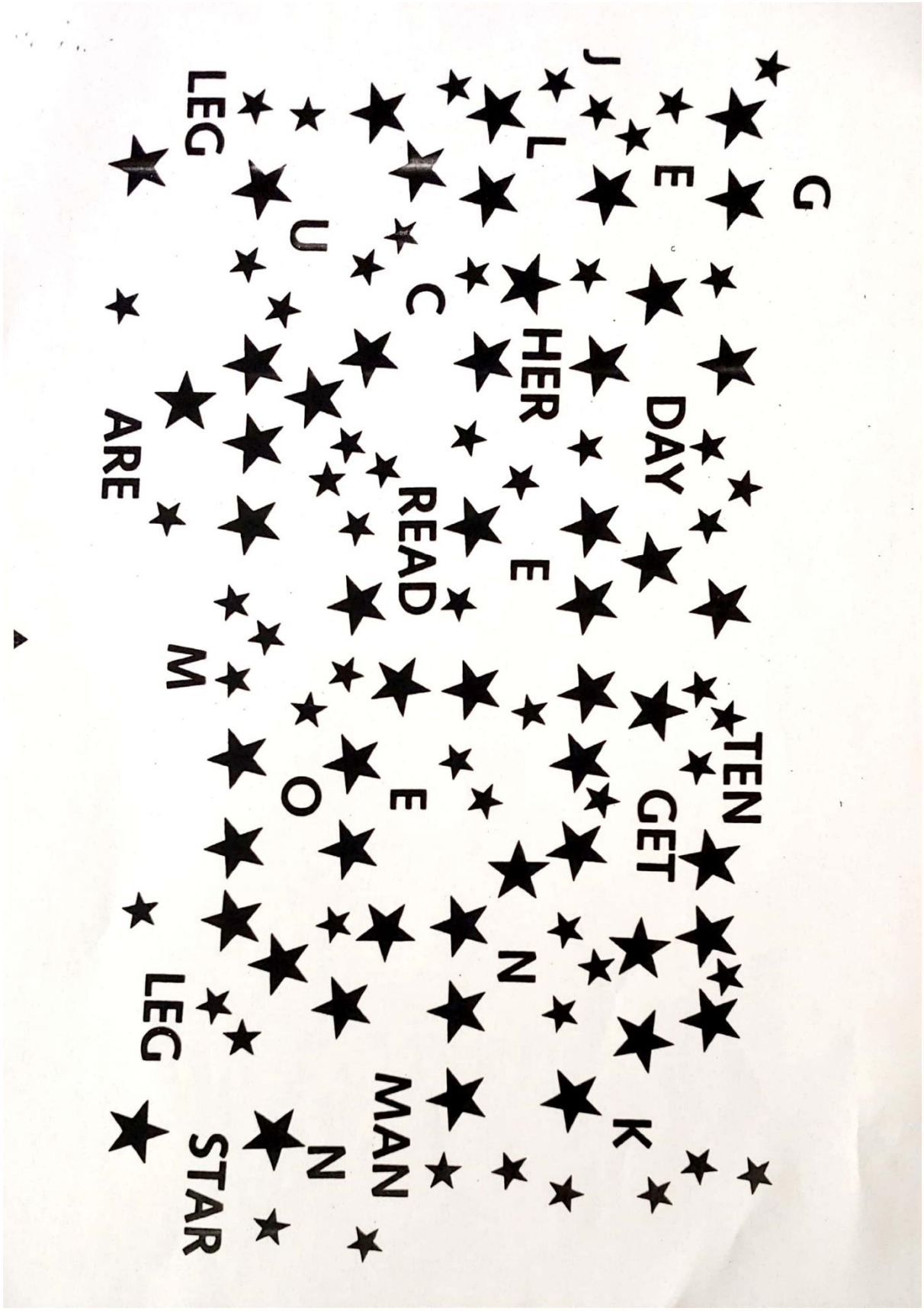
Line bisection



Line crossing



Star cancellation

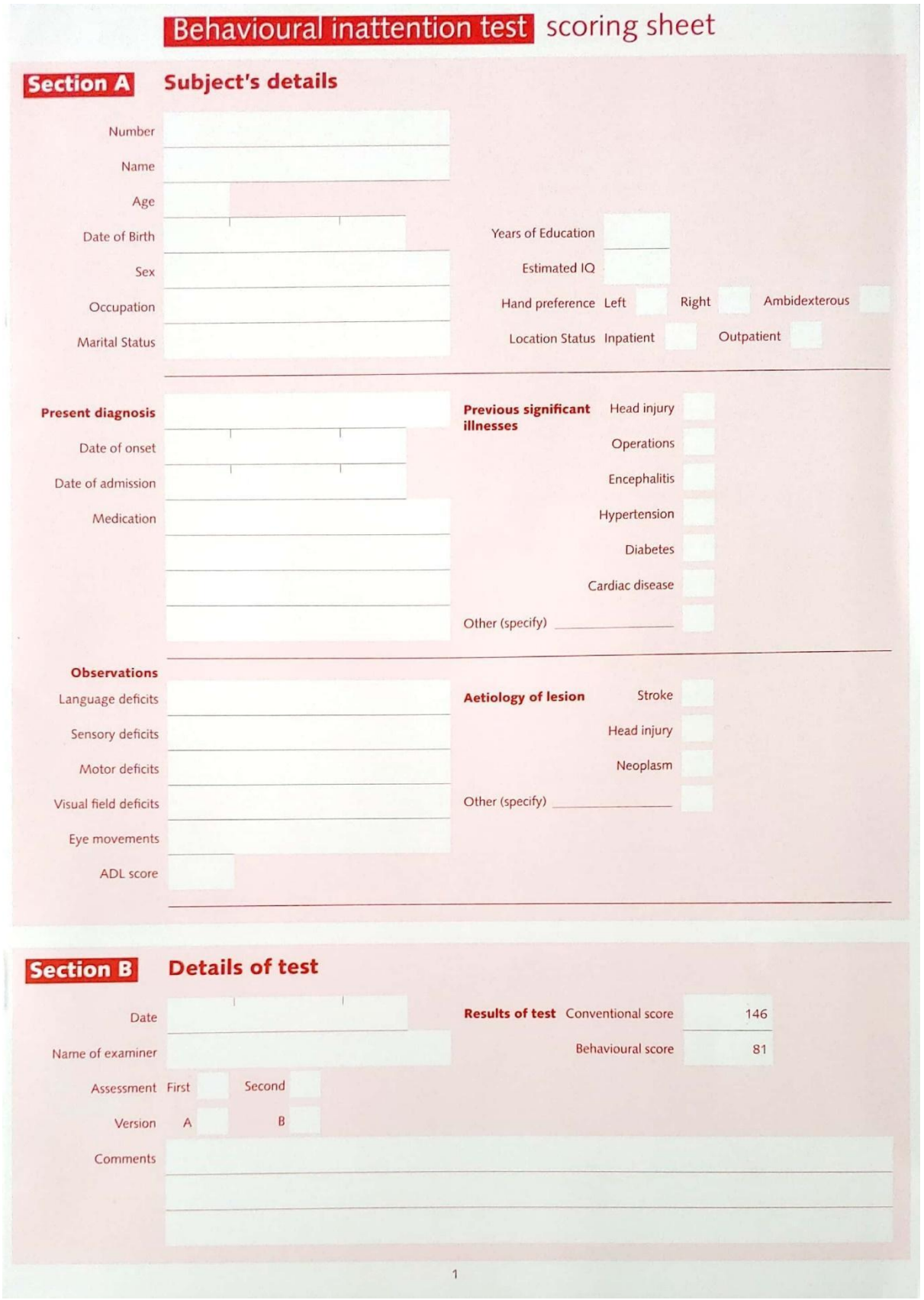


APPENDIX III: CATHERINE BERGEGO SCALE

	0	1	2	3
1. Forgets to groom or shave the left part of his/her face	❑	❑	❑	❑
2. Experiences difficulty in adjusting his/her left sleeve or slipper	❑	❑	❑	❑
3. Forgets to eat food on the left side of his/her plate	❑	❑	❑	❑
4. Forgets to clean the left side of his/her mouth after eating	❑	❑	❑	❑
5. Experiences difficulty in looking towards the left	❑	❑	❑	❑
6. Forgets about a left part of his/her body (eg, forgets to put his/her upper limb on the armrest, or his/her left foot on the wheelchair rest, or forgets to use his/her left arm when he/she needs to)	❑	❑	❑	❑
7. Has difficulty in paying attention to noise or people addressing him/her from the left	❑	❑	❑	❑
8. Collides with people or objects on the left side, such as doors or furniture (either while walking or driving a wheelchair)	❑	❑	❑	❑
9. Experiences difficulty in finding his/her way towards the left when traveling in familiar places or in the rehabilitation unit	❑	❑	❑	❑
10. Experiences difficulty finding his/her personal belongings in the room or bathroom when they are on the left side	❑	❑	❑	❑
Total score (/30)				

0=no neglect; 1=mild neglect; 2=moderate neglect; 3=severe neglect

APPENDIX IV: DEMOGRAPHICS AND CLINICAL FORM



Behavioural inattention test scoring sheet

Section A Subject's details

Number
Name
Age
Date of Birth
Sex
Occupation
Marital Status

Years of Education
Estimated IQ
Hand preference Left Right Ambidexterous
Location Status Inpatient Outpatient

Present diagnosis
Date of onset
Date of admission
Medication

Previous significant illnesses
Head injury
Operations
Encephalitis
Hypertension
Diabetes
Cardiac disease
Other (specify) _____

Observations
Language deficits
Sensory deficits
Motor deficits
Visual field deficits
Eye movements
ADL score

Aetiology of lesion
Stroke
Head injury
Neoplasm
Other (specify) _____

Section B Details of test

Date
Name of examiner
Assessment First Second
Version A B
Comments

Results of test Conventional score 146
Behavioural score 81

1

APPENDIX V: THE BERG BALANCE SCALE

BERG BALANCE TESTS AND RATING SCALE

Patient Name _____
Date _____
Location _____
Rater _____

ITEM DESCRIPTION SCORE (0-4) Sitting to standing _____ Standing unsupported _____ Sitting unsupported _____ Standing to sitting _____ Transfers _____ Standing with eyes closed _____ Standing with feet together _____ Reaching forward with outstretched arm _____ Retrieving object from floor _____ Turning to look behind _____ Turning 360 degrees _____ Placing alternate foot on stool _____ Standing with one foot in front _____ Standing on one foot _____ TOTAL _____

GENERAL INSTRUCTIONS
Please demonstrate each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if the time or distance requirements are not met, if the subject's performance warrants supervision, or if the subject touches an external support or receives assistance from the examiner. Subjects should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing are a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5 and 10 inches (5, 12 and 25 cm). Chairs used during testing should be of reasonable height. Either a step or a stool (of average step height) may be used for item #12.

1. SITTING TO STANDING
INSTRUCTIONS: Please stand up. Try not to use your hands for support.
( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or to stabilize
( ) 0 needs moderate or maximal assist to stand

2. STANDING UNSUPPORTED
INSTRUCTIONS: Please stand for two minutes without holding.
( ) 4 able to stand safely 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unassisted

Page 1

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

3. SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL

INSTRUCTIONS: Please sit with arms folded for 2 minutes.

( ) 4 able to sit safely and securely 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

4. STANDING TO SITTING

INSTRUCTIONS: Please sit down.

( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assistance to sit

5. TRANSFERS

INSTRUCTIONS: Arrange chairs(s) for a pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.

( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cueing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

6. STANDING UNSUPPORTED WITH EYES CLOSED

INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.

( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays steady
( ) 0 needs help to keep from falling

7. STANDING UNSUPPORTED WITH FEET TOGETHER

INSTRUCTIONS: Place your feet together and stand without holding.

( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand for 1 minute with supervision
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds with feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

8. REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING

INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the finger reaches while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)

( ) 4 can reach forward confidently >25 cm (10 inches)
( ) 3 can reach forward >12 cm safely (5 inches)
( ) 2 can reach forward >5 cm safely (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

9. PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION

INSTRUCTIONS: Pick up the shoe/slipper which is placed in front of your feet.

( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5cm (1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

10. TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING

INSTRUCTIONS: Turn to look directly behind you over toward left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.

( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

11. TURN 360 DEGREES

INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only in 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cueing
( ) 0 needs assistance while turning

12. PLACING ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED

INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.

( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps in >20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete >2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

13. STANDING UNSUPPORTED ONE FOOT IN FRONT

INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width)

( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead of other independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

14. STANDING ON ONE LEG

INSTRUCTIONS: Stand on one leg as long as you can without holding.

