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RESEARCH ARTICLE

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Development of a behaviour change intervention to increase the delivery of upper limb constraint-induced movement therapy programs to people with stroke and traumatic brain injury

Lauren J. Christie[a,b,c,d], Reem Rendell[b,c,e], Annie McCluskey[a,f], Nicola Fearn[b,d], Abigail Hunter[b,g] and Meryl Lovarini[a]

[a]Discipline of Occupational Therapy, Sydney School of Health Sciences, Faculty of Medicine and Health, The University of Sydney, Sydney, Australia; [b]Brain Injury Rehabilitation Research Group, Ingham Institute for Applied Medical Research, Sydney, Australia; [c]Brain Injury Rehabilitation Unit, Liverpool Hospital, South Western Sydney Local Health District, Liverpool, Australia; [d]Allied Health Research Unit, St Vincent's Health Network Sydney, Darlinghurst, Australia; [e]School of Health Sciences, Western Sydney University – Campbelltown Campus, Campbelltown, Australia; [f]The StrokeEd Collaboration, Ashfield, Australia; [g]Physiotherapy Department, The Wellington Hospital, London, United Kingdom of Great Britain and Northern Ireland

ABSTRACT

Purpose: Constraint-induced movement therapy (CIMT) is a recommended intervention for arm recovery after acquired brain injury but is underutilised in practice. The purpose of this study is to describe the development of a behaviour change intervention targeted at therapists, to increase delivery of CIMT.

Methods: A theoretically-informed approach for designing behaviour change interventions was used including identification of which behaviours needed to change (Step 1), barriers and enablers that needed to be addressed (Step 2), and intervention components to target those barriers and enablers (Step 3). Data collection methods included file audits and therapist interviews. Quantitative data (file audits) were analysed using descriptive statistics. Qualitative data analysis (interviews) was informed by the Theoretical Domains Framework (TDF) and Behaviour Change Wheel.

Results: Fifty two occupational therapists, physiotherapists and allied health assistants participated in focus groups ($n=7$) or individual interviews ($n=6$). Key barriers ($n=20$) and enablers ($n=10$) were identified across 11 domains of the TDF and perceived to influence CIMT implementation. The subsequent behaviour change intervention included training workshops, nominated team champions, community of practice meetings, three-monthly file audit feedback cycles, poster reminders and drop-in support during CIMT.

Conclusion: This study describes the development of a behaviour change intervention to increase CIMT delivery by clinicians.

Trial registration: Australian New Zealand Clinical Trials Registry, Trial ID: ACTRN12617001147370.

IMPLICATIONS FOR REHABILITATION

- Constraint induced movement therapy (CIMT) is a highly effective intervention for arm recovery after acquired brain injury, recommended in multiple clinical practice guidelines, yet delivery of CIMT is often not part of routine practice.
- The Behaviour Change Wheel, COM-B (capability, opportunity, motivation- behaviour) system and Theoretical Domains Framework (TDF) helped identify barriers and enablers to CIMT delivery by therapists, and design a theoretically-informed behaviour change intervention.
- The effect of the behaviour change intervention on therapists practice can now be evaluated to determine if it increases the delivery of CIMT more routinely in practice.

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Constraint induced movement therapy; behaviour change techniques; implementation; acquired brain injury; rehabilitation; evidence-based medicine; guideline adherence; upper extremity; stroke rehabilitation

Introduction

Constraint-induced movement therapy (CIMT) is an effective intervention for arm recovery after stroke [1,2]. CIMT has evolved over time with a range of published protocols described in the literature. The three core components are (i) intensive graded practice using the affected arm and hand, (ii) restraint of the non-affected hand to encourage use of the affected arm, and (iii) a transfer package of behaviour change strategies to encourage generalisation of arm use in daily life [1]. CIMT is the only upper limb intervention with a strong recommendation included in the Australian clinical guidelines for stroke management [3]. CIMT is also a recommended intervention in international stroke and acquired brain injury guidelines [4,5]. Yet a recent audit of Australian stroke services found that less than 12% of eligible stroke survivors received CIMT [6].

Barriers to CIMT delivery have previously been well explored and include therapist-related barriers (e.g., lack of knowledge and skills), patient-related barriers (e.g. concerns regarding patient suitability for the program), and resource-related barriers (e.g. lack of time) [7–10]. Three studies have investigated ways to overcome

CONTACT Lauren Jade Christie lauren.christie@svha.org.au Senior Implementation Science Research Fellow – Allied Health, St Vincent's Hospital, 370 Victoria Street, Darlinghurst, NSW 2170, Australia

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barriers to routinely delivering CIMT in practice [11–13]. McCluskey et al. (2020) investigated the feasibility of Australian occupational therapists delivering a community-based CIMT program [11]. To enable implementation and practice change, therapists at three health services were provided with CIMT training, mentoring and a community of practice. All teams were able to deliver at least one CIMT program following delivery of implementation support, but unable to sustain practice change [11]. The implementation strategies used to support therapist behaviour change were mapped to the Behaviour Change Wheel but barrier mapping to inform the selection of implementation strategies was not conducted prospectively in that study [14]. This methodological limitation may have affected study outcomes and program sustainment.

Similarly, Jarvis (2016) reported that occupational therapists in one English stroke service required training to start and continue delivering CIMT, in addition to initial caseload adjustments, access to a CIMT mentor for problem solving, and practical prompts including ideas for tasks [12]. Checklists were considered important to ensure the CIMT protocol was remembered and followed. As the study was conducted with only one hospital trust, findings may be contextually dependent and not generalisable to other settings [12].

