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INVITED REVIEW

The Bobath Clinical Reasoning Framework: A systems science approach to the complexity of neurodevelopmental conditions, including cerebral palsy

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Abstract

The current recommended developmental Bobath practice within the Bobath Clinical Reasoning Framework (BCRF) can be conceptualized using the lens of systems science, thereby providing a holistic perspective on the interrelatedness and interconnectedness of the variables associated with childhood-onset disability. The BCRF is defined as an in-depth clinical reasoning framework that can be applied to help understand the relationships between the domains of the International Classification of Functioning, Disability and Health, how those domains can be influenced, and how they impact each other. The BCRF is a transdisciplinary observational system and practical reasoning approach that results in an intervention plan. This provides a holistic understanding of the complexity of situations associated with disorders such as cerebral palsy (CP) and the basis for the lifelong management and habilitation of people living with neurological disorders. The clinical reasoning used by the BCRF draws on the important contextual factors of the individual and their social environment, primarily the family unit. It is rooted in an understanding of the interrelationships between typical and atypical development, pathophysiology (sensorimotor, cognitive, behavioural), and neuroscience, and the impact of these body structure and function constructs on activity and participation. The systems science model integral to the BCRF is a useful way forward in understanding and responding to the complexity of CP, the overarching goal being to optimize the lived experience of any individual in any context.

Within a 'real-world' context, therapists need to apply both clinical evidence and a theoretical framework to their practice. Clinical expertise and experience are frequently overlooked components of evidence-based models of practice, often because they can be difficult to standardize and operationalize. This difficulty in operationalizing theoretical frameworks is apparent in the case of the Bobath Clinical Reasoning Framework (BCRF) and Neuro-Developmental Treatment (NDT). There is diversity of practice in how these terms are understood, applied, and practised. Given that many families and therapists advocate for the continuation of Bobath and NDT,[1] it is relevant to clarify the tenets of practice to resolve misconceptions that might impede the interpretation of published studies and to suggest a framework whose epistemic and clinical value can be assessed through future studies.

This review focuses on a recommended model for Bobath practice in developmental disorders, named the BCRF. Recently, this has been framed in a systems science approach to accommodate the complexity of cerebral palsy (CP) and neurodevelopmental disorders. The in-depth nature of clinical reasoning is a core component underpinning the BCRF,

Abbreviations: BCRF, Bobath Clinical Reasoning Framework; ICF, International Classification of Functioning, Disability and Health; NDT, Neuro-Developmental Treatment.

which since 2001 has been applied to the International Classification of Functioning, Disability and Health (ICF) domains.[2] It highlights the importance of identifying specific participation goals to support the involvement of individuals in meaningful life activities.[3] This review attempts to clarify how BCRF thinking may contribute to improving the quality of therapeutical interventions.

HISTORICAL CONTEXT

The foundations of the BCRF can be traced back to the pioneering work of Berta and Karel Bobath eight decades ago. They provided a fundamentally new approach to intervention for people with a neurological disability, in particular CP, from one of compensation to habilitation or rehabilitation. They hypothesized that the central nervous system has the potential for modification in response to experience, with an associated improvement in function, a then emerging concept known as plasticity, which we are now very familiar with.[4] This was essentially different from the compensatory approaches that were pervasive at that time. Other unique elements of Bobath were the transdisciplinary approach to training and treatment (physiotherapists, speech and language therapists, and occupational therapists training and working together), the understanding of the complexity of CP with its motor, sensory, perceptual, cognitive, emotional, and behavioural components, and the adoption of a lifespan perspective, not only considering the child's functioning in the present but predicting the longer-term impact into adulthood. Then, as today, the aim was to 'to help the child to develop his full potential'[4] and to maintain this for as long as possible.

The understanding of the importance of function has since progressed and has been expanded by others. It is now epitomized in the ICF model and our appreciation of the importance of participation. We also now understand that participation in society is multifaceted and not purely reliant on improvements in the body function and structure or activity domains of the ICF.

The Bobaths were incredibly generous in freely sharing their knowledge without licensing it; thus, the concept spread globally. However, the global spread of NDT also brought challenges and divergence.

