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FEATURE ARTICLE

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Unlocking the restraint—Development of a behaviour change intervention to increase the provision of modified constraint-induced movement therapy in stroke rehabilitation

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Abstract

Background: Strong evidence supports the provision of modified constraint-induced movement therapy (mCIMT) to improve upper limb function after stroke. A service audit identified that very few patients received mCIMT in a large subacute, early-supported discharge rehabilitation service. A behaviour change intervention was developed to increase the provision of mCIMT following an unsuccessful 'education only' attempt. This paper aims to systematically document the steps undertaken and to provide practical guidance to clinicians and rehabilitation services to implement this complex, yet effective, rehabilitation intervention.

Methods: This clinician behaviour change intervention was developed over five stages and led by a working group of neurological experts ($n = 3$). Data collection methods included informal discussions with clinicians and an online survey ($n = 35$). The staged process included reflection on why the first attempt did not improve the provision of mCIMT (stage 1), mapping barriers and enablers to the Theoretical Domains Framework (TDF) and behaviour change wheel (BCW) to guide the behaviour change techniques (stages 2 and 3), developing a suitable mCIMT protocol (stage 4), and delivering the behaviour change intervention (stage 5).

Results: Reflection among the working group identified the need for upskilling in mCIMT delivery and the use of a behaviour change framework to guide the implementation program. Key determinants of behaviour change operated within the TDF domains of knowledge, skills, environmental context and resources, social role and identity, and social influences. Following the development of a context-specific mCIMT protocol, the BCW guided the behaviour change intervention, which included education, training, persuasion, environmental restructuring, and modelling.

Conclusion: This paper provides an example of using the TDF and BCW to support the implementation of mCIMT in a large early-supported discharge service. It outlines the suite of behaviour change techniques used to influence clinician behaviour. The success of this behaviour change intervention will be explored in future research.

KEYWORDS
implementation science, knowledge translation, neurological rehabilitation, occupational therapy, physiotherapy, upper extremity

1 | BACKGROUND

Providing rehabilitation interventions that are supported by current evidence is important for service providers and health consumers (Stroke Foundation, 2022). There has been exponential growth in the stroke rehabilitation literature base over the past decade; however, the delivery of upper limb (UL) rehabilitation to enable stroke survivors to achieve optimal functional independence remains challenging (Connell et al., 2015). One intervention with demonstrated efficacy in improving UL function for eligible stroke survivors is constraint-induced movement therapy (CIMT), including modified versions of CIMT (mCIMT) (Kwakkel et al., 2015). CIMT/mCIMT is the most researched, as well as best supported, UL intervention in stroke rehabilitation, with level 1 evidence supporting its delivery across the stroke recovery continuum (Corbetta et al., 2015; Kwakkel et al., 2015; Wattchow et al., 2018). CIMT/mCIMT is a complex, and often misunderstood, rehabilitation intervention (Christie et al., 2019). Three main components make up the overall CIMT/mCIMT package: intensive, task-oriented practice using the more-affected UL, consisting of repetitive task practice and shaping; a suite of behavioural strategies known as the Transfer Package; and restraint of the less-affected UL for substantial periods of the day (D. Morris et al., 2006; Taub, 2012).

Traditional CIMT programs are 2 weeks (10 weekdays) in duration, with each treatment day consisting of 6 hours of active practice using the more affected UL and a restraint worn on the less affected UL for 90% of waking hours. mCIMT differs from traditional CIMT in the amount of daily practice performed by a stroke survivor and the time spent wearing a restraint. Several mCIMT protocols with demonstrated efficacy have been published in the literature. Page and colleagues' mCIMT protocol, which was designed for chronic stroke survivors in an outpatient setting, involved 30 minutes of shaping exercises, provided three times per week over 10 weeks, with restraint applied for 5 hours per day (Page et al., 2004). Barzel and colleagues' 4-week home-based mCIMT program was primarily driven by a non-professional coach supporting 2 hours of daily active practice, with therapist support to set up and progress the program (Barzel et al., 2015). Studies evaluating 2-week CIMT programs, incorporating 3 hours of daily task-oriented practice, have also demonstrated significant functional gains at all follow-up timepoints (Brogardh et al., 2009; Brogårdh & Lexell, 2010; Gauthier et al., 2008; Taub et al., 2013). The reported reduced demands on staffing, time, and funding have led to mCIMT programs being viewed as more feasible to deliver in the clinical setting (Viana & Teasell, 2012).

Several clinical practice guidelines strongly endorse CIMT/mCIMT to be provided to eligible stroke survivors based on the extensive evidence for clinical efficacy (National Institute for Health and Care Excellence [NICE], 2013; Stroke Foundation, 2022; Teasell et al., 2020). Despite the strength of the evidence for benefit, CIMT/mCIMT is not standard practice across rehabilitation settings internationally (Christie et al., 2019; Daniel et al., 2012; Fleet, Che, et al., 2014; Pedlow et al., 2014), providing an example of the evidence–implementation gap seen across many areas of stroke rehabilitation (Clarke et al., 2018; Eng et al., 2019; Walker et al., 2013). Therefore, implementation strategies

Key Points for Occupational Therapy

- mCIMT is an effective, but complex, upper limb therapy for occupational therapists to deliver in stroke rehabilitation settings
- Implementing mCIMT can be guided by the TDF and BCW to facilitate clinician behaviour change
- Behaviour change interventions are iterative processes and must consider the local context

are needed to address the challenges of translating interventions with demonstrated efficacy into routine clinical practice (Murrell et al., 2021).