Finally, Jolliffe et al. (2020) compared the impact of two implementation packages on delivery of evidence-based upper limb rehabilitation including CIMT, to people with acquired brain injury, by Australian occupational therapists at three health services [13]. The effect on therapists' practice was compared following a facilitator-mediated implementation package, a self-directed implementation package or usual care interventions. The facilitator-mediated implementation package comprised face-to-face education sessions, coaching and mentoring by a senior therapist, auditing and provision of real-time feedback about practice, and provision of consumer seminars. The facilitator-mediated package resulted in greater improvement in therapist adherence to delivery of recommended upper limb interventions at the end of three months, compared to the self-directed package or usual care interventions. However, the facilitator-mediated package was resource and time intensive, and it was unclear if therapist behaviour change was maintained beyond the three month intervention phase.

CIMT is a complex intervention with multiple interacting components, all of which are needed to deliver the intervention with fidelity [15]. CIMT can be delivered by both occupational therapists and physiotherapists. Due to its intensive nature, CIMT requires strong commitment from health professionals and their service, and from the patient (and carer). Therefore, implementation of complex interventions like CIMT are likely to be most effective if implementation strategies and models of CIMT delivery are tailored to local circumstances and contexts, rather than being standardised [15]. Tailoring implementation strategies to address identified determinants of practice have only a small to moderate effect on professional practice and health outcomes [16]. Systematically identifying behaviours that influence CIMT delivery, interventions and behaviour change techniques that target these behaviours, may lead to greater adoption, sustainment and use of CIMT in practice.

The aim of this study was to describe the development of a behaviour change intervention to increase the delivery of CIMT programs by neurological rehabilitation teams in public health settings.

Methods

Design

This study represents one component of a larger research program, the Australian Constraint Therapy Implementation study of the Arm (ACTIveARM). The ACTIveARM study evaluated the impact of a behaviour change intervention (the "implementation package") on therapist behaviour, and the number of CIMT programs delivered across multiple public health services. This paper describes the process and steps involved in developing the ACTIveARM implementation package.

Setting and participants

The study was conducted within the public health system in the South Western Sydney Local Health District, Australia. The District services both suburban and regional communities. Four acute and one subacute hospital within the District provide specialist acute and rehabilitation services for people with stroke and traumatic brain injury across the care continuum. All teams were invited by email to participate in the study by the lead investigator. To be eligible, teams had to employ at least one occupational therapist and one physiotherapist, and have received at least 10 referrals in the previous year for people with stroke or traumatic brain injury who required upper limb rehabilitation.

Ethical approval

The project was funded by the New South Wales Ministry of Health Translational Research Grants Scheme (TRGS) and received ethical approval from South Western Sydney Local Health District (SWSLHD) Human Research and Ethics Committee (ethics number HREC/16/LPOOL/419). Therapist participants provided written consent.

Developing the behaviour change intervention

Steps 1 to 3 of the process proposed by French et al. [17] were followed to identify the barriers and enablers to CIMT implementation. A behaviour change intervention was then developed, taking into consideration relevant implementation theory, to address the barriers and enhance the enablers of CIMT delivery.

Step 1: Identifying the of size of the evidence-practice gap

The first step involved determining the size of the evidence-practice gap (i.e., identifying what proportion of candidates or eligible patients were offered CIMT by therapists, and what proportion accepted then received CIMT). Retrospective medical file audits were conducted between December 2016 and February 2017 by trained members of the research team to establish the proportion of people with upper limb impairment who had been candidates for and were offered CIMT. Whether candidates received a CIMT program, and if programs were delivered with fidelity were also explored during the audits. Audits were conducted at three pre-implementation timepoints of three months duration, with a target of 20 files per team, per timepoint to be audited. Participating teams provided a sequential list of people seen by their service in the preceding three months who met the following three criteria: (1) primary diagnosis of stroke or TBI; (2) aged 18 years or older; and (3) presence of upper limb impairments (mild to severe) at the time of initial occupational therapy or physiotherapy assessment. Data collected included demographic data, upper limb assessment and intervention data and outcomes. File audit data were entered into a purpose designed data collection tool hosted on a secure Research Electronic Data Capture

(REDCap) database then exported to the Statistical Package for the Social Sciences (SPSS) version 25 for analysis using descriptive statistics.

Step 2: What barriers and enablers need to be addressed?

Focus groups and individual interviews were conducted to identify the clinical behaviours that needed to change (to improve CIMT delivery), who needed to change their behaviour, and when and where these behaviours were to be performed. Therapists, allied health assistants and allied health managers with experience working in neurological rehabilitation from participating teams were invited by email to participate.

The interview schedule was informed by the Theoretical Domains Framework (TDF) [18]. The TDF is a validated framework comprising 14 domains based on synthesis of 22 theories of behaviour and behaviour change [18]. The TDF has been used extensively within implementation science and health services research to identify barriers and facilitators to implementing specific evidence-based behaviours [19]. Domains from the TDF informed our interview questions. For example, to address the domain of skills, participants were asked what skills they currently had, or would need, to deliver a CIMT program.

Focus groups and individual interviews were conducted between November 2016 and March 2017. Participants were invited to attend a focus group via an email invitation sent by the investigators, then circulated by department managers and team leaders to therapists and allied health assistants within participating teams. If participants could not attend a focus group due to clinical commitments or personal preference, they were offered an individual interview as an alternative. Focus groups allow timely collection of data, and allow participants to respond to, and build on, the responses of other participants [20]. Focus groups were multidisciplinary and included occupational therapists, physiotherapists and allied health assistants. Allied health managers were interviewed individually to prevent potential power dynamics from influencing the responses of other focus group members. Interviews with managers also allowed greater exploration of strategic and political factors that may influence implementation [20].