Over time, differences developed in the teaching and practice of Bobath, with a global division into 'NDT' and 'Bobath', and a further separation into adult and paediatric approaches in many countries. There was no universal standard to teach and continue to practise using Bobath to ensure its coherence and fidelity. In addition, Bobath and NDT are often not practised as intended.[5–7] This diversity in the practice and teaching initiated by the Bobaths, and the change in landscape and language of paediatric neurodisability, are challenges to understand BCRF therapy and how it can be applied to today's contexts for families, therapists, researchers, and service providers.[7,8] This lack of consensus or clear definition, together with the divergence in practice and teaching, has made interpreting and generalizing any reported findings difficult. This has been compounded by shortcomings in research methodology leading to unfavourable reviews in the literature, including a call to de-implement the approach.[9,10]

What this paper adds

- Systems science can visually represent the complexity of cerebral palsy (CP) and the holistic approach of the Bobath Clinical Reasoning Framework (BCRF).
- Complex relationships can be understood through systems science, giving the possibility to predict the impact of an intervention.
- The systems science model integral to the BCRF helps to understand and respond to the complexity of CP.
- The goal of the systems science model is to optimize the lived experience of any individual in any context.

THE BCRF

In 2022, in response to the challenges outlined here, an international group of paediatric Bobath practitioners and tutors from the UK, South Africa, Australia, and New Zealand sought to define and operationalize their Bobath practice. The Bobath Going Forwards group emerged from these discussions and proposed that current paediatric Bobath therapy should be referred to as the BCRF, with the aim of defining and operationalizing the framework.

Literature reviews revealed several recent models for the BCRF and NDT, including two adult,[11,12] and one combined adult and paediatric NDT Association contemporary practice model.[13] These did not match the group's perspective on current developmental BCRF practice.

DEFINING THE BCRF

Historically, the Bobaths did not define the approach in a way that could be operationalized; they suggested that the way of thinking, not the use of techniques, took precedence. This perspective remains integral to Bobath practice but has not previously been set out clearly and needs to be expressed in contemporary language.

The current challenge for Bobath practice is to conceptualize the framework that supports this system of therapy.[8] A literature search led to systems science[14–16] (also referred to as systems theory), which in recent years has been applied to health care. It has been successfully used to understand the complexity of the pathophysiology of concussion in

acquired brain injury[15,16] and in supporting the development of a shared understanding of environmental factors and child health.[14] Systems science offers a way to define and describe Bobath therapy to reflect its focus on clinical reasoning within complexity.[17] The BCRF is thus defined as an in-depth clinical reasoning framework that can be applied to help to understand the relationships between the domains of the ICF, how those domains can be influenced, and how they impact each other to change the overall outcome for the individual.

This leads to a holistic understanding of the complexity of the situation of individuals with developmental disorders and provides the basis for intervention and the lifelong management and habilitation of people living with neurological disorders.

UNDERSTANDING CP AS A COMPLEX DISORDER

The BCRF has been especially used in the context of children with CP. While CP is a heterogeneous disorder with complex aetiology,[18–20] understanding this, and how it shapes the lived experience of people with CP, is an emergent property of a system and a new and emerging area of knowledge. The BCRF is a model that applies clinical reasoning to that system and understands how interventions can modify the system and optimize the outcome.

Complexity results from the many variables that ultimately determine the capacity for activity and participation. This is illustrated in Figure 1, where the focus is on the child and what they can do.

The BCRF can respond to CP, a complex disorder that requires integrated interdisciplinary understanding and management, and recognizes that this complexity requires holistic management, often addressing multiple factors simultaneously. CP cannot be viewed as a single entity with a series of single separate solutions. Bobath practice is a system of interventions whose many ingredients are included in systematic reviews.[8] It cannot, therefore, be compared to a single treatment like botulinum neurotoxin A or constraint-induced movement therapy. The BCRF should not be evaluated as a single intervention but as a system of interventions.

Systems theory is well suited to elucidate the complexity of CP. The advantage of using systems science and its tools as a way of viewing CP is that it facilitates understanding of the interactions of all the components of the system, in both linear and non-linear ways, which is an advantageous approach to the complexity of intervention planning for children with CP. For example, a period of constraint-induced movement therapy alone may have limited effect if variables of sensory functioning, the home and school environment, motivation, and selective muscle control are not taken into account.[21]

The BCRF provides a non-linear framework to respond to this way of understanding CP, in terms of finding the right interventions and the right management, delivered in the right way at the right time, for each child, and considering their overall goals.