The suite of behavioural strategies and multiple intervention components operating concurrently means that delivering mCIMT requires a practice shift for many clinicians. A theory-informed, behaviour change guide is recommended to facilitate the successful implementation of complex interventions like mCIMT (Francis et al., 2012). Complex interventions often have several interdependent factors influencing their provision of health services (Stockley & Graham, 2022). Understanding these factors and identifying the determinants of behaviour change (Grol & Wensing, 2020a, 2020b) are important considerations when implementing an evidence-based intervention. The behaviour change wheel (BCW) and Theoretical Domains Framework (TDF) are two theory-informed frameworks that facilitate the development of effective behaviour change interventions (Cane et al., 2012; Michie et al., 2011). The TDF provides an integrated behavioural framework to understand the factors influencing behaviour within the context in which they occur (Cane et al., 2012). A better understanding of these factors allows barriers and enablers to implementation to be grouped into constructs and domains, from which tailored intervention strategies can be developed (Lynch, Mudge, et al., 2018). The BCW is a framework that consists of three layers: sources of behaviour, intervention functions, and policy categories (Michie et al., 2014). At the hub of the BCW is the notion that the source of a given behaviour is the capability, opportunity, and motivation to carry out that behaviour (the COM-B system) (Michie et al., 2011). Understanding the sources of behaviour provides guidance on which intervention functions can be used to change behaviour. Used together, mapping the TDF to the BCW facilitates the design of effective behaviour change techniques (Richardson et al., 2019). The TDF supports the identification of determinants of behaviour change, from which interventions to change behaviour can be derived using the BCW.

As noted earlier, the efficacy of CIMT/mCIMT has been repeatedly demonstrated in the literature. As such, the focus of research in this area has now shifted towards implementation studies (McCluskey et al., 2020). However, there are limited practical examples of using behavioural frameworks to change clinical practice in supporting the widespread adoption of evidence-based practice in stroke rehabilitation (J. Morris et al., 2019). Therefore, the aims of this publication are to describe the steps and processes undertaken in developing and implementing a behaviour change intervention to increase the delivery of mCIMT in a large multi-site, early-supported discharge (ESD), community-based, rehabilitation service.

2 | METHODS

2.1 | Design

The TDF and BCW were used iteratively across five stages to guide implementation planning and delivery of the behaviour change intervention, outlined in Figure 1. Quality Activity approval was prospectively obtained through the WA Health Governance Evidence Knowledge Outcomes (GEKO) register (Activity Registration Number 29289), which gives approval for quality improvement data to be published.

2.2 | Description of the service

This project was conducted across a cluster of Rehabilitation in the Home (RITH) services in Perth, Western Australia (WA). RITH is a publicly funded, multidisciplinary, subacute allied health rehabilitation service with seven sites across the Perth metropolitan region. Patients are referred to RITH from public inpatient acute and rehabilitation units and are seen within 24 hours of discharge home to continue their rehabilitation. Home-based rehabilitation is provided over the short to medium term (ranging from 2 to 12 weeks), with service length dependent on patient-centred goals that require a home or community-based approach. Stroke represents the fourth highest diagnostic group referred to RITH (behind elective total hip and knee replacements and medical reconditioning) but receives the highest proportion of occasions of service due to the intensive nature of stroke rehabilitation compared to other diagnoses. UL rehabilitation is delivered by occupational therapists and physiotherapists, with support from therapy assistants.

2.3 | Precedent for this implementation project

RITH audits compliance with therapy provisions against the Australian Stroke Foundation Guidelines for Stroke Management (Stroke Foundation, 2022). A service audit conducted in 2017 identified that of the 52 stroke survivors with a UL impairment whose files were audited, only three received mCIMT as part of their UL stroke rehabilitation in RITH. Adherence to the three core components of mCIMT for these participants was not able to

Stage 1: Why didn't the first attempt work? Reflecting on failures to guide future planning	
Goal	Strategy
• To reflect on failings of previous attempt and understand "what went wrong?" • To develop knowledge in mCIMT delivery and translational science principles	• Informal discussions with therapists • Discussion among working group to identify self-development needs • Knowledge sharing between working group members
Stages 2 and 3: Understanding the barriers and enablers, and developing strategies to change clinician behaviour, guided by the TDF and BCW	
Goal	Strategy
• To identify therapist/service barriers and enablers to mCIMT implementation • To determine target behaviours to prioritise • To determine which behaviour change techniques are to be adopted	• Online survey • Map barriers and enablers to TDF • Collaborative discussion among working group to prioritise target behaviours • Map TDF domains to possible behaviour change techniques using BCW
Stage 4: Developing a mCIMT protocol suitable for the local service context	
Goal	Strategy
• To develop a mCIMT protocol feasible for delivery in the RITH service	• Review of existing published protocols • Online survey • Therapist feedback regarding a feasible frequency and intensity of therapist input • Discussion amongst working group
Stage 5: Piloting the implementation intervention with iterative refinement	
Goal	Strategy
• To deliver the behaviour change intervention to therapists	• Meet with allied health managers to gain support for therapist attendance and engagement • Working group to deliver behaviour change techniques guided by the BCW • Feedback from therapists to guide adaptations to the behaviour change intervention

FIGURE 1 Behaviour change intervention process. BCW, behaviour change wheel; mCIMT, modified constraint-induced movement therapy; TDF, theoretical domains framework.

be determined from audit data, nor was the proportion of stroke survivors that were eligible to receive mCIMT able to be established. To address the low level of mCIMT delivery, an initial quality improvement activity, incorporating an education program to encourage RITH clinicians to provide mCIMT in their practice was undertaken. This involved two 90-minute education sessions each delivered at two RITH sites; one comprised an overview session on mCIMT, and the other was introduced using the Motor Activity Log (MAL). Over 30 RITH clinicians attended each session. Staff were encouraged to use the paperwork developed by the Constraint Induced (CI) Therapy group from the University of Alabama at Birmingham (UAB) (Taub et al., 2011), but no further instruction was provided on how to incorporate the resources into the mCIMT program, nor were adaptations made to the resources to suit them to the local service context. Following informal discussions with clinicians, a survey was conducted 12 months after the education sessions which directly asked respondents if they had delivered a mCIMT program since attending the training. This revealed that the provision of mCIMT to stroke survivors in RITH was unchanged. This paper represents a subsequent quality improvement project that

was designed to plan and deliver a more structured implementation strategy, using the TDF and BCW, to increase the provision of mCIMT to eligible RITH patients post-stroke.

