

THE CONCEPTUALIZATION OF NDT-BASED HANDLING

TECHNIQUES FOR INFANTS: TWO PERSPECTIVES

Preface

The article to follow is intended to provide both general and more detailed information on the NDT (Neuro-Developmental Treatment) / Bobath frame of practice applicable for infants with and/or at risk for cerebral palsy and related neuromotor disorders. Readers, including habilitative therapists, will benefit from an update of theories and concepts applicable to this approach. It is also intended to orient those less familiar with NDT and thus may be of interest to healthcare professionals involved in the examination, evaluation and/or referral of infants for therapeutic assessment and/or treatment. Below, the most current and comprehensive operational definition of NDT is included. Its review includes NDT's role in the management of infants as well as children with CP and related disorders throughout their lifespan. The NDT frame of reference is also applicable to adults with strokes and head injuries.

NDT Defined

NDT is a holistic and interdisciplinary clinical practice model informed by current and evolving research that emphasizes individualized therapeutic handling based on movement analysis for habilitative and rehabilitation of individuals with neurological pathophysiology. The therapist uses the International Classification of Functioning, Disability and Health (ICF) model in a problem-solving approach to assess activity and participation, thereby to identify and prioritize relevant integrities and impairments as a basis for establishing achievable outcomes with clients and caregivers. An in-depth knowledge of the human movement system, including the understanding of typical and atypical development, and expertise in analyzing postural control, movement, activity, and participation throughout the lifespan, from the basic examination, evaluation and intervention. Therapeutic handling, used during evaluation and intervention, consists of a dynamic reciprocal interaction between the client and therapist for activating optimal sensorimotor processing, task performance, and skill acquisition to enable participation in meaningful activities.

Reference: Cayo C. Diamond M, Bovre, T, et al. The NDT/Bobath (Neuro Developmental Treatment/Bobath) Approach. NDTA Network, 2015:22(2):1. Updated by the Instructors Group of NDTA, May 27, 2016.

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INTRODUCTION

The purpose of this article is to describe the “concept” of NDT-based handling techniques, specifically utilized for infants. A concept can be described as “something conceived in the mind; a thought or notion”. 1. While selected concepts are presented via written descriptions of certain infant handling tactics and strategies, others are derived from related principles as well as lessons learned from infant tests. Numerous concepts, in addition to some previously published by others, are used with the intent of expanding the true depth involved in the conceptualization of infant NDT. Additionally, it should be born in mind that concepts are a component of supported theories which are briefly described within. This article presents two major perspectives, one being an ecological and practical viewpoint and the second stemming from a complementary neuromotor examination used for infants. The two major perspectives are then connected via an additional test that contains both of these.

PERSPECTIVE ONE: NATURALISTIC ECOLOGICALLY VALID AND PRACTICAL VIEWPOINT

Finnie’s Contribution

Nancie Finnie, who wrote the classic book *Handling the Young Cerebral Palsied Child at Home* (first in 1968 and updated in 1974), 2, 3 recognized the importance of context and environment for function and therapy using a Neurodevelopmental Therapy (NDT) framework. A third edition was published in 1997 and re-named to reflect contemporary terminology *Handling the Young Child with Cerebral Palsy at Home* and demonstrating that this book had withstood the test of time. 4. A fourth edition with a new editor, Eva Bower, PhD, FCSP, was published in 2009. 5. It maintains the spirit of this classic NDT text but includes updated family-friendly information with new additions. These include diagnostic information including imaging photos as well as the Gross Motor Function Classification System (GMFCS). It should prove beneficial to parents and new professionals seeking information about the practical application of NDT-based handling techniques. The line drawings are clearer and therapists working in early intervention programs may find it a source of daily care routines for the embedding of therapeutic goals.

As astutely recognized by Fethers, the Finnie book was instrumental in making the NDT Approach ecologically valid and thus in line with current viewpoints applicable in pediatric therapy. 6. Perhaps the true strength of the handling techniques depicted in the Finnie book, using illustrations of infants and young children who appear to have real challenges of atypical postural alignment, is that they are carried out in real-life situations, i.e., when the care-giver is managing the child during daily routines at home. The use of furniture and materials of everyday life and/or the use of pieces of therapy equipment commonly employed in NDT are placed in the hands and environments of parents and caregivers. Hence the ecological validity of NDT handling techniques is supported. This important practical recognition was obviously made in light of Fethers’ appreciation of the importance of the environment stemming from her knowledge and potential benefit of ecological theories.

