Fostering upper extremity motor development with an infant prone to play program using an evidence-based approach

Lee, Lowana Lai yee

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SARGENT COLLEGE OF HEALTH AND REHABILITATION SCIENCES

Doctoral Project

FOSTERING UPPER EXTREMITY MOTOR DEVELOPMENT
WITH AN INFANT PRONE TO PLAY PROGRAM USING
AN EVIDENCE-BASED APPROACH

by

LOWANA LAI-YEE LEE
P.D.O.T., Hong Kong Polytechnic, 1981
M.S., Boston University, 1988

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Approved by

Academic Mentor

Simone V. Gill, PhD, OTR/L
Assistant Professor of Occupational Therapy, Rehabilitation Sciences, and Medicine

Academic Advisor

Karen Jacobs, Ed.D, OTR/L, CPE, FAOTA
Clinical Professor of Occupational Therapy
DEDICATION

This dissertation is dedicated to my family, especially my dad and mom, Po-Ken Lee and Yuen-Han Lui, who have always wanted the best education for their children and have always been proud of their achievements. They have encouraged, supported and sacrificed throughout my formative years. Even though they have been in ill health and frail while I was in the doctoral program, they have inspired and spurred me to go on by their courage and resilience in battling their own sickness. Thank you, mom and dad, for all your love. A special dedication is due also to my sister, Lowsana, who has been a constant support throughout while I was in the program.

I also want to dedicate this dissertation to all the babies and families that I have worked with and who had taught me so much in all my 33 years of being an occupational therapist. Each one of you has contributed to my learning and has made me a better person and a caring therapist.

Lastly, I dedicate this dissertation to my Creator, who has given me the courage to go on despite all the disruptions to the study for “The LORD God is my strength; He makes my feet like the feet of a deer, He enables me to go on the heights.” (Habakkuk 3:19).
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I thank my family, especially my parents, for their love and constant belief in my ability to complete this endeavor. Your confidence in me and your enduring support spurred me on. Thank you, Mom and Dad, Wai Hong, Lowsana and Wai Hoi.
ABSTRACT

Due to the fear of Sudden Infant Death Syndrome (SIDS), parents have been putting infants on their backs. The American Academy of Pediatrics (AAP) started to recommend balancing sleeping in supine with prone play - also called Tummy Time - to encourage optimal, healthy infant development (Zachry & Kitzman, 2011). Due to various reasons, parents avoid putting the infants in the prone position even when awake. Evidence-based literature has shown that infants sleeping in supine without spending time in prone can lead to motor delay in their first year of life (Barlett & Fanning Kneale, 2003; Dudek-Shriber & Zelazny, 2007). Evidence also shows that weight bearing in prone is associated with motor development (Salls et al. 2002). This doctoral project attempts to identify the links between prone activities, postural control and fine motor development through research on evidence-based literature. It also provides a theoretical foundation, investigates the evidence and best practice in designing an educational package on prone play for typically developing and high risks infants. It also advocates best practice in occupational therapy by addressing a lack of evidenced based literature and attempts to add to the knowledge base in regards to tummy time and its effect on fine motor development.
motor development. The target audiences are parents and caregivers of infants; the health care professionals that work with them; the funding agencies and policy makers. The qualitative and quantitative benefits of the parent education program will align with health promotion and wellness initiatives of the Ontario government. The project will describes a detailed evaluation plan and dissemination of results with estimated budgets. This will include presentation to the community and the ministries in the government. The project will contribute to these areas of occupational therapy: (1) addressing evidence-based practice in tummy time with typically developing and high risks infants; (2) providing best practice for implementing a Prone to Play program to foster upper extremity motor development; and (3) promoting health and wellness initiatives in occupational therapy.
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CHAPTER ONE

Introduction

Occupational therapists are involved in skills for the job of living (CAOT, 2014). Within the occupational therapy framework, occupational therapists use everyday life activities (occupations) with their clients to enhance or enable their participation in roles, habits and routines in the home, work or community setting (AOTA, 2014). The Canadian Association of Occupational Therapists (CAOT) also recognises that children and youth (boys and girls from birth to 18) have the right for opportunities to develop healthy patterns of occupations (CAOT position statement, 2008). A child’s life is made up of “occupations” or daily activities (AOTA, 2014) that include playing, learning and socializing. For example, an infant’s occupation is to thrive and grow and be healthy. Occupational therapists work with these infants and their families to help them succeed in these activities throughout the day.

The Background

Since 1992, the American Academy of Pediatrics (AAP) advocated the “Back to Sleep” Campaign (AAP, 1992), which states that infants should sleep in the supine position to help prevent Sudden Infant Death Syndrome (SIDS). As the campaign unfolded, many caregivers and parents were not aware of the implications of not providing prone play to infants. Many infants were accustomed being on their backs and cried or fussed when they were put in prone play during their waking hours (Jones, 2004). To combat this problem, AAP started to recommend balancing sleeping in supine with prone play - also called Tummy Time to encourage optimal, healthy infant
development (Zachry & Kitzman, 2011). This initiative is very much within the domains of occupational therapy. In recent years, occupational therapists are also involved in promotion of health and wellness (CAOT, 2008). Health promotion is the process of enabling individuals, families and communities to make positive contributions to their health status through education and/or the provision of information. It also involves the promotion of healthy ideas and concepts to motivate individuals to adopt healthy behaviors and lifestyles. This doctoral project will involve the education of parents and caregivers on promoting the healthy concept of prone play time for their infants.

**The Presenting Issue**

The author’s interest in this topic began with clinical observations while working with infants; some infants did not have prone experiences because of the recommended “Back to Sleep” position. Much emphasis has been placed on “Back to Sleep” since the campaign started in 1992 due to sudden infant death syndrome (SIDS) and its correlation with prone sleeping. Infants with limited prone experiences were also clinically observed by this author to have poor hand development and decreased hand arches. Since the “Back to Sleep” campaign, positioning of infants (term and preterm) in prone during play or waking time has been recommended and its effects on motor development are supported by evidenced based literature (Monson, Deitz & Kartin, 2003; Pin, Elderidge & Galea, 2007; Salls, Silverman & Gatty, 2002). Mildred, Beard, Dallwitz & Unwin (1995) and Zachry & Kitzmann (2011) reported that caregivers and parents avoided putting their infants in prone all together. This problem can be reinforced by infants’ discomfort in this position due to reflux, and infants’ preference for this position out of
habitual position in supine (Mildred et al., 1995). Parents are less likely to put their infants in prone when infants are not happy in this position and may fuss or cry. Parents adhere to the guidelines of Back to Sleep, but may forget to balance it with time in prone when their babies are awake. It may also be difficult to fit into everyday schedules or integrate prone position into playtime.

Infants that are already compromised at birth (history of difficult birth, preterm and low birth weight) and infants with identified impairments may have even more problems with experiencing movements and different play positions. They often demonstrate delays in transitioning from one posture to another (Barlett & Fanning Kneale, 2003), which limits how often they play in different positions. Infants, who already have poor muscle strength and muscle tone, have a preference not to weight bear on their upper limbs. Their lack of variability in positions for play due to issues with body functions and body structures may impact their motor development. There is also a lack of systematic programs and educational materials based on sound theory and evidence for therapists to share with parents. Parental education is the first step towards health and wellness promotion for infants at this age.

Lastly, evidence-based literature is scant with regards to prone position and its effect on fine motor development, though many papers have discussed the effects on gross motor development. Stroke literature (Hunter, Crome, Sim & Pomeroy, 2008) shows that weight bearing on the forearm and the hands provides proprioceptive and somatosensory input that is much needed for hand awareness and preparation of motor activity. The theory this author is proposing is that while in prone, the child will weight
bear (loading in the forearm and the shoulder girdle). This provides proprioceptive input into the forearms and shoulder girdles, which activates the muscle fibers, strengthens the muscles in the shoulder, improves shoulder stability and also builds up the longitudinal arches in the hand (in preparation for hand stability and fine motor skills like grasping and bimanual hand function). Therefore when children spend enough time in prone during their waking hours, not only are their extensor muscles strengthened, they have more postural control and their shoulder girdles are strengthened. This provides the foundation for better reach and other fine motor skills. Appendix A shows a visual model of the causation and the problem.

**Project Overview- Addressing the Problem**

The objectives for developing this doctoral project are: 1) to identify the effect of prone position on motor control and fine motor development through evidenced based literature; 2) to identify if there is an optimal “tummy time” duration through evidenced based literature; 3) to develop an evidence-based educational program on prone play activities for parents and caregivers; 4) to develop a dissemination plan to present to the Ministry of Youth and Social Services and to administrators of McMaster Children’s Hospital. To address the identified problem, this educational program will consist of a seven weekly play sessions with prone activities and an educational package for parents (multimedia and handouts). It will be based on contemporary developmental and motor learning theories with regard to “Tummy Time” and especially play time in prone with an emphasis on fine motor skills and shoulder stability. These will be prone play activities that aim at weight bearing to strengthen the shoulder girdles and upper limbs movements.
The infants will be put into these play positions during their waking hours and these activities will be graded into developmental stages. The parents will be guided in the 7 week educational session, and the time in prone for each infants will be monitored. The project will first be piloted with three infant-parent dyads, followed by the recruitment of more families to participate in the second phase. Emphasis is placed on the dissemination of the educational materials. Once successful, an educational package will be refined and online modules developed to provide a broader means of promoting health and wellness in these young infants. Outcome measures that will be used in this project for evaluation will include standardised assessments that evaluate fine motor development, postural control as well as reach and grasp. Three standardized tests, the Alberta Infant Motor Scale (Piper & Darrah, 1994) and the Posture and Fine Motor Assessment of Infants (Case-Smith & Bigsby, 2000), and the Peabody Developmental Motor Scale (PDMS-2) fine motor subtest would be used (Folio & Fewell, 2000). The quality of hand use and grasp will be noted in the follow-up phase as part of the evaluation plan of the project. The hope is that experience in the prone position may improve the overall long term fine motor development in children as they gain better shoulder stability while weight bearing in prone.

A literature review was done and the focus was on: 1) effects of tummy time on development, and 2) effects of weight bearing and prone activities on upper limb development and fine motor development. Though there are articles on tips for “Tummy Time”, there are very few that are peer reviewed and maybe only a couple alluded to how tummy time can help fine motor development (Dudek-Shriber & Zalazny, 2007; Monson,
Deitz & Kartin, 2003; Salls, Silverman & Gatty, 2002). This doctoral project uses dynamic systems theory (Miller, 2002), sensory integration therapy (1972) and the biomechanical model (2005) as framework to look at prone play activities and its effect on motor development especially in the upper limbs. A family centered model for best practice will be used in knowledge translation (Bruder, 2002).

The educational program consists of a seven weekly play sessions with written educational material for parents. It will also be in the form of multimedia resources. Materials will highlight: 1) importance of tummy time; 2) weight bearing activities in prone that contribute to upper limb development (a small panel of experts will be surveyed to come to a consensus of appropriate activities) and 3) other resources for therapists and parents (Vimeo, You tubes, published resources). A follow-up of the infants up to their 12 month birthday is planned so that longitudinal changes can be documented for further study at 6 months, 9 months and 12 months. Standardized measurement tools will be used to evaluate the program. The measurement tools used include Albert Infant Motor Scale (AIMS), Posture & Fine Motor Assessment of Infants (PFMA), the Peabody Developmental Motor Scale (PDMS-2) and video-taping as a record of changes in postural control and upper limb development.

**Impact of Project**

The main objective of this project is to change parental practices in regards to prone play. Since the primary audience is parents, the educational material will be written at a grade 3 literacy level. It has been noted that since the “Back to Sleep” program started in 1992, there are many babies that do not like being in prone during their waking
hours (Dudek-Shriber & Zelazny, 2007). Subsequently, studies have shown that babies sleeping in supine with no prone playtime affected their acquisition of motor milestones (Dudek-Shriber & Zelazny, 2007). Majnemer & Barr (2006) reported that positioning practices affect the rate of motor development and motor lags are associated with less time in prone while awake. Davis, Moon, Sachs & Ottolini (1998) studied the “effect of sleep position on infant motor development” and concluded that infants who sleep in supine were delayed in their motor acquisition when compared with infants sleeping prone. In their study, Majnemer & Barr (2006) compared the motor development of supine sleepers and prone sleepers (or exposure to prone position) and found a positive correlation of more advanced motor development in those that had been prone sleepers or been exposed to prone position during the day. However, they did acknowledge that prone positioning effects on fine motor skills are unknown (Majnemer & Barr, 2005). It has also been noted that there are higher incidences of plagiocephaly since the “Back to Sleep“ campaign was instituted. Therefore, this project was designed to encourage parents to put their infants in prone play position and provide them with a different and safe position to encourage variability in movement. Under the framework of dynamic systems theory, variability would encourage the infant to improve in motor development (Thelen & Smith, 1998).

This issue under discussion is quite often observed in many settings that see infants: well baby clinics, early intervention programs, children treatment centers and other infant parent programs in Ontario, Canada. An educational package on prone play activities for playtime can be supplementary to doctors’ clinics’ educational material
when discussing sleeping position and “Back to Sleep”. The secondary group audience is the health care professionals that work with infants and their families. This will include pediatric therapists, family doctors and pediatricians, nurses and midwives as well as day-care providers. The information and education material can provide a platform for discussion on the benefits of “Tummy Time” and a resource to balance off the time that the infants spend on their backs.

**Occupational Therapy Domain**

Under the American Occupational Therapy Association Occupational Therapy Practice Framework (AOTA, 2014), and the Canadian Association of Occupational Therapists Position Statement on Occupation and Health (CAOT, 2008), this problem falls into the domain of occupational therapy practice since play is an area of occupational performance essential for an infant to be able to engage in meaningful and purposeful play. Children with poor motor performance and fine motor skills also tend not to do well in participating and engaging in occupation (play), thus negatively impacting on social development. In addition, Tremblay et al. (2012) published the Canadian recommendation guidelines for activity of children from birth to four years old. The guidelines recommended that infants (less than 1 year of age) should be physically active several times during the day and floor-based play in prone is highly recommended.
CHAPTER TWO

Theoretical and Evidence Base to Support the Proposed Project

This chapter contains two main sections. The first section will focus on the theoretical basis for the proposed doctoral project, and the second section will be a review of evidence to address the problem. The evidence will be synthesized in order to design the program to address the issue. Furthermore, a proposed plan for evaluation of the program will be discussed in chapter 4.