2.4 | Participants

The working group (champions) for this quality improvement project comprised three RITH 'P3' neurological expert clinicians—physiotherapist (A. W.) and occupational therapists (R. E. and J. W.). The P3 classification in WA Health is an advanced level of clinical practice, signifying substantial experience in patient management and clinical supervision (students and therapists), and possessing post-graduate qualifications in the relevant area. The P3 neurological positions provide support to RITH clinicians across the entire service (seven sites) through clinical consultation for complex patient presentations and delivery of continuing education. These positions were 1.0 full-time equivalent (FTE) for each discipline; the occupational therapy position was job-shared by two clinicians working part-time at the time of this project. One member of the working group (R. E.) had attended a five-day CIMT course facilitated by Professor David Morris from the UAB CI Therapy group and had run CIMT programs with stroke survivors in another local service. This project was undertaken in addition to the working group's existing roles and responsibilities, with no additional funding, staffing, or resources dedicated to the project.

The target audience for this behaviour change intervention were physiotherapists, occupational therapists, and therapy assistants of the RITH service. At the time of this study, all RITH physiotherapists and occupational therapists were 'Senior' clinicians operating in a generalist capacity and had substantial experience across a range of clinical settings, including neurological rehabilitation. Many RITH therapists have post-graduate neurological qualifications.

2.5 | Stage 1: Why did not the first attempt work? Reflecting on failures to guide future planning

Stage one involved reflection among the working group to understand the reasons for the failure of the original implementation intervention, upskilling in translational science principles, selection of a behavioural framework(s) to inform the implementation plan and self-development to become more confident in delivering mCIMT programs prior to training others. A. W. investigated translational science principles and behavioural frameworks and led the decision to use the TDF and BCW. R. E. led the knowledge exchange in upskilling A. W. and J. W. to deliver mCIMT and train others in delivering mCIMT.

2.6 | Stages 2 and 3: Understanding the barriers and enablers and developing strategies to change clinician behaviour, guided by the TDF and BCW

Stage 2 involved developing and administering an online survey (Supplementary File 1) to understand the current use of mCIMT among RITH clinicians, clinician perceptions and experiences of mCIMT, and to identify determinants of behaviour change. Survey data were mapped to TDF domains to identify barriers and enablers. Due to time and resource constraints, the barriers and enablers were mapped across the entire service, rather than for each site individually. The survey included open and closed response questions, allowing clinicians to provide their own insights into an mCIMT protocol that they thought would be feasible to deliver in the RITH setting, and to explore the level of engagement required across the RITH service for mCIMT to be considered an acceptable intervention. Development of the survey, determinants of behaviour change identification and mapping to the TDF was led by A. W. in collaboration with R. E.. Target behaviours to be prioritised were determined through collaborative discussion, based on behaviours the working group perceived to be most amenable to change within time and resource constraints of the project and service.

Stage 3 mapped the key barriers and enablers to implementation, identified from the TDF, to the intervention functions of the BCW to guide the selection of the behaviour change techniques. This mapping process recognised a need for several strategies, operating concurrently, to facilitate clinician behaviour change. A. W. and R. E. collaboratively mapped the TDF domains to the BCW intervention functions.

2.7 | Stage 4: Developing a mCIMT protocol suitable for the local service context

A review of the available literature on a range of mCIMT protocols was conducted to determine an appropriate protocol to be adopted within RITH. This was combined with therapist responses from the survey on what they perceived would be feasible within the current service delivery model. To maintain fidelity with the overall mCIMT package, the three key components of mCIMT

(described earlier) were required to be included in the RITH mCIMT protocol (D. Morris et al., 2006). The protocol for mCIMT delivery in the RITH service was developed collaboratively by A. W. and R. E. and has been reported as per the TIDIeR checklist (Hoffmann et al., 2014).

Stages 1–4 were conducted sequentially with recursive iterations between May and September 2018.

2.8 | Stage 5: Piloting the implementation intervention with iterative refinement

This stage was conducted between October 2018 and November 2019 and involved the delivery of the multimodal behaviour change intervention by A. W., R. E., and J. W., which was guided by the BCW. All RITH physiotherapists, occupational therapists, and therapy assistants were invited and encouraged to participate in the behaviour change intervention. The working group collaboratively decided on the modes of delivery for each behaviour change technique, considering the practicality and feasibility of delivering the techniques across the entire service without access to additional resources.

3 | RESULTS

3.1 | Stage 1: Why did not it work? Reflecting on failures to guide future planning