Fethers’ acknowledgement of this concept related to her study and understanding of J. J. Gibson who used the term *affordances* to describe the concept that links the environment and humans. Eleanor

Gibson applied the concept of affordances to development, and proposed that infants spend the first year of life exploring and defining the affordances in their world, learning the properties of objects and the relationship between themselves and their environment. The earlier mention of object exploration in normal infants was found to be quite different in a study of object exploration of infants who were born prematurely. Selected findings included a significant decrease in object exploration in the first six months of life, as well as poor use of multiple hand functions. The investigators claimed that very early intervention to promote a variety of important hand functions is vital to prevent what they referred to as “a negative learning loop”. 7. Therapists capitalize upon this theoretical model by modifying the infant or young child’s home and/or therapeutic environment in order to afford opportunities by designing treatment “set-ups” that make participation within the targeted activity either easier or more challenging. Eleanor Gibson also proposed the concept of *visual proprioception* which results in variations to movement upon a variety of surfaces, each with “nooks and crannies” that result in a variation of visual input. Visual proprioception can be described as the optically produced awareness of self-movement that stems from the co-variation between movement and the optic flow field. Recognition of this concept fosters our appreciation of the close linkage between vision and movement and encourages us to facilitate and/or practice movement skills on a variety of surfaces. In summary, ecological theory and its components go beyond the development of movement to include vital early skills including perception, cognition, spatial relationships and others. 8.

All Infants, Both Typical and Those with Special Needs, Require Handling

From a very pragmatic point of view, it was recognized in NDT that babies and young children are handled and require handling in order to be optimally cared for and have their emerging developmental skills guided. Babies are naturally picked up, lifted, held with adequate support where and when needed, carried, put down, have their positions changed, dressed, undressed, bathed, fed, moved through space, played with, rough-housed, and so on. Therefore, we have many natural, built-in windows of opportunity for intervention for the child with special needs. These can be tapped into with an understanding or appreciation of the underlying and developmentally potential emerging skills of the infant. Under normal conditions, the degree of support and control offered by the caregiver or handler changes in a naturalistic manner. The handler without seeming awareness decreases the amount of support offered and allows the child to use his developed or emerging postural and motor competencies. For example initially, an infant is carried with adequate support of the head, trunk and lower body. This allows for organization, postural symmetry, placement of hands toward midline and other skills. As the child’s head and trunk control improve, by approximately four months, the handler now only provides support at the mid and lower trunk. This allows the infant to use and practice his or her new skills and in turn, strengthen associated muscle groups while practicing their emerging anti-gravity postural control.

The conceptualization of the above-described naturally occurring handling practices of typically developing infants fosters our appreciation of the potential power of handling. We can imagine a multitude of enriching, daily and developmentally appropriate sensorimotor as well as social emotional experiences and interactions. Such recognition was the hypothesis of a study that examined the effect of enhanced training to promote the development of head control in normally developing young infants. Modification of positioning, handling and infant/care-giver interactions resulted in improved head control of the training group. Specific to the handling component, care-givers were instructed to stimulate more active head control and to offer less head support than is normally provided to young infants. Such studies contribute to the accumulation of evidence of this natural-ecological perspective of handling techniques. 9. Prior to

concluding this section focusing upon the handling of infants during routine care practices and the increased use of carrying seats resulting in what has clinically been termed “containerized babies”, an important and timely article that discusses the use of fabric/soft carriers presents a variety of fabric carriers, their manufacturers, benefits and disadvantages with suggestions of which may be most appropriate for children with a variety of neuro-motor disorders. 10.