Figure 2 shows how the BCRF can be applied to this systems science view of CP and illustrates a holistic perspective on the interrelatedness and interconnectedness of the variables associated with CP. The model demonstrates how these connections between many factors determine which of the many research-based interventions and treatment options

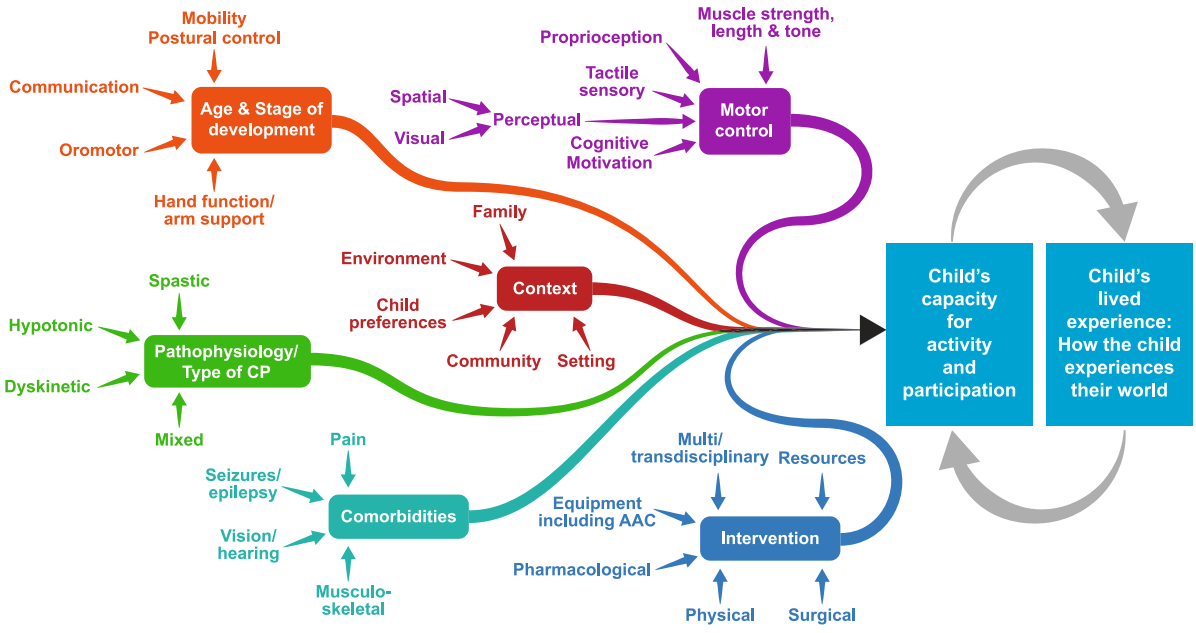

FIGURE 1 The child lived experience depends on the many factors that contribute to their capacity for activity and participation. The left-hand side of the figure depicts the many elements present in varying degrees that contribute to the individual complexity of CP and emphasizes the need for tailor-made intervention. Abbreviations: AAC, augmentative and alternative communication; CP, cerebral palsy.