( ) 4 able to lift leg independently and hold >10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold = or >3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently
( ) 0 unable to try or needs assist to prevent fall

TOTAL SCORE (Maximum = 56: _____

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Berg K, Maki B, Williams JI, Holliday P, Wood-Dauphinee S: A comparison of clinical and laboratory measures of postural balance in an elderly population. Arch Phys Med Rehabil, 73: 1073-1083, 1992.

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APPENDIX VI: THE RIVERMEAD MOBILITY INDEX

Participant study Number Date

Date:

Score

Turning over Please turn from your unaffected side on to your back

Lying to Sitting Please sit up on the edge of the bed from your unaffected side

Sitting balance Please sit on the edge of the bed for 10 seconds

Sitting to Standing Please stand up from your chair (should take less than 15 seconds)

Standing Please remain standing for 10 seconds

Transfers Please go from bed to the chair and back again towards your unaffected side

Walking Indoors Walk 10metres in your usual way

Stairs Please climb up one flight of stairs in your usual way Total Score /40

MRMI - Scoring System: 0 - Unable; 1- Assistance of 2; 2 - Assistance of 1; 3 - Supervision or verbal cueing; 4 - Requires an aid or appliance; 5 – Independent

APPENDIX VII: STROKE SPECIFIC QUALITY OF LIFE SCALE

Participant study Number Date

Scoring: each item shall be scored with the following key

Total help - Couldn't do it at all - Strongly agree 1

A lot of help - A lot of trouble - Moderately agree 2

Some help - Some trouble - Neither agree nor disagree 3

A little help - A little trouble - Moderately disagree 4

No help needed - No trouble at all - Strongly disagree 5

ITEM SCORE

Energy ___

1. I felt tired most of the time. ___

2. I had to stop and rest during the day. ___

3. I was too tired to do what I wanted to do. ___

Family Roles

1. I didn't join in activities just for fun with my family. ___

2. I felt I was a burden to my family. ___

3. My physical condition interfered with my personal life. ___

Language

1. Did you have trouble speaking? For example, get stuck, stutter, stammer, or slur your words? ___

2. Did you have trouble speaking clearly enough to use the telephone? ___

3. Did other people have trouble in understanding what you said? ___

4. Did you have trouble finding the word you wanted to say? ___

5. Did you have to repeat yourself so others could understand you? ___

Mobility

1.Did you have trouble walking? (If patient can't walk, go to question 4 and score ___

questions 2-3 as 1.)

2. Did you lose your balance when bending over to or reaching for something? ___

3. Did you have trouble climbing stairs? ___

4. Did you have to stop and rest more than you would like when walking or using a wheelchair? ___

5. Did you have trouble with standing? ___

6. Did you have trouble getting out of a chair? ___

Mood

1. I was discouraged about my future. ___

2. I wasn't interested in other people or activities. ___

3. I felt withdrawn from other people. ___

4. I had little confidence in myself. ___

5. I was not interested in food. ___

Personality

1. I was irritable. ___

2. I was inpatient with others. ___

3. My personality has changed. ___

Self Care

1. Did you need help preparing food? ___

2. Did you need help eating? For example, cutting food or preparing food? ___

3. Did you need help getting dressed? For example, putting on socks or shoes, buttoning buttons, or zipping? ___

4. Did you need help taking a bath or a shower? ___

5. Did you need help to use the toilet? ___

Social Roles

1. I didn't go out as often as I would like. ___

2. I did my hobbies and recreation for shorter periods of time than I would like. ___

3. I didn't see as many of my friends as I would like. ___

4. I had sex less often than I would like. ___

5. My physical condition interfered with my social life. ___

Thinking

1. It was hard for me to concentrate. ___

2. I had trouble remembering things. ___

3. I had to write things down to remember them. ___

Upper Extremity Function

1. Did you have trouble writing or typing? ___

2. Did you have trouble putting on socks? ___

3. Did you have trouble buttoning buttons? ___

4. Did you have trouble zipping a zipper? ___

5. Did you have trouble opening a jar? ___

Vision

1. Did you have trouble seeing the television well enough to enjoy a show? ___

2. Did you have trouble reaching things because of poor eyesight? ___

3. Did you have trouble seeing things off to one side? ___

Work / Productivity

1. Did you have trouble doing daily work around the house? ___

2. Did you have trouble finishing jobs that you started? ___

3. Did you have trouble doing the work you used to do? ___

TOTAL SCORE:

APPENDIX VIII: THE BARTHEL INDEX

Participant study Number Date

Bowels 0 = incontinent (or needs to be given enema)
1 = occasional accident (once a week)
2 = continent
Bladder 0 = incontinent, or catheterised and unable to manage alone
1 = occasional accident (maximum once per 24 hours)
2 = continent
Grooming 0 = needs help with personal care
1 = independent face/ hair/ teeth/ shaving (implements provided)
Toilet use 0 = dependent
1 = needs some help, but can do something alone
2 = independent (on and off, dressing, wiping)
Feeding 0 = unable
1 = needs help cutting, spreading butter, etc.
2 = independent
Transfer (bed to chair and back)
0 = unable, no sitting balance
1 = major help (one or two people, physical)
2 = minor help (verbal or physical)
3 = independent
Mobility 0 = immobile
1 = wheelchair dependent, including corners
2 = walks with help of one person (verbal or physical)
3 = independent (but may use any aid; for example, stick)
Dressing 0 = dependent
1 = needs help but can do about half unaided
2 = independent (including buttons, zips, laces, etc.)
Stairs 0 = unable
1 = needs help (verbal, physical, carrying aid)
2 = independent
Bathing 0 = dependent
1 = independent (or in shower)
Total /20

APPENDIX IX: JBI REVIEW CHART TABLE

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results

APPENDIX X: JBI REVIEWER'S MANUAL QUASI-EXPERIMENTAL (NON-RANDOMIZED) AND RCT CRITICAL APPRAISAL CHECKLIST



JBI Critical Appraisal Checklist for Randomized Controlled Trials

Reviewer_____Date_____

Author _____Year_____Record Number_____

		Yes	No	Unclear	NA
1.	Was true randomization used for assignment of participants to treatment groups?	☐	☐	☐	☐
2.	Was allocation to treatment groups concealed?	☐	☐	☐	☐
3.	Were treatment groups similar at the baseline?	☐	☐	☐	☐
4.	Were participants blind to treatment assignment?	☐	☐	☐	☐
5.	Were those delivering treatment blind to treatment assignment?	☐	☐	☐	☐
6.	Were outcomes assessors blind to treatment assignment?	☐	☐	☐	☐
7.	Were treatment groups treated identically other than the intervention of interest?	☐	☐	☐	☐
8.	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	☐	☐	☐	☐
9.	Were participants analyzed in the groups to which they were randomized?	☐	☐	☐	☐
10.	Were outcomes measured in the same way for treatment groups?	☐	☐	☐	☐
11.	Were outcomes measured in a reliable way?	☐	☐	☐	☐
12.	Was appropriate statistical analysis used?	☐	☐	☐	☐
13.	Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

_____

_____

_____

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JBI Critical Appraisal Checklist for
quasi-experimental studies

Reviewer_____
Date_____

Author_____Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	□	□	□	□
2. Were the participants included in any comparisons similar?	□	□	□	□
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	□	□	□	□
4. Was there a control group?	□	□	□	□
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?	□	□	□	□
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	□	□	□	□
7. Were the outcomes of participants included in any comparisons measured in the same way?	□	□	□	□
8. Were outcomes measured in a reliable way?	□	□	□	□
9. Was appropriate statistical analysis used?	□	□	□	□

Overall appraisal: Include □ Exclude □ Seek further info □

APPENDIX XI: SUMMARY OF SCOPING REVIEW FINDINGS

Prism adaptation therapy and Visual Scanning

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Turton et al[22]	A single-blinded randomized controlled pilot trial of prism adaptation for improving self-care in stroke patients with neglect	Stroke patients/>20days post-stroke/ thirty-seven	To determine the feasibility of prism adaptation treatment in a clinically valid sample and to assess impact on self-care.	Blinded randomised controlled pilot trial Single	Clinical; Hospital Rehabilitation Ward	Prism therapy/Sham /four therapy sessions	CBS, BIT-C, Motricity Index BI, Nottingham Sensory Assessment	No improvement on self-care or BIT was found.
Nys et al[23]	Acute neglect rehabilitation using repetitive prism adaptation: A randomized placebo-controlled trial	Stroke patients/ Acute phase of recovery/sixteen	Examine the effectiveness of prism adaptation in the treatment of acute neglect.	RCT	Hospital rehabilitation Ward	Prism therapy/Placebo /four therapy sessions	MBI the SCT Line Bisection Copying, Representational Drawing	Improvement in USN symptoms. Effects were short-term,
Mancuso et al[27]	Clinical application of prismatic lenses in the rehabilitation of neglect patients. A randomized controlled trial	Right hemisphere vascular lesion./sub-acute and chronic/ twenty-nine patients.	To investigate the possible effectiveness of less powerful prism lenses, in stroke patients with unilateral spatial neglect	RCT	Clinical; outpatient.	Prism adaptation therapy/placebo/five sessions	LCT, BCT, Lines orientation test and; line bisection, copying drawings, finding objects and dealing playing cards test.	Five degrees prismatic lens did not contribute to the variation in performance. Improvement was observed within the two study groups.
Serino et al [28].	Effectiveness of Prism Adaptation in Neglect Rehabilitation A Controlled Trial Study	Stroke patients with USN/all stages of stroke/twenty patients	To investigate effectiveness of prism adaptation (PA) in comparison to an analogous	Controlled trial.	Clinical; outpatient	Prism adaptation/Placebo/ 10 daily sessions over a period of 2 weeks.	BIT	Spatial abilities improved after both PA and NP treatment. Improvement was Higher in the PA group.

			visuomotor training.					Long-lasting beneficial effects of PA 1 month from the end of treatment was observed.

Prism adaptation therapy and Visual Scanning

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/duration of intervention**	**Outcome measures**	**Important results**
Fortis et al, [29]	Effects of prism adaptation on motor-intentional spatial bias in neglect	stroke patients/Not specified/five patients	To determine whether prism adaptation selectively reduces motor-intentional aiming at spatial bias in neglect Patients.	Case study	Hospital rehabilitation Ward	Prism therapy/placebo / Five treatment sessions	BIT, CBS, Double-stimuli confrontation test	Prism adaptation may primarily Affect motor-intentional "aiming" bias in post-stroke spatial neglect patients.
Yoneda et al,[31]	Effects of prism directionality and active movement adaptation on the symptoms of unilateral spatial neglect	Stroke patients/sub-acute phase/ nineteen patients	To investigate the influence of prism deviations toward the right and toward the left.	Controlled trial	Not specified	Prism Adaptation therapy/NA/14-sessions	BIT, comb and razor test, fluff test	Improvement was observed after PA training in most Subtests of the outcome measures, Long-lasting, according to the Follow-up evaluation.
Rode et al[32]	Long-term sensorimotor and therapeutically effects of a mild regime of prism adaptation in spatial neglect. A double-blind RCT essay	Stroke patient/not specified/twenty	To explore the long-term sensory-motor, cognitive and functional effects of PA	A double-blind monocentric controlled randomized trial	Hospital rehabilitation Ward	prism adaptation therapy/Placebo / 4-weeks (twenty sessions)	Functional Independence measure, Behavioural inattention test	Sensory-motor after-effects produced by PA Produced a more rapid reduction of the rightward manual straight-ahead. 6-month follow-up, the two groups showed similar improvement, indicating that a weekly PA session over 4 weeks was not

								sufficient to produce long-term functional benefit
Làdavas et al[33]	Neglect rehabilitation by prism adaptation: Different procedures have different impacts	Stroke/sub-acute to chronic phase of recovery/Thirty patients	To compare the effects of two treatments in two groups of patients. .	RCT	Hospital rehabilitation Ward	Prism adaptation/Placebo/10 sessions	Behavioural Inattention test	Improvement of neglect. Amelioration was higher for patients treated with TPA than for those treated with CPA.

