

BMJ Open Exploration of physiotherapists' use of motor control strategies for the treatment of idiopathic toe walking in children: a qualitative study

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ABSTRACT

Objectives To explore how motor control interventions are conceptualised during treatment of children with idiopathic toe walking (ITW) by physiotherapists in Australia and USA.

Design A thematic content framework qualitative design was used to triangulate the theories underpinning motor control interventions and participant responses.

Participants Ten paediatric physiotherapists were recruited from Australia and USA. Participation was only open to physiotherapists who provided treatment to children with ITW.

Results Physiotherapists defined the motor control interventions used for children with ITW as having the following non-hierarchical key elements: *use of repetition; task scaffolding; encouraging error recognition; and, active and/or passive movements*. Physiotherapists also described two superordinate themes; (1) *We see motor control through the lens of how we view management* and (2) *Idiopathic toe walking treatment is a game with rules that are made to be broken*.

Conclusions Treatment of ITW continues to challenge clinicians. Physiotherapists viewed their approach to ITW management being evidence-informed, underpinned by motor learning theories, movement strategies and organisational treatment frameworks or guidelines to fit their individual childrens' needs. Future research should investigate if this approach affords more favourable outcomes for children with ITW gait.

Idiopathic toe walking (ITW) is a common exclusionary diagnosis describing when a child has limited or absent heel strike at the contact phase of the gait cycle without any medical reason for the gait disturbance.¹ Sustained toe walking has been associated with ankle equinus,² which can contribute to poor performance in motor tasks,³ lower participation in physical activity,⁴ musculo-skeletal deformity⁵ and pain.⁶ These are the common driving factors for parents to seek care from physiotherapists when their child is diagnosed with ITW.⁷

Clinicians and families express significant challenges in navigating effective, evidence-based interventions for children with

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This research was limited by potential participant self-selection bias.
- ⇒ Findings may not be reflective of practices in other countries with differing health systems.
- ⇒ In spite of reaching saturation, this research may inadvertently have understated or overstated the themes and their relationship to motor learning and control theories.
- ⇒ The strengths of this research are how the data were triangulated to known motor control theories.

ITW.^{8,9} Parents have described seeking care from multiple health providers and experiencing contradictory messages and treatment options.^{7,9} Clinicians have also described challenges in knowing when to initiate treatment. Further, having limited evidence to support ITW treatments, clinicians have observed variable success with some children and treatment failures with other children.⁸ The evidence supporting ITW management techniques is currently equivocal and clinicians may be unaware of evidence underpinning techniques used in clinical practice.¹

In a recent study, 532 of 589 physiotherapists located in Australia and the USA reported using motor control strategies for the treatment of ITW in children,⁸ yet there is only one small case series study that reported its application for ITW management.¹⁰ Study findings described a lack of significant impact on gait, yet this popular treatment approach continues to be used. Motor control is defined as the 'ability to initiate, direct and regulate movement essential for voluntary movement'.¹¹ It is intertwined with motor learning theory, such as Adams closed loop theory¹² or Schmidt's Schema theory,¹³ where the learner shifts from poorly to highly skilled in the activity.¹⁴ Clinicians may thus apply the theory of motor control, in combination with the strategies of motor learning, as an

intervention strategy. Despite these terminology challenges, motor control or motor learning-based treatments have been successfully applied to children presenting with toe walking gait arising from other medical causes such as cerebral palsy.¹⁵ This approach aims to focus not only on impairment remediation (eg, range of motion, strength deficits) but the facilitation of physical activity goals to optimise participation.

Given the usage of motor control interventions by physiotherapists during treatment of children with ITW,⁸ the primary aim of this research was to explore how motor control interventions are conceptualised during ITW treatment by physiotherapists in Australia and USA. The secondary aims were to identify how motor learning interventions and strategies were employed, and how treatment outcomes are measured when using motor control interventions.

METHODS

A qualitative research design was used with semi-structured interviews, and the Consolidated Criteria for Reporting Qualitative Research was applied to ensure study rigour.¹⁶

Patient and public involvement

There was no patient or public involvement in the design of this study. Findings will be disseminated to study participants on request.