Introduction

In 1992, the American Academy of Pediatrics (AAP) started the “Back to Sleep” campaign, which is now called the Healthy Child Care America Safe Sleep Campaign (AAP, 2014). The message of these campaigns is to promote the health and safety of infants and to recommend safe sleeping practices. One of the messages that came out strongly was to not have infants sleeping on their tummies because of the strong association of this position with sudden infant death syndrome (Smith, 2010). The American Academy of Pediatrics (AAP) recognized sudden infant death syndrome as the leading cause of deaths for infants between 1 to 12 months of age. In their brochure titled, “A Parent’s Guide to Safe Sleep”, AAP stated that “unaccustomed tummy sleeping increases the risk of SIDS. Babies who are used to sleeping on their backs and are placed to sleep on their tummies are 18 times more likely to die from SIDS.” (AAP, 2014). One of the three safe practices that AAP put forward includes safe sleep position and advises parents to place infants to sleep on their backs during naps and at nighttime. They also cautioned that infants sleeping on their sides are as in danger as those sleeping on their
stomach because they are more likely to accidentally roll over onto their stomachs (AAP, 2014). Since 1992, most parents in North America are following the new guidelines on safe sleep for their infants (AAP, 2014). Even though AAP recommended balancing sleeping in the back position with playing on tummy position for infants, many infants are happier when they are playing on their backs during awake times (Zachry & Kitzman, 2011). Jones (2004) also noted that it is difficult for parents to implement “Tummy Time” when their infants are playing and infants fuss and cry to get out of the position. Lobo & Galloway (2012) devised an educational program with prone play activities, and showed that enhanced handling had a positive effect on infants’ motor development. One of the goals of this doctoral project is to help parents implement prone play successfully and to evaluate the influence it has on fine motor development.

**Frameworks for Understanding the Nature of the Problem**

To develop this project, it is important to first understand and define the nature and implication of the problem. This was done by framing the problem within the occupational therapy and motor development models and by creating an explanatory model of the problem that listed contributing factors to the identified problem. The plausibility of this model was then checked with current literature and research in this area.

While there is some evidence to support that motor development in infants is affected by prone sleep position, there is limited evidence that prone play or sleeping in prone affects fine motor and upper limb development. Three theoretical frameworks - the dynamic system theory (Zwicker & Harris, 2009), sensory integrative theory (Ayres,
1972) and biomechanical model (Kielhofner, 2009), were used in this project to understand and to provide the foundation for the identified problem. They will be examined individually and discussed with relation to the key elements in the project.

Dynamic Systems Theory

In the late sixties, Bernstein (1967) introduced a systems theory on the study of motor control and proposed this theory to explain organization of functional synergies of movement. Thelen and her associates (1987) took it further and proposed the Dynamic System Theory in development which has now become one of the popular theories used for contemporary understanding of motor control. The person, the context and the occupational goals are emphasized. Motor control is considered a self-organizing phenomenon and the movement that results is thought to require the least amount of energy and effort and also the most “functional” for the task. The theory also favours transition states that are optimal for new behaviors to emerge though there are rate limiting factors that provide constraints to perform a functional task. When it is applied to motor development, it represents a holistic model that the infant, the environment and the functional aspects of the task all interact together. This is congruent with the occupational therapy PEO (Person Environment Occupation) model in which the person, environment and occupation interact (Kielhofner, 2009) to enable occupational performance. Therefore, the Dynamic Systems Theory provides a fresh understanding to the many dimensions in development.

According to Smith & Thelen (2003), Kamm, Thelen & Jensen (1990) and Heriza
(1991), the core assumptions of this theory, with the individual (organism) and the context (includes environment) when applied to motor development encompass the following:

1) Motor behaviors are self organizing and are a result of integration and cooperation of many subsystems as they influence each other. Self-organizing is a process that some sort of order or coordination arises out of interactions between components of an initially disordered system. Therefore when applied to both gross motor and fine motor development in infants, the many subsystems in the infants are seen as components that can fluctuate and interact together to form some sort of order;

2) Motor behavior is very much influenced by the task, the environment and the organism and can be performed in more than one way, depending on the constraints imposed;

3) Subsystems can develop asynchronously- therefore the infant can excel in one area of development over another;

4) New movement development emerges as a series of phase shifts that are non-linear and discontinuous: The changes in the coordinative pattern are envisioned as a series of stabilizing and destabilizing stage like phases;

5) Control parameters (variables that shift the movement from one form to another) can change over time. Therefore, when this theory is applied to motor development, motor behavior is seen as a dynamic cooperation of many subsystems in a task specific context.
Often development is viewed as qualitative and continuous, and Dynamic Systems Theory proposes that new forms of behaviors may emerge from interactions within the context of the task (Smith & Thelen, 2003). Dynamic Systems Theory acknowledges both quantitative and qualitative change (Miller, 2002) - Gradual quantitative change at one level such as an increase in the amount of lower extremity adipose tissue (Thelen, Fisher & Riley-Johnson, 1984) will eventually cause a system wide change that result in the emergence of a qualitatively different behavior (e.g., disappearance of the stepping reflex). The uniqueness of this theory is the emergent view of a behavioral change that is flexible, time-dependent with no predetermined pattern. Motor behaviors are seen as “softly assembled” patterns and change within the contextual constraints of task and environment. Therefore, these changes are viewed more probabilistically than as fully predictable.

Thelen (2005) stated that a dynamic system is organismic and it emphasizes relations between the parts of the living organism. When it is applied to motor development, the organism is viewed as an active system involved in shaping the changes and undergoing self organization. According to the theory, one needs to consider interactions among all the levels (from molecular to the cultural level) of the developing system. The motor behaviors observed are viewed as a whole and as a result of the interaction at multiple subsystems and levels. The theory addresses change over time in a complex holistic way within the system. Most theories that have influenced development in the western world are focused on the individual and separated from the context of the physical and cultural environment (Miller, 2002). Dynamic systems theory offers a
different perspective in that the physical environment and cultural context as well as the
task are coupled together, each playing a role and contributing to the dynamically
changing system. Though there are no direct obvious links with culture, dynamic systems
theory acknowledges that cultural practice (as part of the contextual constraints) can
influence the behavioral outcomes as evidenced by cultural studies done with different
infant rearing practices (Abbott & Barlett, 1999) and cultural practices (e.g., Dennis &
Dennis, 1940). Thelen did not elaborate much on the “nature-nurture” question in the
theory, but the eventual change observed depends on the inherent ability that the
organism is able to self-organize. Instead of looking at critical periods when change
emerges, Thelen focused on looking at the critical levels when systems phase shift and
reorganize (Thelen & Smith, 1998).

According to this theory, motor change or development is never a function of
individual or context alone, but a function of their interaction with each other. Therefore
the assumption that the organism is able to self-organize is a crucial component in
shaping the theory and the emergence of new behaviors. Development is seen as
progressively increasing in complexity and in organization. As the organism tries to
regain a stable state through the re-organization with a series of phase shifts, new forms
of behavior develop. It is this process of self-organization and striving to attain
equilibrium that provides a potential solution for the origins of complexity and shifting
from one developmental “stage” to a more advance “stage.” Shumway-Cook &
Woollacott (2001) also put an emphasis on how movement emerges from interactions
between the individual, the task and the environment. As a result of development, a series
of new movements will emerge. Many factors within the task, the individual and the environment interact together to produce orchestrated movements.

**Application of Dynamic Systems Theory in the Doctoral Project**

Much emphasis has been placed on the “Back to Sleep” campaign which started in 1992 because of sudden infant death syndrome (SIDS) and its correlation with prone sleeping. Mildred, Beard, Dallwitz & Unwin (1995) and Zachry & Kitzmann (2011) reported that caregivers and parents have avoided putting their infants in prone all together due to the present practice of Back to Sleep and fear of SIDS. Mildred et al. (1995) reported that infants prefer not to be in prone because parents habitually put them on their backs. This supine position limited infants’ opportunity to experience alternate positions and to explore movement. Evidenced-based literature supports that positioning infants in prone during their waking hours has a positive effect on motor development (Monson, Deitz & Kartin, 2003; Pin, Elderidge & Galea, 2007; Salls, Silverman & Gatty, 2002). In this project, caregivers are encouraged to put infants into prone during waking hours so that they can explore and practice a variety of movements in this position.

The Dynamic Systems Theory views development as an emergent phenomenon. The infant is seen as an active organism composed of many subsystems. Infants have this ability to self organize (without any code or recipe) to produce patterns of movement. Each subsystem may also develop at a different rate (Thelen, 2005). With the many degrees of freedom in the subsystems, the individuality of development (individual children solving individual problems in their own unique way) is expressed and the course of development is difficult to predict. Development, seen as changes in motor
behavior, comes with variable movement patterns. Variability, an important feature, is considered necessary in order for optimal function to occur (Thelen & Smith, 1998). It allows adjustment to the changes in the environment and it shows many degrees of freedom. Therefore, as one of the control parameters, the environment that infants are in can be manipulated (in this instance, putting infants in prone position) to offer opportunities for the sub-systems to go into shift phases which allows the infant to self-explore, experience challenges and variations in movement and undergo trial and error with movement patterns. The acquisition of new motor skills can be seen as finding the optimum values of constraints that will meet the demand of the task for each individual. It helps to explain variability and flexibility that is observed in motor studies that cannot otherwise be explained by other theories.

Table 1 below categorizes specific and appropriate connections between features of the theory and design of the intervention or program.

**Table 1**

<table>
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<tr>
<th>Core elements of dynamic systems theory</th>
<th>Connections to specific features of the project (including intervention design)</th>
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<tr>
<td>Motor behavior is an emergent phenomenon.</td>
<td>The human infant is dynamic and is the focus of the study. In developing the program for the project, the nature of motor development, as an unfolding phenomenon, is the generative product of multiple subsystems within the infant. The interaction with the environment and the task is emphasized. Infant are able</td>
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<td>even one small shift in a component can cause unpredictable and complex changes in a system.</td>
<td>The infant has the capacity to self-organize. Because one small shift in a component can cause unpredictable and complex change, the intervention program is designed in such a way that adaptive changes are recognized as non-predetermined and non-linear changes. Therefore the program created is aimed to provide information and motor experiences that will allow infants to undergo self-exploration, to go by trial and error and to be able to practice a variety of motor skills. In essence, by challenging the infant through change in control parameters (task and environmental context), the infant will undergo shift phases and self-organization occurs with resultant new motor behaviors.</td>
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<tr>
<td>Phase states are where the systems self-organize and change occurs to shift to another phase. This transition from one attractor state to another becomes new behavior change. Change is non-linear and multi-dimensional.</td>
<td>Rate of growth varies in different individuals. Not predictable. There is no code or recipe as to how the system develops. The environment (as one of the control variables) changes non-linearly. Since the rate of growth varies in different infants, the program is devised in such a way that it recognizes the individuality of the infants, and the therapist helps the parents to tailor the education package to the needs of the infants. The variability of movements that the infant exhibits will be seen as a characteristic of normal growth.</td>
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parameters) can be manipulated to induce changes. Variability is associated with transition. Movements and activities will promote exploration of a variety of variable and flexible movement patterns that will lead to success in achieving a task. The right challenge will be provided to help the infant to move to the next shift phase instead of using remediation or “normalization” of movement. Acceptance of “atypical” movement is allowed.

<table>
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<th>Transition periods and change</th>
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<td>- Infants have the potential to re-order patterns. Stable movement patterns become unstable while the motor system explores new possibilities before discovering a new movement pattern and becoming stable again.</td>
</tr>
<tr>
<td>Transitions are periods when children are assumed to be amenable to change during a period of instability. These periods are defined as increased latency in returning to a stable state and increased variability in motor behaviors. The intervention program recognizes these states and will help caregivers to identify these periods to allow the infant to have more opportunities to explore and practice. Since Law et al. (1998) reported that transition periods are periods indicative of developmental readiness for change in motor abilities and for impacting motor changes, more practice and opportunities in alternate positions can be given to the infant at this time.</td>
</tr>
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Possible prediction of the theory within the context of project

Using the dynamic systems theory as framework, emergent forms of movement are thought to represent the most efficient motor solution for a desired task. Functional tasks can be achieved with a variety of movement patterns, but the organism tends to use the most efficient one (Kamm, Thelen, and Jensen, 1990; Fetters & Holt, 1990). If the infant is dynamically active and is able to self-organize with input and interaction from the environment and task, then new forms of behavior will emerge as phase shifts, which is a result of fluctuations and transitions occurring as the systems in the infant tries to regain stability. In this project, the environment (control parameters) will be manipulated, so that the infant will be provided with alternate positions (prone being one of the positions) to play in while awake. The new position acting as the new shift in the sub-system, will in turn causes changes in equilibrium and self-organization. As the infant - comes with a combination of biomechanical, neurological, cognitive and perceptual factors (person variables) and interacts in relation to environmental conditions (variables) specific to the task and the context of the infant’s action (task variables), new adaptive characteristics and variability in movement patterns are seen. This will be observed as developmental changes in motor skills, and can be quantified using a standardized measurement as specific motor functional tasks are attained. One such assessment tool, the Albert Infant Motor Scales (which uses the dynamic systems theory as the framework for the test construction) can be used to observe these changes (Piper & Darrah, 1994). The motor behavior that emerges will be compared with that of children not using
alternate positions. The quality and variability of movement pattern can also be recorded by video for comparison with the control group

**Sensory Integrative Theory**

Sensory integration theory was first described by Dr. A. Jean Ayres (1972) and is referred to as the “neurological process that organizes sensation from one’s own body and from the environment to make it possible to use the body effectively within the environment” (p.11). In the field of neuroscience, research has shown that when animals and humans are allowed to explore and interact with environments that are meaningful and interesting to them, there are significant increases in the formation of synaptic connections between the neurons that send messages within the brain (Volkmar & Greenough 1972; Floeter & Greenough 1979). Kielhofner (2009) in Conceptual Foundations of Occupational Therapy Practice, summed up the five assumptions made in sensory integration: 1) Neural plasticity of the brain enables it to have the ability to change or modify as a result of ongoing experiences of sensory processing; 2) As a result of the interaction between brain maturation and accumulation of sensory experiences through sensory processing, a developmental sequence of sensory integrative capacities emerges; 3) The brain functions as an integrated hierarchical whole; 4) Brain organization and adaptive behavior are interactive: brain organization enables possible adaptive behavior; and adaptive behavior involves processing of sensory information which in turns helps with brain organization; 5) Individuals have an inner drive to participate in sensory motor activities. Therefore, the brain has the ability to organize sensory information and to use it to learn and perform as the child interacts with normal
environmental challenges. As Bundy et al. (2002) stated, learning is dependent on the ability to take in and process sensation from movement and the environment and to use it for planning and organizing behavior (p. 5). When applied to motor development in infants, the infant will organize sensory information and will use it to learn and perform to interact with environmental challenges while parents facilitate this process of integration for their infants. This multimodal processing of sensory information in the brain is presumed to facilitate the development of new neural connections that allow sensory information to flow through and connect with other sensory data. Therefore, sensory intake, sensory integration and organization followed by adaptive occupational behavior results in a spiral of development (Bundy & Murray, 2002). This provides a basis for further intake of sensory information for future motor activities. As development continues, the infant builds on each level of brain organization as a result of previous adaptive behavior (Kielhofner, 2009).