Prism adaptation therapy and Visual Scanning

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/duration of intervention**	**Outcome measures**	**Important results**
Gossmann et al[24]	Prism Adaptation Improves Ego-Centred but Not allocentric Neglect in Early Rehabilitation Patients	Stroke/post-acute phase of stroke /Sixteen	To explore if prism adaptation Improves Ego-Centered but Not Allocentric Neglect in Early Rehabilitation Patients	Single case design studies	Hospital rehabilitation Ward	Prism adaptation/NA/ 4 sessions	LBT, apples test, Clock drawing, spontaneous body orientation, reading	Patients improved in cued body orientation and in the cancellation task
Fortis et al, [35]	A home-based prism adaptation training for neglect patients.	stroke patients/ Mixed phases of stroke/ seven	Investigated the effectiveness of the ecological PA method when performed in a home-based setting, with the help of caregivers and family members.	Controlled trial	Clinical; outpatient.	Prism adaptation therapy/Sham/Twenty	BIT, Cancellation task, CBS, NIH.	Two weeks of ecological PA training proved to be able to significantly improve performance in neuropsychological tests (BIT, Cancellation tasks), a neurological scale (NIH), and functional abilities (CBS), when compared to both the baseline and the neutral control treatment, with improvements being

								maintained over 6 months
Nijboera et al[25]	Prism adaptation improves postural imbalance in neglect patients	Stroke/sub-acute to chronic/Thirty-eight	To evaluate the effects of a 2-week PA therapy on USN assessed with the Behavioural Inattention Test	A randomized controlled trial.	Clinical; Hospital Rehabilitation Ward	prism adaptation therapy/placebo /ten sessions	BIT, the CBS, FIM	The FIM improved significantly more in the prism group. In mild USN patients, there was a significantly greater improvement of BIT and FIM in the prism group.
Mizuno et al,[26]	Prism Adaptation Therapy Enhances Rehabilitation of Stroke Patients With Unilateral Spatial Neglect: A Randomized, Controlled Trial	Stroke/sub-acute to chronic/Thirty-eight	To evaluate the effects of PA therapy on USN.	A randomized controlled trial.	Clinical; Hospital Rehabilitation Ward	prism adaptation therapy/placebo /ten sessions	BIT, the CBS FIM	The FIM improved significantly more in the prism group. In mild USN patients, there was a significantly greater improvement of BIT and FIM in the prism group.
Fortis et al,[30]	Rehabilitating Patients With Left Spatial Neglect by Prism Exposure During a Visuomotor Activity	stroke/Not specified/ten	Comparing the effects of the classic adaptation procedure with those of a novel adaptation method	crossover design,	Clinical; Hospital Rehabilitation Ward	prism adaptation therapy/ /twenty	Cancellation, reading, drawing tasks, and on a standardized scale. (NIH) stroke scale, FIM	The 2-week treatments (EC, CE) were equally effective, improving both USN.

Prism adaptation therapy and Visual Scanning

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Rusconi and Carelli[34]	Long-Term Efficacy of Prism Adaptation on Spatial Neglect: Preliminary Results on Different Spatial Components	stroke patients with Right Hemi/ sub-acute-chronic phase/seven	To evaluate the efficacy of PA training in a long-term follow-up about the different clinical neglect manifestations	Pre-post intervention.	Not specified	Prism Adaptation therapy/NA/14-sessions	BIT, comb and razor test, fluff test.	Improvement was observed after PA training in most subtests, and resulted to be long-lasting, according to the Follow-up evaluation
van Wyk et al,[67]	The Effect of Visual Scanning Exercises Integrated Into Physiotherapy in Patients With Unilateral Spatial Neglect Post-stroke: A Matched-Pair Randomized Control Trial	Stroke patients due to HIV/AIDS/Acute/twenty-four	To determine the effect of saccadic eye movement training with visual scanning exercises (VSEs) integrated with task-specific activities on USN post-stroke.	RCT	Clinical; Hospital Rehabilitation Ward	Visual scanning/ computerized dual-task training/ thirty sessions	King-Dev ick Test Star Cancellation Test, and Barthel Index.	Significant difference was noted on the King-Devick Test (P = .021), Star Cancellation Test (P = .016), and Barthel Index (P = .004).
Van Kessel et al,[66]	Visual scanning training for neglect after stroke with and without a computerized lane tracking dual task	stroke/sub-acute/twenty-nine	To investigate the additional value of visual scanning training	RCT	Clinical; Hospital Rehabilitation Ward	Visual scanning/ computerized dual-task training/ thirty sessions	LCT, Letter cancellation. Bells test. LBT, Word reading task. greyscales. Baking tray task. Semi-structured scale for the evaluation of extra personal neglect. Semi-structured scale for the evaluation of personal neglect.Subjec	No significant additional positive effects of dual-task training. Significant improvements after training were observed. Ameliorations were generally not correlated to post-onset time, but spontaneous recovery,

							tive neglect questionnaire	

Mental Practice and Mirror Therapy

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Park and Lee,	The effects of mental practice on unilateral neglect in patients with chronic stroke: a randomized controlled trial	stroke/ Chronic phase/thirty	To investigate the effects of mental practice on unilateral neglect in patients with chronic stroke.	RCT	Hospital rehabilitation Ward	Mental Practice/standard rehabilitation/twenty sessions	Line bisection, star cancellation test	Both treatment and control groups showed significant improvement in the LBT. But there were no significant differences in the changes in the SCT between both groups.
Welfringer et al,[69]	Visuomotor imagery as a new tool in the rehabilitation of neglect: a randomised controlled study of feasibility and efficacy	stroke/ sub-acute/fifteen	To investigate the feasibility of mental practice upper limb in sub-acute neglect patients	RCT	Hospital rehabilitation Ward	Motor Imagery/ Placebo/fifteen sessions	A Research Arm Test, The Bells Cancellation Test, Drawing tasks, copying a flower, Arm function tests Sensation	Imagined activation of the contralesional upper limb significantly reduces the severity of neglect.
Wang et al, [70]	Mirror neuron therapy for hemispatial neglect patients	stroke patient/ Not specified/ two	To evaluate the therapeutic efficiency of video watching of a series of hand actions/movements in two patients with left hemispatial neglect.	Case study	Hospital rehabilitation Ward	Mirror neuron therapy/fifteen	Behavioural inattention test, FMRI	Significant improvement in the CBIT-HK scores at the first and third weeks, respectively.
Panadian et al, [71]	Mirror Therapy in Unilateral Neglect After	stroke patients/Acute/forty-eight	Explored the effectiveness of mirror therapy (MT) in the treatment of unilateral	RCT	Hospital rehabilitation Ward	Mirror therapy/placebo /twenty sessions	star cancellation test, the line bisection test,	Improvement in scores on the star cancellation test over

	Stroke (MUST trial)		neglect in stroke patients.				and a picture identification task, FIM and modified Rankin Scale	6 months was greater in the MT group)

Combination treatment

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/duration of intervention**	**Outcome measures**	**Important results**
Aparicio-López et al, [36]	Combination treatment in the rehabilitation of visuospatial neglect	Right hemispheric stroke/sub-acute/ twenty-eight	To assess the combined use of computer-based cognitive rehabilitation and RHEP in VSN patients.	Randomized clinical trial	Hospital rehabilitation Ward	(computer-based cognitive rehabilitation + right hemifield eye patching)/ computer-based cognitive rehabilitation/ fifteen sessions	Bell Cancellation Test, Figure Copying of Ogden, Line Bisection , Baking Tray Task, Reading test.	Combination treatment is not more effective than rehabilitation applied in isolation.
Fong et al,[37].	Combined effects of sensory cueing and limb activation on unilateral neglect in subacute left hemiplegic stroke patients: a randomized controlled pilot study	Right hemispheric stroke with neglect/sub-acute phase of recovery/Forty	To compare the effects of contralesional sensory cueing and limb activation with that of sham control in the treatment of unilateral neglect	A randomized, single-blinded, sham-controlled pilot study.	Inpatient Hospital rehabilitation ward	Combination (sensory cueing and limb activation)/Placebo /fifteen sessions	BIT, FIM, FTHUE, Functional Test for Hemiplegic Upper Extremity; Fugl-Meyer Assessment.	The results did not confirm that sensory cueing and limb activation treatment is effective when compared with those receiving placebo to reduce unilateral neglect
Wu et al,[40].	Effects of constraint-induced therapy combined with eye patching on functional	Stroke patients with USN/Chronic/twenty-four	Investigated the effect of constraint-induced therapy (CIT) plus eye patching (EP), CIT alone, and conventional treatment	Randomized pretest and posttest control-	Inpatient Hospital rehabilitation	Constrain induced therapy+ eye patching/Constrain induced	CBS, eye movement, and trunk–arm kinematic analysis.	The EP and CIT groups Demonstrated larger improvements in functional performance

	outcomes and movement kinematics in poststroke neglect.		stroke patients with neglect syndrome.	group design		therapy alone /fifteen sessions		

Combination treatment

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Yang et al,[41].	Effects of repetitive transcranial magnetic stimulation combined with sensory cueing on unilateral neglect in subacute patients with right hemispheric stroke: a randomized controlled study	stroke patients/sub-acute phase/ sixty	To compare the effects of rTMS combined with sensory cueing, rTMS alone, and conventional rehabilitation on unilateral neglect, hemiplegic arm functions and performance of activities of daily living.	A single-blinded randomized controlled trial.	A convalescent hospital.	rTMS + sensory cueing/rTMS alone and conventional rehabilitation/ten sessions	Conventional subtests of the BIT, The CBS, Fugyl-Meyer Assessment, upper extremity subscore, the Action Research Arm Test, and MBI	rTMS combined with sensory cueing and rTMS alone (88.2±28.7) significantly reduced unilateral neglect than conventional rehabilitation (ADLs improved in all patients across groups but no significant differences were found between the groups.
Pitteri et al,[42].	Is two better than one? Limb activation treatment combined with contralesional arm vibration to ameliorate signs of left neglect	stroke patients/not specified/one	To test the effect of the simultaneous use of two techniques on visuospatial aspects of LN	Case study	Hospital rehabilitation Ward	Limb activation treatment combined with contralesional arm vibration/Limb activation test/40 sessions	Picture scanning test, Bell's test, line bisection test, semantic verbal fluency test.	The results showed an improvement of performance on the Bells test following the combined application of LAT and CAV. LAT alone had no significant effects of treatment on., Line

								bisection and Picture scanning).
Polanowska et al,[43]	Left-hand somatosensory stimulation combined with visual scanning training in rehabilitation for post-stroke hemineglect:	stroke patients/sub-acute/forty	The aim of this randomised, double-blind study was to investigate the therapeutic effectiveness of left-hand electrical stimulation for patients with post-stroke left visuospatial neglect.	A randomised, double-blind study,	Hospital rehabilitation Ward	Left-hand somatosensory stimulation + visual scanning training/Sham stimulation and scanning training/twenty sessions	Behavioural Inattention Test and a task of reading letters aloud.	Contralesional hand stimulation combined with visual scanning was a more effective treatment for hemineglect rehabilitation than scanning training alone.

Combination treatment

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/ duration of intervention**	**Outcome measures**	**Important results**
Luauté et al,[44]	Rehabilitation of hemispatial neglect. Utility to combine prism-adaptation and methylphenidate. RITAPRISM study	stroke patients/sub-acute/twenty four	The purpose of this study was to assess the utility to combine prism adaptation (PA) and methylphenidate	randomized-controlled-trial	Hospital rehabilitation Ward	PA + methylphenidate /treated by PA and a placebo/	functional independence measure(FIM)	Significant improvement of the FIM. Neglects tests did not change differently in the two groups. By contrast, the number of omitted responses on the sustained attentional computerized test decreased with a trend toward a difference
Saevarsson et al,[45].	Strength in numbers: Combining neck vibration and prism adaptation	Stoke patients/chronic patients/twelve	Performed to explore possible additive benefits when neck vibration and prism adaptation	randomized-controlled-trial	Hospital rehabilitation Ward	Neck vibration + Prism adaptation/ Prism adaptation only/not specified.	Standard paper-and-pencil neglect tests.	Patients that underwent the combined intervention (NVPA) showed clear

	produces additive therapeutic effects in unilateral neglect		interventions are used in combination to treat chronic neglect					Improvements in visual search, unlike the NV-only group.
Schroder et al,[46].	TENS and optokinetic stimulation in neglect therapy after a cerebrovascular accident: a randomized controlled study	Stroke/Sub-acute/ thirty	To compare the effectiveness of exploration training alone and in combination with TENS or OKS.	Randomised control trial	Hospital rehabilitation ward	Optokinetic stimulation and TENS/ exploration training/ twenty sessions	Line cancellation, star cancellation, line bisection, figure copy and freehand drawing the reading test, writing a dictated sentence	exploration training alone resulted in no improvement on both standard neglect tests In contrast, TENS or OKS showed significant improvements in both sets of measures.
Turgut et al,[48]	tDCS combined with optokinetic drift reduces egocentric neglect in severely impaired post-acute patients	Stroke/Acute /thirty-two	To investigate the combined effects of Tdcs and optokinetic drift on different forms of neglect.	A randomized controlled trial.	Hospital rehabilitation ward	Optoninethic +tDCS/Conventional physiotherapy/Eight sessions	Body orientation in the wheelchair, line bisection task, Clock Drawing Test, Apples Cancellation Task, Barthel index, Functional independent measure.	Intragroup comparisons showed broad improvements on egocentric but not on allocentric symptoms only for the intervention group. A short additional application of tDCS during an optokinetic task led to improvements of severe neglect compared to a standard neurological early rehabilitation treatment
Luaute et al,[49]	Adding methylphenidate to prism-adaptation improves outcome in	Stroke/Mixed phases/Twenty-four.	To test whether combining prism adaptation (PA) and methylphenidate (MP) could enhance the recovery of neglect	A randomized, double-blind, placebo-	Hospital rehabilitation ward	Prism adaptation+methylphenidate/Sham/ 10 mg of MP (one capsule) at 8 AM and one at 12 PM	Line bisection, Line cancellation, Balloon test, Reproduction (copy) of a	The main result is a long-term functional improvement (on the functional independence measure (FIM) and