The same interview schedule was used during focus groups and individual interviews. Five focus groups and all individual interviews were facilitated by LC and AH. Two focus groups were facilitated by a third member of the research team (AM); that person was not employed by the health district and did not have a working relationship with those team members. All focus groups and interviews were conducted face to face at each work site in a quiet room or therapy space.

All focus groups and interviews were audio-recorded, professionally transcribed verbatim and anonymised. Each speaker was assigned a number so that quotes were correctly attributed. Transcripts were imported into NVivo for analysis. Focus group and interview data were coded deductively using the 14 domain TDF [18]. Analysis was conducted at the domain level of the TDF then mapped to the Capability, Opportunity, Motivation- Behaviour (COM-B) system [14]. The COM-B system provides a framework for understanding behaviour, viewing behaviour as the interaction between the elements of capability, opportunity and motivation to generate behaviour [21]. Each domain of the TDF [14] can be linked to a component of the COM-B and forms the hub of the Behaviour Change Wheel (Figure 1) [21]. Barriers to and enablers of behaviour change can be mapped to both the TDF and COM-B using the Behaviour Change Wheel. This mapping process helps to identify influences on behaviour and strategies that may support behaviour change [14].

All focus groups and interviews were coded by the primary investigator (LJC). A subset of interviews were randomly assigned to associate investigators (AH, NF, RR) for independent coding. Investigators then met with LC to compare results, discuss coding differences and achieve agreement about final codes. Agreement was reached when both investigators identified the same response and allocated it to the same domain. Differences were resolved through discussion. Themes that could not be mapped to the existing TDF domains, such as factors that may influence a person's suitability for CIMT and ability to participate, were incorporated into a second round of coding as additional nodes.

Step 3: Which intervention components (behaviour change techniques, mechanisms of action and mode(s) of delivery) could overcome the modifiable barriers and enhance the enablers?

Following identification of barriers and enablers to CIMT delivery in Step 2, we used the Behaviour Change Taxonomy (version 1) [22] and Behaviour Change Wheel (including the COM-B and TDF) [14] to identify, select and match behaviour change techniques and intervention functions to the barriers and enablers, and inform design of the behaviour change intervention. The Behaviour Change Wheel defines intervention "functions" as broad categories and mechanisms by which an intervention can change behaviour (Figure 1) [14]. There are nine intervention functions within the COM-B system: education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling and enablement [14]. Table 1 presents definitions of each intervention function.

For example, an identified barrier to CIMT implementation was therapists' lack of knowledge about eligibility for a CIMT program (TDF domain: Knowledge, COM-B component- Psychological capability). To address this barrier, education was provided to therapists on the minimum physical and cognitive requirements a person would require to be suitable for CIMT and when to implement CIMT (Behaviour change technique: Instruction on how to perform behaviour; Intervention function: Education).

Using this matching process, we determined the content of each intervention i.e., what would be delivered (e.g., a workshop), and possible modes of delivery i.e., how each chosen behaviour change technique would be delivered (e.g., face to face vs. online workshop) [22]. Mode of delivery for behaviour change techniques was selected using the APEASE criteria which considers Affordability, Practicability, Effectiveness/cost-effectiveness, Acceptability, Side effects/safety and Equity of each technique [14]. The research team's knowledge of CIMT and clinical settings were also taken into consideration. For example, the nine participating teams were spread across a large region, therefore monthly community of practice meetings had to be offered both face-to-face and by telephone, to reduce therapist travel and the potential impact on clinical service delivery.

Results

Step 1: Identifying the of size of the evidence-practice gap

Who needs to change their behaviour?

The target audience for this behaviour change intervention was occupational therapists, physiotherapists and allied health assistants working in publicly-funded rehabilitation teams in Australia.