**Possible prediction of the theory within the context of project**

The senses that emerge early and have a major impact on an individual's development are the tactile, vestibular, and proprioceptive senses. These three senses are interconnected with one another and are also connected to several areas of the central nervous system and brain. Therefore, the activation of some regions of the central nervous system can influence the function and plasticity of others (Scriber, 2011). When the child is in prone, proprioceptive and tactile input are given to the palm through muscles and joints. The input in turn stimulates the supinated movement of the forearm. The rolling of the ulnar over the radius also allows weight bearing on the forearm and
hands. Warner, Lephart & Fu (1996) studied the effect of proprioception on shoulder stability in adult patients with orthopedic shoulder problems and found that it provides afferent sensory feedback and mediates muscle control in the shoulder. Together with the tactile input received, it provides information to the individual connecting physical contact with the external world. All the sensory information is organized and processed in the brain. They are then converted to meaningful information and used to plan and execute motor behavior. By placing the infant in prone, meaningful sensory information is provided to assist in the development of the new motor behavior. As development continues, the infant builds on previous adaptive behavior as a result of a new level of brain organization. Therefore, new gross and fine motor skills emerge as new sensory information is taken in, integrated and organized to adapt to new occupational behavior - in this instance, new motor development.

**Biomechanical Model**

The biomechanical model has long been used in occupational therapy especially during the period of mechanistic paradigm (Kielhofner, 2009). The model helps to explain how the body is designed for and is used to accomplish motion. This approach utilizes principles from the field of kinetics (the study of the way forces produce motion in the parts of the body) and kinematics (the study of motion of the parts of body in time). The anatomy of body structures and musculoskeletal system is crucial to the model. The theory explains how a person stabilises and moves body parts in order to achieve movement needed for performing occupations. This model embraces three broad concepts: Firstly, the range of motion potentially in the joints; secondly, the strength
which is the ability of muscles to produce tension to maintain postural control; and thirdly, endurance which is the ability to sustain motion over time in order to perform particular tasks (Kielhofner, 2009). With positioning in prone and weight bearing, the joint most involved in the process is the glenohumeral joint of the shoulder. Most infants come with potential joint range to perform the tasks. It is the strength to maintain postural control and the endurance to maintain motion in these postures that may pose a challenge during development. For example, the occupational performance of reaching for and grasping a toy generally requires the stabilization of the shoulder before moving the forearm out, stabilising the wrist and grasping the toy in the hand (Barthel, 2010).

Another observation of the biomechanical model is the capacity for movement; not only is it affected by occupational performance, but occupational performance in turn affects this capacity as well. Muscle strength increases and decreases according to the variable stresses the muscle experiences during daily occupations. The structure of the bones is positively affected by the amount of weight bearing they do, and joint mobility is affected by the joint movement (Kielhofner, 2009). Therefore, if the infant is able to experience the weight bearing in prone play, the structure of bones and the muscle in the upper body and extremities are strengthened, and the interplay between the different play positions foster ongoing joint movement. As the activity level changes over time, the capacity for endurance also changes.

**The role of sensation in the biomechanical model**

Strictly speaking, sensation is not a biomechanical issue, but it is often intertwined with movement. This is not surprising as proprioception is mediated by
receptors located in muscles, tendons and joints, giving a sense of position of body parts in relation to each other and whether the body is moving. Studies have shown that sensory changes occur in parallel with changes that accurately produce motor commands (Wong, Wilson & Gribble, 2011). Specifically, research done by Mizuguchi, Sakamoto, Muraoka, Nakagawa, Kanazawa et al. (2011) in a motor imagery study also suggests that corticospinal excitability is modulated by proprioceptive and tactile input. Blanchard, Roll, Roll & Kavounoudias (2011) have reported that when tactile and proprioceptive input work complimentarily, they provided very strong feedback to hand movement perception.

**Postural stability and hand development in the biomechanical model**

The development of dexterity in the hand depends on the interaction of all the joints in the upper extremity: scapulothoracic, glenohumeral, elbow and wrist joint. (Magrun, n.d). In addition to adequate range of motion, biomechanically, every proximal joint must provide a stable base of support for the joints distal to it to enable maximal control. Therefore early reaching is characterized by muscle torques to produce stabilized postures and movement of the arm on stable base (Thelen & Spencer, 1998). Developmentally, experiences in the first year of life, especially when in prone, afford proprioceptive weight bearing as the infant’s weight is distributed forward onto the cervical region and on the forearms. Through the biomechanical model, this prone weight bearing affects the muscles and joints in the shoulder, contributing to its stability and building of postural tone (Magrun, n.d.). This in turn provides proximal stability for the hand to experiment with grasp, release and physical contact with objects. The opening
and closing of the hand, while bearing weight in prone against a surface, also helps to develop muscle strength and finger movements, preparing them for more advanced hand development and function.

In summary, based on dynamic systems theory, sensory integrative theory, and the biomechanical model, it helps to form the theoretical framework for this project. These theories offer a conceptual framework that sees the central nervous system as a necessary component (but not the sole responsible component) in explaining movement changes. The infant, the environment and the functional significance of the task become a synthesized unit and motor behavior is seen as a product of their interaction with tactile and proprioceptive input having moderating effects on the structures.

**Proposed Explanatory Model of the Identified Problem**

With these three theories as the framework, the identified problem is made clearer by developing an explanatory model showing the relationships between the identified problem and the proposed factors influencing it. There is limited evidence within literature to indicate that prone position in play or daily activities affect fine motor development or upper limb development. Another concern is that some parents are limiting prone position due to the Back to Sleep campaign. This author proposes that fine motor development (as defined in this project as reaching and upper limb movements) is influenced by prone play position while the infant is awake. A description of this explanatory model is explained in the following section and depicted visually in Appendix A.

There are 3 factors that bring about optimal fine motor development in infants.
These three factors pose an indirect casual relationship with 2 elements posing a modulating effect on one of the factors. Fine motor development is defined as reaching, midline finger play, grasping and any upper limbs movement seen in the first year of life. Presumably, spending time in prone (Factor 1) will inevitably provide an indirect casual relationship to Factor 2 (increase time the infant puts weight onto the forearms and upper body). Another indirect casual relationship is Factor 2, which causes stability in shoulder (Factor 3) leading to the final outcome, fine motor development in the infant. It is important to note that along the way, 2 elements, proprioceptive input and tactile input have modulating effects in producing shoulder stability. These factors are linked - with the assumption that prone activity given by infants during wake time will provide variability in movement and opportunities for weight bearing that will enhance shoulder stability which in turn helps in fine motor development.

The first factor (spending time in prone position) in this explanatory model is influenced by how much time the caregivers or parents will put the infants in prone during play. Since the “Back to Sleep” campaign that started in 1992 by the American Pediatric Association because of sudden infant death syndrome (SIDS) and its correlation with prone sleeping, many parents and caregivers have avoided putting infants in prone all together due to the present practice of Back to Sleep and fear of SIDS (Zachry & Kitzmann, 2011). Infants are also noted not to prefer playing in prone because parents habitually put them on their backs (Mildred, Beard, Dallwitz & Unwin, 1995).

The second factor (i.e. prone activities leads to weight bearing on forearms) has been documented in literature in infant development. These prone activities have been
used in various programs to enhance motor development, particularly in gross motor
development (Salls, Silverman & Gatty, 2002). In this instance, body weight is defined as
infant’s own weight onto the forearm. Weight bearing exercises/activities place demands
on the shoulder musculature and affects muscle activation (Uhl, Carver, Mattacola, Mair
& Nitz, 2003).

The third factor is shoulder stability which is modulated by proprioception and
tactile input. Studies have shown that shoulder stability leads to improved upper limb
reported that when the upper limb is in a weight bearing position, different shoulder
muscles, especially the infraspinatous, is activated and helps to strengthen the shoulder
girdle.

How Shoulder Stability Affects Developed Anatomical Hand Structures
Upper trunk and scapular stability provide control for changes in upper extremity support
patterns (Gilfoyle et al., 1990). Gilfoyle and her colleagues (1990) stated as the infant
changes from primitive extension when lying down to having weight on forearms and
elbows slightly aligned in front of shoulders, combinations of flexion and extension
develop and create shoulder stability. The unique structure of infants’ shoulder allows
them to move their hands in many positions. The only downside of mobility is that it
comes at the price of stability. When the muscles in the shoulders are well developed, it
allows better movement in elbow and arm. The on-hand posture allows proprioceptive
input through the hands across the palmar surface. Boehme (1988) noted that prone
position helps to strengthen the arm and hand muscles and provides tactile and
proprioceptive input through the hands across the palmar surface. This helps to develop functional anatomical hand structures (includes building of hand arches) that facilitates good grasp (Flatt, 1972). Benbow (2006) noted that lack of weight bearing on the hands can affect hand structures, including under developed arch formation and stabilization, and affect the skilled use of the hands.

The moderators - Studies have also shown that proprioceptive and tactile elements facilitate effective reaching strategy through multimodal input. Warner, Lephart and Fu (1996) studied unstable shoulders and came to the conclusion that there is decreased proprioception in unstable shoulders. Biomechanically, they found that proprioception provides afferent sensory feedback and mediates muscle control in the shoulder. Joint compression increases the concavity compression fit of the humeral head into the glenoid socket of the shoulder thus providing stability.

Tactile information from the contacting surfaces while the infant is in prone provides stimulation for alternating finger flexion and extension. With feedback from rubbing of the hand against a surface, isolated finger movements first occur automatically when in touch with a flat surface and are refined later with more voluntary control (Case-Smith, 1995). Thus, tactile input from the contacting surface when prone provides the foundation for grasp development and later on refined isolated finger movements. Being in prone also facilitates controlled release and precise release of small objects by stabilizing the proximal arm on a surface.

The explanatory model incorporates the person, environment and occupational elements that are so crucial in the conceptual model of occupational therapy (Law,
Cooper, Strong, Stewart, Rigby & Letts, 1996). Play is considered the infants’ occupation under AOTA Occupational Therapy Practice Framework (AOTA, 2014) and children that have poor motor performance (including fine motor skills) will have problems in participation and engagement in occupation. Good occupational performance during play results from the dynamic relationship between infant, play positions in prone and the environment in which this was carried out. In the explanatory model (see Appendix A), Factor 1 of spending time in prone engaging in a dynamic relationship with Factor 2 of increased stability in shoulders results in Factor 3 of optimal health outcome related to fine motor development. These factors are actively modulated by elements of proprioceptive and tactile input to the weight bearing shoulders. As infants are given the opportunity and environment to practice in prone play, motor change will happen over time and quality of hand use will change.

**Evidence for Proposed Explanatory Model of Identified Problem**

In order to test the proposed explanatory model (described previously in this chapter), the following questions were formulated to guide search for evidence related to each component of the proposed model:

1. Is there evidence that weight bearing on the forearms and upper body can affect muscle strength and activation in the shoulder girdles?
2. Is there evidence that the amount of time spent in prone during waking hours will affect fine motor development?
3. Is there evidence that shoulder stability and developed anatomical hand structures will allow better movement in the upper extremities?
4. Is there evidence that proprioceptive input can affect joint stability in the shoulder girdle?

5. Is there evidence that tactile input from the contacting surface facilitates fine motor development?

Since there is a relatively small body of literature looking at the effect of prone play on fine motor development, the elements of this literature search was categorized into 5 main areas according to the questions outlined above to establish links between the factors and elements. Using the databases PUBMed, CINAHL, PsychoInfo, Boston University and McMaster University library databases, Cochrane and online search engine for OTseeker and the American Journal of Occupational Therapy (AJOT), Google scholar; evidence reviewed was related to: (1) weight bearing on upper body and effect on muscle strength and activation in shoulder girdle (keywords: “weight bearing”, “shoulder girdles”, “muscle activation”, “muscle strength” and “upper limbs”, “weight bearing, shoulder musculature and infants”), (2) prone play position and fine motor development (keywords: “tummy time”, “fine motor”, “prone”, “motor development”, “motor outcomes”, “motor milestones”, “sleep positioning”, “back to sleep” and “prone to play”), (3) shoulder stability and developed hand structures and movement in upper extremities (keywords: “shoulder stability”, “fine motor skills”, “upper extremities”, and “anatomical hand structures”), (4) proprioceptive input and joint stability in the shoulder (keyword: “proprioception”, “shoulder stability”, “development”, “shoulder girdle”), and (5), tactile input and fine motor development (keywords: “tactile” “kinesthetic input”, “shoulder”, “fine motor development” and “weight bearing”). For each search, a core
cluster of article with repeated occurrence through different databases were gathered and reviewed. Of the articles that matched the search terms, not all are listed in the Scientific Citation Index or with robust evidence under the Sackett scale. The decision to include them in the literature search and review was due to the lack of documented research and publishing of good quality of these results. However, the articles do demonstrate associative or inferred nature in the subject studied.

The first search yielded 4 articles relating to the effect of weight bearing on forearm on muscle strength and activation of muscle in the shoulder girdle. The second search yielded 9 articles regarding the effect of the amount of time spent in prone during wake time and fine motor development. The third search yielded 7 articles on the relationship of shoulder stability and its effect on upper limb movement. The fourth search yielded 2 articles on the effect of proprioception and joint stability in the shoulder. The final search yielded 5 articles that discuss tactile input from contacting surfaces and its effect on fine motor development.