Infants with Special Needs Require Specialized Handling

Infants who require intervention also need to be handled, albeit for longer periods and/or with an increased awareness of their underlying impairments so as to allow the handler to adapt accordingly. This may mean that the handler must offer greater support to certain areas, carry the infant in a particular orientation with regards to gravity or to more vigorously elicit certain automatic responses so as to facilitate optimal and potentially available postural control and motor skills. Therapists learn the components of movement of typically developing infants, particularly the bio-mechanical and related alignment changes within each position (supine, prone, sitting, standing and walking) 11 along with an in-depth understanding of the process of development and the interconnection between multiple domains of development. This process is particularly pertinent in light of our recognition of a variety of theoretical foundations that go far beyond motor skills. This knowledge is integrated with an understanding of the natural course of development in infants with motor skill challenges. In turn, this information is shared with other caregivers in order to promote the carryover of handling throughout the day.

The Alberta Infant Motor Scale (AIMS) has been used to identify problems in motor development of babies 18 months or younger. The record booklet includes line drawings of basic postures and movement transitions. A summary of key qualitative descriptions of each skill offers a condensed means for evaluation and also a quick study of what to anticipate. This test if used via observation and administration with typical infants and young children may be helpful to therapists, parents and other caregivers. This suggestion is not meant to imply that the sequence presented on the AIMS needs to be followed but rather that the key components of 1) basic postural alignment, 2) anti-gravity movements, and 3) weight-bearing patterns may offer insights into the handling needs of infants. 12. Although tempting, especially when handling babies, it is well-appreciated that typical motor development is uneven and non-linear in direction and marked by periods of progression and regression. The Bobaths and since then others have reminded us of the potential danger of using the normal motor sequence as a strict template for treatment planning. 13, 14. In fact, a key concept of NDT infant treatment is to work in the past, present and future. 15.

The NDT-based Infant Sequenced Trunk Activation Treatment Protocol Within the NDT Problem-Solving Assessment and Intervention Planning is available through the primary author of the article referenced in the bibliography. This protocol exquisitely describes the essential postural and movement components utilized in the NDT approach to infants. These include vertical orientation of the head, horizontal-visual gaze, an appropriate base of support, neutral pelvic alignment, actively balanced trunk musculature with weight shifting, elongation of the trunk on the weight bearing side as well as appropriate relationships of the head and body parts to the base of support. 16.

A Sampling of Impairments and Variables Addressed and Used During Handling

Overlapping impairment-level neuro-musculoskeletal and other challenges may require attention during both therapy sessions and the carryover and integration of handling techniques which need to be embedded into daily care practices. Stated simply, the NDT practice framework utilizes infant handling

tactics with a firm appreciation of impairment-level challenges with the goal of reducing functional limitations and participatory activities. This dynamic and complex process necessitates the therapist's need to take into account the child and his family, the environment and the selection of tasks in order to holistically begin to assist the infants we service. With an emphasis upon optimal improvement in posture and movement, the many challenges needing to be addressed and the comprehensive nature of the NDT's examination and evaluation certainly stem beyond the impairments mentioned below. Selected desired outcomes and goals are individually pre-determined, while the use of handling techniques entails on-going feedback between the infant and therapist. Handling techniques, selected tasks and activities require adaptation and modification to best meet the needs of the infant. By adapting and modifying each of these, the interventionist has the opportunity to make the targeted postural and motor-based tasks easier or more challenging while always attempting to impose the "just right" challenge so as to elicit a more-adaptive behavioral response.

The following impairment-level challenges are a sampling of those requiring handling during intervention sessions. It is appreciated that depending on the various types of cerebral palsy and the potential impact upon all major bodily systems and functions may need to be addressed. Other possible delays and disorders in various developmental areas such as perception, cognition, speech, oral-motor skills, play and other occupations may require the practitioner's attention. It is no wonder, then, that NDT recognizes the vital role of inter-disciplinary treatment and management.

- Atypical muscle stiffness,
- Insufficient range of motion,
- Impaired muscle activation/excessive co-contraction,
- Impaired muscle synergies,
- Impaired timing, sequencing and scaling of muscle force production,
- Excessive overflow,
- Insufficient muscle force production/strength,
- Impaired anticipatory postural control,
- Poverty of movement,
- Loss of dissociated movement,
- Sensory processing impairments, and
- Secondary impairments including muscular contractures and bony deformities. 17, 18

During handling, we have the opportunity to modify several bio- mechanical and kinesiological variables including postural alignment, range of motion, the base of support, muscle strength, postural control and the imposition of weight shifting/mobility. 17, 18. These are important changes that underlie functional movement, posture and preserve the body's musculoskeletal integrity.