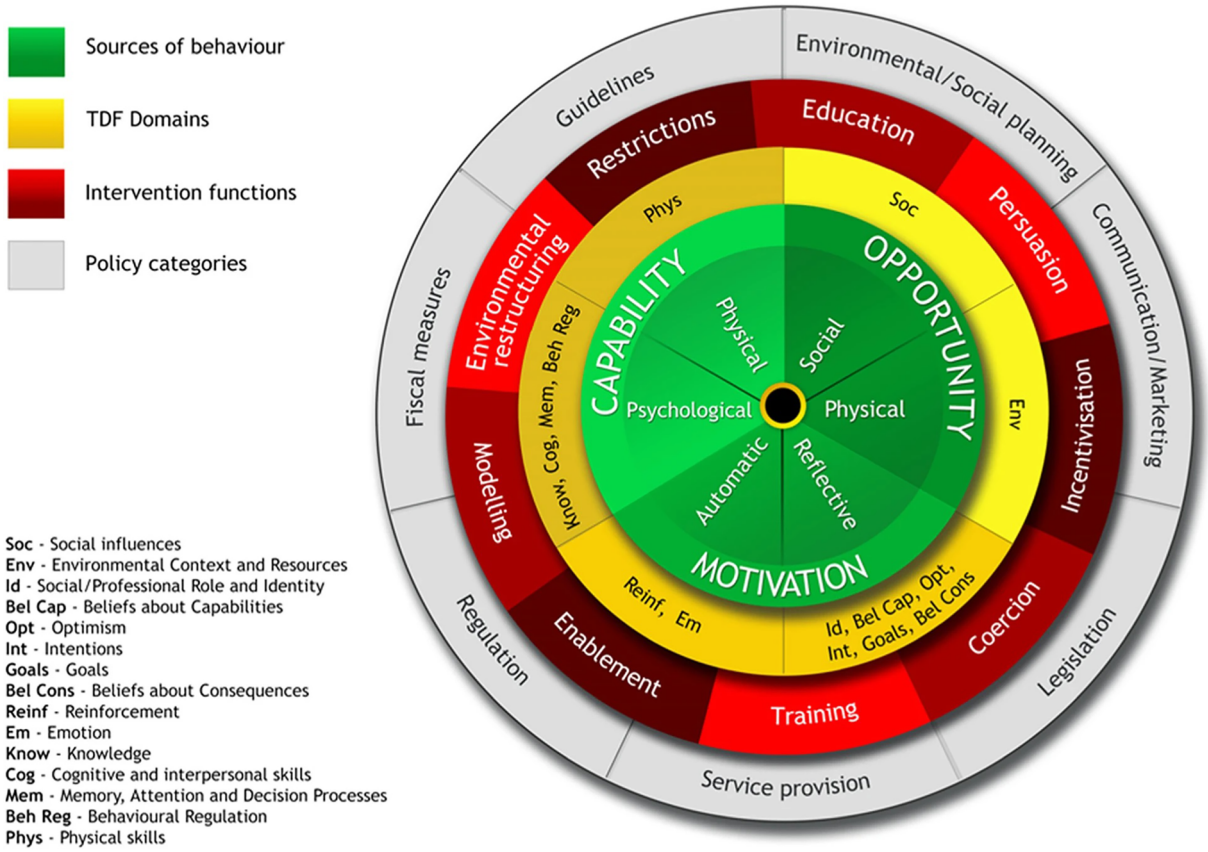

Figure 1. The Behaviour Change Wheel including the TDF domains and sources of behaviour as outlined in the COM-B [14, 21].

Table 1. Behaviour Change Wheel intervention functions and definitions [14].

Intervention function	Definition
Education	Increasing knowledge or understanding
Persuasion	Using communication to induce positive or negative feelings or stimulate action
Incentivisation	Creating an expectation of reward
Coercion	Creating an expectation of punishment or cost
Training	Imparting skills
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)
Environmental restructuring	Changing the physical or social context
Modelling	Providing an example for people to aspire to or imitate
Enablement	Increasing means/reducing barriers to increase capability (beyond education and training) or opportunity (beyond environmental restructuring)

Participating teams worked in acute stroke units ($n = 2$), a combined acute/rehabilitation stroke unit ($n = 1$), a specialist brain injury rehabilitation unit ($n = 1$), general inpatient rehabilitation ($n = 2$), general outpatient rehabilitation ($n = 2$) and a specialist community brain injury rehabilitation service ($n = 1$).

What needs to be done differently?

The target behaviour for the ACTIveARM behaviour change intervention was that all stroke survivors with some movement in two fingers and their thumb should be offered a CIMT program for upper limb recovery. We selected this target behaviour because CIMT is the only upper limb intervention in the Australian clinical guidelines for stroke management [3] graded with a strong recommendation, with robust evidence supporting its effectiveness in acute, subacute and chronic upper limb recovery post-stroke. [3]. Delivery of CIMT by therapists was also selected as the target behaviour because prioritisation and selection of the upper limb interventions delivered to stroke survivors are primarily driven by therapists, rather than by patients.

Baseline medical file audits at three pre-implementation timepoints ($n = 425$) revealed that approximately 31% of the patient sample ($n = 130$) were eligible candidates for CIMT. We identified two evidence-practice gaps. First, few stroke survivors who were candidates for CIMT were being offered or considered for a program (less than 3% of eligible candidates, $n = 3$). Second, very few CIMT candidates received a CIMT program (less than 2% of eligible candidates, $n = 2$). Medical record entries also revealed that the few CIMT programs conducted were not being delivered with fidelity (i.e., they typically did not include shaping principles alongside intensive practice or a transfer package).

Step 2: What barriers and enablers need to be addressed?

Seven focus groups and six interviews were conducted with occupational therapists ($n = 26$), physiotherapists ($n = 15$), allied health assistants ($n = 9$), and occupational therapy and physiotherapy managers ($n = 2$). The number of focus group participants ranged from three to 10. The majority of participants were female ($n = 38$),

with up to 10 years of clinical experience ($n = 31$). Participant characteristics are presented in Table 2.

Key barriers to, and enablers of CIMT implementation were mapped to TDF domains, and are presented in Supplementary Table 1. These barriers and enablers became the target for the behaviour change intervention.

Therapist-related barriers included the following domains:

Limited knowledge and skills,

> It's not something I've used… without having any training in it I would not be comfortable to just start going ahead with anything…In terms of myself…I'd be getting more training, more practice with CIMT and then I'd be more confident to use it in everyday practice outside of a specific research project so I could implement it more often" (Respondent 042, Acute Inpatient Stroke Unit)

The environmental context including limited resources,

> At the moment I would have to probably rely on others being involved like family for example or OT or a variety of people being involved for that duration. I don't think I would be able to spend 4 hours with the patient every day. Because that would take away from my own therapy time and non-clinical time (Respondent 044, Comprehensive Stroke Unit)

Therapists beliefs about their capabilities,

> I don't feel confident at all, but I think…if I was given a guideline to say this is what we do, then I would anticipate that I would be able to read that, figure it out and go and do it (Respondent 012, Acute Stroke Unit)

and attention, memory and decision-making processes;

> No, I don't consider the program routinely because I know how much time and preparation it takes; it's not something I can just jump in to do, whereas other types of therapy like ES (electrical stimulation), if I already know they have a dense upper limb I'll bring the ES machine with me to the initial assessment… I can just do [it] on the spot quickly (Respondent 006, Comprehensive Stroke Unit).