Is there evidence that weight bearing on the forearms and upper body can affect muscle strength and activation in the shoulder girdles?

Weight bearing on Forearm and Upper Body

The weight is defined as the body weight or infants’ own weight onto the forearm. Weight bearing exercises/activities place demands on shoulder musculature and affects muscle activation as documented in recent research. (Uhl, et al., 2003). Various studies (Pontillo, Orishimo, Kremenic, McHugh, Mullaney & Tyler, 2007; Chulvi-Medraqno, Martinez-Ballester, & Masia-Tortosa, 2012; Kang, Jung, Nam, Shin & Yoo, 2014) have
shown that pushing up and weight bearing on stable or unstable surfaces cause activation of shoulder musculature and increases muscle strength in normal subjects. Moreover, studies on upper extremity weight bearing in children with cerebral palsy also showed improvement in hand function and prehension pattern in these children (Pin, 2007; Chakerian & Larson, 1993).

**Is there evidence that the amount of time spent in prone during waking hours will affect fine motor development?**

**Amount of Time in Prone Position during Wake Time –**

The amount of time in prone position has been documented by researchers as a factor in affecting motor development (Monson, Deitz & Kartin, 2003; Pin, Elderidge & Galea, 2007; Salls, Silverman & Gatty, 2002; Kuo et al., 2008; Majnemer & Barr, 2006; Jennings, Sarbaugh & Payne, 2005). Evidenced-based literature indicated that weight bearing can affect shoulder musculature and shoulder girdle. The exact amount of time in prone to affect fine motor development has not been documented in the research, but the Uhl et al. article (2003) stated that when the upper limb is in a weight bearing position, different shoulder muscles, especially the infraspinatous are activated and helps to strengthen the shoulder girdle. When shoulder girdle is strengthened, it provides better stability to enable the upper extremities to engage in fine motor activities (Case-Smith, 1995).

**Is there evidence that shoulder stability and developed anatomical hand structures will allow better movement in the upper extremities?**

**Shoulder Stability and Developed Anatomical Hand Structures**
Upper trunk and scapular stability provide control for changes in upper extremity support patterns (Gilfoyle et al., 1990). Gilfoyle and her colleagues stated as infants change from primitive extension when lying down to placing weight on forearms and elbows slightly aligned in front of shoulders, combinations of flexion and extension develop and create shoulder stability. The unique structure of the infant’s shoulder allows him to move his hands into many positions. However, the downside of mobility comes at the price of stability. When muscles in the shoulders are well developed, it allows better movement in elbow and arm. The on-hand posture allows proprioceptive input through the hands across the palmar surface. Boehme (1988) noted that prone position helps to strengthen the arm and hand muscles and provides tactile and proprioceptive input through the hands across the palmar surface. This helps to develop good anatomical hand structures (including the building of hand arches) that facilitates good grasp (Flatt, 1972). Benbow (2006) noted that lack of weight bearing on the hands can affect hand structures; moreover under developed arch formation and stabilization, affect the skilled use of the hands. Shin, Park, Lee, Lee & Kim (2010) also studied the effect of shoulder stabilization exercises and provided evidence that there is an increase in hand functions in post intervention.

Is there evidence that proprioceptive input can affect joint stability in the shoulder girdle?

Biomechanically, Warner, Lephart & Fu (1996) studied the effect of proprioception on shoulder stability and found that it provides afferent sensory feedback and mediates muscle control in the shoulder. Joint compression increases the concavity
compression fit of the humeral head into the glenoid socket of the shoulder providing stability. Myers & Lephart (2000) also noted that shoulder stability is mediated by the sensorimotor system of which proprioception plays an important role in neuromuscular control. Barden, Balyk, Raso, Moreau & Bagnall (2004) studied the relationship of proprioception and shoulder stability. They concluded that subjects with multidirectional shoulder instability have a reduced capacity to use proprioception to refine and control the motor output of the upper extremities.

**Is there evidence that tactile input from the contacting surface facilitates fine motor development?**

Majnemaer, Bourbonnais & Frak (2008) commented on the how cutaneous afferents affect refined hand function and manipulation by providing feedback mechanism through interplay of sensory inputs from fingers and the motor output of the hand and finger muscles. Tactile information from the contacting surfaces while infants are in prone provides stimulation for alternating finger flexion and extension. With feedback from rubbing of the hand against a surface, isolated finger movements first occur automatically when in touch with a flat surface and are refined later with more voluntary control (Case-Smith, 1995). Tactile input from the contacting surface when prone thus provides the foundation for grasp development and later on refining isolated finger movements. Being in prone also helps controlled release and precise release of small objects by stabilizing the proximal arm on a surface which can be provided by playing in prone position while awake.
Theoretical Basis for the Explanatory Model - Dynamic Systems Theory, Sensory Integration Theory and Biomechanical Model:

Using these three theories as the framework, one can see the identified problem fits very well in occupational therapy’s PEO (person, environment, occupation or task) model (Strong et al., 1999). According to dynamic systems theory, infants are viewed as active organisms composed of many subsystems. They have the ability to self organize to produce patterns of movement. Each subsystem may also develop at a different rate (Thelen, 2005). With the many degrees of freedom in the subsystems, the individuality of development for each individual child in their own unique way is expressed. Development, seen as changes in motor behavior, comes with variable movement patterns. Variability, an important feature, is considered necessary in order for optimal function to occur (Thelen & Smith, 1998). It allows adjustment to the changes in the environment. It shows many degrees of freedom. Therefore, as one of the control parameters, the environment can be manipulated (in this instance, providing an environment that encourages the infant to play in prone position) to offer opportunities for the sub-systems to go into shift phases which allows infants to self-explore, experience challenges and variations in movement, and undergo trial and error with movement patterns. The system is capable of self-organizing and modifying the motor skill depending on the constraints imposed on the system and the level of function in each subsystem. The elements (i.e. central nervous system, head size) can mature at different rates and any factor can be rate limiting and delays the emergence of a new skill. Therefore, the acquisition of new motor skills can be seen as finding optimum values of
constraints that will meet the demand of the task for each individual. It helps to explain
variability and flexibility that is observed in motor studies that cannot otherwise be
explained by other theories.

Sensory Integration theory proposes that the brain has the ability to organize
sensory information and to use it to learn and perform as the child interacts with normal
environmental challenges. As Bundy et al. (2002) states, learning is dependent on the
ability to take in and process sensation from the environment and to use it to plan and
organize behavior. When the child is in prone, proprioceptive and tactile input are given
to the palm through muscles and joints. The input in turn stimulates the supinated
movement of the forearm. The rolling of the ulnar over the radius also allows weight
bearing on the forearm and hands. Warner, Lephart & Fu (1996) studied the effect of
proprioception on shoulder stability in adult patients with orthopedic shoulder problems
and found that it provides afferent sensory feedback and mediates muscle control in the
shoulder. Together with tactile data received, it provides information to the individual
concerning physical contact with the external world. All this sensory data are organized
and processed in the brain, then converted to meaningful information and used to plan
and execute motor behavior. By placing infants in prone, meaningful sensory information
are provided to assist in the development of the new motor behavior.

A biomechanical component is also present and intertwined with proprioceptive and
tactile input. It explains how the body produces shoulder stability and movement to
facilitate strength and endurance and range of motion for fine motor skills as infants
develop (Kielhofner, 2009). Schneck (1991) and Laszlo & Bairstow (1983) studied how
kinesthesia and tactile input can affect pencil grasp and motor control respectively.

Based on dynamic systems theory, sensory integrative theory, and the biomechanical component, they help to form the theoretical framework for this project. These theories offer a conceptual framework that sees the central nervous system as a necessary component (but not the sole responsible component) in explaining movement changes. The infant, environment and functional significance of the task become a synthesized unit and motor behavior is seen as a product of their interaction with tactile and proprioceptive input having moderating effects on the structures.

Fine Motor Development in Infants (Optimal Health)

The ultimate optimal health in this project is age appropriate fine motor development. Using the theories of dynamic systems theory, sensory integration theory and biomechanical theory as framework, engineering the environment to provide variability and opportunities to practice movement in different position (of which prone is one position) offers more time in loading weight onto the forearms and upper extremities. This research project attempts to provide a link that associates weight bearing with optimal fine motor development.

Optimal health (Appropriate fine motor development) will be considered as the outcome of the educational program of having the infant in longer prone position during play. Play in infants is considered their occupational performance and under AOTA Occupational Therapy Practice Framework (OTPF), children that have poor motor performance (including fine motor skills) will have problems in participation and engagement in occupation. When infants obtain enough experience in the prone position
during their waking hours, one can see positive changes in their fine motor development.

**Summary of Evidence for Explanatory Model**

Much emphasis has been placed on the “Back to Sleep” campaign which started in 1992 because of sudden infant death syndrome (SIDS) and its correlation with prone sleeping. Mildred, Beard, Dallwitz & Unwin (1995) and Zachry & Kitzmann (2011) also reported that caregivers and parents have avoided putting their infants in prone all together due to the present practice of Back to Sleep and fear of SIDS. Infants are noted not to prefer playing in prone because parents habitually put them on their backs (Mildred et al., 1995). Therefore, opportunities for weight bearing in prone are limited and may affect fine motor development in children. Through tummy time, playing in prone, has been advocated by many pediatric therapists in many early intervention programs. However, there are no randomised control studies on its efficacy (Wen, Baur, Simpson, Rissel & Flood, 2011). Other articles that were reviewed indicated an association that being in prone position while awake has a significant effect on the acquisition of motor skills and rate of motor development in infants two to six months of age (Dudek-Shriber & Zalazny, 2007; Monson, Deitz & Kartin, 2003; Salls, Silverman & Gatty, 2002). Infants who were put into prone for play while awake showed significantly better scores on two standardized gross motor tests, namely the Alberta Infant Motor Scales ((Dudek-Shriber & Zalazny, 2007; Monson et al., 2003) and the Denver II Gross Motor Sector (Salls et al., 2002), when compared to infants that slept supine with little or no tummy time. Dudek-Shriber & Zalazny (2007) also found that spending greater than 2 hours of prone time while awake is significantly associated with rate of attainment of prone,
supine and sitting milestones, or skills that require weight bearing patterns against gravity, in prone and other positions in 4 months old infants. Davis et al. (1998) & De Kegel (2012) found that prone sleepers appeared to acquire motor milestones at an earlier age than supine sleepers. Bridgewater et al. (1999) and Salls et al. (2002) noted that time spent in certain positions that involve greater stimulation can affect motor changes. Salls et al. (2002) specifically stated that tummy time for 15 minutes per day can show significant associations in 2 months old infants compared to those that spent less. Interestingly enough, some researchers found positional preference of sleep position or wake position made no great effect on motor development after 6 months (Carmeli et al., 2009; Dewey et al., 1998). In fact some infants showed a transient decreased motor developmental score at 6 months of age, and appeared to catch up and differences were no longer obvious by 18 months (Dewey et al., 1998). This is suggestive of a critical window of time for intervention and provides a time frame that may be crucial for changing outcomes. This may even be important for those infants that are considered premature or at high risk for developmental delay. Most infants are now sleeping in supine as recommended by the American Academy of Pediatrics. The only time that can be used for prone weight bearing and activities are wakeful times. Kuo et al. (2008) & Majnemer & Barr (2006) concluded that wakeful time in prone can affect prone specific motor milestones in the first 6 months of life. The association of putting children in prone while awake with improvement in motor development gave us more information to consider tummy time as part of a daily positioning program in children under 6 months old.
From another angle, the amount of time spent in prone will affect the amount of weight bearing through the shoulders that infants receive throughout the day. Evidenced-based literature indicates that weight bearing on upper limbs whether through exercises or positioning can affect shoulder musculature and shoulder girdle (Uhl, Carver, Mattacola, Mair & Nitz, 2003). The amount of time in prone to affect fine motor development has not been documented, but the Uhl et al. article (2003) stated that when the upper limb is in a weight bearing position, different shoulder muscles, especially the infraspinatous are activated and help to strengthen the shoulder girdle. Upper trunk and scapular stability provide control for changes in upper extremity support patterns (Gilfoyle et al., 1990). Gilfoyle and her colleagues stated as infants change from primitive extension when lying down to having weight on forearms and elbows slightly aligned in front of the shoulders, combinations of flexion and extension develop and create shoulder stability. However, as most of the studies are descriptive, temporal associations between putative causes and effects are not clear, and one must be careful in drawing causal inferences. Some studies are cross-sectional and by nature of the design, they provide association rather than causation between the event (tummy time) and outcome (motor development) and is difficult to establish causality. The information gathered so far can provide us with basis for further research using more vigorous analytic studies.

**Implications for Program Design**

Interestingly, though there are many programs for tummy time or prone playing activities both in books, magazines and on the internet, researchers have not defined exactly what constitutes tummy time. On reviewing research articles and present existing
programs, tummy time appears to consist of weight bearing activities in prone during play time (Zachry et al., 2011 & Koren et al., 2010). These activities are reported to affect postural control and motor development as reviewed in the last section. Case-Smith et al. (1992), Wang et al. (2011) and Samson (2000) also reported association of postural control with fine motor development. Therefore, as supine sleeping position and play position limits infants to experience of alternate positions to explore movement, in this project, caregivers are encouraged to put infants into prone during waking hours so that they can explore and practice a variety of movements. According to Dynamic Systems Theory, development is an emergent phenomenon. Infants are viewed as active organisms composed of many subsystems. Infants have this ability to self organize (without any code or recipe) to produce patterns of movement. Each subsystem may also develop at a different rate (Thelen, 2005). With many degrees of freedom in subsystems, the individuality of development (individual children solving individual problems in their own unique way) is expressed and the course of development is almost impossible to predict. Development, seen as changes in motor behavior, comes with variable movement patterns. Variability, an important feature, is considered necessary in order for optimal function to occur (Thelen & Smith, 1998) and it allows adjustment to changes in the environment. Therefore, the environment as one of the control parameters can be manipulated (in this instance, putting the infant in prone position) to offer opportunities for the sub-systems to go into shift phases to allow infants to self-explore, experience challenges and variations in movement, and undergo trial and error with movement patterns. As infants practice a variety of movements in prone, weight bearing through
shoulder joints occurs while receiving proprioceptive and tactile input to the contacting surfaces (Warner, Lephart & Fu, 1996). Researchers found that it provides afferent sensory feedback and mediates muscle control in the shoulder. Joint compression increases the concavity compression fit of the humeral head into the glenoid socket of the shoulder providing stability. Myers & Lephart (2000) also noted that shoulder stability is mediated by the sensorimotor system in which proprioception plays an important role in neuromuscular control.