Thorough study of the NDT practice framework from its inception to the present, appropriately reveals our application of current theories and concepts. Classically, emphasis was placed upon the facilitation and inhibition of neurophysiological mechanisms used to describe the basis of handling strategies and tactics. A strong guiding influence of the inclusion of biomechanical and kinesiological variables resulted in stress placed upon these factors. As one result of this important contribution I coined the phrase "NDT techniques are not neurophysiological cures, but rather biomechanical and kinesiological lures." More recently, I have considered that while the above phrase may be partially true, it is important that we equally emphasize neurological concepts and theories that support the NDT practice framework. These include:

- First, and perhaps foremost, is the resurgence of the study of neuroplasticity and recovery mechanisms being tested in the laboratory and revealing concepts and mechanisms that provide further support of the potential general strategies that may further the ability to actually eliminate or decrease neurological damage. 19, 20.
- Our need to continue to integrate and further study the natural course of history of the infants we service with cerebral palsy and related neuromotor challenges. This includes not only infants but children throughout their lifespan. 21, 22. This serves to promote our understanding of common impairments and may assist us in planning early intervention aimed at limiting these.
- The Theory of Neuronal Group Selection proposed by Gerald Edelman describes the actual biological development of the brain and mind through a dynamic process involving three steps. The initial stage is proposed to occur pre-natally via the dynamically arranged epigenetic. The results are the newborn's ability to perform early skills.

The second stage, often referred to as Experimental Selection, takes place post natally via sensorimotor experiences which result in a modification in the strength of neuronal/synaptic linkages that form variable and diverse secondary repertoires.

Stage three involves re-entry of the synaptic networks results in the development of complex and dynamic maps defined as an interconnective series of neuronal groups which in and of themselves are receptive to naturally occurring sensory input which results in the formation of perceptual concepts. As a result of this dynamic process, no two brains or minds are exactly the same. This may contribute to the variability of movement, a desired outcome of infant NDT intervention. 23, 24

- Finally, NDT's adoption of the Dynamic Systems Theory has expanded our perception of the role of many systems and subsystems in the development of a skill, thus no one system is viewed as the main or leading system. To a large extent studies involving the facilitation and promotion of infants' lower extremity kicking stem from this theory which is being carried out using a variety of positions and tactics for infants with periventricular brain injury, spina bifida and plans for those with Down Syndrome. Such protocol combined with additional infant NDT techniques may allow for a comprehensive early intervention program. 25, 26, 27, 28.

PERSPECTIVE TWO: INSIGHTS INTO HANDLING FROM THE COMPLEMENTARY NEURO-MOTOR EXAMINATION USED FOR THE EARLY AFFIRMATION OF NORMALCY

Overview

French neurologists Claudine Amiel-Tison and Albert Grenier brilliantly include as part of their neurological assessment what they describe as a Complementary Neuromotor Examination to rule out the presence or risk for CNS impairments in infants. This clinical examination is well-described and depicted in the reference listed below and should prove very helpful to NDT-oriented therapists wanting another perspective on the evaluative as well as intervening benefits of NDT-like handling techniques for infants. Using a variety of hands-on, carefully applied and graded maneuvers, these examination techniques "liberate motor activity" from very young infants (as young as 8 days old). In doing so, more mature and organized sensory and postural/motor competencies are elicited.

Liberated Motor Activity

During liberated motor activity, the examiner's hands offer positional stability, primarily at the head, trunk and pelvic regions, i.e. these regions are used as "key points of contact or control." Simultaneously, rocking motions similar to the imposition of weight shifts are provided and such activities are described as bringing the young infant into a more optimal behavioral state and mature-like level of function. The latter achieved level of function resembles that of a typical four-month old when head control is well established and the interfering influence of disorganized and/or reflex influenced movements are achieved. Specifically, by stabilizing the head, the potential influence of the Moro Response is inhibited or mechanically constrained and thus are the associated limb movements. 29. Lest critics suggest that I am implying that NDT techniques involve "inhibition of reflexes", it needs to be appreciated that the physical or bio-mechanical restriction of disorganizing influences, including reflex movements, can be temporarily achieved and thus offer the opportunity to elicit and activate more mature and potentially underlying motor competencies.