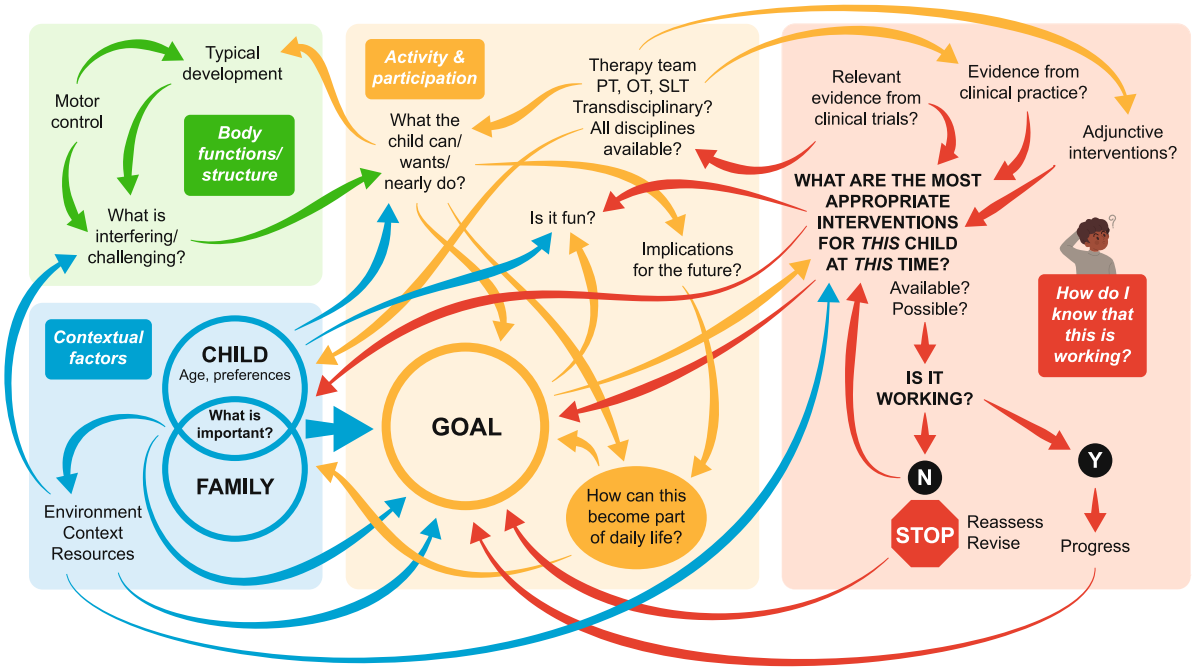

FIGURE 2 The Bobath Clinical Reasoning Framework (BCRF) model for paediatric Bobath based on systems science. The child, family, and their goal(s) are central to the many variables that are interconnected and impact on intervention selection and goal achievement. The various related International Classification of Functioning, Disability and Health factors are shown: activity and participation (orange); contextual factors (blue); and body function and structure (green). The intervention factors are shaded in red. Abbreviations: OT, occupational therapist; PT, physiotherapist; SLT, speech and language therapist.

will be best suited to the individual and how they are best delivered. It also demonstrates that the focus of the therapy is the child, the family, and the goals that are important to them, in line with the principle of family-centred services.[22] The relationships between factors in each of the ICF domains are identified and explored to understand where and how interventions can be applied to achieve the desired participation outcomes. This may involve intervention in a single ICF domain or, more usually, several domains. The intervention is determined based on the analysis and interpretation of what the child can do, can nearly do, and wants to do. Continual reassessment ensures that the intervention remains effective for the child and family.

The BCRF, as a non-linear approach to clinical reasoning, should be differentiated from intervention-based evidence from clinical trials only, which is a more linear, somewhat reductionist, prescriptive approach (Figure 3). For example, to improve walking speed, a period of partial body weight-supported treadmill training is recommended or selective dorsal rhizotomy is suggested to improve gait kinematics.[23] Other management models suggest that a combination of approaches is sometimes used.[24] The BCRF proposes that the complexity of CP often requires multiple component solutions often delivered simultaneously because of the complexity and non-linear nature of CP.

An important aspect of the BCRF is that therapists learn to identify and anticipate the relationships among systems and how these will impact the individual.[25] For example, a child with unilateral spastic CP may neglect their more affected side, leading to overuse of their less affected side, which in turn may limit the potential use of the more affected limb. Determining the potential for improved function of the more affected arm and hand for unilateral or bimanual tasks based on the child's goals, and deciding on the most appropriate interventions, requires a systems understanding of what the child can do, how they do it, and the capacity that they have to do it, incorporating skilled interpretation of these observations. Overuse of the less affected side could be due to lack of primary or secondary sensory awareness and processing, a lack of motor ability because of muscle weakness or spasticity, lack of motivation of the child, or any combination of these factors. This will have an impact on which intervention approach will be important.

Systems science provides a way of showing the interrelationships and interconnectedness of the main components contributing to the complexity of CP; the clinical reasoning applied using the BCRF determines how interventions can be applied in a holistic way with an understanding of that complexity. This holistic intervention plan may address several components of the system simultaneously to achieve the desired goal.

TRAINING AND CLINICAL REASONING

Knowledge acquisition is a critical factor in clinical reasoning and fosters better performance of it.[26] Knowledge acquisition and the development of clinical reasoning expertise is fundamental to the BCRF and involves therapists