Based on the review of prone positioning articles for sleep and play, a prone play program that requires parents to put infants into at least 15 minutes of prone play daily will affect some motor function (Mildred et al., 1995). Research has shown that if home programs and educational programs are incorporated into developmental follow-up programs, they will be effective and beneficial to infants and families (Lekskulchai & Cole, 2001). A home program is also cost effective and families can carry this out during play-time as part of their daily routine. The proposed intervention will be an educational package of prone play activities that the parents can use for the appropriate age during play time. They will be recommended to use these activities for play in prone at least 15 minutes daily so that the child will experience the prone position.

**Evaluation of the project design**

A program evaluation of the “Prone to Play” education program should be done with the infant-parent dyads. A small scale pilot study of 3 infant-family dyads will be first conducted. A pre-intervention test should be done to establish a baseline. The pre-intervention test should also include parental surveys that identify needs, perceptions and
learning goals. Infants will also be assessed on motor abilities and postural control using the Alberta Infant Motor Skills (AIMS), the Posture and Fine Motor Assessment of Infants (PFMAI) and the Peabody Developmental Motor Scales, 2nd edition (PDMS-2). These are three standardized tests that can be used to work with infants at that age (Piper & Darrah, 1994; Case-Smith & Bigsby, 2000; Folio & Fewell, 2000). AIMS is a criterion referenced test and will give results that will be quite valid. During the intervention, parents will be asked to record in a log the time how long the child has been in prone. After 7 weeks of intervention (in the form of educational sessions and written material), families are asked to give feedback through another questionnaire to rate the effectiveness of the program. The frequency and rate of playing prone are also documented for future use. Infants are reassessed with the AIMS, PFMAI and PDMS-2. A longitudinal follow-up of the babies up to 12 months old is also planned. Details of the evaluation plan are provided in the next section.
CHAPTER THREE
Description of Proposed Program

Introduction

Since 1992, the American Academy of Pediatrics (AAP) began promoting the importance of prone play – also called “tummy time” – for optimal infant development (Zachry & Kitzman, 2011). This balanced the AAPs recommendation in the same time period that infants should sleep in the supine position to help prevent Sudden Infant Death Syndrome (SIDS); this has been called the Back to Sleep campaign (Moon, Horne & Hauck, 2007).

Pediatric therapists observed that many children demonstrated a slower start in certain motor skills as a result of the Back to Sleep campaign and recommended tummy time while awake to help remedy the situation (Zachry & Kitzman, 2011; AOTA, 2013). Moreover, since the advocacy of the Back to Sleep program by pediatricians, many babies who were supine sleepers ended up playing in supine while awake. Many caregivers still are unaware of the complications that could occur if prone play is not made available to infants. In practice, it has been observed that many infants dislike playing in prone since they are accustomed to sleeping on their backs (Jones, 2004). It has been noted that it became very difficult for some parents to implement prone play for their infants because the infants cried and tried to get out of the prone position.

Occupational therapists can play a key role in educating and training caregivers on the importance of prone play and how to incorporate this into the infant’s daily routine. An education program with prone play activities has been recommended to help parents and
caregivers to teach infants to play in the prone position which had been shown to advance development in the first year (Lobo & Galloway, 2012).

Within the domain of occupational therapy practice, pediatric occupational therapists have been concerned with performance skills such as functional motor skills that impact play in children. Under AOTA Occupational Therapy Practice Framework (OTPF), (AOTA, 2002), and the Canadian Association of Occupational Therapists Position Statement on Healthy Occupation for Children and Youth (CAOT, 2009), one area of occupational performance for children is to be able to use motor skills to engage in meaningful and purposeful play. Play is an essential occupation for an infant. Children with poor motor performance and fine motor skills will also tend not to do well in participations and engagement in occupation (play) thus losing out on social development that was fostered while playing with their peers. In addition, Tremblay et al. (2012) published the Canadian guidelines for activity of children from birth to four years old. The guidelines recommended that infants (less than 1 year of age) should be physically active several times during the day of which floor-based play in prone is highly recommended.

Lobo & Galloway (2012) found that enhanced handling and positioning in early infancy can affect the advancement and emergence of certain motor skills like reaching and object exploration. This project focuses on developing, implementing, and evaluating a play positioning program that provides opportunities for infants to experience prone position in play during waking hours and to explore the association of prone play position with fine motor development.
This chapter focuses on the development of a prone-play education program, called “Prone to Play” Program for parents and caregivers. This program will provide enhanced handling and positioning in prone. This will be based on contemporary developmental and motor learning theories with regard to positioning and play time in prone with an emphasis on fine motor and shoulder stability. These will be prone play activities that aim at weight bearing and strengthening shoulder girdles via upper limbs movements. The infants are put into these play positions during their waking hours and play time. These activities are embedded into play and will be related to the appropriate developmental level. Using the contents of the program, it is envisioned that these activities will facilitate postural control and eventually influence fine motor development.

The following is a description of the program itself and related play activities developed for parental education for this doctoral project followed by intended outcomes of the program, and potential barriers and challenges for the implementation of the program.

**Parent programs and parent education on prone play**

One of the important components of the project is using parental education to facilitate change in behavior in parents. The parents are educated to provide optimal environments to induce variability in movement in the infants. The 45 minutes weekly sessions, with at least 20 minutes of prone play activities, will provide opportunities for the parents to learn how to structure the environment and situations to help infants experience prone play. The literature review indicated that overall caregivers and parents are not typically aware of the developmental benefits of prone position during play and “tummy time” (Koren, Reece, Kahn-D’angelo, & Medeiros, 2010; Mildred, Beard,
Dallwitz, & Unwin, 1995; Zachry, & Kitzmann, 2011). Though there are tip sheets and handouts (AOTA, 2013, CDRP, 2004), there have not been formal education programs for parents to work with their infants in prone when they are discharged home after birth. The Children Developmental Rehabilitation Programme has provided a “Tummy Time “fact sheet for parents (CDRP, 2004). Therapists surveyed by graduate students in 2012 mentioned the need to have a more comprehensive program to teach parents about prone play (Lee, Cain & Mallory, 2012). A literature review also presented that parents do not typically receive a lot of information regarding play positioning when newborns are discharged from hospital. The most beneficial type of communication tool appears to be the use of printed materials (Jennings, Sarbaugh & Payne, 2005).

Program Design

Occupational therapists have been advocating tummy time along with their physiotherapy colleagues. Evidence-based literature supports that tummy time affects postural control and the rate of gross motor development (Salls, Silverman & Gatty, 2002). Very little has been discussed about how this affects fine motor skills, but occupational therapists have always used their clinical reasoning based on their experience to encourage parents to use tummy time to enable infants to bear weight and facilitate upper limb development. In the spring of 2012, two graduate students under the supervision of this author put together a short handout on tummy time “Prone to Play” to give parents when they bring their infants in for therapy. The handout was reviewed by a panel of experts that consisted of two physiotherapists and three occupational therapists from the Children’s Developmental Rehabilitation Programme (CDRP) of McMaster
Children’s Hospital. All the therapists interviewed had more than 10 years of experience working with infants. At present, the therapists at CDRP used a one sheet handout to give to parents. All identified the need to have an education package that incorporates the information regarding specific positions and activities used and to be easily understood by parents of all backgrounds.

Based on the results of the interview, the students together with this author drafted a booklet on “Prone to Play” (Appendix B). In the summer of 2012, the preliminary results and the draft of the booklet were presented in the form of a poster at an evidence based symposium for the graduating 2012 McMaster OT student class in Hamilton (Appendix C). One of the main findings was the need to enable knowledge dissemination of prone play to parents in an effective way. Evidenced-based literature also support that there is a gap in research of how prone play can promote upper limb development.

As a result, a package of prone play multimedia education program for parents and caregiver was envisioned. As a pilot study, it will be delivered to 3 dyads of parents of young infants aged 2 months at the time of recruitment. Inclusion criteria will be supine sleepers. As part of the program, the booklet on “Prone to Play” will be redrafted and trialed with these 3 infants before implementing on a larger scale with high-risk infants attending treatment at CDRP. These materials can be used for infants without a diagnosis or at high risks for motor delay due to prematurity or other complications. For the sake of simplicity, the material will be piloted on typically developing infants for this doctoral project. The education program will provide enhancement in playing in prone and provide ideas for structuring the environment in such a way that variability of
movement is encouraged. The infant-parent dyads will be recruited directly from the nursery after they are discharged from McMaster Children’s Hospital.

The family’s demographic details and socioeconomic background will be noted. As a baseline, the infants will be assessed using the Alberta Infant Motor Assessment (Piper & Darrah, 1994). Both the Posture & Fine Motor Assessment of Infants (Case-Smith & Bigsby, 2001) and the Peabody Developmental Motor Scales, second edition, (Folio & Fewell, 2000) will be used for the baseline measurement for fine motor skills. The same three tests will be used immediately post intervention for measurement of change in motor skills. The Alberta Infant Motor Assessment (AIMS) is a norm referenced measure with good reliability and validity for measuring the postural control and motor skills of infants from 0–12 months old. The administering therapist does not need to attend special training, but need to have an understanding of essential components of each item and, have skill in the observation of movement. The Posture & Fine Motor Assessment of Infants (PFMA) is criterion referenced for children aged 2–12 months old. It can be administered by therapists who are familiar with fine motor development in a standardised procedure and the raw scores will help track the progress of infants longitudinally. The Peabody Developmental Motor Scales-second edition (PDMS-2) with the fine motor subtests can be administered separately from the gross motor subtests. PDMS-2 is also a norm referenced developmental measure designed to measure fine motor development of children from 0 to 72 months old.

Fifteen-minute minute- video clips of the infants’ movements will also be recorded and analyzed during the 3-month period. As part of the education package, the
infant & parent dyads will attend a 45 minute weekly session emphasizing prone play and, utilising material from the multimedia educational package. A description and sample of the 45-minute prone play sessions are recorded in Appendix D. The therapist conducting the session will be well trained in infant development and have more than 2 years of experience working with infants. The 45 minute weekly sessions will be conducted in a room in the hospital. The room décor will be as naturalistic as possible, and be child friendly so that it resembles the home environment. The parents will also be asked to do a daily parental log of the infant’s head position as well as frequency and duration of prone play during a 15-minute period. The parents will be provided with a sheet of photographs showing what the different degrees of prone head lift look like (Appendix E). The parent can select the photo that looks closest to their infant’s level of achievement and write the code number of the photograph in the logbook. During the 45-minute weekly sessions, the parents will have demonstration of the activity and a reverse demonstration of what they had learnt in the sessions so that they can do so at home with the infants. The major advantage will be repetition of movement and constant reinforcement to increase confidence, competence and skill retention. A video called “Heads up and Prone to play” a 6 ½-minute video on Dr. Anne Zachry’s Tummy Time website (2014) will also be used as a teaching tool. This is a cost effective, easy and time efficient way if the video is streamlined and put onto a webinar format. The same sort of material will be repeated for the next client in order to make the teaching more standardized.

The weekly sessions and emphasis on daily prone play will continue until infants
are 3 months old. The daily log (see Appendix F) will continue until infants reach 3 months old. By the end of the 3rd month, infants will be reassessed using the same instruments. A follow-up period to look at the infants’ postural control, gross motor and fine motor development will be when the infant turns 6 months, 9 months and 12 months old. During these 3 follow up encounters, the infants will be reassessed for their gross motor and fine motor development using the AIMS, PFMA and PDMS-2. A 15 minute video of the infants’ activity will also be recorded during the 3 follow-up encounters after the infant has turned 6 months, 9 months and 12 months old. A pediatric therapist, knowledgeable in administration of the two standardised tests (AIMS, PDMS-2 & PFMA) but blinded to the study and intervention will be recruited to do the pre and post intervention assessment. Another pediatric therapist knowledgeable in baby movement and posture will be recruited to analyse the 15-minute video clips done during the study. This therapist will be independent of the training and the 45-minute education session. The results from the subsequent 9-month follow-up period will provide some information if prone play activities and upper limbs development have any longitudinal associations.

**Application of determinants of dynamic theory in the development of prone play program**

The selected activities for prone play in the education package will be congruent with the theoretical assumptions in motor learning (Zwicker & Harris, 2009) and dynamic system theories in development (Thelen & Smith, 1998). Development, seen as changes in motor behavior, comes with variable movement patterns. Variability, an important feature, is considered necessary in order for optimal function to occur (Thelen,
2005). It allows adjustment to the changes in the environment and shows many degrees of freedom. Therefore, as one of the control parameters, the environment can be manipulated (in this instance, by putting the infant in prone position) to offer opportunities to allow the infant to self-explore, experience challenges and variations in movement, undergo trial and error with movement patterns. The education package and the intervention phase will offer opportunities for the environment to be manipulated by putting the infant in a prone play position. As the infant matures, the tolerance to prone play also increases and they will spontaneously spend more time in prone play.

**Participants**

Three parent-infants dyads will be recruited to try out the new “Prone to Play” parent education program. At the time of recruitment, the infants will be surveyed to be supine sleepers since birth. The families will be recruited from family physician offices and midwives that provide follow-up new born care in the Hamilton Wentworth area. The physicians will be selected from a list provided by the Hamilton Academy of Medicine that list family physicians involved in care of the new born. The midwives, who will be contacted, are members of the College of Midwife in Ontario and see families in the Hamilton Wentworth area. The families and caregivers recruited will be English speakers and will be able to read instructions in English. Parents’ reading level will be at least at Grade 6 or above as the material will be in English and will be at about a Grade 6 level. Infants will be from two parent families and one parent will at least be the principal caregiver. Infants with premature birth or suspected developmental delays and other health issues are excluded from the study.
Components of program

The educational program on prone play and 45 minutes weekly “therapy sessions” will be the key components designed to change motor skills. The education program consists of 45 minutes of weekly sessions, a package of education material in the form of a printed booklet and a set of video clips on a USB thumb drive. Activities in the weekly sessions include positioning the infant mainly in prone during the play sessions; allowing the infants to experience variability in the movement during play, practice on reaching in a prone position and hand play in a prone position (Appendix D). The selected activities are congruent with the theoretical assumptions in motor learning and recent dynamic system theories in development. Some examples of the activities include: child lying prone on belly and weight shifting, prone play with a toy, lying prone and reaching for a dangling toy etc. The activities will be taught and demonstrated to the parents by pediatric occupational therapists during the weekly sessions. These therapists are knowledgeable and are trained in observing motor development and normal movement patterns. To ensure that parents understand and grasp ideas in the program, there will be return demonstration by the parents to practice the activities at the session before going home to implement the program. Parents will be requested to document the total prone activity time and the highest degree of head angle reached in a log book during the seven weeks period of program delivery. A pre-program phase (Phase A) will consist of taking baseline measurements that include using standardised gross motor and fine motor assessments. This will be followed by Phase B in which the 7-week intervention program will be delivered to each infant-parent dyad. Data will be collected during this period and
a post intervention assessment done at the end of the 7\textsuperscript{th} week. Phase C will be the follow-up period where the infants will be seen for re-assessment at 6 months, 9 months and 12 months of age.