Patient-related barriers included:

The limited amount of family/carer support available to help the person with their program,

> Their family can be an issue with this clientele so it would just be how to sort of negotiate with them and make sure that they are completing the program as it's meant to be completed; it would be a little bit challenging (Respondent 020, Inpatient Brain Injury Rehabilitation Unit)

Perceived limited/poor patient motivation,

> It is a lot of time to put into someone if we're not really sure whether they've got the motivation or the insight or whatever the case might be or the support networks (Respondent 001, Community Brain Injury Rehabilitation Service)

and balancing competing patient goals;

> Sometimes patients… do seem to…prioritise going to the gym and doing their lower limb therapy…. With their walking and so then to… potentially say to them no you… need to spend a few hours a day doing your arm exercise as well because that's important. There is sort of an educational side of it there that we may need to chat to the patient and the family about as well as other staff working with them and them sort of wanting to prioritise their own therapy (Respondent 044, Comprehensive Stroke Unit).

Several enablers to practice change were also identified in the following domains:

Beliefs about consequences,

> Well I guess if, if the program is, is proven to be effective and we are not delivering it to the appropriate patients then I guess these patients are not achieving the best outcome (Respondent 047, General outpatient rehabilitation service)

Social influences,

> Being able to implement an intensive program I think that we would actually work quite well in being able to share that workload across the disciplines. It is something that we already do quite well (Respondent 014, Inpatient Brain Injury Rehabilitation Unit)

And social and professional identity;

> Here Physios and OT's are both involved in upper limb assessment and therapy. So I would consider it part of our role (Respondent 044, Comprehensive Stroke Unit).

Therapists believed that most services already provided upper limb rehabilitation using an interdisciplinary team model (physiotherapy and occupational therapy with allied health assistant support). They also believed that further training to improve their skills would enable them to deliver CIMT programs. Finally, therapists believed that delivery of CIMT programs and delivering evidenced-based interventions was part of their role. They were concerned about the potential negative impact of not delivering CIMT on patient outcomes and the need to adhere to clinical guidelines.

Table 2. Characteristics of health professionals ($n = 52$).

Demographic variable	*n*	(%)
Discipline		
Occupational therapy	27	(51.9)
Physiotherapy	16	(30.8)
Allied health assistant	9	(17.3)
Gender		
Female	38	(73.1)
Male	14	(26.9)
Clinical experience (years)		
0–5	18	(34.6)
6–10	13	(25.0)
11–15	3	(5.8)
>15	14	(26.9)
Not specified	4	(7.7)

Step 3: Which intervention components (behaviour change techniques, mechanisms of action and mode(s) of delivery) could overcome the modifiable barriers and enhance the enablers?

Once behaviour change techniques had been selected, their intervention function and mechanisms of action were mapped to the TDF domains and COM-B system using the Behaviour Change Wheel (Figure 1, Table 3).

Intervention content and mechanisms of action

The intervention consisted of 17 behaviour change techniques and seven intervention functions from the Behaviour Change Wheel (Table 3). Behaviour change techniques included instruction and demonstration (of CIMT), problem solving, practical social support, information about health consequences, monitoring of the behaviour and restructuring of the environment. Intervention functions of education, modelling and training featured prominently. These intervention functions were used to address barriers

Table 3. Characterising the ACTIveARM implementation package, intervention content and mechanisms of action using the behaviour change Taxonomy (V1) [22] and behaviour change Wheel (including the COM-B and TDF) [14].

	Intervention content		Mechanisms of action	
Intervention component	BCTs	Functions	COM-B	TDF
CIMT implementation education and training workshops delivered to staff in groups (2 days)				
Summary of the evidence base for CIMT	Information about health consequences	Education	Capability-Psychological	Knowledge
Evidence for CIMT efficacy in improving upper limb outcomes in both stroke and TBI populations	Information about health consequences	Education	Capability-Psychological	Knowledge
Instruction on who is suitable for CIMT and when to implement	Instruction on how to perform behaviour	Education	Capability-Psychological	Knowledge
Use of video story of occupational therapist with two stroke survivors who have received CIMT and what benefits they gained from the program	Salience of consequences, information about health consequences	Persuasion	Motivation-Reflective	Beliefs about consequences
Discussion of different models of CIMT implementation and associated outcomes that have been outlined in the research literature	Salience of consequences, information about health consequences, restructuring the physical environment	Persuasion	Opportunity-Social, Motivation-Reflective	Social influences, Beliefs about capabilities, Social/ Professional identity
Discussion of different models of CIMT implementation that have been used successfully in practice	Social comparison	Persuasion	Opportunity-Social, Motivation-Reflective	Social influences, Beliefs about capabilities, Social/ Professional identity
Team-based activities with prompting questions to support designing a model of CIMT delivery that will fit within local context and resources	Problem solving, restructuring the physical environment	Enablement	Capability-Psychological, Opportunity-Social, Motivation-Reflective	Beliefs about capabilities, Behavioural regulation, Social influences
Videos provided demonstrating the key CIMT components of shaping tasks, mitt wear and using the Motor Activity Log (MAL) as part of the transfer package	Instruction on how to perform behaviour, demonstration of behaviour	Modelling, education, training	Capability-Psychological, Capability-Physical	Knowledge, Skills
Practice of CIMT program components with stroke and traumatic brain injury survivor volunteers	Instruction on how to perform behaviour, demonstration of behaviour, behavioural practice, habit formation	Modelling, education, training	Capability-Psychological, Capability-Physical	Knowledge, Skills, Memory, attention, decision making processes, Behavioural regulation
Videos provided demonstrating completion of outcome measures suitable to use in a CIMT program	Instruction on how to perform behaviour, demonstration of behaviour	Modelling, education, training	Capability-Psychological, Capability-Physical	Knowledge, Skills
Practice of administration of relevant outcome measures with stroke and traumatic brain injury survivor volunteers	Demonstration of behaviour, instruction on how to perform behaviour, behavioural practice, habit formation	Modelling, education, training	Capability-Psychological, Capability- Physical	Knowledge, Skills, Memory, attention, decision making processes, Behavioural regulation
Provided with CIMT workbook including all written templates required to complete a CIMT program	Instruction on how to perform the behaviour, prompts/cues	Enablement, environmental restructuring	Opportunity- Physical, Capability- Psychological	Behavioural regulation
Staff encouraged to seek support from superiors and facilitators regarding implementation issues	Social support (practical)	Enablement	Opportunity- Social	Social influences
Teleconference community of practice with local champions				
Use of local clinical opinion leaders	Social support (practical)	Education	Opportunity- Social	Social influences
Sharing of challenges to implementation between teams and strategies to overcome these challenges	Problem solving, action planning	Enablement	Motivation-Automatic, Capability-Psychological	Reinforcement, Behavioural regulation
Agreeing on processes for completion of CIMT programs when CIMT participants transfer between facilities	Problem solving, action planning	Enablement	Opportunity-Physical	Environmental context and resources
Sharing of success stories including number of CIMT programs completed and observed participant outcomes	Feedback on outcomes of behaviour	Persuasion	Motivation-Reflective	Beliefs about capabilities, Optimism
Ongoing team-level audit and feedback				
Verbal and visual feedback provided to teams on a quarterly basis regarding the proportion of CIMT candidates offered and delivered a CIMT program via face to face feedback session	Monitoring of behaviour by others Feedback on behaviour	Persuasion, Education	Motivation-Reflective, Capability-Psychological	Beliefs about consequences, Beliefs about capabilities, Knowledge