Head Stabilization to Overcome Infants' Lack of Postural Control

The use of head stabilization during this complementary neuro-motor examination is remarkable in its ability to allow very young infants the ability to demonstrate visual attention skills, upper limb reaching and grasping and upright postural alignment of the spine and pelvis in positions such as supported bench-sitting. 30. During the latter, infants demonstrate the ability to orient their pelvis, thighs and feet to the support surface while accepting and bearing weight through these appropriate bodily regions. Are these not similar to goals incorporated within NDT handling techniques for infant treatment sessions? I would suggest that they are and agree with the developers of this complementary examination that less than optimal observations can be important clues of deviations, delays and/or disorders in infants with or at risk for cerebral palsy and related neuromotor disorders. For example, an infant with underlying impairments may not exhibit the ability to maintain an upright pelvis or spine during such manipulation.

The development of postural control is a common goal in infant NDT and a major aspect of this complementary examination. To challenge our facilitation of optimal postural control is an appreciation of variability and more recently, the concept of complexity. In a case report involving three infants born prematurely with brain injuries, the temporal structure of variability (complexity) can be too little or too much. Desired complexity can be defined as a state of between excessive order and excessive disorder. The results of this case report found one infant to develop optimal complexity and thus exhibited adequate postural control. A second infant showed a lack of complexity and the third excessive complexity. Thus infants two and three developed decreased postural control which interfered with their ability to use perceptual and motor skills in a typical fashion. 31.

Description of the affects of head stabilization of young infants used in this complimentary examination should not be interpreted as a suggested handling technique to be used during intervention. Rather, it points to the now well-accepted understanding that an infant's lack of postural control is *one* constraining system that limits their early ability to use and demonstrate more advanced motoric skills. During actual use of NDT handling techniques for infants, therapists keenly recognize the need to promote the development of postural control and provide subtle support around selected joints and

offer tactile input over muscle groups for activation of, for instance, abdominals and back extensors. Facilitation of head and trunk control is addressed in various positions for skill acquisition. This includes the importance of postural control in sitting.

This evaluation also includes the *Recamier Position* which allows the examiner to handle the infant in a propped, side-lying posture. This offers an opportunity to palpate and/or feel for restrictions or asymmetries in lateral head, neck or trunk musculature. Careful observations for signs of relaxation, or conversely distress, are noted along with ease in obtaining the necessary muscular length required in this posture.

Directed Motor Activity

Further components are termed “directed motor activity” and bear great resemblance to NDT-based handling techniques used to facilitate:

- Lateral head, neck and trunk righting in side-lying,
- The assumption of sitting through side-lying with promotion of arm activation for pushing into and off of the support surface on the weight bearing side,
- Rolling using either the upper or lower body as key points of contact and/or control,
- Stimulation of lower limb weight bearing on each foot, much earlier than one typically anticipates observation of this motor task.

These maneuvers point to the potential power of handling to elicit or activate muscle functioning and in turn postural and motor skills.

The Importance of Control in Side-lying

Throughout the examination, much emphasis is placed on activation of anti-gravity lateral movements. This is achieved via the use of the so-called Grenier’s Maneuver. It is utilized to evaluate control and strength of lateral head, neck, trunk and hip movements. Certainly, the importance of the balance between anti-gravity flexors and extensors is emphasized within NDT handling techniques for infants for the establishment of lateral/frontal plane anti-gravity control. The authors suggest that the dynamic tests or “motor exercises” are used to show subtle motor activity in the lateral plane which indicates “early evidence of normalcy” before three months of age. These examination procedures help demonstrate how normal infants’ dormant potential of underlying postural and motor skills can be facilitated. Here, again, an analogy can be seen between this examination and NDT handling techniques for infants. 32.