The dependent variables are identified as follows:

1. Motor skills - defined as a learned sequence of movements that combine to produce a smooth, efficient action in order to master a particular task. In this study, this will be the ability to stay in the prone position to perform movements such as lifting the head, reaching for objects, weight shifting to the side, lifting chest off the supporting surface.

Measured by appearance of prone motor markers using pictures to identify stage:

a. Prone motor markers: Out of the AIMS, motor markers (in prone) will be selected for 1st month, 2\textsuperscript{nd} month, and 3\textsuperscript{rd} month old (Qualitative), by using pictures to depict the degree of head position when in prone: (see Appendix E).

b. At 1 month-turns head to side

c. At 2 months - the infant raises head to 45\textdegree{} asymmetrically and turns head to side without maintaining it to midline.

d. At 3 months- the infant is able to lift head past 45\textdegree{} and maintains this position for more than 1 minute when in prone, elbows in line with the shoulders. Elbows flexed.

e. At 4 months- the infant is able to lift head to 90\textdegree{} with weight on forearms, abdomen and thighs
2. Strategies used to measure the dependent variable:
   a. Frequencies of prone markers occurring are noted - daily recorded observation by parents
   b. Total duration of prone play (in seconds) recorded by parents daily
   c. Parental logbook of total prone time each day for 7 weeks.
   d. Videotaping of prone play 15 minutes during pre-intervention (baseline measurement), and post intervention at 6, 9, 12 months intervals.
   e. Self-rating report: On a Likert scale of 1 to 5, parents will rate their perception of the effectiveness of the prone play program at the beginning and end of intervention. (Appendix G)

3. Standardized measurement using the Alberta Infant Motor Scales (AIMS), the Peabody Motor Developmental Scales-second edition (PDMS-2, Fine Motor) and the Posture & Fine Motor Assessment of Infants (PFMA) to measure motor skills pre-intervention and after intervention.

The program is based on treatment methodologies found from literature reviews of peer-reviewed journals (Dudek-Shriber & Zelazny, 2007; Monson, Deitz & Kartin, 2003; Pin, Eldridge & Galae, 2007). Most of these articles are not randomized controlled studies; rather many are retrospective and prospective longitudinal studies. However, they did present a protocol of “Tummy Time” that the parents or caregivers utilized during the infant awake time to do prone play activities. All are encouraged to do at least 15 minutes or more prone time per day. The infants were all in their home environment or naturalistic setting when the prone play was done. Most of the activities used motor learning and dynamic.
systems theories as their basis. The intervention is modeled as close as possible to the
settings and environments and participants as reported in the other evidence based studies.
Training of the therapists, caregivers, and parents who administered the intervention is
consistently the same. As motor development can be an effect from maturation, careful
consideration is given to the design of the study using non-congruent multiple baseline
designs. The ultimate core purpose of the project is to study the effectiveness of the prone
play educational program on motor skills development in healthy infants. The hope is that it
can be replicated easily in a naturalistic setting.

Program objectives: Baseline and Targeted change

The main objectives of the program will be: 1) After attending the 7-week
education program, the infants will be able to attain postural control and motor skills
above the 50th percentile at their chronological age compared with their peers on the
Alberta Infant Motor Scale; 2) After attending the 7-week education program, the infants
will be able to show increase in raw scores on the Posture & Fine Motor Assessment of
Infants (PFMA) for fine motor skills; 3) After attending the 7-week education program,
the family will be able to put the infants in prone activity play for at least 15 minutes
daily without the baby fussing; 4) After the education play program, the infants will show
carry over and maintain their improvement of fine motor skills into the following months
when they reach 12 months old. As this is a pilot study, it is hoped that after this clinical
trial, the researchers will be able to recruit up to 30 families to do a large-scale study to
validate the results obtained in this pilot study.
Parent Education & Evidence

Three peer reviewed journal articles (Koren, Reece, Kahn-D’angelo & Medeiros, 2010; Mildred, Beard, Dallwitz & Unwin, 1995; Zachry & Kitzmann, 2011) were appraised on this topic. Koren, Reece, Kahn-D’angelo and Medeiros (2010) did an exploratory study using surveys, focus groups and analysis of parental websites to describe parents’ understanding of infant play positions. The sample consisted of 119 mothers of newborn babies, nine health care providers and popular parental websites. Results of this study reported that 90% of mothers received information about positioning their infants during sleep, but only 55% of mothers received information about positioning for their infants while awake. Mothers reported that the barriers to understanding were confusing guidelines and lack of consistency for the initiation and duration of tummy time. Weaknesses of this study included convenience sampling therefore decreasing generalizability, small sample size, a lack of different health care professionals’ opinions, and hierarchical levels of influencing responses.

Mildred, Beard, Dallwitz and Unwin (1995) conducted self administered questionnaires to determine if knowledge about sleeping supine to avoid SIDS influenced caregivers’ positioning of their infants for play. The sample consisted of 100 caregivers who were attending Child Adolescent and Family Health Services. Results of this study showed that 37% of caregivers were influenced by their knowledge of SIDS and avoiding prone to sleep (p= .002), and 26% of caregivers reported that they never put their children in prone to play. Strength of this study was that it was a large sample size. Weaknesses of this study included convenience sampling therefore decreasing generalizability and the
self administered questionnaires.

Zachry and Kitzmann (2011) used a questionnaire with five short answer questions and 21 multiple choice questions to examine caregivers’ awareness of prone play recommendations. The sample consisted of 205 caregivers of infants from four different pediatric clinics. Results reported that 25% of caregivers were not aware of the recommendations of prone play, and one quarter of this group were not aware of complications from the lack of prone play. Fifty-three percent of infants had less than 30 minutes of prone play per day, and 35% were intolerant to prone play. Caregivers reported getting their information about prone play from written materials and pediatricians. Strengths from this study included large sample size, and a piloted and revised questionnaire. Weaknesses from this study included a 60% return rate of completed questionnaires, convenient sampling, therefore not generalizable, and no direct observation from researchers. Overall, caregivers of infants are not typically aware of the benefits of being in prone position for play and ‘tummy time’.

**Resources**

Resources from McMaster University, Hamilton Health Sciences will be utilised in the implementation of the program in addition to community resources. Therapists from the Early Intervention Team will have the expertise and knowledge of both assessments for assessing fine and gross motor functions in infants and the delivery of the prone to play program. There are also a number of therapists trained in neurodevelopmental therapy (NDT) and a few are also certified in baby treatment by the Neuro-Developmental Treatment Association. These therapists are trained in movement analysis
of infants and will be potential effective assessors for the project. The Children Developmental and Rehabilitation Programme are also well connected with the community and family physicians. The recruitment of the infant-family dyads should not be a difficult process.

Regarding the development of written educational material, graduate occupational therapy students from McMaster University have been able to provide assistance with the first draft. Further revamping of the material will be done with the help the Education Specialist from the Education Department at Hamilton Health Sciences. The Education Specialist will be able to provide consultations to the appropriate reading level, illustrations and layout of the written booklet. If adopted by the hospital for distribution, it will be finalised and copies will be printed and distributed to parents during the weekly sessions. The Education Department and the visual media department will also be involved in the production of the video clips. Consent from subjects to use this clips for educational and teaching purposes need to be sought, keeping in mind that this will be put on the hospital website. Whether this can be put on You-tube or Vimeo needs to be discussed as the hospital and the College of Occupational Therapists in Ontario (our professional and licensure body) has certain guidelines regarding social media. Subjects that will participate in this video will need to understand that it may be put on social media for education.

Graduate students from the School of Rehabilitation Science are another group of people that can help. Every year, the graduating class will have an evidence based project and they can contribute to this study, including the production of such education material.
One of the two students from the graduating class of 2012 who had been involved in the production of the written material had indicated a willingness to help. Colleagues at the McMaster Children’s Hospital and researchers at CanChild (who had been very helpful in the past) can be enlisted to give suggestions and help if needed. Being affiliated with McMaster University and CanChild, also allows this author to draw on students and researchers as resources for statistic support and data management if needed. For publicising and dissemination resources (which will be discussed in more detail in the coming chapters), professional bodies and associations in Ontario can also be approached for assistance.

**Challenges and barriers to implementation**

This project has several challenges to implementation. First, the theoretical links between weight bearing in prone and development in fine motor skills were created by this author and have not otherwise been tested empirically. Hence, there is a strong rationale for doing the study. Though tummy time and weight bearing in prone play have been advocated and implemented by many health care professionals, a direct causal relationship has not been established empirically.

A second challenge to implement this project is the follow through by 3 committed parent-infant dyads for this one year period. In a longitudinal study, the continual participation is important for follow-up. Recruitment of subjects is not too difficult, but obviously the commitment for the year is crucial in order to provide long term data. The subjects will also need to have time to do the log book daily as part of record keeping for the 7 weeks of program implementation. Their time, motivation,
energy and family commitment may be a barrier for successful completion. To encourage
and reinforce participation, a small souvenir to the family will be given in the form of a
video record of their milestones at the various assessments at pre-, post and during the
program delivery.

Time is the fourth challenge. The actual manpower of selecting experienced and
qualified therapists to administer the program is not difficult; however having qualified
therapists to do this as part of their job routine will pose a time constraint for them. One
solution will be to use extra funding to pay for extra hours involved in the project by
engaging two therapists: one an evaluator blinded to the administration, the other an
administrator of the program.

The fifth challenge is related to funding, resources and policies. It can be an
advantage and a disadvantage to be under a big corporate organization like Hamilton
Health Sciences. Though there will be help with the education material, there will be
policies and applications to go through before the actual proposal is approved. Certain
distribution and dissemination methods may also be affected by policies of the hospital
and also social media policies of the professional colleges.

Lastly, the study design has to take into account the development and maturation
of infants during this one year. It is not easy to eliminate the effect of maturation from the
whole project. Continuous effort and refinement of the design is needed to eliminate
confounding variables.
CHAPTER 4

Program Evaluation

Introduction

Program evaluation uses a systemic method to address questions about the program operation and results (Newcomer, Hatry & Wholey, 2010). Newcomer et al. (2010) recommended that program evaluation should be designed before the program is carried out and desired data can be obtained if provision for data collection is made earlier. Analysis of the data can be a means to monitor the implementation and performance of the program in addition to the ability of the program to achieve its stated goals. The results will be helpful to change the practice of parents and caregivers and provide suggestions for future work with at risk infants. The purpose of this report is to establish a plan to evaluate the effectiveness of the “Prone to Play” parent program for caregivers and occupational therapists.

Since 1992, the American Academy of Pediatrics (AAP) began promoting the importance of prone play – also called “tummy time” – for optimal infant development (Zachary & Kitzman, 2011). This balanced the AAPs recommendation in the same time period that infants should sleep in the supine position to help prevent Sudden Infant Death Syndrome (SIDS); this has been called the Back to Sleep campaign (Moon, Horne & Hauck, 2007). The proposed “Prone to Play” parent program comprises a caregiver-friendly designed activity program with an occupational therapy focus enabling upper extremity and fine motor development. This program involves the training and education
of parents and caregivers to use daily waking times and infant playtime to enable infants to spend more time in the prone position.

**Overall vision**

This is primarily a formative, qualitative program evaluation that includes preliminary outcome testing. It looks at the feasibility and potential effectiveness of implementing an education program and instructional package. The program that is under evaluation is designed to teach caregivers how to address prone play in infants aged 2 to 12 months in order to enhance their fine motor development. The program will consist of 45-minute weekly sessions and the dissemination of an information package. The sessions will be held at McMaster Children’s Hospital, in Ontario, Canada. The room will be set up that is conducive for parent and caregiver education. The parents will carry out at home what they learnt in the session. Given that results of the program evaluation are encouraging, the plan is to implement this on a larger scale with the aim of increasing the practice of prone play in the homes and daycares of Hamilton Wentworth region of Ontario.

The results of this program evaluation will be used by stakeholders to decide whether the program sufficiently educates caregivers to provide prone play activities and whether this is likely to enhance the fine motor development of infants. This demonstrated effectiveness will provide the evidence needed for the program to continue. The evaluation will also assess the degree to which program goals are reached. It will provide accountability for the dollars used in funding the program and demonstrate to stakeholders, including caregivers, program staff and funding sources that the program is
helping to support the infants’ development.

Primary intended users of this information will include parents and caregivers who will be the recipients of the program, and pediatric therapists who will be administering the program. In addition, workers from “Well Baby” clinics, hospital administrators, and funding agencies, including the Hamilton District Society for Disabled Children and the Ministry of Health and Long Term Care, will be interested in using the information for future program planning.

**Key Stakeholders**

The key stakeholders for the Prone to Play program are the parents and caregivers receiving the education program and carrying out the program activities, the occupational therapists (OTs) that are doing the training, the healthcare professionals that are in contact with the parents of these young infants (including physicians, nurses, midwives), program supervisor of the Children Developmental Rehabilitation Program, policy makers at the hospital and ministry level, as well as funding agencies (i.e., Hamilton District Society for Disabled Children). The parents, therapists and health care professionals are directly involved in the service delivery for the infants. The program and hospital administrators, the policy makers and funding agencies are interested in the cost effectiveness and efficacy of the program.