	neglect patients. A randomized clinical trial.		patients at a functional level.	controlled study		from day 11 to day 15 + four sessions of PA	scene, Daisy (drawing from memory), Alert test, Sustained attention	on Bergego's scale) induced by MP combined with PA. No serious adverse event occurred.
Kim et al, [50]	Effect of Combined Therapy of Robot and Low-Frequency Repetitive Transcranial Magnetic Stimulation on Hemispatial Neglect in Stroke Patients.	Stroke/ Acute-subacute/ Thirty-nine	To investigate the effect of upper limb rehabilitation combining robot with low-frequency repetitive transcranial magnetic stimulation (rTMS) on unilateral spatial neglect in stroke patients.	RCT	Hospital rehabilitation ward	Robot Therapy+ rTMS/Conventional neglect treatment/ Ten sessions.	Motor-Free Visual Perception Test-3 (MVPT-3), line bisection test, star cancellation test, Catherine Bergego Scale (CBS), Mini-Mental State Examination (MMSE), and the Korean version of Modified Barthel Index (K-MBI).	Two weeks after the therapy, all groups showed significant improvement in MVPT-3, line bisection test, star cancellation test, CBS, MMSE, and K-MBI. However, changes in measurements showed no significant differences among groups.
Iwanski et al, [51]	Low-frequency rTMS combined with visual scanning training in patients with post-stroke visuospatial neglect. A randomized, double-blind, placebo-controlled study	Stroke/not stated/ Twenty-eight	To investigate the therapeutic effect of 1 Hz rTMS applied over the left angular gyrus, combined with visual scanning training in patients with post-stroke VSN.	A randomized, double-blind, placebo-controlled study	Hospital rehabilitation ward	Low frequency rTMS+visual scanning training /Sham/ Fifteen sessions	Behavioural Inattention Test, eye-tracking device and functional measures.	No differences were detected in any outcome measure between the real rTMS group and the sham group after completion of therapy.
Vatanparasti et al, [52]	The Effect of Continuous Theta-Burst Transcranial Magnetic Stimulation Combined with	Stroke/sub-acute to Chronic/ Fourteen	To investigate the effect of prism adaptation (PA) combined with continuous theta-burst transcranial magnetic stimulation (cTBS) on	Randomised controlled trial	Hospital rehabilitation ward	(PA alone and PA+ cTBS)/Sham/Ten sessions	Star Cancellation Test (SCT), Line Bisection Task (LBT), Figure Copying Test, and Clock	Both groups (PA alone and PA+ cTBS) showed improvement in their neglected symptoms (measured by SCT, LBT, Figure Copying Test, and

	Prism Adaptation on the Neglect Recovery in Stroke Patients		the neglect recovery of stroke patients with unilateral neglect.				Drawing Task and Modified Rankin Scale (MRS)	Clock Drawing Task), and in their disability in the neurological function (measured by MRS) (P< .05).

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/duration of intervention**	**Outcome measures**	**Important results**
Oh et al, [47]	The effects of prism glasses and intensive upper limb exercise on hemineglect, upper limb function, and activities of daily living in stroke patients: a case series	Stroke/ not specified/ three	To examine the effects of visual field with prism glasses, and intensive upper limb functional training on the reduction of hemineglect and improvement in upper limb function and activities of daily living in three stroke patients with hemineglect.	Case study	Hospital rehabilitation Ward	Prism therapy/nil/75 sessions	Line bi Section, Motor-Free Visual Perception Test-3 (MVPT-3), Manual Function Test (MFT), Box & Block Test (BBT), and Assessment of Motor and Process Skills (AMPS)	Subjects' hemineglect decreased and upper limb function on the paretic side improved after the intervention, which enhanced activities of daily living.
Luukkainen-Markkul et al, [38].	Rehabilitation of hemispatial neglect: A randomized study using either arm activation or visual scanning training	stroke/post-acute/twelve	To determine whether left arm activation alone could be sufficient to produce a long-lasting amelioration of neglect comparable to the effect obtained with traditional visual scanning training.	Randomized control trial	Hospital rehabilitation Ward	arm activation /visual scanning/fifteen sessions	CBS, BIS, FIM, BDI, WAIS-R, picture completion	Visual neglect of the arm activation group recovered significantly in the conventional subtests of the Behavioural Inattention Test both post-rehabilitation and at 6-months follow-up.

Cha et al, [39.]	The Effect of 1 Hz Repetitive Transcranial Magnetic Stimulation Combined with Task-oriented Training on Upper Limb Function and Hemineglect in Stroke Patients	stroke/Sub-acute/twenty-five	To investigate the effect of rTMS on upper limb dysfunction and hemineglect patients after stroke and to find out the most effective application method.	Randomised control trial	Outpatient	rTMS/Placebo/twenty sessions	Fugl Meyer assessment (FMA), box and block test (BBT), Albert test (AT) and grip strength test.	A significant difference. in the post-training gains in FMA, AT, and grip strength test were observed between the experimental group and the control group ($p < 0.05$).

Pharmacological treatment

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Paolucci et al, [75].	An open-label pilot study of the use of rivastigmine to promote functional recovery in patients with unilateral spatial neglect due to first ischemic stroke	stroke patients/not specified/Twenty	To evaluate the efficacy and safety of rivastigmine as an add-on treatment to specific cognitive rehabilitation for unilateral spatial neglect	open-label pilot study	Hospital rehabilitation Ward	Rivastigmine treatment/ conventional physiotherapy and cognitive training/40 sessions	Length of stay in the rehabilitation unit, Barthel Index (BI) and the Rivermead Mobility Index (RMI),	Rivastigmine as an add-on treatment to specific cognitive training for USN improve and accelerated recovery on some specific impairment tests as compared with cognitive training alone.
Lucas et al, [76].	Effects of pro-cholinergic treatment in patients suffering from spatial neglect	Stroke/not specified/ten patients.	To examine the effect of single-dose transdermal nicotine treatment on spatial neglect in stroke patients	double-blind placebo-controlled protocol	Hospital rehabilitation Ward	pro-cholinergic treatment/placebo/not applicable	Bells' cancellation task, Letter cancellation task, Shape cancellation task, Compound-word reading task, Line bisection.	Nicotine-induced systematic improvement on cancellation tasks and facilitated orienting to single visual targets, but had no significant effect on other tests.
Gorgoraptis et al,[77]	The effects of the dopamine agonist rotigotine on	Stroke/nil/Sixteen	Investigated whether the dopamine agonist rotigotine would have a beneficial effect on hemispatial neglect in stroke patients	Double-blind, randomized, placebo-controlled	Hospital rehabilitation Ward	Dopamine agonist rotigotine/not applicable	Performance on cancellation (visual search), line bisection,	Performance on the Mesulam shape cancellation task improved significantly while on rotigotine, with the number of

	hemispatial neglect following stroke			ABA design			visual working memory, selective attention and sustained attention tasks, as well as measures of motor control.	targets found on the left side increasing by 12.8% (P = 0.012) on treatment and spatial bias reducing by 8.1% (P = 0.016
Dalmaijer et al,78	A randomised, double-blind, placebo-controlled crossover study of single-dose guanfacine in unilateral neglect following stroke.		This study aimed to test the effects of guanfacine, a noradrenergic alpha-2A agonist, on ameliorating aspects of neglect.	Randomised double blind, placebo-controlled crossover study	Hospital rehabilitation Ward	Single-dose guanfacine/Placebo	Computerised, time-limited cancellation paradigm, as well as tasks that independently assessed sustained attention and spatial working memory.	On guanfacine, there was a statistically significant improvement in the total number of targets found on the cancellation task when compared with placebo (mean improvement of 5, out of a possible 64). However, there was no evidence of a change in neglect patients' directional attention bias.

Electrical stimulation and Robotics

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Varalta et al, 2014.	Effects of contralesional robot-assisted hand training in patients with unilateral spatial neglect following stroke: a case series study	stroke patients with USN/sub-acute to chronic/ Three	To determine whether robot-assisted left (contralesional) hand activation alone could lead to an improvement in hemispatial neglect following stroke.	Case study	Hospital rehabilitation Ward	Robot-assisted hand training/ Placebo/ ten session	Line Crossing test, the Bells test, the Sentence Reading test, the Saccadic Training, the Sustained Attention to Response Task, and the Purdue Pegboard test.	All patients showed improved performance on Bells test: no patient reached normal performance levels.
Chieffo et al,[60]	Effects of TDCS in modulating the after-effect of prismatic lenses training in subacute stroke patients with neglect	Stroke/Sub-acute phase/ Fifteen	To evaluate the effects Effects of TDCS in modulating the after-effect of prismatic lenses training in subacute stroke patients with neglect	RCT	Hospital rehabilitation Ward	Tdcs /Sham/ Three sessions	Behavioural inattention test	No difference in the after-effect was obtained comparing the c-tDCS and sham stimulation. Error correction during the PL training does not significantly differ among the three sessions.
Karner et al, [74]	Effects of a robot intervention on visuospatial hemineglect in post-acute stroke patients: a randomized controlled tri	Stroke/post-acute/thirty-nine	To evaluate the effects of an intervention using the robot device PARO on visuospatial hemineglect and activities of daily living, and its acceptance during stroke rehabilitation	RCT	Hospital rehabilitation Ward	Robotics/conventional Physiotherapy/six sessions	Cancellation test, Line Bisection Test, Independence Index for Neurological and Geriatric Rehabilitation (SINGER) test	Improvement of hemineglect at T1 and T2 was significantly higher in the PARO group (T1: mean (SD) = 6.23 (3.81); T2: mean (SD) = 7.85 (3.68)) compared to the

								control group (T1: mean (SD) = 2.66 (4.19); T2: mean (SD) = 3.33 (4.16)) (T1: P < 0.05; T2: P < 0.05).
Nyffeler et al,[61]	Theta burst stimulation in neglect after stroke: Functional outcome and response variability	Stroke/not stated/sixty	To assess the characteristics and determinants of the effects of inhibitory non-invasive brain stimulation in neglect, identifying which patients would respond to this therapeutic approach and which not.	A randomized controlled trial.	Hospital rehabilitation Ward	cTBS/ Sham/8cTBS trains, 16cTBS trains	Catherine Bergego scale, Fluff test, bird cancellation task, Functional independence measure,	On a group level, both cTBS protocols (i.e. eight and 16 trains) significantly reduced neglect severity in both the Catherine Bergego Scale and the neuropsychological tests, at discharge and 3 months later.
Harding & Riddoch, 2009,[72]	Functional Electrical Stimulation (FES) of the upper limb alleviates unilateral neglect: A case series analysis	stroke patients/not specified/Four	To explore if Functional Electrical Stimulation (FES) of the upper limb alleviates unilateral neglect.	Single subject experimental design	Outpatient Rehabilitation hospital	functional electrical stimulation/placebo/fifteen sessions	BIT, Rivermead Motor Assessment Barthel Index the Baking Tray Test, and the Picture Naming Test	Three of the four patients tested responded to the FES, showing good amelioration of neglect and also making good physical and functional recovery.
Kim et al, 2013,[54]	Effect of High- and Low-Frequency Repetitive Transcranial Magnetic Stimulation on Visuospatial Neglect in Patients With Acute Stroke:	Stroke patients with USN/acute /twenty-seven	To compare the therapeutic effect of low- and high-frequency repetitive transcranial magnetic stimulation (rTMS) of in patients with acute stroke with visuospatial neglect.	Double-blind, sham-controlled trial.	Hospital rehabilitation Ward	(low (1Hz) ,and high-frequency (10Hz) rTMS/Placebo/ Ten sessions	Motor-Free Visual Perception Test, line bisection test, star cancellation test, and Catherine Bergego Scale.	High-frequency rTMS is effective in the treatment of visuospatial neglect in patients with acute stroke.