Informal discussions among the working group, and with clinicians as part of the working group's normal role in clinical supervision, attributed the initial failure to increase mCIMT provision in RITH to several factors. Education was the only behaviour change strategy provided to clinicians in this initial intervention. Feedback from clinicians acknowledged that the education was didactic in nature, and of insufficient duration to allow the development of a clear understanding of the complex elements of mCIMT. For example, training on the use of the behavioural contract did not contain sufficient opportunities for experiential learning. Future education would need to follow adult learning principles (Taylor & Hamdy, 2013), accepting that individual clinicians learn in different ways, and adopt a range of educational approaches. Although existing CIMT resources were shown to clinicians, they were not adapted for use in the RITH setting, and clinicians were not trained in how to use them. A clear description of the mCIMT protocol was not included in the initial training, nor was information provided on how to structure a therapy session to be time-efficient within the constraints of a busy caseload. The initial training was conducted by four clinicians experienced in neurological rehabilitation and included A. W. and J. W.; however, none had received formal training in CIMT or delivered the therapy to a patient before. This lack of CIMT-specific knowledge impacted the ability to provide clarity to others on what was important for the delivery of mCIMT, such as how to incorporate this intervention into their caseload and who to engage among the wider interdisciplinary team to share the workload. Subsequently, several factors were identified as critical prior to further implementation planning. Firstly, the working group needed to develop their own knowledge and confidence in delivering mCIMT programs. The return of R. E. to the RITH service led to knowledge exchange and skill development among the group. This individual's procedural knowledge on how to deliver mCIMT within a public rehabilitation service was shared with A. W. and J. W. over several months for self-development across the TDF domains of knowledge, skills, and beliefs about capabilities. Examples of this knowledge exchange included training on how to complete the behavioural contract, designing shaping activities that were relevant to a specific motor impairment, and providing strategies to engage family and carers to support mCIMT programs at home to ensure sufficient active practice was achieved in lieu of direct therapist supervision of task-specific practice. Secondly, it was identified that a framework was required to support the behaviour change intervention. This would provide the working group with a clear understanding of the factors influencing the implementation of mCIMT, and guidance on which behaviour change techniques would be most likely to support implementation. This led to a period of upskilling in translational science principles and the eventual selection of the TDF to understand barriers, and enablers and the BCW to guide the behaviour change intervention.

3.2 | Stages 2 and 3: Understanding the barriers and enablers and developing strategies to change clinician behaviour, guided by the TDF and BCW

Thirty-five clinicians completed the survey: 19 physiotherapists, 11 occupational therapists, and five therapy assistants. Perceived barriers included a lack of knowledge of how to deliver mCIMT and a lack of confidence in neurological rehabilitation skills. Similarly, concerns were raised regarding patient compliance with the required intensity and about inadequate staffing and resources.

Identified enablers included the availability of expert neurological clinicians to provide mentoring support (P3 neurological therapists), the perception that RITH managers were supportive of mCIMT, and the view that clinicians were keen to provide mCIMT because of its strong supporting evidence.

Although mCIMT requires engagement from patients, carers, therapists, and managers for successful implementation, the initial 'roadblock' to implementation was the clinician deciding whether or not to offer mCIMT. Consequently, the initial behaviour change intervention was targeted at clinicians. Following discussion among the working group, the key barriers considered to be most amenable to change, and therefore prioritised, included developing procedural knowledge, skills development, building confidence (belief about capabilities), and adapting the mCIMT program and resources to suit the environmental context. Domains to be enhanced among identified enablers included social/professional role and identity, social influences, and the ability to develop knowledge and skills through expert peer support.

The determinants of behaviour change identified from the survey using the TDF were then mapped to the BCW to guide the selection of interventions that addressed the target behaviours. These interventions included education, persuasion, training, environmental restructuring, modelling, and enablement. A summary of the behaviour change techniques, mapped to the TDF domains, is presented in Tables 1 and 2.

3.3 | Stage 4: Developing a mCIMT protocol suitable for the local service context

The development of the RITH mCIMT protocol considered the published mCIMT protocols in addition to the resource, time, and length of stay restrictions of the RITH service identified by clinicians in the online survey. Based on these considerations, the protocol developed was a two-week program (12 days—10 weekdays and one weekend) consisting of the following:

- The full 'Transfer Package' (behavioural contract, regular administration of the MAL, daily diary completion and review, and problem-solving with clinicians)
- Three 1-hour training sessions with a therapist per week, each session comprising the following:
  - 15 items of the MAL as described by Taub et al. (2011), alternating between the first and second 15 items each visit (approx. 10–15 minutes)
  - Setting home practice tasks and reviewing previous day(s) completion of the training diary (approx. 5–10 minutes)
  - Up to four shaping tasks, 10 trials of each task (approx. 40–45 minutes)
- Two hours of daily independent task practice (combining repetitive task practice and home practice/home skills assignment tasks)
- Up to 6 hours of restraint of the less-affected UL each day

This protocol was discussed with therapists and deemed feasible, particularly if the program was to be delivered in an interdisciplinary fashion, and the workload shared between occupational therapists, physiotherapists, and therapy assistants. A sample timetable and session plan for the entire program and weekly schedule are provided in Supplementary File 2.

3.4 | Stage 5: Piloting the implementation intervention with iterative refinement based on clinician feedback

The multi-modal behaviour change intervention consisted of facilitated workshops, development of context-specific mCIMT paperwork, expert peer modelling, information provision, and engagement with managers, with subsequent refinement in the delivery of behaviour change techniques based on clinician feedback.

Across the four facilitated workshops, a total of 46 RITH physiotherapists, occupational therapists, and therapy assistants attended session 1, 40 RITH staff attended session 2, 45 staff attended session 3, and 43 staff attended session 4.

3.5 | Facilitated workshops

To increase clinician attendance and reduce travel constraints for individual clinicians, a series of four 90-minute workshops was conducted at each of the seven RITH sites. This also provided opportunities for part-time staff to attend a session at another site if they did not work on the day a session ran at their usual site. During each session, draft resources were tested with clinicians for feedback and were refined based on their suggestions for improvement.

3.5.1 | Session 1: The Transfer Package—Behavioural contract

This workshop involved a brief PowerPoint presentation reviewing the literature and reflecting on the

TABLE 1 Barriers, TDF domains, and behaviour change techniques.