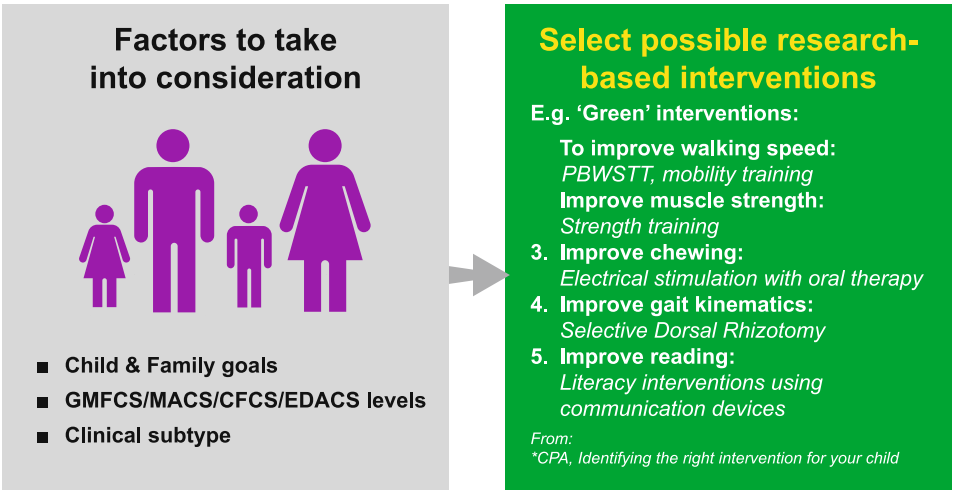

FIGURE 3 Intervention based on clinical research leads to a linear, prescriptive approach to intervention.[23]* Abbreviations: CFCS, Communication Function Classification System; EDACS, Eating and Drinking Ability Classification System; GMFCS, Gross Motor Function Classification System; MACS, Manual Ability Classification System; PBWSTT, Partial Body-Weight Supported Treadmill Training.

undertaking extensive and rigorous training of all therapy disciplines together, so that they learn to share a common thinking and language; this enables not only interdisciplinary but also transdisciplinary working.[27] This focus on clinical reasoning makes the approach adaptable to all resource settings. This is particularly important in resource-constrained areas (Appendix S2, clinical case study 2). Working with the complexity of the coronavirus pandemic, Klement,[28] suggested that transdisciplinary practice was the highest and most effective way of working because of sharing in a conceptual framework. This type of practice is a key component of the BCRF.

THE BCRF IN PRACTICE

A modified version of the clinical reasoning cycle originally described by Levett-Jones et al.[29] explains the process of the BCRF clinical reasoning as shown in Figure 4. The 'collect information' section of the cycle is where the clinician uses in-depth knowledge, for example, of typical child development, movement disorders, and the neuroscience of motor control to establish what is hindering the child's ability to do a task more effectively or to learn a new task. Based around the child's goals, this information gathering step, and most importantly its analysis and interpretation, is critical in hypothesizing the best interventions at any particular time.

The steps taken by the BCRF therapist to determine the clinical decision-making for each child are not dissimilar to how most therapists would approach this task.[9,24,30,31] Figures 4 and 5 (see also Appendix S1, clinical case study 1) illustrate how the BCRF addresses the problem-solving approach to clinical reasoning. The emphasis is on the activity and participation domains, but it is also important to recognize the body function and structure domain of the ICF to determine what impairments might be amenable to management in a way that may positively impact multiple activity and participation outcomes.

Clinical case study 1 (Appendix S1) describes a child with bilateral spastic CP, classified in Gross Motor Function Classification System (GMFCS) level III, aged 2 years 6 months, where the goal is for the child to be able to play independently on the floor while sitting with peers (participation domain; for a detailed report of the clinical case study, see Appendix S1). The intervention focus is on activity while standing to promote trunk activity and weight transference (activity domain) to then enable easier practice of play while sitting (participation domain) and the ability to move in and out of sitting. Therapeutic handling can be a valuable tool to assist this.

It must be stressed that the aim cannot be 'normality' (i.e. trying to 'fix the child') or to follow the typical developmental sequence, but rather to use the BCRF to gain a holistic understanding of the relationship of the many interrelated factors in the different domains of the ICF as a basis for optimally achieving the goal of a child or their family by applying the science of systems thinking and the principles of neuroscience in particular.

The BCRF appreciates that neuroplasticity is at the heart of development.[4] The child's active experience drives their development in all domains, with particular intensity during the first 2 years of life. Such neuroplasticity is driven by activity, novelty, and meaningful practice; the developing infant is constantly challenged by the environment and the task to become more proficient. This concept of experience-dependent plasticity also underpins learning in the child with CP, and the principles of motor control and learning are applied to the practice of tasks, which is always incorporated into daily living as an achievable and motivating goal, providing the intensity required to drive neural changes, irrespective of the setting in which the child is living.