Participant recruitment

Participants were recruited via advertisements to physiotherapists within Australia and USA through professional organisations, clinical and researcher informal and formal professional and workplace networks and via online social media. Participation was only open to clinicians who currently provided treatment to children with ITW. All participants provided written informed consent prior to their interview.

Data collection

After confirming inclusion criteria, interviews were conducted at a mutually convenient time using web-based conferencing methodology. Rest breaks were offered if requested. Participants provided demographic information including their credentials, job title, job role, gender and work experiences. They were also asked to describe their workplace experience including settings, any split between different job roles, common demographics of patients referred, workplace role, years of experience and any relevant postgraduate qualifications.

All interviews were conducted by a single clinician researcher (AC), who has extensive experience in assessing, treating and researching children who have ITW. Due to this experience, bracketing principles were applied to ensure there was open-mindedness during the interviews.¹⁷ These principles included the questions being developed and piloted by the research team with diverse research and clinical skills, including a highly

experienced physiotherapist, who does not treat children with ITW.

The interviewer used the semi-structure interview script to elicit responses about the participants' use of motor control interventions with children with ITW (online supplemental file 1). Questions prompted participants to describe their clinical practice in managing ITW, particularly focusing on motor control interventions, and how treatment outcomes were measured. Questions were designed to discourage leading answers, and where needed, additional probing questions were used as per the interview guide.

The interview was video recorded, and data was transcribed verbatim using a third party transcription service. The accuracy of the transcription was confirmed by the principal researcher (AC) through relistening to the audio and repeatedly reading the transcription. Participants were offered a copy of their transcription after the completion of their interview for member checking prior to data analysis.

Data analysis

Descriptive statistics were used to summarise the demographic data of participants. A thematic content framework method was used for data analysis.^{18 19} This method was used due to the homogeneous nature of the research question, participants' training or scope of practice, population of interest, theoretical frameworks underpinning the questions and the interview process. The analysis method enabled key themes to be extracted from the whole data set, while using the views and intervention context described by each participant to be exposed, compared and contrasted. Early coding and theme development was inductive. This approach allowed the participants' responses to determine and inform emerging themes.

Four transcriptions were initially coded by two researchers (AC and CW). An analytical framework was developed and applied to the remaining transcriptions in an iterative process. The analysis undertook the following steps: Individual transcripts were read multiple times. This enabled the researchers to develop a deep understanding of the thoughts of the participants. Descriptive notes and initial nodes were created using colour coding in Microsoft Word 2016 (Microsoft, Redmond, Washington, USA). The nodes were then used to create themes unique to each transcript. When all transcripts were coded, similar themes were grouped together. To address the primary aim, theories underpinning motor control interventions were used to triangulate concepts described by participants. These theories included the Adams closed loop theory¹² or Schmidt's Schema theory.¹³ Subsequently, superordinate and subordinate themes were developed to describe how participants employed the motor learning interventions and strategies, and how they measured treatment outcomes. Direct quotations were taken from participants to illustrate themes and ascribed to individual participants. We ceased recruiting

Table 1 Participant demographics

Participant	Location (country)	Role category	Paediatric specific clinical experience (years)	Estimated number of children with idiopathic toe walking treated per week	Postgraduate qualifications relevant to paediatric practice	Setting
Participant 1	USA	Leadership, clinician	>25 years	2–3	Yes	Hospital
Participant 2	USA	Academic, clinician	>25 years	1–2	Yes	Hospital
Participant 3	USA	Clinician	10–25 years	2	Yes	Community*
Participant 4	Australia	Academic, clinician	<10 years	4	Yes	University, hospital
Participant 5	USA	Leadership, clinician	10–25 years	5	Yes	Community*
Participant 6	Australia	Clinician	10–25 years	1	No	Hospital, community*
Participant 7	Australia	Clinician	>25 years	1	No	Community*
Participant 8	USA	Clinician, leadership	10–25 years	5	Yes	Hospital
Participant 9	USA	Clinician	10–25 years	<2	Yes	University
Participant 10	Australia	Academic, clinician	<10 years	<2	Yes	University, community*