Table 6b: Electrical stimulation and Robotics

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Cha and Kim,[53].	Effects of repetitive transcranial magnetic stimulation on arm function and decreasing unilateral spatial neglect in subacute stroke	stroke patients/sub-acute/thirty	The objective of this study is to investigate the effect of repetitive transcranial magnetic stimulation (rTMS) on the functional recovery of stroke patients with unilateral neglect.	A randomised control trial	Outpatient rehabilitation hospital.	Repetitive transcranial magnetic stimulation/ Placebo/twenty sessions	Line bisection, Albert, Box and block and Grip strength tests	A significant difference in the post-training gains in Line bisection Albert, Box and block, and Grip strength tests was observed between the experimental group and the control group.
Cao et al, [55].	Intermittent θ burst stimulation modulates resting-state functional connectivity in the attention network and promotes behavioural recovery in patients with visual-spatial neglect	Stroke patients with USN/sub-acute phase/thirteen.	Aimed to investigate the activity of the LDLPFC through intermittent θ burst stimulation (iTBS) could modulate the resting-state functional connectivity in	A randomised control trial	Not stated	Intermittent θ burst stimulation/Sham/ ten sessions	Line bisection, star cancellation.	Patients who received iTBS at 80% RMT showed a large-scale reduction in the resting-state functional connectivity ,
Fu et al, [56].	Long-term effects of continuous theta-burst stimulation in visuospatial neglect	Stroke patients with USN/acute-chronic/twenty	To investigate whether the efficacy of continuous theta-burst stimulation (cTBS) for improving visuospatial neglect can be enhanced by providing more days of	A randomised control trial	Outpatient	continuous theta-burst/sham continuous theta-burst/ten sessions	Star Cancellation test, Line Cancellation test.	SCT scores in the cTBS group were improved by 37.03% at the end of treatment and by 47.21% after 4 weeks' follow up, and the line bisection

			stimulation and more stimulation trains per day.					score improved by 21.37% at the end of Treatment and by 35.99% after 4 weeks' follow up.

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/duration of intervention**	**Outcome measures**	**Important results**
Hegarty, [79]	The Effects of Animal-Assisted Therapy on the Recovery of Individuals with Unilateral Spatial Neglect	Stroke/Chronic phase/one	To examine the effects of limb-activating strategy using either a rote activity or a meaningful activity (animal-assisted therapy) in the treatment of an individual with unilateral spatial neglect.	Case study	Hospital rehabilitation Ward	animal-assisted therapy/Nil/	Star Cancellation Test, Line Bisection , Baking Tray test	Participant's Baking Tray Task and Line Bisection score showed improvements from baseline during both the meaningful and rote activity phases.. The Star Cancellation Test showed minimal changes
Wood et al, [80].	Improvement in arousal, visual neglect, and perception of stimulus intensity following cold pressor stimulation (CPS)	Stroke /chronic phase/one	To determine effects of cold compression on contralesional neglect, perception of stimulus intensity (magnitude estimation), reaction time, and an electrophysiological correlate of ascending reticular activating system activity	Case study	Not specified	Cold pressure stimulation /not applicable/two sessions	Clock Face Drawing subtest of the BITC	Measures that normalized from baseline following CPS included contralesional neglect on a clock drawing test, perception of stimulus magnitude,.

Gilbert et al,[81]	A rehabilitation program based on music practice for patients with unilateral spatial neglect: a single-case study	Stroke patients with USN/Chronic /one	To Underline how a multisensory method– music practice-could lack of long-term efficiency and a lack of generalization to daily life.	Single case study	Outpatient	Music practice/ N/A /8 weeks	Bells cancellation test, copy drawing, clock drawing, line bisection, writing and perceptual tasks overlapping figures test, reading,Montreal Battery of Evaluation of Amusia (MBEA):	An Improvement of USN was found on paper-pencil tests but also in daily activities. Benefits subsisted 4 months after rehabilitation.

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Cha and Kim, 2015[57]	The effects of repetitive transcranial magnetic stimulation on unilateral neglect of acute stroke patients: A randomised controlled trial	stroke/sub-acute/twenty	To evaluate the effects of repetitive transcranial magnetic stimulation on the functional recovery of stroke patients with unilateral neglect.	RCT	Hospital rehabilitation Ward	transcranial magnetic stimulation/Placebo/twenty	The Motor Free Visual Perception Test (MVPT), Line Bisection Test (LBT), Albert Test (AT), and SCT	Increase in the MVPT, LBT, AT, and SCT values compared with MVPT, LBT, and A results compared with the preintervention results ($p < 0.05$). A significant difference in the post-training gains for the MVPT (8.9 2.5 vs. 4.8 3.0), LBT (19.3 7.5 vs. 6.5 9.5), AT (13.1 8.0 vs. 4.0 1.9), and SCT (13.6 6.9 vs. 4.5 6.9) were observed between the experimental group and the control group
Cazzoli et al,[58]	Theta burst stimulation reduces disability during the activities of daily living in spatial neglect	stroke/ sub-acute /twenty-four	To investigate whether the repeated application of continuous theta burst stimulation trains could ameliorate spatial neglect	Randomized double-blind, sham-controlled design,	hospital rehabilitation ward	Theta burst stimulation/placebo/ Eight trains of continuous theta burst stimulation over two consecutive days(sessions)	SCT, Random LCT or Bells test a line bisection task, LBT , and a drawing task , copy; Five-point test, Figure copying test, Copy drawing test	Results showed a 37% improvement in the spontaneous everyday behaviour of the neglect patients
Nyffeler et al, [59].	One session of repeated parietal theta burst stimulation trains induces long-lasting	Stroke Patients with USN/acute-chronic/ Eleven	Aimed to test whether parietal TBS can induce a long-lasting improvement of visual neglect by reducing the interhemispheric inhibition	Controlled trial	Hospital rehabilitation ward	Parietal Theta Burst Stimulation/Placebo/sham/three sessions	Bell Cancellation, Line Bisection, Reading test Drawing neglect.	Two TBS trains significantly increased perceived visual targets for 8 hours.

	improvement of visual neglect							

Table 7c: Electrical stimulation and Robotics

Table 8a: Other Treatments

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Bernard et al, [82].	Improving left spatial neglect through music scale playing	Stroke patients/ Sub-acute-chronic/twenty-three.	The study assessed if auditory reference provided by a music scale improve spatial exploration of a standard musical instrument keyboard in right-brain-damaged patients with left spatial neglect.	Counterbalanced design	hospital rehabilitation ward	music scale playing/ (Silence Vs Music Vs Random),/two sessions	Line bisection, Letter Cancellation, Bell Cancellation, star cancellation, complex drawing.	In all groups. The frame provided by the music scale improves exploration of the left side of space, contralateral to the right hemisphere, damaged in patients with left neglect.
Tsai et al,[83]	Listening to Classical Music Ameliorates Unilateral Neglect After Stroke	Stroke patients with USN/not specified/sixteen	To determine whether listening to excerpts of classical music ameliorates unilateral neglect (UN) in stroke patients.	within-subjects repeated-measures	Hospital rehabilitation Ward and Outpatient clinic	listening to classical music/silence condition/not specified	LBT, Picture Scanning Test, SCT, VAS for arousal and mood.	Participants generally had the highest scores on the Outcome measures under the classical music condition and the lowest scores under the silence condition.
Oren et al, [85]	Immediate effects of exposure to positive and negative	Stroke patients with USN/sub-acute/sixteen	To determine the effect of exposure to non-lateralized emotional stimuli	Controlled trial	Mixed (Hospital out-patient and in-patient)	Emotional stimuli/Placebo (Healthy Vs USN patients)/ not specified	Behavioural inattention test, line bisection,	USN subjects, but not controls, were slower and more variable in their RT for left- compared to

	emotional stimuli on visual search characteristics in patients with unilateral neglect		on UN patients' attentional bias and performance variability.				Mesulam–Weintraub cancellation test	right-sided targets. In the USN group, detecting left-sided targets was significantly slower in trials that followed presentation of negative pictures as compared to positive pictures.

Table 8b: Other Treatments

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/duration of intervention**	**Outcome measures**	**Important results**
Trejo-Gabriel-Galan et al,[86]	Rehabilitation of hemineglect of the left arm using movement detection bracelets activating a visual and acoustic alarm	Stroke/Not specified/nine	To determine if a visual-acoustic alarm in the hemineglect arm activated by a certain discrepancy in the movement of both hands can enhance neglect arm use in five tasks of daily living.	pre-post intervention study	hospital rehabilitation ward	visual and acoustic alarm/NA/ seven sessions	Catherine-Bergego scale,	Both motion and function of the neglected hand improved during the seven days of training when visual acoustic alarms were active but a worsening to baseline values occurred on day 8 and day 30 when alarms where switched off. Improvement was limited to vision-dependent tasks
Bang et al, [87].	Effects of body awareness training on mild visuospatial neglect in	stroke patients with usn/acute/twelve	Aimed to investigate the effects of body awareness training (BAT) on mild visuospatial neglect in	A pilot randomized controlled trial	Hospital rehabilitation Ward	Body Awareness Training/Placebo/fifteen sessions	MVPT: Motor-free Perception Test; LBT: Line Bisection Test;	The results of this study suggest the feasibility and suitability of BAT with task-oriented

	patients with acute stroke: a pilot randomized controlled trial		patients following acute stroke.				MBI: modified Barthel index.	training for mild visuospatial neglect in patients with acute stroke.
Sato et al, [88].	Influence of Colour Lightness Differences in Patients With Left Unilateral Spatial Neglect	stroke patients/Not specified/forty-seven	Assessed the effects of colour lightness differences in patients with USN.	pre-post interventio n study	Hospital rehabilitation Ward	Colour Lightness Differences/not specified/not specified	Line cancellation test of the Japanese version of the Behavioural inattention test	Letter Cancellation Test consisting of black letters with a yellow background showed favourable effects of colour lightness differences with mild left USN, but not in those with severe left USN.

Table 8d: Other Treatments

Authors	**Study title**	**Study population/ intervention/population size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparator/duration of intervention**	**Outcome measures**	**Important results**
Funk et al, [89].	Effects of Feedback-Based Visual Line-Orientation Discrimination Training for Visuospatial Disorders After Stroke	Stroke patients with USN/not specified/thirteen	Investigated a novel feedback-based perceptual training procedure for the rehabilitation of patients after stroke	uncontrolled clinic trial	Outpatient department	feedback-based, perceptual orientation training/nil/nineteen sessions	Mack Levine test, JLOT, Analog clock reading, Horizontal writing.	Rapid improvements in trained but also in nontrained spatial orientation tests stability of the obtained improvements at 2-month follow-up.
Yoshihiro et al, [90]	Effect of passive limb activation by Functional Electrical Stimulation on	Stroke patients with USN/sub-acute – chronic phase/ two	This study examined the effect of passive limb activation by functional electrical stimulation (FES) on	A single-subject design-baseline-	Hospital rehabilitation Ward	Passive limb activation/not applicable/twenty sessions	Line bisection task, star cancellation task, Fugyl Meyer	USN on the Cognitive test in the extra personal space

	wheelchair driving in patients with unilateral spatial neglect: A case study		wheelchair driving for patients with USN, and to discuss the possibility of application of this treatment to occupational therapy.	interventio n-baseline			assessment, and Modified Ashworth scale	indicated a tendency to improve after phase B
Kim et al, [91]	The Effect of Virtual Reality Training on Unilateral Spatial Neglect in Stroke Patients	Stroke/Acute phase/twenty-four patients.	To investigate the effect of virtual reality training on unilateral spatial neglect in stroke patients.	Randomise d control trial	Hospital rehabilitation Ward	Virtual reality/Conventi onal rehabilitation/fift een sessions.	Star cancellation test, line bisection test, Catherine Bergego scale (CBS), and the Korean version of the modified Barthel index (K-MBI).	The changes in star cancellation test results and CBS in the VR group were significantly higher than those of the control group after treatment. Changes in line bisection test score and the K-MBI in the VR group were not statistically significant.