(*Continued*)

Table 3. Continued.

	Intervention content		Mechanisms of action	
Intervention component	BCTs	Functions	COM-B	TDF
Reporting of patient outcomes data in visual feedback sessions	Feedback on outcome of behaviour	Persuasion	Motivation- Reflective	Beliefs about consequences
Praise on post patient outcomes achieved in CIMT programs	Social reward	Incentivisation	Motivation-Reflective, Motivation-Automatic	Beliefs about capabilities, Reinforcement
Quarterly feedback provided in written format (de-identified) benchmarking team performance against other teams	Feedback on behaviour, Social comparison	Education, persuasion	Capability- Psychological, Motivation- Reflective	Knowledge, Beliefs about consequences, Social/ Professional identity
Provided with updated infographic of current performance each quarter to display in team offices	Feedback on behaviour	Education, persuasion	Capability-Psychological, Motivation-Reflective	Knowledge, Beliefs about consequences
Generation and recording of solutions to improve implementation rates (staff and facilitator feedback)	Problem solving	Enablement	Capability-Psychological, Opportunity-Social, Motivation-Reflective	Behavioural regulation, Social influences, Beliefs about capabilities
Poster reminders and resources				
Two poster designs used- one targeted at therapists and displayed in team offices, the other targeted at patients and their families encouraging them to ask about CIMT	Adding objects to environment, prompts/ cues	Environmental restructuring, enablement	Capability- Psychological	Attention, memory, decision making processes, Behavioural regulation
Provision of resources to support CIMT implementation				
Provision of electronic templates for CIMT participant workbooks	Adding objects to environment	Environmental restructuring, enablement	Capability-Psychological, Opportunity-Physical	Attention, memory, decision making processes, Environmental context and resources
Provision of assessment kits to support evaluation of CIMT outcomes including Action Research Arm Test (ARAT), Canadian Occupational Performance Measure (COPM), Box and Blocks Test (BBT), Motor Activity Log (MAL)	Adding objects to environment	Environmental restructuring, enablement	Capability-Psychological, Opportunity-Physical	Attention, memory, decision making processes, Environmental context and resources
Provision of electronic clinical competency checklist for senior staff	Instruction on how to perform the behaviour, prompts/cues	Education, environmental restructuring	Capability-Psychological, Capability-Physical	Behavioural regulation
Drop in face to face support during team's first CIMT program				
Face to face support to discuss initial implementation challenges and generation of solutions to overcome these challenges	Problem solving	Enablement	Capability-Psychological, Opportunity-Social, Motivation-Reflective	Behavioural regulation, Social influences, Beliefs about capabilities
Verbal feedback and praise on CIMT program commencement	Social reward	Incentivisation	Motivation-Reflective, Motivation-Automatic	Beliefs about capabilities, Reinforcement

Abbreviations: CIMT: constraint induced movement therapy; TBI: traumatic brain injury.

such as limited knowledge and skills, while environmental restructuring was used to address resource-related barriers. These intervention functions were primarily used for elements of the behaviour change intervention that were delivered first, to support initial adoption. The intervention functions of enablement and persuasion also featured prominently. Shared problem solving was used to address initial implementation challenges when therapists first started offering CIMT programs and any ongoing issues. Persuasion also helped support sustainability of CIMT practice change.

The intervention content and mechanisms of action linked to 11 of the 14 TDF domains, and all six components of the COM-B system. Psychological capability and reflective motivation were most prominent (Table 3). TDF domains included increasing *knowledge*, which was targeted using the intervention function of education, and challenging *beliefs about their capabilities*, targeted via the intervention function of enablement. *Behavioural regulation* was targeted using environmental restructuring. *Social influences* and *beliefs about consequences* were targeted using persuasion. *Social influences* such as existing strong interdisciplinary collaboration and leadership support were identified as key enablers that could be enhanced to support behaviour change. The domain of *skills* was identified as important to help therapists get started and run their first CIMT program. Skills were targeted using modelling and training during educational workshops (Table 3).