*Inclusive of public and private settings in the community.

and interviewing participants when we reached data saturation. Data saturation was considered being met when no novel nodes or themes were developed during analysis,²⁰ and there was significant response replication.²¹

The researchers acknowledged their personal bias and its potential influence on the research findings.¹⁶ Each coder independently reviewed the transcripts to minimise this potential bias and development of themes were undertaken on review of words and phrases by participants. Any discrepancy in decisions around coding was resolved through discussion with the entire research team.

RESULTS

The interviews were undertaken between March and September 2019 and interviews ranged between 35 and 45 min. Twelve physiotherapists consented to participate (n=4 from Australia, n=8 from USA), with interviews undertaken with 10 physiotherapists. The two remaining physiotherapists withdrew during interview planning due to scheduling challenges. Participants had a mean (SD, range) of 17.7 years (8.1, 5.5–29) of practice experience, and were all women. All (n=10, 100%), worked in more than one type of healthcare setting. Participants also described only working with children, with a broad range of experience working with children with ITW. Some clinicians described up to 50% of their caseload being children with ITW. **Table 1** provides the demographic details regarding individual participants.

Most participants struggled to quantify their response to any question with a scale, therefore all responses were incorporated during development of themes. Similarly, participants did not uniformly provide specific responses

to outcome measures. This was unexpected, despite there not currently being uniform outcome measures for this population. A range of themes were developed regarding how interventions were conceptualised during ITW treatment. The use of motor control interventions for children with ITW was highly influenced by the participants' understanding and experiences in treating the gait condition, their self-identified bias regarding the long-term impact of ITW and any potential impact on motor development and musculoskeletal function.

To address the primary aim, participants defined motor control interventions used for this population as having the following non-hierarchical key elements: *use of repetition; task scaffolding; encouraging error recognition; and, active and/or passive movements*. These elements were aligned with theories as follows:

Use of repetition

The use of repetition in motor skills may be referred to as 'blocked practice' as part of the Adams closed loop theory of motor learning. This element involves performing the same exact movement repeatedly.²² It is thought that repetition in this manner, and through these principles, increases learning towards an accurate motor end goal. Block practice through repetition of practice was highlighted through the statements 'block practice, have a smaller skill and then build it out into bigger functional things...break the skill down, and you look at some of the components of the skill, and you will do multiple repetitions or practices of the smaller component' (P5) and reiterated through the description of the volume of practice as 'take(ing) that much repetition sometimes' (P2) and 'the repetition is either intensive or distributed' (P10).

Task scaffolding

Often a systems model approach to motor control was described by participants in how learning was scaffolded. This scaffolding incorporated multiple sensory inputs; vestibular, tactile, proprioceptive and visual, and is illustrated by the following participant: ‘and I might give them either a visual or tactile cue, but I’m not holding them in that position per se. It’s making them a little bit more aware of how they move through space’ (P1). Task scaffolding was described as changes made within therapy, for example: ‘whether it’s the difficulty of the number of skills added in, or maybe it’s the speed, or maybe it’s the number of reps’ (P5). Targeting an ecological motor learning approach some therapists felt it was best ‘to ensure that some of these strategies are being practiced outside a therapeutic environment’ (P10).

Encouraging error recognition

Both Schmidt’s Schema and Adams closed loop theories highlight a need for error identification in practice, and learning from mistakes.²² Physiotherapists described during scaffolding of practice; error recognition was encouraged such as ‘allowing them to experience some errors’ (P1). This method of learning was reflected in the statement that ‘a feedback process associated with the practice, there’s contextualized practice, which is not necessarily deliberate, but there’s definitely a deliberate nature to that feedback... that allows a child to become cognitively aware of what their body is doing, but then also like teaching internal feedback strategy’ (P10). Other participants described teaching children to find their errors, such as ‘Are you being quiet? Are (you) being loud? And they can generally tell me what that means. And then sort of internalize what I’m asking for... So, there are their strategies about giving cues to the child. Whether it’s auditory, visual, tactile, to guide them, but also to help them reflect on what was an error that they did in their movement pattern, so they can internalize some new patterns’ (P1).