Table 8e: Other Treatments

Authors	**Study title**	**Study population/ intervention/pop ulation size**	**Study aim**	**Design**	**Study setting**	**Intervention type/comparat or/duration of intervention**	**Outcome measures**	**Important results**
Schaadt et al, 2014[95]	The effect of rotating random-dot motion on visuospatial line orientation in patients with right-sided stroke individuals	Stroke patients with USN/not specified/ twenty	Investigated whether rotational RDM modulates judgements in an oblique line task	Controlled trial	Hospital rehabilitation ward	Random dot motion/Healthy Vs neglect patients/not specified	Line bisection test, Number cancellation, Judgement of line orientation	In baseline condition with stroke background, the impaired patient group showed a significant counterclockwise tilt

Khurshid et al, [62]	Monocular patching affects inattention but not perseveration in spatial neglect	stroke patient/not specified/one	To investigate the effects of eye patching on perseveration versus omission errors,	Case study	Hospital rehabilitation Ward	Mono-occular patching/not applicable/not specified	Line cancellation test,	Contralesional patching had no effect on the omissions (p=0.871), whereas ipsilesional patching reduced left-sided omissions compared with the unpatched condition (p=0.016).
Tsang et al,[64].	Occupational therapy treatment with right half-field eye-patching for patients with subacute stroke and unilateral neglect: A randomised controlled trial	stroke/ sub-acute/ Thirty-five	Investigated the efficacy of conventional treatment with right half-field eye patching in treating subacute stroke patients with UN.	Randomized control trial	Hospital rehabilitation Ward	half-eye patching/conventional therapy/twenty session	Functional independence measure, Behavioural inattention test	Patients treated with right half-field eye-patching had significantly higher BIT gain than those treated with the conventional treatment. No significant difference in FIM gain between patients in both groups.

Other Treatments

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Shiraishi et al,[65].	Right half-field eye patching may not be an effective approach for chronic hemispatial neglect – a two-case investigation	Stroke/Chronic stroke patients/two patients.	To determine Whether right half-field eye-patched glasses are an effective intervention for USN patients over a year after onset.	Case study	hospital rehabilitation ward	Right half-field minutes (ranging from 40 to 60 minutes per intervention), and the duration of the intervention was 8 weeks. Eye patching/NA/ 50	Line, letter, and star cancellation tests, a flower drawing test, and a line bisection test	. The centre of gravity shifted significantly to the right and backward. Letter and star cancellation tests were improved in both cases. Line bisection test showed improvement in one patient. However, line cancellation and line bisection tests were worsened in the other. The rCBF was not changed after intervention. .
Ianes et al,[63].	Stimulating visual exploration of the neglected space in the early stage of stroke by hemifield eye-patching: a randomized controlled trial in patients with right brain damage	stroke/ acute phase/eighteen	To evaluate the effectiveness of right half-field patches in treating neglect in patients during the early phase of the stroke.	randomised control trial	hospital rehabilitation ward	Right field Eye patching/ placebo/twelve sessions	Bell's test, line bisection test, line crossing test, Barthel index	Both groups significantly improved their performance in all outcome measures. No difference in the amount of improvement between the two groups was found.

Other Treatments

Authors	Study title	Study population/ intervention/population size	Study aim	Design	Study setting	Intervention type/comparator/duration of intervention	Outcome measures	Important results
Schmidt et al,[93].	Galvanic Vestibular Stimulation Improves Arm Position Sense in Spatial Neglect: A Sham-Stimulation-Controlled Study	Stroke/not specified/Thirty-two	Aimed to investigate the immediate effects and aftereffects of sub sensory, bipolar GVS	Case study	Hospital rehabilitation Ward	Baseline without GVS, left-cathodal/right-anodal GVS, right-Cathodal/left-anodal GVS, sham GVS).	optoelectronic apparatus (arm position device); star cancellation, letter cancellation, line bisection, and figure copying, paragraph reading test	. Left-cathodal/right-anodal GVS improved left APS significantly, which further improved into the normal range 20 minutes post-stimulation. GVS had no effect in patients without neglect but right-cathodal/left-anodal GVS worsened left APS
Nakamura et al, [94]	Influence of the stimulus parameters of galvanic vestibular stimulation on unilateral spatial neglect	stroke patients/not specified/seven	Explored the influence of these stimulus parameters on USN.	Single-blind, sham-controlled crossover trial.	Hospital rehabilitation Ward	Galvanic vestibular stimulation/three stimulating parameters/3 sessions	Behavioural inattention test conventional test	The cancellation scores were significantly increased after 10 and 20 min L-GVS, with a greater increase observed after the latter ($P < 0.0001$). There was a significant positive correlation between the change in the increase in the cancellation score with L-GVS and the total charge ($r = 0.81$, $P = 0.0004$).
Zubko et al,[92]	The effect of repeated sessions of galvanic	STROKE/sub-acute phase/two	Assessed whether repeated sessions of galvanic vestibular stimulation induce	Case study	Hospital rehabilitation Ward	Galvanic vestibular stimulation/NA/Five sessions	letter and star cancellation tasks of the Behavioural	Improvement was observed compared to baseline. More

	stimulation on target cancellation in neglect:		longer carry-over in neglect patients.				Inattention Test on four occasions;	so, this improvement was still evident at follow-up three days later.
Turgut et al, [100]	Adaptive Cueing Treatment of Neglect in Stroke Patients Leads to Improvements in Activities of Daily Living: a Randomized Controlled, Crossover Trial	Stroke patients/ Mixed phases of stroke/ seven	Investigated the effect of adaptive cueing during a reading task as a possible treatment for neglect	Randomised controlled cross over trial	Hospital rehabilitation Ward	Adaptive cueing/Sham/Fifteen sessions.	Sitting position, Clock Drawing Test, Rivermead Behavioural Memory Test, line bisection task, Apples Cancellation Task, Clock Drawing Test,	Significant improvements were shown after intervention on scores for reading (word and text reading), daily life activities (Catherine Bergego Scale), Line Bisection, and the Clock Drawing Task
Varalta et al,[99]	Effects of neck taping in the treatment of hemispatial neglect in chronic stroke patients: A pilot study	Stroke/Chronic/Twelve	To assess the effect of therapeutic neck taping on visuospatial abilities, neck motion, and kinaesthetic sensibility in chronic stroke patients with hemispatial neglect	RCT	Hospital rehabilitation Ward	Neck taping/Sham/Thirty sessions	Stars Cancellation Test; neck active range of motion; Letter Cancellation Test; Comb and Razor Test; Cervical Joint Position Error Test	Between-group comparison showed significant differences only for the Cervical Joint Position Error Test after treatment (p = 0.009).
Saj et al,[101]	Effect of a single early EEG neurofeedback training on remediation of spatial neglect in the acute phase.	Stroke/ Acute phase/Four	To investigate the effect of a single early EEG neurofeedback training on remediation of spatial neglect in the acute phase	Case study	Hospital rehabilitation Ward	EEG neurofeedback training/Nil/Ten Sessions	Line bisection, scene copying, and bell cancellation	Visuospatial tasks showed decreased error rates (mean neglect score 18%) as compared with before NFB (56%; P = 0.01) and 1 week after (42%; P = 0.02). The difference in error rates between before NFB and 1 week after was not

								significant (P = 0.18).
Wen et al,[98]	An observation on the curative effects of rehabilitation intervention of adjuvant horticultural therapy for the treatment of stroke-induced unilateral spatial neglect	Stroke/ Sub-acute/ fourty-six	This study was intended to observe the influence of rehabilitation intervention of adjuvant horticultural therapy on unilateral spatial neglect in the stroke.	RCT	Hospital rehabilitation Ward	Horticulture therapy/ conventional physiotherapy/not stated	Fugl-Meyer assessment, Modified Barthel index, Shenckenberg test, clock drawing test, Albert	After two groups of patients received the therapy, the scores of FMA, MBI and HAMD were of significant difference
Kutlay et al, [96]	Kinaesthetic ability training improves unilateral neglect and functional outcome in patients with stroke: A randomized control tri	Stroke/All phases/Sixty-four	To investigate the effects of kinaesthetic ability training with the Kinesthetic Ability Trainer (KAT) on unilateral neglect and functional outcomes in stroke patients.	RCT	Hospital rehabilitation Ward	Kinaesthetic training/OT and PT conventional therapy/ twenty sessions	BIT, Functional independence measure.	Both groups showed significant improvements in all subscales of the BIT (conventional and behavioural) ($p < 0.001$) and the FIM motor scale ($p < 0.001$) after therapy. Recovery from neglect was assessed, based on the BIT cut-off scores. The recovery rate for behavioural BIT was 40% in the KAT group and 17.9% in the control group ($p = 0.07$), whereas recovery rates according to the conventional BIT were 16% and 10.7% in the KAT and control groups, respectively.

Kang et al,[84]	Musical Neglect Training for Chronic Persistent Unilateral Visual Neglect Post-stroke.	Stroke/Chronic/Two sessions	To evaluate the effect of Musical Neglect Training for Chronic Persistent Unilateral Visual Neglect Post-stroke.	Case study	Outpatient department	Music therapy/Nil/Six sessions	Albert test, Bissection test	Participant 1 (26 months post-stroke) benefitted from MNT training as evidenced by Albert's test with statistical significance and showed small but non-significant improvements on the Line Bisection Test. Characteristics of the performance of participant 1, however, was her difficulty to sustain training benefits from session to session and at follow-up. Participant 2 (10 years post-stroke) showed significant benefits from MNT training on Albert's test with each session as well which seemed to also carry-over to reduced pretest scores from session to session, indicating that the participant's neglect status was consistently reduced across the 3-week training period

Svaerke et al, [97]	Computer-Based Cognitive Rehabilitation in Patients with Visuospatial Neglect or Homonymous Hemianopia after Strok	Stroke/ Sub-acute/ Eighteen	To investigate the feasibility and effects of computer-based cognitive rehabilitation (CBCR) in patients with symptoms of visuospatial neglect or homonymous hemianopia in the subacute phase following stroke.	randomized, controlled, unblinded cross-over	Hospital rehabilitation Ward	Computer-based cognitive Rehab/versus late CBCR /Twelve sessions	Butterfly Test, Star cancellation, WAIS-IV Block, The drawing test Mental Status Undersøgelse (MSU), The Street completion test, The Symptom Checklist-90-Revised (SCL-90-R)	CBCR improved visuospatial symptoms after stroke significantly when administered early in the subacute phase after stroke. The same significant effect was not found when CBCR was administered later in the rehabilitation.
Tramontano et al,[102]	Visual-spatial training in patients with sub-acute stroke without neglect: a randomized, single-blind controlled trial.	Stroke/sub-acute/thirty	The primary aim of this study was to investigate the effects, on balance, of visual-spatial training as an add-on intervention to conventional neurorehabilitation in patients with subacute stroke without neglect;	Randomised controlled trial	Hospital rehabilitation Ward	Visuospatial training/Trunk stabilization and weight transfer to Paretic leg/12 sessions	Tineti balance and Gait scale, Bathel Index, Berg Balance Scale, Computerized Posturography	Significant TIME x GROUP interactions were recorded in the experimental group with respect to the control group for the TBG score [Both groups recorded non-significant improvements on the instrumental postural assessment. These data suggest that visuospatial training as an add-on intervention to conventional neurorehabilitation could be an effective complementary strategy to improve balance and activities of daily living.

Abbreviations: RCT, randomized controlled trial; ns, not specified; BIT-c, behavioural inattention test-conventional subtest; BIT-b, behavioural inattention test-behavioral subtest; FIM, functional independence measure; CBS, Catherine Bergego scale; VST, visual-scanning training; CIT, constraint-induced therapy; NA, not applicable.

APPENDIX XII: WITWATERSRAND COMMITTEE FOR RESEARCH ON HUMAN SUBJECTS APPROVAL LETTER

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Mr Chuka Umeonwuka

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M180155

NAME: (Principal Investigator)	Mr Chuka Umeonwuka
DEPARTMENT:	Physiotherapy Charlotte Maxeke Johannesburg Academic Hospital Chris Hani Baragwanath Academic Hospital Selected Tertiary Hospitals in Nigeria
PROJECT TITLE:	Effect of Prism Adaptation Therapy on Unilateral Spatial Neglect of Patients with Stroke in Sub-Acute Phase of Recovery
DATE CONSIDERED:	26/01/2018
DECISION:	Approved
CONDITIONS:	South African Human Research Ethics Committees (HRECs) have no standing outside South Africa. Ethics approval is also required from local HRECs in Nigeria
SUPERVISOR:	Prof Veronica Ntsiea and Dr Ronel Roos
APPROVED BY:	CB Penny Professor CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	12/07/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **January** and will therefore be due in the month of **January** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX XIII: NATIONAL RESEARCH ETHICS COMMITTEE OF NIGERIA ETHICS APPROVAL LETTER FOR THE SURVEY STUDY

National Health Research Ethics Committee of Nigeria (NHREC)

Promoting Highest Ethical and Scientific Standards for Health Research in Nigeria

Federal Ministry of Health

NHREC Protocol Number NHREC/01/01/2007-24/07/2018
NHREC Approval Number NHREC/01/01/2007-30/07/2018
Date: 30 July 2018

Re: Effect of Prism Adaptation Therapy on Unilateral Spatial Neglect of Patients with Stroke in Sub-Acute Phase of Recovery.