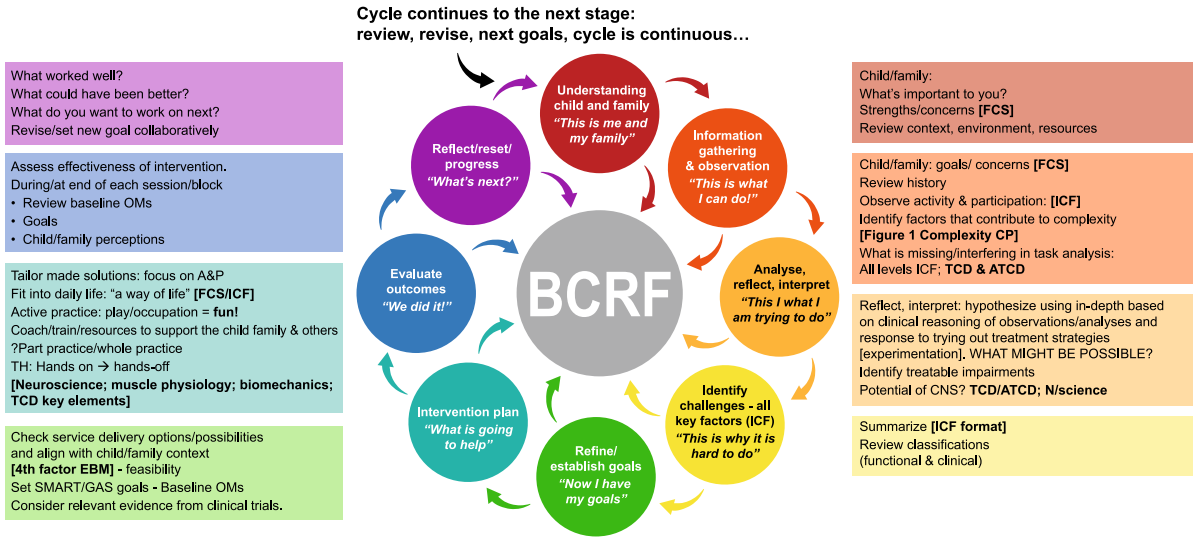

FIGURE 4 The clinical reasoning cycle adapted for the Bobath Clinical Reasoning Framework. Abbreviations: ATCD, atypically developing child; CNS, central nervous system; EBM, evidence-based medicine; FCS, Family Centred Service; GAS, Goal Attainment Scaling; ICF, International Classification of Functioning, Disability and Health; OMs, outcome measures; SMART, Specific, Measurable, Achievable, Relevant, Timed goals; TCD, typical child development.

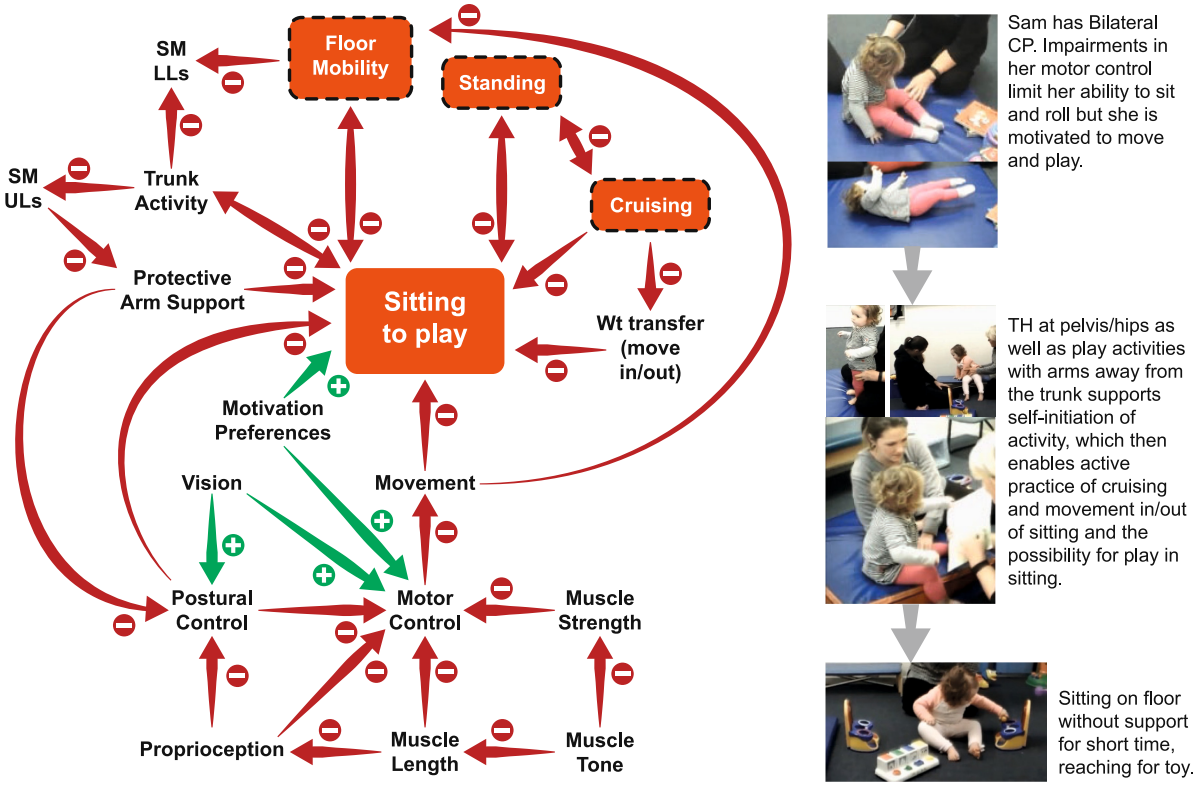

FIGURE 5 Simple causal loops of some of the factors that contribute to the impairments of motor activity which need to be managed to achieve the goal of independence in sitting to play within the treatment session (Appendix S1, clinical case study 1). Abbreviations: CP, cerebral palsy. SM, selective movement; TH, therapeutic handling; ULs, upper limbs; LLs, lower limbs.