**Purpose**

The purpose of this program evaluation will be to find out: 1) whether the parents and caregivers are satisfied with the education program, including factors such as ease of understanding and format for teaching, 2) whether the parents and caregivers are able to
apply what they learned and if they do indeed provide appropriate regular prone play to
the infants, 3) whether the therapists who administered the program feel that it is practical
to administer in a naturalistic environment and if they will recommend modifications, 4) whether infants who received at least 30 minutes of prone play daily will show enhanced fine motor development, 5) whether there are any considerations for cost-effectiveness. The information gathered will be applied to fine-tune the program and provide guidelines for improvement.

**Logic Model Description**

Logic model shows how programme activities are understood to contribute to a series of intermediate outcomes that produces the intended long-term impacts. It is a visual expression of the rationale behind a program. Logic model can be used as a planning tool to help conceptualize, plan and communicate to stakeholders what the project intends to do (McLaughlin & Jordon, 2010). It is often used when evaluators are designing evaluability assessments and performance measurement systems. The logic model acts like a road-map, outlining the outcomes of the program, the activities the program will undertake and the outputs that it intends to produce to achieve the expected outcomes. Therefore, a typical Logic model will include resources, outputs, outcomes, and external/environmental factors (McLaughlin & Jordan, 2010).

**Logic Model**

**Problem Statement:**

Since the advocacy of Back to Sleep program by pediatricians, many babies who were supine sleepers show the risk of developing poor shoulder stability and decreased
strength in shoulder muscles which can lead to delay in fine motor development.

**Goal:**

This program is designed to educate parents how to use play activities in the prone position with their infants and to incorporate these activities into their daily routine to impact motor development in upper extremities.

**Rationale:**

By educating parents how to perform “Prone to Play” activities, the infant spends more time in prone play; the infant will show improvement in fine motor development.

**Assumptions:**

When the infant is playing in prone position, the shoulders receive proprioceptive and tactile input to activate the shoulder muscles to enhance shoulder stability and improve fine motor development. Developmental theorists and researchers affirm a positive effect on postural control & gross motor development.

**External Factors:**

The success of the “Prone to Play” program for home implementation may be affected by many external factors including (1) General awareness of the program by front-line health care professionals (2) Parents and caregivers buy-into the program (3) program funding from funding agencies and Ministry of Health (4) Resources and support from Hamilton Health Sciences (5) Health care changes may affect budgetary resources.
Logic Model - tabulated (see Figure 1 next page)

Overview Plan of Evaluability Assessment

Using the 6 steps process outlined by Wholey (2010) as a framework, the following plan on evaluability assessment is proposed:

**Step 1.** The evaluators will review documents and meet with a small number of policy makers, managers and stakeholders to determine who should be in the team. Key stakeholders will include 2 therapists that are program implementers, the therapy supervisor, 2 parents/caregivers, hospital finance manager. External stakeholders will include a representative each from Ministry of Health and Long Term Care and the Hamilton District Society for Disabled Children.

**Step 2.** Stakeholders will be interviewed to clarify their expectations, concerns and information priorities. Key program inputs, intended activities outputs, intended short-term, intermediate and long term outcomes will be identified for clarification of the design from the perspectives of key stakeholders. A logic model will then be developed (McLaughlin & Jordan, 2010).

**Step 3.** The program design will be compared with the actual program inputs, activities, outputs and outcomes. Existing documents, interviews, site visits and discussion with knowledgeable observers will be utilized. Problems inhibiting effective program performance will be reviewed.

**Step 4.** The plausibility of the program will be done through reviewing information gathered to ensure that the education package is being delivered to the recipients and the
Program Title: Education program for caregivers to address prone position in play to enhance fine motor development in infants (aged 2 to 12 months) that are at risk or have normal development

Resources
- Program Clients
  - Parents of infants (aged 2 to 12 months, normally developing & at risk, without diagnosed disabilities), attending training sessions in a children’s hospital.
  - Caregivers in daycare for these infants may also be included if the infants have child care.

- Program Resources
  - Funding: provincial & federal. Also grants from Hamilton District Society for Disabled Children.
  - Staffing: 1 PT & 1 OT in Infants & Toddler Team at McMaster Children’s Hospital (MCH).
  - Facility - treatment room.
  - Research & Education Dept at MCH.
  - Knowledge of motor development.

Theory
- Nature of the Problem
  - Risk of poor stability in shoulder girdles and decreased strength in shoulder muscles when infants spend too much time in the supine position; this leads to delay in fine motor development.

- Program Theory
  - With infants spending time in prone play and weight bearing, the shoulders receive proprioceptive and tactile input that activates the shoulder muscles, thus enhancing shoulder stability and improving fine motor development.

- Interventions and Activities
  - Therapy sessions once a week for 45 minutes of prone play and training using education package.
  - Home exercises given to caregiver/parents after each session to practice at home. Review of home exercises with parents at the beginning of sessions.
  - Parents use parental log to record total prone time.

Outputs
- Short-Term Outcomes
  - Parents use the education package to implement prone play activities.
  - Frequency of playing in prone increases.
  - Infants are able to bear weight on upper limbs at least 30 minutes daily.
  - Infants show age appropriate fine motor skills when assessed developmentally by a standardized fine motor measure.

- Intermediate Outcomes
  - Well developed infants’ hand arches and structure for improved grasp and release.
  - Infants show age appropriate fine motor skills when assessed developmentally by a standardized fine motor measure.

- Program Outputs
  - # infant-parent dyads participants (3 in the pilot program, eventually 100 in funded study)
  - # of weekly therapy sessions (over 7 wks) delivered for each family.
  - # of developmental assessments by 1 PT & 1 OT staff.
  - Training manual produced by the Education & Research Dept.

- Long-Term Outcomes
  - Well developed hand function for good handwriting and other upper extremity activities when the children enter school.

External/Environmental Factors: (facility issues, economics, public health, politics, community resources, or laws and regulations)
1) Resources: Staffing and budget cuts, possible problems with room booking, possible limited funding from government, funding available for the pilot study from Hamilton District Society for Disabled Children.
2) Clients: good networking with front-line health care professionals for recruitment.
3) Positives: “Best Start initiatives” can help increase awareness of play position; resources from the Research and Education Dept. will help to produce the training manual and make sure the language used is easy to understand without jargon.
likelihood that the program will be implemented resulting in infants attaining age appropriate fine motor skills.

**Step 5.** Information gathered will help to explore what has been learned and to decide on the next steps. Informed agreement between all parties will be reached as to what to evaluate. If there are insufficient resources, changes to level of funding and staffing will need to be reflected to the hospital and funding sources to adjust program activities or to modify intended outcomes.

**Step 6.** Evaluation options will be determined by the evaluators and agreement on evaluation focus and intended use of evaluation information will be reached with the key stakeholders.

**Core purpose(s) of the evaluation**

The primary core purpose of the program evaluation is formative and descriptive in order to determine the “what” of the program. It will involve gathering of data from objective observation, focus groups, surveys and observer ratings that will help with ongoing program development. This aspect of program evaluation will also help to determine if the program is delivered as intended. The secondary core purpose is summative. Standardized test data will also be gathered to look at the relationship of prone play and fine motor development in the pilot outcome study.

**Scope of the evaluation**

This program evaluation will take place after a 7-week education program plus the dissemination of an educational package. The education program will take place at McMaster Children’s Hospital in Ontario, Canada. Data will be collected on 3 infant-
parent dyads that attended the “Well Baby Clinic” in the fall of 2014. The inclusion criteria will be infants aged 2 months with normal development who have passed the Nippising District Developmental Screen (1993) on entry to the program. The Nippising District Developmental Screen (1993) is a standardized developmental screening tool for infants and children from birth up to 6 years of age. It focuses on motor (gross and fine), cognitive and social development and can be completed by a parent/health care professional. They will come from white, middle socioeconomic two-parent families. All these babies will be supine sleepers who have never been put into prone position during play or sleeping. To ensure that they have not been sleeping in prone, the parents will be asked what sleep positions and play positions their babies have been put into since birth. Infants that are born prematurely, diagnosed with chromosomal disorder, developmental delay, neurodevelopment, neuromuscular and metabolic disorders will be excluded from the program.

**Evaluation Team**

The evaluability assessment team will include two pediatric therapists involved in the implementation of the program, one or two parent consumers, program manager, facility administrators and representative from funding agencies. This core group will be from the interested stakeholders in the program.

**Design and Evaluation Method - program level**

This program evaluation is primarily formative with some summative preliminary testing of intervention outcomes using selected scores before and after the intervention to look at the magnitude of change. This evaluation will focus on component analysis,
analysis of client feedback and some performance monitoring. Both qualitative and quantitative evaluation methods will be used. Two separate focus groups will first be conducted with a small group of key stakeholders that includes caregivers/parents and therapists that treat infants from 0-12 months old. The discussion in the caregiver focus groups will provide information on the parental or caregivers’ understanding of prone play, best time to implement prone play during the day as well as the best set up for implementation of the education program. In the therapist focus group, the logistics on when, where, how to run the education program will be discussed. The therapy supervisor will be a good person to include in this forum. At the two focus groups, corresponding versions of therapists and parent/caregivers surveys will be distributed to the participants. A 5 point Likert rating scale will be used as well as open-ended questions to gather information on level of knowledge of prone play and perceived self-efficacy of the participants. Quasi-experimental, repeated measure fixed effect design will be used in the quantitative approach. A convenience sample of 100 families with normally developing infants will be recruited to participate in the education program after the pilot study.

**Quantitative Study on the 3 Infant-Parent Dyads (Individual level)**

This study will use a concurrent multiple-baseline single subject design across three subjects with a pre and post intervention follow-up standardized measure using the Alberta Infant Motor Scales (AIMS), Posture and fine motor assessment of infants (PFMAI), and Peabody Fine Motor Assessment (PDMS-2).

Dependent variables

Three dependent variables will be targeted for intervention: The variables for
repeat measurement as part of the single subject design will be: 1) frequency of prone play, 2) duration of prone play, 3) angle of head lifting (in degrees) by the infants. All these variables are noted to be associated with motor abilities (Piper & Darrah, 1994). Parental logs of daily prone time will be reviewed. The readings on total duration of prone play time, the highest angle of prone head lifting in degrees during prone play intervals will be recorded by the parents (details of recording duration, head angle were recorded in Appendix F). The readings recorded will be reorganized by the author on a sample chart as shown in Appendix H1, H2, and H3 for each dyad. As motor abilities improve, the infant will be able to spend more time, with increased frequency, in neck and back extension when in prone (Piper & Darrah, 1994). The angle or degrees of prone head lifting will also be evident as motor abilities improve.

Independent variables

The intervention is based on treatment methodologies found from literature reviews in peer-reviewed journals (Dudek-Shriber & Zelazny, 2007; Monson, Deitz & Kartin, 2003; Pin, Eldridge & Galae, 2007). Most of the literature reviewed presents a protocol of “Tummy Time”. In these studies, all participants were encouraged to engage the infant in at least 15 minutes or more of prone time per day. The infants were all in their home environments or other naturalistic settings when the prone play was performed. Most of the activities were based on motor learning and dynamic systems theories (Thelen & Smith, 1998).
Data Analysis (individual level)

Graphs will be plotted using the data sets from the data record sheets. The graphs will follow standard conventions with the x and y axis labeled clearly and logically with the phases clearly labeled (Phase A and Phase B), delineated with vertical lines. The axis will be clearly labeled and the data paths separated between phases and the scales will be consistent to facilitate comparison across graphs. The plan for data analysis will include visual analysis to look at the level, trend and variability. Visual inspection of the data will also include making sure that there are enough data points (at least 5) in baseline phase and an equal number of points in the intervention phase to make the phases comparable for statistical analysis. This visual analysis will also give some inferred conclusions about cause and effect through looking for a change in level; trend or variability between phases when treatment is instituted or withdrawn (Deitz, 2006).

Binomial or 2 SD analysis with no baseline trend and celeration line analysis with a baseline trend would be used.

Evaluation Questions for the surveys with different stakeholders

It is envisioned that different stakeholders will be interested in different evaluation questions. Using Newcomer, Hatry & Wholey (2010) as a guide, sample questions are shown in Table 2.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Program Evaluation Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential clients</td>
<td>Would an education program on prone play be feasible to enhance infant fine motor development?</td>
</tr>
<tr>
<td></td>
<td>What is the duration in prone play that will bring about the improvement?</td>
</tr>
<tr>
<td></td>
<td>Is this feasible at home or at a daycare setting?</td>
</tr>
</tbody>
</table>
| Therapists | Is the program showing short, intermediate and long term results?  
How do the results compare with other therapy programs?  
Is 30 minutes of prone play each day sufficient enough to produce the change?  
Are the seven-week sessions during which the program is taught to caregivers sufficient to produce the desire change to meet the immediate and long-term goals?  
Is the current program meeting the needs of clients and families?  
Is it applicable to carry out the program in the infant’s natural environment at home or daycare? |
| --- | --- |
| Therapy supervisor or program manager | Does the “Playing in Prone” program follow an established protocol as indicated in the project proposal?  
Are two therapists, namely one PT and one OT sufficient to carry out the program?  
Is it the best use of manpower in terms of cost effectiveness? |
| Facility administrator | Are the budgeted funds from the government and the grant from Hamilton District Society for Disabled Children enough to cover the running cost of the program, staff time and the overheads involved?  
Is the program well received by the parents and clients? |
| Funding agencies | Is the cost effective? Do the benefits for the infants and their caregivers justify the costs involved in the program?  
Are clients’ satisfied with the intervention? |

**Data management plan**

Data collected will be input into the clinic serve computer which has a back-up system. At the same time, the data will be fed from the clinic server into the Researcher’s Station. Data will also be fed from the clinic server computer into the Clinician’s Workstation. As the billing system is managed separately by the clinic’s administrative assistant, and linked to the Ministry of Health and Long Term Care, the research data will not be mixed with the billing system of the hospital, but the evaluator would be able to retrieve records if needed. CanChild, a research collaborative group with McMaster University will be enlisted to provide research assistants to help with data entry and in both quantitative and qualitative statistical analysis (Figure 2).
Figure 2: Logistics of Data Flow plan: (Boston University, 2013)

Data Gathering

Qualitative data will be gathered mainly through focus groups, interviews and field observations with videotaping in a naturalistic environment. Separate structured interviews with administrators, therapy supervisor and representative from funding sources will also be arranged to have a common understanding on the goals of the program evaluation and their expectation. The main qualitative data will come from the information gathered at the two rounds of focus groups for parents/caregivers and for the therapists. The pre intervention therapists’ focus group will gather information for refining the content of the program and review the logistics of carrying out the problem
in various settings. The pre intervention parents/caregivers focus group will gather information on parents' perceived level of understanding of prone play, the content of the education program and the feasibility of carrying it out at home or in a day care setting. The post interventions focus groups will help to gather information on how all the participants feel about the program and their perceived effectiveness of it. Structured open ended questions will be first developed and a moderator will guide the participants in the discussions. Each group will consist of 10-12 persons. The focus groups will be audio-recorded after consent has been obtained. These data will be transcribed and fed into the researcher’s computer. Some narrative accounts in the focus group will be used as evaluation stories to augment the quantitative evaluation and to offer insights to parental experiences. Field observations and structured interviews on a small group of participants will provide additional qualitative data. These observations and interviews will follow a schedule and an interview protocol will be maintained. The information collected will be reviewed, transcribed and coded and fed into the computer.