Health Research Committee assigned number: NHREC/01/01/2007
Name of Student Investigator: Umweonwuka Chuka Ifeanyi
Address of Student Investigator: Department of Physiotherapy,
School of Therapeutic Sciences,
Faculty of health science
University of Witwatersrand
Johannesburg
Email: chuguespt@unimaid.edu.ng
Tel: +27605535722, +2347065492665

Date of receipt of valid application: 24/07/2018
Date when final determination of research was made: 30-07-2018

Notice of Expedited Committee Review and Approval

This is to inform you that the research described in the submitted protocol, the consent forms, advertisements and other participant information materials have been reviewed and *given expedited committee approval by the National Health Research Ethics Committee.*

This approval dates from 30/07/2018 to 29/07/2019. If there is delay in starting the research, please inform the HREC so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. *All informed consent forms used in this study must carry the HREC assigned number and duration of HREC approval of the study.* In multiyear research, endeavour to submit your annual report to the HREC early in order to obtain renewal of your approval and avoid disruption of your research.

The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code including ensuring that all adverse events are reported promptly to the HREC. No changes are permitted in the research without prior approval by the HREC except in circumstances outlined in the Code. The HREC reserves the right to conduct compliance visit your research site without previous notification.

Signed

Professor Zubairu Iliyasu MBBS (UniMaid), MPH (Glasg.), PhD (Shef.), FWACP, FMCPH
Chairman, National Health Research Ethics Committee of Nigeria (NHREC)

Department of Health Planning, Research & Statistics
Federal Ministry of Health
11th Floor, Federal Secretariat Complex Phase III
Ahmadu Bello Way, Abuja

Tel: +234-09-523-8367
E-mail: chairman@nhrec.net, secretary@nhrec.net, deskofficer@nhrec.net
URL: http://www.nhrec.net

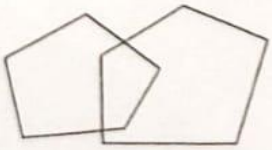
APPENDIX XIV: MINI MENTAL SCALE

SMART

MINI MENTAL STATE EXAMINATION (MMSE)

Patient's name:

Hospital number:

ONE POINT FOR EACH ANSWER	DATE			
ORIENTATION				
Year Month Day Date Time	____/5	____/5	____/5	____/5
Country Town District Hospital Ward	____/5	____/5	____/5	____/5
REGISTRATION Examiner names 3 objects (eg apple, table, penny) Patient asked to repeat (1 point for each correct). THEN patient to learn the 3 names repeating until correct.	____/3	____/3	____/3	____/3
ATTENTION AND CALCULATION Subtract 7 from 100, then repeat from result. Continue 5 times: 100 93 86 79 65 Alternative: spell "WORLD" backwards - dlrow.	____/5	____/5	____/5	____/5
RECALL Ask for names of 3 objects learned earlier.	____/3	____/3	____/3	____/3
LANGUAGE Name a pencil and watch.	____/2	____/2	____/2	____/2
Repeat "No ifs, ands, or buts".	____/1	____/1	____/1	____/1
Give a 3 stage command. Score 1 for each stage. Eg. "Place index finger of right hand on your nose and then on your left ear".	____/3	____/3	____/3	____/3
Ask patient to read and obey a written command on a piece of paper stating "Close your eyes".	____/1	____/1	____/1	____/1
Ask the patient to write a sentence. Score if it is sensible and has a subject and a verb.	____/1	____/1	____/1	____/1
COPYING Ask the patient to copy a pair of intersecting pentagons: 	____/1	____/1	____/1	____/1
TOTAL	____/30	____/30	____/30	____/30

APPENDIX XV: RCT PILOT STUDY RESULT

1.RESULTS

Demographic and clinical information

The mean age of the patients in the control and intervention group was 58.3±5.86 and 59.5±8.81 years respectively. Two (28.57%) patients were females and five (71.43%). Five patients (71.43%) were blacks while Asian and Caucasians were one respectively. Table 1 shows the demographic and clinical information.

Ischaemic stroke type made up the majority of the stroke types amongst patients

(n=6; 85.71%) while supratentorial stroke was in the majority (n=7; 100%)

Unilateral spatial neglect assessment

The conventional sub-test of the behavioural inattention test and the Catherine bergego scale was used to assess for USN. A total of twenty-two right hemispheric stroke patients were assessed before seven stroke survivors were identified with USN making the prevalence rate of USN occurrence at the selected facility to be 31.8%.

The average BIT-C score 89.67 ± 8.02 and 69.00 ± 37.42 in the control and intervention group respectively. Mean CBS scores were 23.00 ± 1.00 and 23.50 ± 4.12 for the control and intervention group respectively. Table 2 shows the BIT-C and CBS scores .

The feasibility of recruiting stroke survivors was established from the study site screened with the BIT-C and the CBS.

Table 1: Demographic and clinical characteristics

Variable	n	Control group (n=3)	Intervention group (n=4)	Comparison	
Sex, (%)					
Male	5(71.43)	2	3	X^2 = 0.06	P = 0.809
Female	2(28.57)	1	1		
Age, years	7	58.33(5.86)	59.5 (8.81)	*t* = 0.20	P = 0.852
Years of education	7	6.33(7.09)	7.75(5.91)	*z* = -1.028	P = 0.304
Employment status					
Employed	2(28.57)	1(33.33)	1(25.00)	X^2 = *0.88*	P = 0.646
Unemployed	1(14.29)	0(0.00)	1(25.00)		
Retired	4(57.14)	2(66.67)	2 (50.00)		
Marital status (%)					
Single	0(0.00)	0(0.00)	0(0.00)		
Married	7(100.00	3(100.00)	4(100.00)		
widowed	0(0.00)	0(0.00)	0(0.00)		
Race (%)					
Black	5 (71.43)	3(100.00)	2(50.00)	X^2 = 2.10	P = 0.350
Asian	1(14.29)	0(0.00)	1(25.00)		
Caucasian	1(14.29)	0(0.00)	1(25.00)		
Hand preference (%)					
Right	7(100.00)	3(100.00)	4(100.00)		
Left	0(0.00)	0(0.00)	0(0.00)		
Stroke type (%)					
Ischaemic	6(85.71)	3(100.00)	3(75.00)	X^2 = 0.88	P = 0.571
Haemorrhagic	1(14.29)	0(0.00)	1(25.00)		
Lesion site (%)					
Supratentorial	7(100.00)	3(100.00)	4(100.0)		
Infratentorial	0(0.00)	0(0.00)	0(0.00)		
Mixed (diffuse)	0(0.00)	0(0.00)	0(0.00)		
Cognitive ability, *(MMSE score)*	7	22.67 (2.31)	20.75(2.22)	*t* = -1.11	P = 0.316

Activities of daily living, Functional Mobility, Quality of life and Balance abilities

The Barthel index (BI), Modified Rivermead mobility index (MRMI), Berg balance scale (BBS) and the stroke specific quality of life questionnaire (SSQoL) was used to establish the patient's activities of daily living functional ability, functional mobility, balance abilities and quality of life respectively. Table 3 shows the result.

The feasibility of assessing activities of daily living, functional mobility, quality of life and balance abilities was established in sub-acute stroke patients and no challenges were recorded.

Table 2: Unilateral neglect screening pre-post

Variable	**Baseline Assessment (t_0)**		**Baseline comparison**		**Post-intervention assessment (t_1)**		**Post-intervention comparison**	
	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value
BIT-C Total (146)	89.67 ± 8.02	69.00 ± 37.42	-20.67	0.400	72.00± 21.79	64.50±54.81	-7.50	0.835
Catherine Bergego scale	23.00 ± 1.00	23.50±4.12	0.50	0.849	23.00 ± 5.20	18.00 ± 6.08	-5.00	0.340

Table 3: Activities of daily living, Functional Mobility, Quality of life and Balance abilities screening pre-post.

BI item	Baseline Assessment (t_0)		Baseline comparison		Post-intervention assessment (t_1)		Post-intervention comparison		Between group comparison (t_1-t_0)	
	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value	Control group (ẋ±SD)	Intervention group (ẋ±SD)	Mean difference	p-value	Test statistics	p-value
BI	7.33±1.53	6.50±2.38	-0.83	0.623	9.33±1.15	5.50±5.20	-3.83	0.275	0.164	0.875
SSQoL	75.00±20.66	71.25±15.31	-3.75	0.792	86.67±26.57	62.50±43.71	-24.17	0.441	0.000	1.000
MRMI	11.33±5.03	11.75+4.72	0.42	0.915	12.67±9.63	12.00±9.63	-0.67	0.913	0.223	0.831
BBS	4 ±1.73	5.25±2.63	1.25	0.511	5.0 ±1.73	9.5±15.76	4.50	0.651	0.646	0.542

APPENDIX XVI: CLINICAL TRIAL REGISTRY APPROVAL LETTER

11 March 2019

To Whom It May Concern:

RE: Effect of Prism Adaptation Therapy on Unilateral Spatial Neglect of Patients with Stroke in Sub-Acute Phase of recovery

As project manager for the Pan African Clinical Trial Registry (www.pactr.org) database, it is my pleasure to inform you that your application to our registry has been accepted. Your unique identification number for the registry is **PACTR201903732473573**.

Please be advised that you are responsible for updating your trial, or for informing us of changes to your trial.

Additionally, please provide us with copies of your ethical clearance letters as we must have these on file (via email or post or by uploading online) at your earliest convenience if you have not already done so.

Please do not hesitate to contact us at +27 21 938 0835 or email epienaar@mrc.ac.za should you have any questions.

Yours faithfully,

Elizabeth D Pienaar
www.pactr.org Project Manager
+27 021 938 0835

The South African Medical Research Council
Cochrane South Africa | PO Box 19070, Tygerberg, 7505
Tel: +27 (0)21 938 0438 | Email: cochrane@mrc.co.za | Web: www.southafrica.cochrane.org

APPENDIX XVII: RCT STUDY APPROVAL LETTERS FROM STUDY CENTRES

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:
Ms. N. Mzila
Office of the Clinical Director
Email:Nolwazi.Mzila@gauteng.gov.za
Tell: (011): 488-4812
20th April 2018

Dear Umeonwuka I. C.

STUDY TITTLE: Effect of Prism Adaptation Therapy on Unilateral Spatial Neglect of Patients with Stroke in Sub-Acute Phase Recovery.

Permission to conduct the above mentioned study is provisional approved. Your study can only commence once Ethics approval is obtained. Please forward a copy of your Ethics Clearance Certificate as soon as the study is approved by the Ethics Committee for the CEO's office to give you the final approval to conduct the study.

Supported / ~~not supported~~

Dr. M.J. Mofokeng
Clinical Director
DATE: 24/4/2018

Approved / not approved

Ms. G. Bogoshi
Chief Executive Officer
DATE: 26.04.2018

GAUTENG PROVINCE
REPUBLIC OF SOUTH AFRICA

Joburg
a world class African city

JOHANNESBURG HEALTH DISTRICT

Faculty Of Health Sciences
Human Research Ethics Committee(Medical)
University of The Witwatersrand
Johannesburg, South Africa
ptchux@gmail.com

Enquiries: Dr EM Ohaju
Tel: 011 694 3888 Cell: 076 8831659
Email: Elizabeth.Ohaju@gauteng.gov.za

Hillbrow CHC: Administration Building
Cr Smith Str. & Klein Street
Private Bag X21, Johannesburg
South Africa, 2017

DRC Ref: 2019-09-003

NHRD Ref no: GP_201909_023

Dear: Mr Chuka Umeonwuka

Title: ***EFFECT OF PRISM ADAPTATION THERAPY ON UNILATERAL SPATIAL NEGLECT OF PATIENTS WITH STROKE IN SUB-ACUTE PHASE OF RECOVERY***

Your application for the clinical trial refers.

The District Research Committee has reviewed your application. This letter serves as a recommendation to Gauteng Provincial Office to give the final approval letter for this clinical trial.

- The facility to be visited: **CHIAWELO CHC, HILLBROW CHC, LENASIA CLINIC, MOFOLO CHC, SOUTH RAND HOSPITAL**
- This facility will be visited from **10/10/2019 to 10/10/2020**
- You will report to the Facility Manager before initiating the study.

Region	Regional Health Manager	Contact No.	Cell phone
D	Ms. Maria Mazibuko	011 674 1200	082 781 9919
G	Mr P Mathole	011 213 9708	072 483 6839
Southrand	Dr N Maleka	011 681 2002	071 872 6649

The following conditions must be observed:

- Participants' rights and confidentiality will be maintained all the time.
- No resources (Financial, material and human resources) from the above facilities will be used for the study. Neither the District nor the facility will incur any additional cost for this study.
- The study will comply with **Publicly Financed Research and Development Act, 2008 (Act 51 of 2008) and its related Regulations**.