Active and/or passive movements

Participants discussed intertwining passive and active management strategies with treatments such as serial casting, ankle and foot or just foot orthoses as motor control interventions via motor learning strategies. While this was reported, participants described this with suspended disbelief such as ‘this might be a little controversial’ (P1) and describing the movement being forced through equipment use ‘as part the motor control intervention strategy’ (P1). Motor control intervention was often described as an overarching layer to different modalities of treatment highlighted through the statement ‘we’re doing it with a motor learning, motor control aspect to it’ (P5) and ‘because I think, regardless of whatever strategy we’re doing, I would always (use a) motor control (theory)’ (P7). Traditionally, treatment options for ITW are seen as either active or passive conservative management strategies, however others support these

being part of the motor control interventions, such as: ‘serial casting and orthotics, which are, I feel like really strong interventions that work, I feel like they are motor control interventions’ (P2).

Participants described two superordinate themes identifying how motor learning interventions and strategies were employed, and how treatment outcomes were measured when using motor control interventions. These themes were (1) *We see motor control through the lens of how we view management* and (2) *Idiopathic toe walking treatment is a game with rules that are made to be broken*.

Theme 1: we see motor control through the lens of how we view management

Participants described three subordinate themes relating to this theme and how they used a clinical lens during practice. These subthemes included (a) *Impairment versus functional paradigms/Success comes in variable shades* and (b) *We have seen it work before with other populations, why not ITW?*

Impairment versus functional paradigms/success comes in variable shades

All participants discussed that cessation of toe walking was important to either the family or a therapy goal, but was not the only or most important goal. Many participants described outcomes that aligned with the International Classification of Functioning, Disability and Health (ICF) framework.²¹ This framework guides clinicians through assessment, classification and management of function and disability through the lens of participation, daily living and social involvement.²³ This steers clinicians away from the impairment mindset from the medical model of health which may pigeonhole a patient, as in the absence or presence of disease. Physiotherapists when asked to describe their management approach to treating children with ITW stated ‘that the treatment for physical therapy is tailored towards their impairment’ (P1) with often the clinician’s ‘goal is really for them to eliminate toe walking’ (P2). This is reflected in the impairments measured by all clinicians such as range of motion, strength, gait, balance and pain. Participants described the remediation of these impairments as indicators of treatment success. Participants did not highlight one of these factors as more important than another.

A small number of participants described goals and outcomes for social impacts, participation and peer interaction. One clinician stating when ‘it comes down to it, you know, their participations’ the number one thing’ and she has ‘definitely pulled back on treatment with children...if painful participation (has) improved, even if they are still tight, I will still pull back on that because it shows me that something we’re doing is working’ (P8). A way to quantify participation and additional impacts of ITW was through tools identified by some participants, such as the Oxford Ankle and Foot Questionnaire.²⁴ Yet responses did not reflect a strong relationship between

the focus of the management strategy and workplace setting, role within setting or country of workplace.

We've seen it work before with other populations, why not ITW?

Evidence-based practice is the 'integration of best research evidence with clinical expertise and patient values'.²⁵ There was a general consensus by study participants that there was lack of high-quality evidence for the management ITW, including the use of motor control as an intervention. This was a 'frustration' for clinicians with many having the approach of Participant 9 'So I'm always kind of telling families..... a lot of times we're throwing stuff at the wall and hoping something's gonna stick trying to use our best clinical reasoning, based on what we do know'. Describing this approach to evidence-based practice when treating ITW with motor control interventions, Participant 10 stated she uses a 'mishmash of all the different pieces of information that I've been able to pick up and integrate(s) them'. While Participant 5 reflected on the general rules of motor learning and motor control and applied them 'across our practice field'. Further, another described using what she has learnt from the management of other populations. 'I think, we kind of have to pull evidence from other conditions. I guess around dosages ...what type of structures might be more successful than others, and maybe it's not actually been assessed in, or there's no evidence around the idiopathic toe walking population, how effective it is. But we'/re seeing it being used in CP [cerebral palsy]' (P6). Participants referenced patient and family involvement being integral to impairment management or when addressing functional insufficiencies.