Table 4 summarises the key components of the ACTIveARM behaviour change intervention in accordance with the Template for Intervention Description and Replication (TIDieR) framework for the reporting of interventions [23]. All nine participating teams received all components of the behaviour change

Table 4. Overview of the ACTIveARM implementation package[#] based on TIDieR reporting guidelines.

Intervention components	Rationale	Mode of delivery	Delivered to	Delivered by	When/How often
CIMT implementation education and training workshops delivered to staff in groups (2 days)	To increased therapist knowledge and skills in CIMT and provide opportunity for them to design a model of CIMT suitable for their local context	Face to face (group)	Occupational therapists, physiotherapists and allied health assistants working in participating teams	Workshops 1 and 2 delivered by Chief Investigator as co-lead Facilitator (Occupational Therapist) with support from external facilitator with extensive CIMT experience (Occupational Therapist). Workshops 3 and 4 delivered by Chief Investigator as lead Facilitator (Occupational Therapist) using same workshop materials. All workshops supported by associate investigators AM (Occupational Therapist), ML (Occupational Therapist), RR (Physiotherapist) and NF (Occupational Therapist) as co-facilitators for practical and group based activities.	Two workshops run when ACTIveARM implementation package first introduced and two additional workshops run at time of staff rotations (6 months and 12 months after initial implementation)
Teleconference community of practice with local champions (1 h)	To provide peer support to staff in problem solving challenges in relation to implementation through sharing of ideas and experiences	Face to face and via teleconference	Local champions nominated in each team (occupational therapists and physiotherapists)	Facilitated by Chief Investigator (LC) with support of Associate Investigators RR and NF.	Monthly
Team-level audit and feedback- verbal and written feedback given	To focus staff on their progress and targets	Rates of people eligible for, offered and delivered CIMT displayed. Other upper limb interventions that were offered displayed. Feedback delivered face to face (group). Written feedback provided including deidentified rates of CIMT candidates offered and delivered CIMT, benchmarking to other teams participating in the study. Infographic summarising team outcomes provided for displaying in team office	All available occupational therapists and physiotherapists within team	Facilitated by Chief Investigator (LC) with support of Associate Investigators RR and NF.	Face to face and written feedback provided every three months for an 18 month period
Poster reminders	To remind therapists to offer CIMT To increase patient awareness of CIMT	Environment changes/ Documents	Therapist targeted poster placed in team offices Patient targeted poster placed on display in wards or therapy areas	Not applicable	Posters provided to each team in first three months post commencement of implementation
Provision of resources to support CIMT implementation*	To make implementation more convenient	Environment changes/ Documents	Core resources including CIMT booklets, therapist checklists and video resources provided to all therapists electronically. Provision of outcome measure kits varied between teams based on needs	Not applicable	Provided to each team member at education and training workshop

(*Continued*)

Table 4. Continued.

Intervention components	Rationale	Mode of delivery	Delivered to	Delivered by	When/How often
Drop in face-to-face support	To ensure therapists were familiar with CIMT program processes and build confidence in delivering CIMT	Face to face	Occupational therapists, physiotherapists, allied health assistants	Facilitated by Chief Investigator (LC).	During each team's first CIMT program post initial training
District project advisory Committee	To update management and leaders on progress with implementation and identify support needs for sustainability and scale up of implementation	Face to face and via teleconference	Occupational therapy and physiotherapy managers from all participating sites, executive allied health leadership representatives, medical and nursing leadership representatives and state-wide clinical innovation and health education and training representatives.	Facilitated by Chief Investigator (LC) with support of Associate Investigators RR and NF.	Every 3 months for an 18 month period

[#]Resources included electronic CIMT booklets, therapist checklists, a copy of the booklet, "How to do constraint-induced movement therapy: a practical guide" [35], provision of outcome measure kits and manuals.
Abbreviations: CIMT: constraint induced movement therapy; TIDieR: template for intervention description and replication.

intervention. This behaviour change intervention consisted of a multimodal implementation package with the following components: a two day CIMT training workshop to increase knowledge and skills; resources to support CIMT implementation including templates for CIMT workbooks and assessment kits; reminder posters targeting therapists and patients; local site champions; a monthly community of practice by teleconference; drop-in support during each teams' first CIMT program and three-monthly file audits followed by feedback. Initially, two two-day training workshops were planned and provided in March 2017 at the start of the implementation period. However at the request of local champions, two additional two-day training workshops were provided, one at six months and another 12 months following initial implementation, to support new team members following staff rotations.

Discussion

We systematically identified barriers to, and enablers of CIMT implementation in public health settings across 11 TDF domains and all six components of the COM-B system. These domains informed the selection of theoretically-informed behaviour change techniques and development of a tailored behaviour change intervention (the ACTIveARM implementation package) to help therapists implement CIMT into routine practice. Occupational therapists, physiotherapists and allied health assistants needed to routinely identify more eligible CIMT candidates, offer and deliver more CIMT programs with fidelity.

We found that knowledge, skills and resources were key barriers to CIMT implementation, consistent with earlier studies in Australia and Ireland [8,11]. However, other influences and barriers to CIMT delivery were identified. Therapist's beliefs about their capabilities (lack of confidence) appeared to influence their decision-making and whether or not they offered CIMT to potential candidates. An important enabler was social influences and the existing strong working relationships between occupational therapy and physiotherapy. However, there was a need to enhance relationships within the multidisciplinary team to make CIMT programs feasible in busy public health settings. Consolidating existing collaborative relationships between the occupational therapy and physiotherapy disciplines, and delivering CIMT using an interdisciplinary model, was one strategy to overcome these barriers.