THE BCRF IS APPLICABLE TO ALL PEOPLE AND IN ALL SETTINGS

The BCRF places the child and family centrally; as described, it has the advantage of being a holistic, systems theory-informed, transdisciplinary approach that can be applied to any child in any context, irrespective of their functional classification level. It uses this understanding to select from and apply available interventions, technology, and a range of assistive devices to achieve the goal. This is extremely important in resource-constrained settings where therapists are confronted with a high proportion of children

functioning in GMFCS levels IV and V who have significant comorbidities and other impairments.[32] Given that most children with CP live in low- and middle-income countries, this is extremely relevant.[33]

As illustrated in clinical case study 2 (Appendix S2), for a young person classified in GMFCS level V, effective intervention for the identified goal of comfortable sitting was intricately linked to the goals of safety for eating and drinking, participation in community activity with friends, and improved respiration for communication using voice. Achievement of this goal was dependent on the therapist's ability to analyse how the causal links between the elements of motor subtype (dystonia in the context of dyskinetic CP) were impairing the child's ability to sit comfortably in an assistive device. Without access to medication, surgery, and technology, the therapist was dependent on their therapeutic handling skills, understanding the level of body function and structure (impairments), and their link to activity and participation to clinically reason how to achieve these goals (Figure 6).

These case studies provide some insight into the in-depth analysis of the BCRF, which provides therapists with a way of deciding which tools may or may not be effective for an individual child. It enables therapists to consider the complexity of the disorder and combine interventions to provide a tailor-made therapy programme for each child, whatever their context. Integrating the intervention activities into daily life routinely, another key element of the BCRF, means that treatment is seamlessly transposed into the lived experience of the child and becomes a way of life.

THE BCRF AND RESEARCH-BASED PRACTICE

As part of the in-depth clinical reasoning skills (Figure 4 and Appendices S1 and S2), and embedded in the training, the BCRF-trained therapist considers research evidence when planning interventions (Figure 2).

Recent publications focused on experimental evidence in the form of systematic reviews, which synthesize experimental studies, mostly randomized controlled trials. While these have been developed with the intention of making decisions about intervention choices easier for clinicians, the traffic light alert system is an oversimplification.[8,34,35] Because of a lack of methodological rigour, randomized controlled trials and systematic reviews should be viewed with caution to understand effective treatments.[36,37]

Research into a complex disorder like CP, which often requires a combination of different intervention ingredients for different individuals, is challenging;[24,30,37] as suggested in this review, a reductionist or linear approach to intervention is inadequate in addressing the complexity of the disorder. Testing the non-linear, systems thinking-based clinical reasoning used by the BCRF raises many challenges and requires a different approach from the use of randomized