Theme 2

The theme *Idiopathic toe walking treatment is a game with rules that are made to be broken* was reiterated by all participants, and the use of motor control was seen as an element during the course of care, but that there were no hard and fast guidelines to guide this. This was highlighted through two subordinate themes: (a) *Timing is key to implementation* and (b) *Algorithms for care*.

Timing is key to implementation

The early timing of such is highlighted by physiotherapists' desire to initiate therapy early, where a toe walking gait style has been adopted. This is in contrast to most observational and interventional studies on children with ITW where interventions start at 4 years of age onwards. Participant 1 discussed a missed 'window of typical gait development' as a challenge to gaining positive outcomes. She follows-up with 'they've learned this motor pattern, it is very hard to unlearn'. Participant 2 reiterated the need for early therapy, stating 'Obviously, the younger the child, the more successful it is... once they have that ingrained pattern, it's really hard'. The theme of timing of therapy did not always relate to age but where on the timeline motor control interventions fell on a 'continuum of care' (P1). Some clinicians felt they were

using motor control intervention within, or in addition to other modalities. Motor control interventions 'need(ed) to be used together' (P4) with other treatment options or that 'motor control overlaps with some of the treatments I do' (P2). Others felt motor control interventions were initiated with improvements in structural impairments ...'motor control has a place for the children who have full range of motion and are able to practice a heel toe gait pattern with a device outside of the clinic' (P1).

Algorithms for care

Care pathways or algorithms of care enable clinicians a best fit approach that outline objectives, expected outcomes, risks and benefits to the child and family. Although not routinely described in the literature, workplace-implemented care pathways or algorithms of care will often use evidence-based practice and models of care to guide decision-making. Some participants felt this was missing in their workplace and it would be 'extremely helpful to have like a, like a treatment algorithm,' (P10) while others stated they 'don't have a cookie cutter protocol' (P6). On reflection of the use of a strict protocol with impairment focused outcomes and goals, Participant 9 stated 'it was interesting, because we started like doing like a retrospective chart review, and found that if we lost a tonne of kids, and we're not sure what happened to them, and so there was a lot, we've had a lot of hypotheses about going, you know, is it possible that the families are more satisfied before we are, as clinicians?'. This reinforces the need for outcomes and goals that align themselves to the ICF framework. This is reflected in Participant 2's comments regarding treatment protocols: 'And I think it also depends again on the child, and we have to tailor our treatments ... there's so many factors to consider... And so I think it's a really hard population to just do like a "one size fits all" treatment approach'. She goes on to acknowledge the difficulty in solid methodology in interventional studies by stating 'So I think that's what makes doing research on this a little tricky, it's because you can't just set up a protocol of interventions that works for every child that toe walks'. This is reiterated in Participant 9's view: 'even studies that come across that might be considered higher level studies, because they are randomized control trials, or, you know, the, when you actually get into the methodology, it's still not great'.

DISCUSSION

This is the first known study exploring the views of physiotherapists and how they considered motor control interventions in relationship to therapy partnerships with children with ITW. We also identified and described how these physiotherapists used motor control strategies during therapy with children who have ITW. Only one study¹⁰ has used motor control interventions in children with ITW to date. Given the complexity highlighted by participants and the variety in how motor control strategies are implemented, this may be the reason the study

reported an absence of effect. Participants also described the challenging constructs of motor control interventions, highlighting how variable they would be for any treatment effect to be measured quantitatively or on a scale. Our findings should encourage researchers to consider refining treatment protocols investigating motor learning interventions through the lens of definitions provided by participants. This will assist in understanding the key elements resulting in positive outcomes.