- You will submit a copy (electronic and hard copy) of your final report. In addition, you will submit a six-monthly progress report to the District Research Committee.
- Your supervisor and University of The Witwatersrand will ensure that these reports are being submitted timeously to the District Research Committee.
- The District must be acknowledged in all the reports/publications generated from the research and a copy of these reports/publications must be submitted to the District Research Committee.

We reserve our right to withdraw our recommendation, if you breach any of the conditions mentioned above.

Please feel free to contact us, if you have any further queries. On behalf of the District Research Committee, we would like to thank you for choosing our Johannesburg health district to conduct such an important study.

Regards,

Dr E.M Ohaju
Chairperson: District Research Committee
Johannesburg Health District
Date 18/10/2019

Mrs M.L Morewane
Chief Director
Johannesburg Health District
Date: 21/10/2019

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 24th April 2018

TITLE OF PROJECT:

Effect of Prism Adaptation Therapy on Unilateral Spatial Neglect of Patients with Stroke in Sub-Acute Phase of Recovery

UNIVERSITY: Witwatersrand

Principal Investigator: Mr C Umeonwuka

Department: Physiotherapy

Supervisor : Prof V Ntsiea

Permission Head Department (where research conducted): Yes

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Academic Hospital. The CEO / management of Chris Hani Baragwanath Academic Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Committee for Research on Human Subjects of the University of the Witwatersrand.
- The Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- The MAC will be informed of any serious adverse events as soon as they occur
- Permission is granted for the duration of the Ethics Committee Approval.

.....
Recommended
(On behalf of the MAC)
Date: 24/04/2018

.....
Approved/Not Approved
Hospital Management
Date: 26/04/18

GAUTENG PROVINCE
REPUBLIC OF SOUTH AFRICA

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
PHYSIOTHERAPY DEPARTMENT
CONTACT: ELIZMA HAARHOFF
EMAIL: Elizma.Haarhoff@gauteng.gov.za
TEL: 011 933 8927 (#6457)

24 April 2018

To Whom It May Concern

Umeonwuka Chuka requested permission to conduct research at Chris Hani Baragwanath Academic Hospital (CHBAH) as part of his PhD studies. He submitted a research protocol for ethical clearance from the University of Witwatersrand (Protocol ref nr: M180155) for his research titled "Effect of Prism Adaption Therapy on Unilateral Spatial Neglect of Patients with Stroke in Sub-Acute Phase of Recovery" with NHRD application reference number GP_20183_038.

The Physiotherapy Department of CHBAH grants permission for the research to be conducted with the following provisions:

1. The Physiotherapy Department can assist with the identification, but not the formal recruitment of possible research subjects.
2. The research process and procedures does not in any way impede the operations of the Physiotherapy Department.
3. The researcher and/or research assistants declare that CHBAH will not be held liable for the loss of any equipment that they choose to store on site as it was made clear to the researcher that we do not have safe storing space for equipment.
4. That the research is granted ethical clearance from the University of Witwatersrand as well as from CHBAH.

Kind Regards

Elizma Haarhoff
(Assistant Director: Physiotherapy)

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Enquiries: P/N Mabizela
Directorate: Staff Development
Telephone number: (011) 590 0109
Email: Thandiwe.Mabizela @gauteng.gov.za

Date: 15 October 2019

Mr Chuka Umeonwuka

Thelle Mogoerane Regional Hospital Management Team is pleased to grant you provisional permission to conduct your study to conduct research **On Effect of Prism Adaptation Therapy on Unilateral Spatial Neglect of Patients with Stroke in Sub-Acute Phase of Recovery , Thelle Mogoerane Regional Hospital.** Your data will be conducted through obtaining information through **"Prospective data collection"** in your protocol for which you will obtain the ethics clearance certificate from the **University of Witwatersrand** The following condition must be adhered to otherwise permission will be withdrawn:

- Only the research and/or research methods outlined in the protocol presented to the Research Committee should be conducted and/or followed otherwise the research will be cancelled.

Please note that you can only get full clearance once you provide the hospital with the Ethics Clearance Certificate

Dr. Malaka MM
Chief Executive Officer
Thelle Mogoerane Regional Hospital
Date: 2019/10/16

Thelle Mogoerane Regional Hospital
Office of the CEO
16 -10- 2019
12390 Nguza Str, Vosloorus, 1475
Private Bag X01, Alrode, 1451
South Africa

"To be the best provider of quality health care services to the people of Gauteng"

APPENDIX XVIII: INFORMATION SHEET AND CONSENT FORM FOR RCT STUDY

Please tick to indicate you consent to the following

I have read, or have had read to me in my first language, and I understand the Participant Information Sheet.	Yes □	No □
I have been given sufficient time to consider whether or not to participate in this study.	Yes □	No □
I have had the opportunity to use a legal representative / family support or a friend to help me ask questions and understand the study.	Yes □	No □
I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.	Yes □	No □
I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without this affecting my medical care.	Yes □	No □
I consent to the research staff collecting and processing my information, including information about my health.	Yes □	No □
If I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.	Yes □	No □
I know who to contact if I have any questions about the study in general.	Yes □	No □
I understand my responsibilities as a study participant.	Yes □	No □
I wish to receive a summary of the results from the study.	Yes □	No □

Declaration by participant:

I hereby consent to take part in this study.

Participant's name:

Signature: Date:

Declaration by member of research team:

I have given a verbal explanation of the research project to the participant, and have answered the participant's questions about it.

I believe that the participant understands the study and has given informed consent to participate.

Researcher's name:

Signature: Date:

APPENDIX XIX: PARTICIPANT'S INFORMATION SHEET

Department of physiotherapy,
School of therapeutic sciences,
Faculty of health sciences,
University of Witwatersrand,
Johannesburg
South Africa (Republic of).

Study title: Effect of prism adaptation therapy on unilateral spatial neglect of patients with stroke in sub-acute phase of recovery.
Ethics committee Ref.:
Lead investigator: Umeonwuka Chuka Ifeanyi
Contact phone number: +27605535722

Dear Sir/ Madame
Gooday,
My name is Chuka Umeonwuka, a postgraduate student the University of the Witwatersrand. You are invited to take part in a study on: ***Effect of prism adaptation therapy on unilateral spatial neglect of patients with stroke in sub-acute phase of recovery***. Whether or not you take part is your choice. If you don't want to take part, you don't have to give a reason, and it won't affect the care you receive. If you do want to take part now, but change your mind later, you can pull out of the study at any time.

This Participant Information Sheet will help you decide if you'd like to take part in this study. It sets out why we are doing the study, what your participation would involve, what the benefits and risks to you might be, and what would happen after the study ends. We will go through this information with you and answer any questions you may have. You do not have to decide today whether or not you will participate in this study. Before you decide you may want to talk about the study with other people, such as family, friends, or healthcare providers. Feel free to do this.
If you agree to take part in this study, you will be asked to sign the Consent Form. You will be given a copy of both the Participant Information Sheet and the Consent Form to keep.

1.1 WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of the study is to investigate the effectiveness of prism adaptation therapy in the management of unilateral spatial neglect sub-acute right hemispheric stroke survivors.
It's expected that findings from this study will contribute to knowledge in the management of stroke patients with unilateral spatial neglect.
The procedures in this study meet the best intervention standards. If you accept to participate in this study, you will be randomly assigned to either an intervention or a control group. If you are allocated to the intervention group you will receive the treatment under investigation while if you are assigned to the control group you will receive standard treatment (or placebo treatment) as the control. The reason for this group allocation is to allow the researchers to determine any effects of the treatment

when compared with the no treatment. However; irrespective of the group assigned you will still receive your routine physiotherapy treatment. The duration of the study intervention is 4 weeks; you will receive treatments (the study intervention) for 3 sessions per week for 4 weeks totalling 12 sessions

1.2 WHAT WILL MY PARTICIPATION IN THIS STUDY INVOLVE?

You are being invited to participate in this study because you fit into our study criteria. Before commencement of the study, baseline and post treatment measurements will be taken using the assessment tools as described below. All assessment and treatment for this study will be conducted at this hospital where you are receiving treatment.

I. **Stroke Specific QOL (SSQOL):** This questionnaire will be used to assess your quality of health. Structured questions regarding your health will be asked and will be centred on: energy, family roles, language, mobility, mood, personality, self-care, social roles, thinking, upper extremity function, vision and work/productivity. The researcher will assist you in responding to the questions if the need arises. It is expected this questionnaire will take about 10-15 minutes for you to respond to.

II. **Behavioural Inattention Test (BIT):** This is a standardized test battery for assessing unilateral spatial neglect. You will be required to carry out simple task such as line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection, representational drawing, picture scanning, phone dialling, menu reading, article reading, telling and setting the time, coin sorting, address and sentence copying, map navigation, and card sorting. It is expected this test will take about 20-25 minutes to perform.

2. **Mini-Mental State Examination (MMSE):** This test instrument will be used to screen you any cognitive impairment before recruitment into the study. You will be required to carry out simple such as telling time, identifying your location, registration of three words, attention and calculation. It is expected this test will take about 10-15 minutes

IV. **Barthel Index (BI**): The Barthel Index (BI) is very simple and consists of 10 common functional ADLs and administered through direct observation. This outcome measure will assess for independence/dependence in activities of daily living. It comprises of ten items that represent activities related to personal care: feeding, bathing, grooming, dressing, bowels continent, bladder continent, toilet use and transfer (bed to chair and back), to mobility on level surfaces and stairs.

V. **Modified Rivermead Mobility Index (MRMI):** This instrument will be used to assess your functional mobility level. It has eight tasks which cover a range of activities from turning over in bed to walking.

VI. **Berg Balance scale:** This Scale (BBS) will be used to measure your balance abilities. The berg balance scale is a 14-item scale designed to measure balance. You will be asked to perform certain simple tasks to assess your balance.

1.2.1 Description of study intervention:

The study intervention of this study involves performing a reaching task and a walking task wearing a prismatic goggle).

The reaching task; You will be asked to point to the 3 targets on a table with the index finger of your ipsilesional hand, according to the instructions of the therapists, who will randomly indicate 3 points to you. First, you will be asked to repeat the pointing task 30 times without prism glasses. Then, will put on prism glasses that will shift your visual field 10° to the right (deluxe Prism google; (Bernel 1138KIT28+) and will repeat pointing 90 times. After pointing at targets, the prism glass will be taken off and you will repeat pointing 60 times. You will undergo daily training sessions for about 30 minutes each, 3 times a week for 4 weeks, for a total of 12 sessions. The interventions will take place during regularly scheduled rehabilitation sessions; all other routine interdisciplinary stroke rehabilitation will be provided as usual. The control and intervention group will undergo the same intervention procedure. However, the control group will utilize a neutral googles whilst the intervention group utilizes prism goggles.

1.3 WHAT ARE THE POSSIBLE BENEFITS AND RISKS OF THIS STUDY?

I. There is no foreseeable risk if you participate in this study.
II. While participating in this study, you will also continue receiving your routine physiotherapy care.
III. The outcome of this study may provide useful information on other rehabilitation approach to add to the conventional physiotherapy treatment in the management of patients with unilateral spatial neglect and this might mean better treatment options for stroke patients. The outcome of the study will be presented at seminars, workshop and published in a peer reviewed journal.

1.4 WHO PAYS FOR THE STUDY?

I. You will not incur any cost if you decide to participate in this study.
II. You will be reimbursed the cost of your transportation fare to the maximum of R80.00 If you are to visit the study Centre for this study on days that isn't your clinic visit or therapy session days.

1.5 WHAT HAPPENS TO RESEARCH PARTICIPANTS AND COMMUNITIES AFTER THE RESEARCH

Rehabilitation services will be continued by the clinical site if required following completion of the project

1.6 WHAT ARE MY RIGHTS

I. Participation in this study is voluntary, and you can decline to participate or to withdraw from this research at any practical time.
II. You have the right to access information about your data collected in this study.

III. Information gathered about you from this study will be treated with confidentiality. Data will be made available to only the investigator and supervisor. Data published from this study will be a pooled data and cannot be linked to you in any way.

1.7 WHO DO I CONTACT FOR MORE INFORMATION OR IF I HAVE CONCERNS?

If you have any questions, concerns or complaints about the study at any stage, you can contact:

Name: Prof. Veronica Ntsiea (research supervisor)

Department of physiotherapy, University of the Witwatersrand

Telephone number

Email: Veronica.Ntsiea@wits.ac.za

Name: Dr Ronel Roos (research supervisor)

Department of physiotherapy, University of the Witwatersrand

Telephone number

Email: Ronel.Roos@wits.ac.za

OR

The Chair, wits research ethics committee that gave approval for this study

Telephone number Email: HREC-Medical.Researchoffice@wits.ac.za