We also found that education and training alone were likely to be insufficient to implement and sustain CIMT delivery, consistent with behaviour change interventions used in other areas of stroke care and rehabilitation [24,25]. Although workshops helped improve therapists' knowledge of CIMT and their skills, other strategies such as local champions and a community of practice, regular audit and feedback to teams, drop-in sessions and poster reminders were also needed to support behaviour change. The monthly community of practice meetings helped therapists share practical advice and develop their confidence in a supportive environment.

This behaviour change intervention was developed using a systematic process. Tailoring behaviour change interventions to local barriers and facilitators is more likely to result in clinician behaviour change than guideline dissemination or educational materials alone [16]. However, the methods used in this study were time and resource intensive. These processes cannot support rapid knowledge translation by clinicians. To address this challenge, Atkins and colleagues [19] suggest the use of an adaptive interview method where interview questions target the three components of the COM-B system (capability, opportunity, motivation-behaviour). Dependent on participant responses, additional questions can be asked representing the related TDF domains. This alternative interview process may be simpler, help expedite analysis and design of implementation strategies, and support rapid implementation in practice.

A number of patient-related barriers to CIMT delivery were reported by therapists. Some of these barriers did not fit a specific TDF domain. Consistent with the findings of Stewart and colleagues [24], patient-related barriers identified in this project included lack of carer support, concern about patient acceptance of CIMT program intensity, and lack of patient motivation. Stroke survivors have reported that upper limb rehabilitation is a

neglected area of their recovery [26], yet some stroke survivors, including those with severe upper limb weakness, can and do participate in high intensity programs when they are provided [27]. This willingness suggests that therapists have a key role to play in ensuring that stroke survivors are educated about evidence based interventions and opportunities to participate in these therapies.

Baseline file audits during our study revealed that almost no CIMT programs were being offered in the nine month period prior to delivery of the implementation package. Therefore, further investigation is needed regarding therapists' attitudes towards patient motivation, how these attitudes influence the interventions that are offered to stroke survivors, and how these attitudes influence therapists' decision-making about the prioritisation and delivery of interventions.

Strengths and limitations

There were numerous strengths for this study. Firstly, data were collected from all nine teams in the ACTIveARM project, including allied health managers involved in both department and district service planning. This comprehensive sampling process allowed identification of barriers to, and enablers of CIMT delivery at a team, hospital and service (district) level. Secondly, the development and design of the tailored behaviour change intervention was informed by multiple sources, including focus group and interview data, and relevant behaviour change theory [14,18,28]. We considered the strength of evidence in relation to implementation strategies known to change behaviour [29–32], and relied on previous research with clinicians who had successfully implemented [11] and sustained CIMT programs internationally [33].

One study limitation was use of self-reported data when identifying barriers and enablers to CIMT delivery (from focus groups and interviews). Self-reporting may have biased the views presented, with therapists focusing primarily on external rather than internal factors that influenced their behaviour. Future studies could triangulate data, using clinical observation of therapists or validated TDF surveys [34] to confirm findings. Although therapists raised patient-related factors as a potential barrier to CIMT implementation, this barrier was not corroborated with patients or carers. The views of service users and carers are needed about barriers to, and enablers of CIMT delivery. Service users should also be involved in the co-design of implementation strategies.

Another potential limitation is that the study was conducted within only one public health district in Sydney, Australia. Whilst we considered a range of different clinical settings within this context and interviewed a representative sample (greater than 85% of clinicians per participating team were interviewed), the findings may not be generalisable to other clinical settings, such as private practice or alternative healthcare system structures which may have different barriers and enablers to CIMT delivery (e.g. different staffing structures and service delivery models).

Implications for practice

We developed a theoretically-informed behaviour change intervention and identified factors that were needed to support therapists delivering a complex evidence-based intervention (CIMT) in practice. Our findings again highlight that traditional methods of evidence dissemination, such as training workshops, may be insufficient to overcome barriers to practice change when used in isolation. The next phase of this research program is to test the multifaceted behaviour change intervention across a range of clinical settings, understand the effectiveness of the behaviour change intervention in different clinical contexts and, if effective, it's suitability for generalisation across other health services.

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Ethical approval

The South Western Sydney Local Health District (SWSLHD) Human Research and Ethics Committee (ethics number HREC/16/LPOOL/419) approved this study. All participating hospitals subsequently provided ethical governance clearances prior to data collection. All participants gave written informed consent before data collection began.

Author contributions

LC conceptualised the study, contributed to the design of the study and methods and obtained funding; completed data collection, data analysis, prepared the first draft of the manuscript and revised and approved the final manuscript. RR contributed to data analysis, revised and approved the final manuscript. AM contributed to the design of the study and methods and obtained funding, contributed to data analysis, revised and approved the final manuscript. NF contributed to data analysis, revised and approved the final manuscript. AH assisted data collection, contributed to data analysis, revised and approved the final manuscript. ML contributed to the design of the study and methods and obtained funding, contributed to data analysis, revised and approved the final manuscript.

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ORCID

Lauren J. Christie http://orcid.org/0000-0003-4900-5614
Reem Rendell http://orcid.org/0000-0001-7522-3012
Annie McCluskey http://orcid.org/0000-0002-9719-6657
Nicola Fearn http://orcid.org/0000-0002-9332-1043
Abigail Hunter http://orcid.org/0000-0002-4395-9460
Meryl Lovarini http://orcid.org/0000-0003-4304-0793

Data availability statement

The data that support the findings of this study are available on request from the corresponding author [LJC], upon reasonable

request but restrictions apply to the availability of these data in accordance with the approved ethics protocol for this study. The data are not publicly available due to them containing information that could compromise research participant privacy/consent.

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