The themes described by physiotherapists provide descriptions of the ways motor control interventions were used when treating ITW. Thus, physiotherapists described a combination of motor control theories and motor learning strategies. These theories and strategies were interchangeably conceptualised and employed by physiotherapists similar to other rehabilitation studies with children who have movement disorders.¹⁵ This interchangeable practice may be the 'black box' of treatment success, with some physiotherapists individualising strategies more effectively than others but unable to measure or quantify how or why. Ryan *et al*¹⁵ described that how physiotherapists defined motor control strategies was varied, however the personalisation or uniqueness of the approach was similar between studies. This challenges translation and further study of motor control strategies.

Physiotherapists linked motor control interventions with the age and stage of the child. Most observational and interventional studies on children with ITW start at 4 years of age.²⁶ At this age, children have an evolving central nervous system. Through neural plasticity, adaptive motor behaviours in children with ITW may possibly be gained by task specific training.^{27 28} The call for early treatment commencement and the timing of motor control intervention within the management plan, although given with conviction by some therapists within this study, requires further exploration to understand what treatment success looks like.

This research highlights that while one treatment approach might not fit all, principles of care should also underpin any individualised approach. What was apparent is that there was no consistent application of outcome measures or measures of treatment success used by physiotherapists within this present study. Finding disparity in ITW outcome usage is not new, it has been highlighted within both observational and interventional studies.^{1 26} The only quantifiable treatment success measure consistently used by physiotherapists in this present study was cessation of toe walking, a measure that may not be practical, based on what is known about the gait type.²⁹ Clinicians should be cautious when applying this information to generic management plans in the absence of validated protocols or algorithms. Physiotherapists within this present study described the nexus between practice underpinned by evidence and clinical experiences, be it, personal beliefs or organisational policy for condition-management pathways. Where a healthcare professional engages in an action with doubt of its effectiveness, there may be an internal conflict or cognitive dissonance.³⁰

Examples of this internal struggle were highlighted in the reported discussions around algorithms of care, the lens through which they viewed ITW management and their approach to evidence-based practice. Future research should investigate the development of clinician-reported and family-approved outcomes which may assist in identification of ITW treatment success in clinical settings.

This research was limited by potential participant self-selection bias. Physiotherapists who have committed to use and potentially have a favourable opinion in using motor control interventions may have been more motivated to participate. The research team used language during study advertising that aimed to not attract physiotherapists who had a particular bias toward or against this approach, however it was not something that was able to be controlled as part of the recruitment. We also acknowledge bias towards physiotherapists recruited from the USA and Australia, and that findings may not be reflective of practices in other countries with differing health systems. These countries were chosen based on the self-reported use of motor control interventions in ITW treatment practice. This research approach means the results are specific to this participant group and transferability may be limited. This research however may inadvertently have understated or overstated the themes and their relationship to motor learning and control theories.

The strengths of this research are that known theories attributed to motor control are highlighted by participants. This enabled us to map how physiotherapists conceptualised the use of motor control strategies while engaging in treatment of children with ITW. This research also highlighted the challenges physiotherapists face when treating children with ITW with or without motor control strategies as part of their treatment plan. This was observed from outcome measure and goal setting, selecting management pathways and acknowledgement that treatment may mean a shift away from researched-based practice. Future research may consider validating the design implementation and task application when considering a motor control intervention approach during ITW management.

CONCLUSION

This study highlighted the different views of a small cohort of physiotherapists for treatment of children with ITW. This variety in views had similar foundational principles, however resulted in diverse practice. Physiotherapists described using an evidence-based approach to management; often using theories, strategies, frameworks or guidelines to fit their individual patient's needs. Future research should investigate if this approach displays more favourable outcomes for children with ITW.

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Contributors AC and CW conceived the study. AC, PM and CW equally designed the study and the outcomes. AC undertook the data collection. AC, PM and CW undertook the data analysis. AC, PM and CW equally interpreted the data. AC

drafted the manuscript draft and circulated to authors for contribution. AC, PM and CW approved the current manuscript version for publication. AC was the author responsible for the overall content as the guarantor.

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