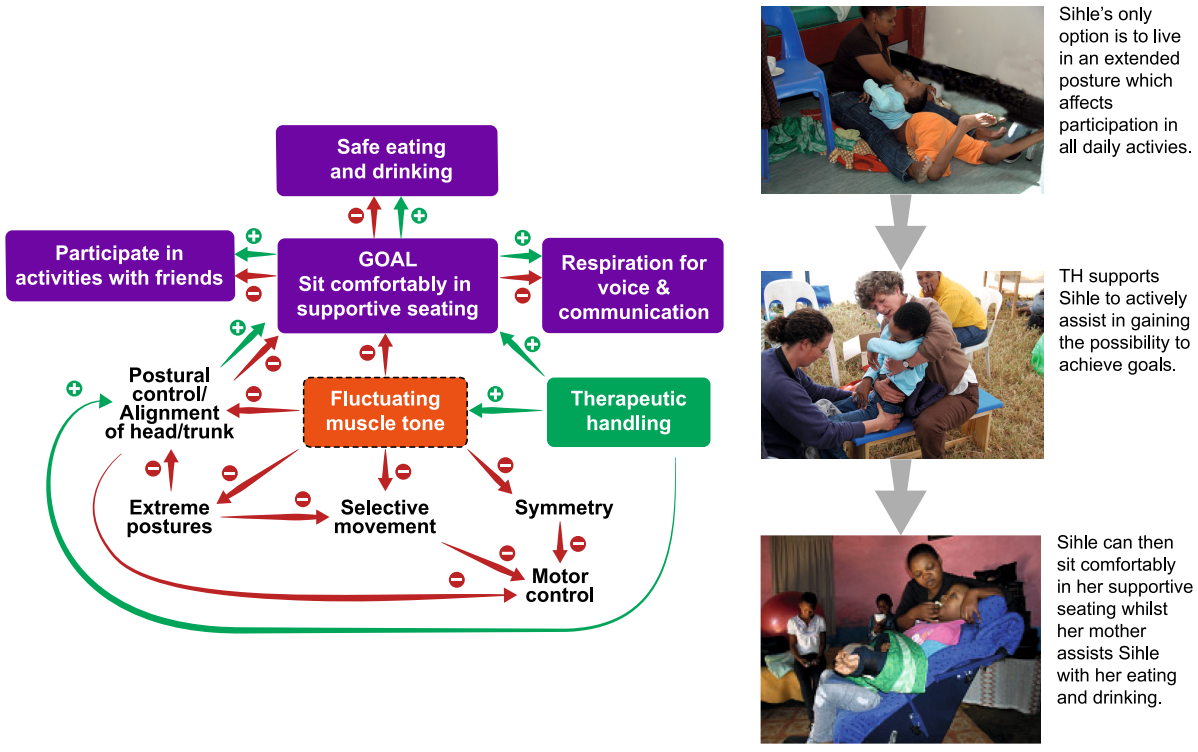

FIGURE 6 Therapeutic handling (TH) was key in assisting this young person to achieve the goal of sitting comfortably, which also enabled safe eating and drinking, improved breath control for voice for communication, and the opportunity to go out in her buggy with friends (Appendix S2, clinical case study 2).

controlled trials, as discussed by Gough and Shortland.[38] They articulated the difficulty of decision-making for best treatment based on the average findings of clinical trials when faced with the individual, and asked if clinicians would feel able to override the guidelines provided by systematic reviews based on their understanding of the patient and their preferences.[38] A fourth factor for consideration in evidence-based practice is the clinical practice context.[39,40] This is vital to include because it considers the mode of service delivery as well as financial constraints, important aspects to consider in decision-making connected to service delivery and available resources, particularly in the family context, as highlighted in clinical study 2.

THE WAY FORWARD

Many of the basic tenets of the BCRF are not new or unique and are applied in usual clinical practice, including that child and family goals and motivation are paramount when selecting treatment priorities.[24]

Factors more unique to the BCRF are: (1) understanding that CP is a complex disorder with many non-linear interactions, where the same activity limitations and participation restrictions may be caused by varied combinations of impairments to body functions and structure that are influenced by a range of personal and environmental factors;[17] and (2) multidisciplinary and transdisciplinary care are important for the holistic treatment of each individual.

A shift in emphasis of research into evidence-based practice is essential to contend with the complexity of neurodevelopmental disorders and their impact on the lived experience of the individual.

Ways of measuring complex interventions need to be developed; this may require input from non-traditional health research communities, for example, systems science experts, system modellers, and data analysts.[41]

This review provides a current definition and model of recommended paediatric Bobath practice that sets the approach within a systems science model. It is complementary to and collaborative with usual clinical practice.

A limitation of this review is that it is not representative of all Bobath practitioners. Each author has over 30 years' experience of working in neurodisability using the Bobath approach, and one author worked with Dr and Mrs Bobath for 7 years. The authors practice in high-income countries and also in low-to-middle income countries across three continents; all have been, or currently are, senior Bobath tutors. Hopefully, our collective experience will drive further development of the BCRF through global discussions with Bobath- and non-Bobath-trained clinicians and researchers.

CONCLUSION

This review describes the detailed clinical reasoning applied using the BCRF and explains how this approach is distinct from others in addressing neurodevelopmental disorders through a systems theory perspective. This is important in interventions addressing complex neurodevelopmental disorders. The systems science model adopted by the BCRF provides a unique understanding and perspective in the management of CP and is a helpful framework for planning and delivering intervention and management programmes. This approach requires appraisal and research using systems theory-based methods.

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DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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SUPPORTING INFORMATION

The following additional material may be found online:

Appendix S1: Clinical Case Study 1: Bobath Clinical Reasoning Framework.

Appendix S2: Clinical case study 2: Bobath Clinical Reasoning Framework (low- to middle-income countries).

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