Using the TDF, which BARRIERS need to be addressed?	Which theoretical domains do the barriers operate in?	Behaviour change techniques and modes of delivery
Lack of knowledge in applying mCIMT Limited neuro or practical skills in administering the mCIMT program	Knowledge (therapist) Skills Belief about capabilities	**Technique:** Information provision; skills development; rehearsal. **Mode:** Facilitated workshops; journal clubs; small group discussions **Content:** In-depth education on components of mCIMT. Role play on completing contract; practical sessions on developing shaping trials; literature review on efficacy. Expert clinical support to a therapist when first using mCIMT with a patient. Provide clear eligibility criteria.
Unable to see patients frequently enough (time and staffing constraints)	Environmental context and resources Belief about capabilities Skills Knowledge (therapist)	**Technique:** Barrier identification; model behaviour of peers; information provision. **Mode:** Facilitated workshops; interdisciplinary collaboration **Content:** Resource development to minimise/simplify paperwork. Encourage interdisciplinary collaboration to share workload. Develop a session plan to increase time efficiency during therapy sessions.
Patient compliance	Social influence Knowledge (patient)	**Technique:** Information provision; persuasive communication **Mode:** Information handout; AV material; facilitated workshops. **Content:** Respective clinician drip feeds information about mCIMT to build 'buy-in'. Show resources highlighting neuroplasticity, patient examples, and video to get patients motivated to participate. Engage carer. Small group activity to practice the 'sell'.
Complexity of admin/paperwork	Environmental context and resources	**Technique:** Barrier identification, information provision **Mode:** Context-specific resource development; facilitated workshops **Content:** Develop easy-to-access mCIMT paperwork; provide training on use during practical sessions. Peer expert to demonstrate use.
Balancing mCIMT with patient's other therapy needs	Beliefs about consequences Social/professional role and identity	**Technique:** Information provision; monitoring consequences of own behaviour **Mode:** Facilitated workshops **Content:** Encourage interdisciplinary collaboration to share mCIMT workload. Commence the mCIMT program after mobility/ADL/speech goals have progressed to the point where they are lower priority.
Lack of home support for patient Patient's cognitive and language deficits	Knowledge (therapist)	**Technique:** Information provision **Mode:** Facilitated workshops **Content:** Therapists to seek expert clinical support for complex patients. Clear eligibility criteria to be provided and ideas to support patients with communication/cognition impairments through collaboration with speech pathology and occupational therapy.

importance of the Transfer Package as part of the CIMT intervention (Taub et al., 2013). Studies that compared CIMT outcomes with and without the Transfer Package were presented, to highlight the differences in effect sizes and improved long-term outcomes when the Transfer Package is provided (Taub et al., 2013). The practical component of this session consisted of a role play between the P3 neurological physiotherapist and occupational therapist in completing the behavioural contract; one acting as a therapist, and the other as a patient. To facilitate experiential learning, this was followed by participants working in pairs to conduct their own role play in completing the behavioural contract.

TABLE 2 Enablers, TDF domains, and behaviour change techniques.

Using the TDF, which ENABLERS should be enhanced	Which theoretical domains do the enablers operate	Behaviour change techniques and modes of delivery
Staff are motivated to participate and engage in the program	Social/professional role and identity Optimism Belief about consequences Social influences	**Technique:** Persuasive communication; provide opportunities for social comparison among therapists. **Mode:** Facilitated workshops; patient case study presentations; collaboration. **Content:** Therapists who ran successful mCIMT programs to share experiences with other therapists, use of change champion in team meetings. Case conferences to discuss patient outcomes, make comparisons with other therapies.
Management is supportive of providing evidence-based practice and mCIMT implementation	Knowledge Reinforcement Social/professional role and identity Social influences	**Technique:** Persuasive communication; enablement **Mode:** Facilitated workshops; caseload restructuring **Content:** Therapists are able to attend workshops during clinical time. The potential restructuring of clinical caseload during mCIMT to allow therapists to complete the program. Support to allow joint interdisciplinary consults when setting up the mCIMT program.
Availability of advanced clinical support from P3 neurological therapists	Knowledge Skills	**Technique:** Information provision; model behaviour by peer expert **Mode:** Facilitated workshops; observation of the mCIMT program with patient **Content:** Therapist to 'buddy up' with an expert peer during first and second mCIMT programs. Expert peer to provide additional consultative support on an ad hoc nature.

Feedback and actions taken

Clinicians suggested that completion of the behavioural contract with patients should be conducted as a joint session with the treating physiotherapist and occupational therapist to ensure all parties were 'on the same page'.

- Information provision and persuasive communication: discussions with site coordinators to obtain support for clinicians to conduct joint home visits when setting up mCIMT programs. Communication with coordinators involved outlining the benefits of joint visits in improving patient engagement by creating a 'team' working together on the mCIMT program, better therapist satisfaction from working collaboratively, and the potential influence of this on the success of the program.

Clinicians reported apprehension about completing the behavioural contract with a patient who was not 'super motivated' and wanted guidance on this to facilitate the negotiation. Similarly, concerns were raised about completing the behavioural contract with people with aphasia, who were appropriate to participate in an mCIMT program but needed additional support due to communication deficits.

- Model behaviour by peer expert: Initially, clinicians could observe a P3 neurological therapist completing a behavioural contract with patients when setting up a mCIMT program.
- Information provision: Strategies to overcome 'challenging contract negotiations' included suggested prompts for negotiating the contract with patients with whom it was difficult to find tasks to complete, due to their limited engagement in functional tasks outside of scheduled therapy.
- Engagement with the multi-disciplinary team: Encouragement to collaboratively work with the treating speech pathologist, including joint visits, to facilitate the patient's clear understanding and expression during the contract negotiation process.

3.5.2 | Session 2: The Transfer Package—MAL, home skills assignment, and diary

This session involved an in-depth review of the MAL, particularly understanding the Amount and Quality of Movement Scales and how to differentiate between the two. A role play was conducted between the P3 physiotherapist and occupational therapist, followed by a role play among

clinicians completing the MAL in pairs. Examples of home skills assignment tasks and education on recording completion using the training dairy were provided.