TYING THE TWO PERSPECTIVES TOGETHER THROUGH APPRECIATION OF THE TIMP

I had the opportunity to attend a conference session entitled: The Test of Infant Motor Performance (TIMP): Development of an Outcome Measure Based on the Neuro-Developmental Treatment Approach. This presentation was delivered at the Section on Pediatrics Annual Conference (SoPAC) 2010 by Gay L. Girolami, PT, PhD. 33 Her presentation clearly described that the TIMP was developed with a clinical appreciation of both NDT-based evaluative and handling techniques initially originated by Mary Quinton, Physiotherapist, and Dr. E. Köng, MD. 15. As I carefully listened to the presentation, it became clear that the TIMP contains many items that include NDT-based infant handling tactics and strategies, is sensitive to detecting the efficacy of NDT-based early intervention 34 and includes items similar to the test developed

by Amiel-Tison and Grenier described above. 32. Thus, the two major perspectives of this article are connected.

In light of this information, I have studied more about the test through a self-instructional CD program of The Test of Infant Motor Performance (TIMP) and highly recommend it to those wishing to further appreciate the conceptualization of NDT- based handling techniques for infants. The constructs upon which the TIMP was developed include postural control, i.e. “control of the infant’s body in space and orientation, the ability to maintain the center of mass within the base of support, and alignment of body segment along with selective control”. 34. NDT certified, trained or oriented therapists will immediately see that these are precisely the fundamental components embedded in NDT techniques as well as the goals of NDT-based early intervention.

To connect the TIMP to the ecologically valid and practical perspective, Ms. Girolami also shared research findings that looked at the number of TIMP items that were naturally incorporated in daily handling of infants via care-giving practices with a large number being observed and reported. So, the TIMP further sheds insights to assist us in better conceptualizing NDT-based handling techniques for infants. Inclusion of handling techniques taught and applied by parents validates the ecological strength of this test. In addition to the handling tactics, this test includes 42 items as a means of comprehensive assessment of the premature or full-term infant up to 4 months of age. This sensitive, comprehensive and practical early test should prove to be a means of determining the status of our youngest patients.

It is also noteworthy that the TIMP along with other tests including the TIMPSI (Test of Infant Motor Performance Screening Items), GMA (General Movement Assessment), AIMS (Alberta Infant Motor Scale) and PDMS-2 (Peabody Developmental Motor Scales) in a specified order are being used in a study; “The Norwegian Physiotherapy Study in Preterm Infants”. This study’s protocol is available via the website noted in the references. This clearly written protocol describes an early intervention program used to improve the motor outcome of pre-term infants. As included in the protocols’ title, the study entails both a randomized control trial as well as a qualitative study of physiotherapy performance and parental experiences. The latter combines the use of what appears to be NDT-like infant handling techniques combined with a program previously used to improve cognitive skills through enhancement of caregiver-infant interactions. Parents/caregivers will provide the intervention via teaching and coaching by experienced therapists. Clear descriptions of the therapeutic objectives, performer activity (NDT-like handling techniques) and activity goals for the child are included for the “promotion of postural and selective control of movements in the supine, side-lying, prone and sitting positions. 36.

SUMMARY

The concept and application of NDT-based infant handling can be described from an ecologically valid and practical perspective, i.e., the early recognition made by the Bobath’ s, described by Finnie 2, 3, 4, 5 and further developed by NDT instructors. Pertinent to this article are the major contributions by Mary Quinton and Dr. Köng. 15. This included the teaching of NDT Coordinator Instructors to become certified as NDT Infant Course Instructors. Also, the book by Bly 37 offers a description and individual photos of actual infant NDT facilitation strategies and tactics. An appreciation of the complementary neuromotor examination developed and reported by Amiel-Tison and Grenier also offers concepts similar to NDT baby handling techniques. Both of these perspectives can be connected via an understanding and study of the TIMP.

The NDT practice framework continues to grow in depth. Major advances relate to the update of our

theoretical basis and increasing evidence both regarding the need for early intervention as well as the efficacy of early NDT. 16, 34. Additional achievements include the definition of the NDT/Bobath approach, the development of on-line modules for the teaching of certification courses as well as videos and articles for individuals to become re-certified, the initiation of NDT-related literature reviewed by NDT Instructors as a component of the NDT Network and the publication of the new book which is truly the definitive guide to the current NDT practice framework. 38. In conclusion of this article on conceptualization, perhaps the greatest aspect of so many achievements further assures that the Neuro-Developmental Treatment Approach will remain a living concept.

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NOTE: References printed in **bold** are highly recommended.