Feedback and actions taken

Concerns were raised at one site regarding the time taken to go through MAL. Comments were made such as 'patients would only think we talk for therapy' and 'if we spend all this time with the behavioural contract and MAL, when do we do rehab?'

- Information provision and persuasive communication: The importance of behaviour change in mCIMT to drive functional improvement was highlighted, and literature supporting behavioural strategies, patient engagement, and self-management was discussed.

Clinicians requested visual tools to help them demonstrate change in MAL scores over the course of the program to assist with patient motivation.

- Audio-visual resource development: A Microsoft Excel electronic template was developed so that clinicians could enter MAL scores, and it would generate a bar graph to share with patients (see Figure 2 for an example).

3.5.3 | Session 3: Intensive practice—Repetitive task practice and shaping

This workshop was entirely practical, stressing the importance of the patient undertaking 2–3 hours of training per day during the RITH mCIMT program. Shaping was demonstrated using a series of workstations and therapy equipment, and clinicians were given examples of shaping exercises to target specific UL motor deficits. Large sheets of paper ('butcher's paper') were used to mark out task templates as a method to ensure consistency between clinicians and to reduce the time taken for setting up the exercise area in a patient's home. Figure 3 demonstrates an example of a shaping task set-up. Repetitive task practice is considered 'usual care' for UL rehabilitation in RITH, so education regarding task practice was not required. However, in the RITH mCIMT program, task practice was combined with the 'home skills assignment' to be conducted by patients independently outside of scheduled therapy, which was explained to clinicians as an adaptation from the original program to fit the local service delivery model.

Feedback and actions taken

Instead of drawing and measuring landmarks on the recording sheet to ensure consistency for shaping tasks, clinicians preferred to photograph the shaping task set-up using their smartphone and print that photo to leave at the patient's house.

- Resource development: the section for drawing a diagram of each shaping task on the shaping recording

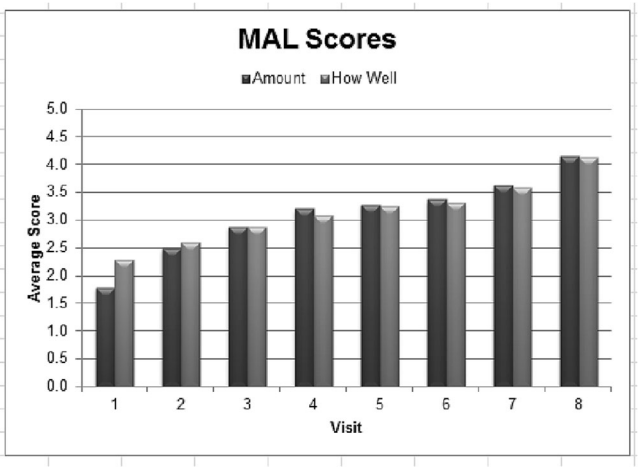

FIGURE 2 Example of repeat MAL scores for one mCIMT participant. *Note*: only visits 1 and 8 included the full 30 items of the MAL. Fifteen items of the MAL were completed for visits 2–7 and form part of the behavioural intervention of mCIMT.

FIGURE 3 Example of shaping task set-up (spooning rice). Description: pick up spoon, scoop rice from bowl 1, bring to mouth, then pour into bowl 2. Targeted movements: cutlery use, forearm pronation/supination, elbow flexion/extension, shoulder flexion, and shoulder horizontal abduction. Feedback parameters: number of spoonfuls completed in 30 s, do not count spills. Progression ideas: remove adaptive foam, use teaspoon, and raise bowls to challenge shoulder elevation.

form was removed, and all clinicians were encouraged to use photographs and the markings on the butcher's paper to encourage standardised task set-up.

3.5.4 | Session 4: Getting buy-in and 'putting it all together'

This final workshop involved outlining clear eligibility criteria for early identification of potential mCIMT candidates, role playing the education of patients and carers to engage them to participate in mCIMT and get 'buy-in', and providing clarity on how the overall mCIMT program should run. Visual aids and provision of patient examples to support patient (and therapist) engagement were used. Examples included using images from published studies demonstrating expanded cortical representation on functional MRI after participating in mCIMT (Gauthier et al., 2008). The P3 therapists then modelled scripted examples explicitly linking this change in cortical representation to improved hand function. Flow charts (Supplementary File 3) and sample patient timetables (Supplementary File 2) were developed to describe how and when each component would be integrated into the RITH mCIMT program.

Feedback and action taken

A preference to use YouTube clips for CIMT education was expressed by most clinicians, as web links could be emailed to prospective patients and families to be viewed outside of therapy time, which was more time-efficient for clinicians.

- Audio-visual resource development: A resource sheet with web links for a range of YouTube videos and online resources was developed (attached as Supplementary File 4)

TABLE 3 Eligibility criteria for RITH mCIMT.

Minimum requirements from the literature	Best for early RITH success	As clinicians become more confident
10° active wrist, finger, and thumb extension	Start with patients with good/ok active movement demonstrated by the use of the 'flannel test'	Greater upper limb impairment
30° shoulder elevation	Able to follow instructions and comprehend tasks and theory and consent	Aphasia or cognitive impairment with adequate support from capable carer and communication strategies from a speech pathologist
MMSE > 24/30	Good carer support, low carer stress	Patients living alone or with minimal carer support
Able to stand, balance	No/minimal shoulder pain RITH base's ability to provide intensity Motivated Preferably without apraxia	Shoulder pain is present but the program can focus on distal UL

Abbreviation: MMSE, Mini Mental State Examination.

3.6 | Identifying suitable patients

Clinician mCIMT-specific skills are known to develop over time with practice and experience (Christie et al., 2021). The workshops stressed the importance of selecting patients 'more likely to succeed' for the first programs delivered by a therapist, which allows skills and confidence to be developed, prior to progressing on to inviting more complex patients to participate. Eligibility criteria for a RITH clinician's first program are described in Table 3, as well as suggestions to broaden the criteria as clinicians became more confident in delivering mCIMT programs. This was discussed during the fourth workshop, 'Putting it all together'.

3.7 | Expert peer modelling

Most clinicians requested to observe the P3 therapists set up and deliver a mCIMT program. This peer modelling was the final aspect of the education program and was offered to every clinician about to commence delivering their first mCIMT program. Observing a program in its entirety and understanding how to include all components of the mCIMT program into the delivery, as well as some 'tricks' to keep each session within 1 hour, was an important component of the behaviour change intervention. P3 therapist support for initial programs involved conducting the first two preparatory sessions (the behavioural contract, MAL, and setting up shaping trials) and

the first 'mCIMT session' on day 1. Further support was available to clinicians as required.

3.8 | Context-specific resource development

Initial resource development was based on a range of resources, including the training manual developed by Edward Taub's team at UAB (Taub et al., 2011), Harrison Training's 'How to do CIMT' manual (Meharg & Kings, 2015), and an mCIMT participant pack developed by Massie and colleagues (Massie et al., 2014) that was retrieved from the StrokeEd Collaboration website (http://strokeed.com/resource-collection). Therapist survey feedback reported that the paperwork for mCIMT programs was complex, took a long time to complete, and was cumbersome to carry into the home environment. RITH-specific resources were developed and combined into a single file comprising the following:

- A Patient and Carer mCIMT education sheet to clearly outline the processes specific to the RITH program
- The behavioural contract
- The MAL (modified into table format to reduce the number of pages and include a separate colour-coded MAL scoresheet)
- Shaping recording sheets adapted from the StrokeEd resource (Massie et al., 2014)
- The home skills assignment task list and daily diary that were merged into a single document

A photographic shaping task repository of de-identified real patient examples was also developed for therapists to access when trying to plan appropriate shaping tasks and was maintained on a shared computer drive, accessible to all clinicians. Examples of shaping tasks have been included in Supplementary File 5.

3.9 | mCIMT delivery within the broader context of rehabilitation services

Therapists from inpatient and outpatient hospital services connected to each of the seven RITH sites were invited to join the mCIMT training sessions. This was done with a view to sharing knowledge and skills, developing a common language, and facilitating a consistent approach to introducing mCIMT to patients at any stage of their rehabilitation. For example, inpatient therapists could start 'priming' the patient and relevant others with information about mCIMT concepts and success stories to support later patient readiness and potential engagement with the mCIMT program in RITH. This strategy was adopted to address the reported barrier of patient compliance that was identified from the survey.

4 | DISCUSSION

This paper aims to provide a practical guide to implementing mCIMT, using one example of an implementation program across a large, multi-site, home-based subacute rehabilitation service. Substantial evidence for efficacy supports the provision of mCIMT to eligible stroke survivors (Corbetta et al., 2015; Fleet, Page, et al., 2014; Kwakkel et al., 2015); yet its widespread adoption continues to present challenges for rehabilitation clinicians and services (Christie et al., 2019; Jarvis, 2016; Pedlow et al., 2014).

This was the second attempt to implement mCIMT in this service, after a failed 'education-only' first attempt. The first attempt aimed to train clinicians quickly with minimal disruption to usual clinical workloads. However, the haste to get the program up and running led to several shortcomings, which meant that service provision did not improve. mCIMT is a complex intervention that did not neatly fit into the current RITH service delivery model, and it became apparent that clinicians needed far more training and education to deliver mCIMT than what was initially assumed. The reflection during stage 1 of this project highlighted that implementing mCIMT was a substantial undertaking, requiring planning, resources and engagement of the 'right' people throughout the process. The need for multi-faceted behaviour change interventions in stroke rehabilitation has been documented previously (Connell et al., 2015; Stewart et al., 2020). For example, Stewart and colleagues used the TDF and BCW in developing their behaviour change intervention to increase the amount of active practice performed in a stroke rehabilitation unit. The behaviour change techniques adopted included education and training, audit and feedback, enhancing communication among the multi-disciplinary team, quarantining time for clinicians to administer the resource (a practice book), and assigning a responsible clinician for each patient (Stewart et al., 2020). In our intervention, mapping the barriers and enablers to the TDF informed the working group that successful implementation would require greater emphasis on skill development and adapting the protocol and resources for the local context. The use of scripting and modelling by peer experts and leveraging social influences such as managers were other strategies that were adopted in this behaviour change intervention that were not included in the first attempt at increasing

the delivery of mCIMT. By using the BCW to guide the choice of behaviour change techniques, a tailored and structured approach to addressing factors influencing implementation was developed. The adoption of a structured implementation framework provided key learnings on why the first attempt had failed.

This paper documents the application of the TDF and BCW in our implementation of mCIMT in a specific rehabilitation context. Two previous studies have used theory-informed frameworks to guide CIMT implementation (Jarvis, 2016; McCluskey et al., 2020). Jarvis used the Promoting Action on Research Implementation in Health Services (PARIHS) framework to design and implement a CIMT program within an ESD stroke rehab service in the United Kingdom (Jarvis, 2016). However, despite substantial time investment to develop the CIMT protocol, only three patients received the intervention during the investigation study period. In an Australian study, McCluskey and colleagues used the BCW to develop their CIMT implementation strategy across several outpatient rehabilitation centres (McCluskey et al., 2020). They reported that it took approximately 242 hours to plan and deliver a first CIMT program, including time spent learning how to deliver CIMT, developing resources and obtaining organisational support (McCluskey et al., 2020). Our process was similar and required time to develop skills, collaborate with clinicians, develop resources, and engage with managers. The time spent during this process was not recorded, but the 242 hours reported by McCluskey and colleagues indicates the complexity of planning and implementing CIMT/mCIMT. Many services will likely have to implement mCIMT without dedicated additional resources. As such, we hope our example assists other rehabilitation services in successfully implementing this evidence-based therapy within existing resources.

Clinician and manager engagement is essential for successful implementation (Christie et al., 2021). Clinicians required time away from clinical duties to attend the facilitated workshops, contribute to resource development and deliver an individual mCIMT program with support from a P3 clinician. Managers supported clinician attendance during the training period, and their ongoing support will be required for clinicians to deliver mCIMT programs in the future. Ongoing feedback will be required to understand the impact of this behaviour change intervention on clinicians and the service, as well as to identify any further adaptations to the program required to support the sustained implementation of mCIMT. Future qualitative research is planned to understand the perceptions and experiences of clinicians and managers of the implementation program and continued provision of mCIMT in the RITH service.

Similarly, the success of community-based mCIMT programs relies on patient engagement and carer support (Stark et al., 2019). mCIMT is an intensive program that, despite its efficacy, can be challenging to complete (Borch et al., 2015; Christie et al., 2022). The perceptions and experiences of patients and carers who undertake or support a mCIMT program will be investigated in future research to understand the feasibility of the RITH mCIMT program. Participant feedback from interview data will be used to further adapt the program to support sustained implementation, and to understand the impact of this behaviour change intervention on health consumers.

4.1 | Limitations

Stages 2 and 3 of the study involved interpreting and mapping survey findings to the TDF and BCW. The analysis of qualitative data was conducted collaboratively among the working group members, who brought differing experiences and viewpoints to the analysis. However, as all members were employees of the service and motivated to increase the provision of mCIMT, this may have introduced bias into the analysis. No formal process was used to control for bias, and this component of the study was not conducted in adherence to accepted reporting standards (Equator Network; https://www.equator-network.org/). Although the process we used is a common approach in clinical settings, it is acknowledged as a limitation of the study.

The use of site-based champions can support behaviour change interventions in achieving successful and sustained change to practice (Santos et al., 2022). This was particularly relevant to the RITH service with a substantial workforce spread over a large geographic area. It is possible that the working group continuing to drive behaviour change over the long term may become unsustainable. However, due to the limited time availability of clinicians, the identification and training of site-based champions were not included as part of this behaviour change intervention. This is a limitation of this project and a threat to long-term sustainability. The use of site-based champions will be explored in future research planned to follow the delivery of this behaviour change intervention.

Similarly, audit and feedback is another strategy reported in the literature to support the sustainability of behaviour change interventions (Dempsey et al., 2022; Johnson & May, 2015). Audit and feedback was not adopted as part of this initial behaviour change intervention, as the knowledge on how to provide mCIMT and tailor delivery to the local context were viewed as likely

to have a greater influence on implementation. However, the success of this implementation program will be explored through future audits, with feedback provided to clinicians and managers as a strategy to support the sustained implementation of mCIMT.

Translational science is an emerging field of research across health and remains in its infancy in stroke rehabilitation (Lynch, Chesworth, & Connell, 2018). The use of theory to inform complex intervention implementation is supported in the literature and numerous behavioural frameworks exist to support behaviour change in health (Birken et al., 2018; Damschroder et al., 2009; Francis et al., 2012; Graham et al., 2006; Michie et al., 2014). However, it is unclear which is the best framework to use for a given setting/behaviour change intervention (Lynch, Mudge, et al., 2018; J. Morris et al., 2019). We chose the TDF and BCW primarily due to the availability of user-friendly publications to guide their use (Atkins et al., 2017; French et al., 2012; Michie et al., 2014), rather than the conviction that they were the best frameworks for this implementation project. Future research should provide clinician-researchers with clearer guidance on selecting optimal framework(s) for the chosen intervention (Lynch, Mudge, et al., 2018; J. Morris et al., 2019).

4.2 | Future work

The processes reported in this paper represent the initial phase of a larger scale mixed methods process evaluation on mCIMT implementation in RITH that is currently being undertaken (Registration: ACTRN126 20000079943). Following the development and implementation of this mCIMT program, the success (or otherwise) of this behaviour change intervention will be evaluated through quantitative audit data over two separate 6-month time periods. Implementation is an iterative process and further adaptations will likely be required to ensure the feasibility and longer term sustainability of mCIMT programs within this RITH service. These adaptations will be guided by qualitative data obtained from all stakeholders relevant to mCIMT implementation in the RITH service (patients, carers, therapists, and managers). Strategies such as ongoing audit and feedback will leverage quantitative data to support the increased provision of mCIMT.

5 | CONCLUSION

This paper provides an example of how the TDF and BCW can be applied to support the implementation of mCIMT in a home-based, ESD rehabilitation service. It has outlined the delivery of a suite of behaviour change techniques to influence clinician behaviour in offering and delivering this evidence-based intervention. Although this guide demonstrates the complexities of translating research findings into 'real-world' clinical practice, we have shared our strategies and learnings to assist other services to support the implementation of this highly efficacious UL rehabilitation intervention. The success of this behaviour change intervention will be explored in future research.

AUTHOR CONTRIBUTIONS

Ashan Weerakkody, Jocelyn White, and Robyn Emmanuel conceived the project idea and collaboratively led the development and delivery of the intervention. Ashan Weerakkody prepared the initial draft of the manuscript with support from Barby Singer and Erin Godecke. All authors critically reviewed the final version for publication. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

Nil to declare. Ashan Weerakkody, Robyn Emmanuel, and Jocelyn White were employed by the RITH service at the time of this project; however, no additional funding or benefit was received by the undertaking of this project.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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