Quantitative data will be collected through surveys on perception of therapists and caregivers, observers’ ratings scale and standardized measurements on fine motor skills. The surveys will be distributed to the participants of the focus groups either on site or electronically to those families that have not attended the focus group interviews. The purpose of the surveys will be focused on gathering information on the level of understanding of parents/caregivers have on prone play; how much time the parents/caregivers let the infants spend in prone play pre and post intervention, and for therapists to indicate how much time in prone play daily that they think is adequate in
order to make a change in motor development. The surveys will be distributed again at the completion of the program. The ratings will be on a 5 point Likert scale and the results will be tabulated and entered into the computer. Observers rating scale will also be used to collect data on parents’ performance in prone play after the education program and the increased in prone play for the infants at the end of the program. These observations will be done at home or at the daycare which are the naturalistic environment where play occurs. Behaviors that are representative of fine motor milestones will be picked with pictures as a rating scale. Frequency charts will be used to note for parental behaviors of putting the infant in prone play. Graduate occupational therapy students will be trained as observers to do the rating. Videotaping segments of the prone play of infants’ pre and post intervention can provide additional qualitative data to show the effectiveness of the education program. A standardized measure, the Posture and Fine Motor Assessment of Infants (Case-Smith & Bigsby, 2000) will be used to collect quantitative data before and after to show the developmental changes of the infants after participating in the program.

**Data analysis and reporting**

Using the “PPOIISED framework” as a guideline (Rogers & Goodrick, 2010), qualitative data will be reviewed and analyzed before and after to identify the themes that emerged out of the focus groups. The qualitative data gleaned from the focus group interviews, structured interviews, and field visits will need to be interpreted and categorized through descriptive and pattern coding. Two people will be recruited to code the same material. Iterations will be built into the analytical process. Data collected in the
focus groups will be reflected on as more focus groups are being held and more data collected, at the same time data collection procedures will be adapted on more emerging reflections of the trends, and ways of applying prone play to the daily routine of the infants. Strategies to ensure the standards for quality analysis will be met through checking the coding and interpretation through member checks with groups of key stakeholders. Triangulation will be done through collection and examination of data from the structured interviews, field observations and focus groups. Due to the descriptive nature of the data, extra care is used to ensure confidentiality of the participants so that they will not be identifiable in the community. Display of the qualitative material will be done through matrix presentation and will be included in the reporting. As the research assistants at CanChild have access to computer-assisted qualitative data analysis software, their help will be enlisted to manage this large data set as a result of multiple methods of data collection.

Quantitative data will be collected both through the surveys and the observers’ rating scale. These data will be quantified and analyzed using non-parametric descriptive statistics. Using a 5 point Likert scale, the summary measures will be presented as percentages, means or median for satisfaction score and observed frequencies. Chi-square will be used for testing the statistical significance. Another portion of evaluation will be using the education program as independent variable and the fine motor performance as the dependent variable and conducting statistical analysis to determine the magnitude and significance of change by comparing the infants’ performance scores to developmental norms before and after the program. In this instance, bivariate statistics will be used to
study the relationship of the two variables.

Last but not least, the findings will be communicated in a program evaluation report. Suggestions for improvement will be offered. Even before the program evaluation report is published, some thoughts will be put into developing strategies for reporting the findings. These will include initial brainstorming with the team and stakeholders. The suggestions will flow from the findings. Financing tactics for the suggestions will also be offered. An informal forum will be held with stakeholders to discuss the preliminary report before the final draft will be written up. This will ensure that all practical, feasible ideas are incorporated into the final report.
CHAPTER FIVE

Funding Plan

Project Description

Since 1992, the American Academy of Pediatrics (AAP) advocated the “Back to Sleep” program and occupational therapist have supported “Tummy Time” programs. This involves placing infants in prone position during play time (AOTA, 2013). This doctoral project examined the evidence and theory behind prone-play and its effect on fine motor development. Though there have been many suggested activities and tip sheets created for parents by therapists and professional associations (AOTA, 2013), there are limited studies that examine the theory and evidence to guide occupational therapists in their practice. This doctoral project 1) attempts to identify the links between prone activities, postural control and fine motor development that form the basis of these activities; 2) enhances clinical practice with a redesigned educational package; 3) implements the education program; 4) advocates best practice by proposing a study to look at the effect of tummy time and fine motor development; and 5) proposes a plan to disseminate the information to the community after program evaluation is done.

Introduction

The purpose of this chapter is to establish a funding plan for a prone play program that can encourage fine motor development in young infants. The prone play program consists of an education package delivered to newborn infants and their parents to enhance the prone experience of the infants during play and wake time in the first three months of life. The program activities are based on current theories on motor
development and adapted from current literature reviewed that supports the use of prone position to enhance motor development. The program consists of 45-minute 7 weekly sessions of therapist guided prone play sessions. The parents are given ideas on how to incorporate prone play into the infants’ play during their wake time. This is enhanced by providing educational material in a written and audio visual format. It is also hoped that the program will lead to long term changes in the infant’s fine motor development. These prone activities are also designed to be applicable to high risk infants that require enhanced handling and variability of positions. Though not included in this project, a future project will be to collect data on infants with high risks and to analyze the effect on this group of infants.

The funding plan addresses three funding scenarios: (1) setting up and implementing the program, (2) obtaining consultation services from (technology experts, professional colleagues), and (3) disseminating program material and program results. The implementation costs will involve the (a) recruitment of qualified therapists to implement the program, (b) review of the constructed educational materials before publication, (c) printing the written material, and (d) putting the contents in an audio-visual format. Consultation services involve getting expert opinions from professional colleagues and other technical support for using audio-visual techniques and social media.

The cost to disseminate the information in the education package includes the dissemination of information to parents and to the general community. Some of the dissemination cost will include the presentation of the program evaluation results at
appropriate annual professional conferences (see Appendix A). The Dissemination Plan is discussed more thoroughly in Chapter 6.

To implement the program in a multi-cultural environment, the program material will be translated into French in the first year and then other languages (first Chinese in the second year), then Italian or Arabic in the coming years. The reason for translating the material to French is because it is also an official language in Canada and to translate into Chinese because there are many Chinese families in Ontario. It can be used by the author for her voluntary work in China when working with high risks infants once translated into that language. Italian and Arabic are also common as a second language spoken in Hamilton and translation into these languages will help new immigrant families understand the importance of prone time in play. If successful, this can be expanded and translated to other languages and put on a DVD or USB thumb drive. Other dissemination avenues include putting on using YouTube and Vimeo.

**Available local resources**

Over the years, the Hamilton Health Sciences and McMaster University have a strong affiliation and partnership with one another. This author has dual appointment at both institutions and can draw on their resources. The Education Department at Hamilton Health Sciences and the audio visual department can provide assistance with the production of the education package. The graduate students in the occupational therapy program at the School of Rehabilitation at McMaster University can also assist in revamping the draft of the written program by using it as an evidenced-based project in Term 6. As for expertise in delivering the program and data collection, the therapists on
the Early Intervention Team will be able to provide the training for the parents and also perform the follow-up assessments. In 2011, the therapists in the Early Intervention Team identified a gap for a need to produce educational material for teaching parents to put children in prone play. After discussion with our program manager, it may be possible to negotiate time with the Children Developmental Rehabilitation Programme to carry out this new project with the expertise of the Early Intervention Team. If there is concern with the allocation of hours and workload, volunteers with this kind of expertise may have to be recruited from the Early Intervention outside office hours. The venue of the sessions can be negotiated to be held in one of the therapy rooms in the center. The therapist will do one home visit to understand the set-up of home environment before incorporating activities. However, the therapist’s travel and time will have to be covered through research funds. If the project is to expand in its recruitment and benefiting families in the community, the sessions may need to be held at the center to minimize therapist’s time and travelling.

The production of the education material for the families can also be done with the assistance of the Education Department at Hamilton Health Sciences. As a first step, this author will review the booklet they had published on writing health information for patients and families. This will be very helpful for developing the needed education program for this project (Wizowski, Harper & Hutchings, 2014).

Researchers and statisticians at the CanChild Centre for Childhood Disability and Research will be contacted to see if they can help or give support to the handling of data and statistical analysis. CanChild was founded in 1989 and is a global research and
education center located in McMaster University in Hamilton, Ontario in Canada. Their research is focused on improving the lives of children and youths with disabilities and their families. This author envisioned that this project will extend to high risks infants and their families. Engaging CanChild’s support at this stage will be good for future partnership. The CanChild Centre for Childhood Disability and Research also has a website for disseminating information to families and service providers (2014). If they think it is appropriate, they will be able to help putting on the website as a family resource. If not, it may be possible to discuss support and help in developing a website for parents to access this information. The other possible avenue is through the Hamilton Health Sciences website, but again has to be negotiated with Hamilton Health Sciences.

In terms of financial resources, the municipal of Hamilton Wentworth region is also interested in advancing the development of health and wellness programs. Projects like “Best Start”, “Healthy Babies, Healthy Babies”, “Healthy Moms, Healthy Babies” are some of the health and wellness initiatives put out by the Ontario government (2003). This project can be incorporated as a small component into some of these programs. It can also help with disseminating the information on prone play to parents and expectant mothers. The government has already funded for these programs and if a partnership is formed, some of these funding can offset some of the costs for the delivery of training and production of educational material for the project. Local community resources can also be utilized for funding and for helping to disseminate information.

**Needed resources: Budget**

The budget can be divided into 4 categories: Please refer to Appendix A for details
1. Program Implementation Set-up Costs

2. Program Implementation Maintenance Costs

3. Consultation Services for (Information Technology or IT) statistics

4. Dissemination Costs

The program implementation cost is anticipated to be higher in the first year. Once the program starts, the cost of maintenance of the program will be minimal in the second. The production of the materials will also be higher in the first year, but in the second year, the budget will be expected to decrease as the consultation fee will also be decreased. By the second year when the program is up and running, it is anticipated that the hospital will take over to incorporate into their operating budget provided the project is successful after program evaluation. However, the dissemination costs in the second year will appear higher as the program will be in full swing, and to disseminate the results nationally, this author propose attending out of province conferences which will incur higher travel and accommodation costs.

**Program Implementation Costs**

Development of the program requires the re-drafting and finalizing the content of the education package. There will be no cost in involving the graduate students to use it as evidence based project. Already one former graduate student now working in the Hamilton area has indicated an interest to continue the work.

The main cost will be from having an artist draw the pictures and then printing the materials. It will cost about $5 to produce one of these booklets (see Appendix A), but is expected to be absorbed by the Education Department in Hamilton Health Sciences. The
other cost will be engaging a technician for videotaping and the audio-visual department to download the video onto DVDs or thumb drives. Normally, it will cost about $5 dollars for this production, but the cost for labor is waived by the audio-visual department. However, there will still be the cost for the thumb drives that will be bought from online from Logotech. Operational expenses may also include the follow-up assessment after the program delivery. This will be a longitudinal record of how the infants are doing one year later. This follow up will require the expertise of a therapist knowledgeable in assessing movements.

The maintenance cost for program implementation is not as high once the program is set up and running smoothly. The expenses are mostly for the setting up. Most of the maintenance cost of the program will be to provide the therapist time for training, assessment and replenishing the education material for parents. It is hoped that once the program demonstrated its usefulness, the hospital or CanChild will be a partner of the project.

**Consultation fees**

Consultation fees will be minimal as the author can enlist the help of colleagues. However, it would be helpful if some sort of honorarium can be given to compensate for the consultants’ time and services. Fees may need to be paid initially for consultation in technology and the designing of the websites. Possible compensation may need to be offered to colleagues who may be using off work hours to help with the training and program delivery. Possible internal transfer of funding may occur in order for the
Education Department of the hospital to work with the Children Developmental Rehabilitation Programme.

**Dissemination Costs**

Most of the dissemination activities can be completed without cost. Details for dissemination and the associated costs will be discussed in Chapter 6. Some dissemination activities will include connecting with offices of family physicians that care for newborn babies, midwives and community clinics. The main cost for dissemination of the program will probably be travelling and accommodation for out of town professional conferences. This will be budgeted and estimated in the appendices (see Appendix A & B). The other venue for dissemination can be through writing articles for journals and parental magazines, creating fact sheets and conducting podcasts. These can all be done as part of the dissemination activities and there will be minimal costs without additional budgeting (See Chapter 6)

**Potential Funding sources**

Most of the activities in this funding plan can be covered by the university and hospital budget if the project is presented to the managers during the prior year. As Hamilton Health Sciences is a teaching hospital, there is room and opportunities for some of these kinds of projects to be tried out provided that it benefits the clients. There are staff education grants for staff education and support to go to conferences. The university also has support researchers and presenters in the past. Some of these funds will be able to cover some of the travel costs (see Table 3).

As this is a project that benefits clients, the Hamilton Health Sciences Volunteer
Association will also be interested in funding some of the costs. They have been known to fund patient projects such as the Toy Library at the Children’s Developmental Rehabilitation Programme. Another great supporter of innovative programs at the McMaster Children’s Hospital had been the Hamilton District Society for Disabled Children- they funded different projects in the past that our program at McMaster Children’s Hospital had not funded. They helped kick start some programs we had not had before and gave support in resources and staffing. Each project and proposal will be discussed at their meetings before being passed by the board for funding.

In terms of federal and provincial funding, the government has ongoing health and wellness promotion initiatives: “Healthy Moms, Healthy Babies” and “Healthy Babies, Healthy Children” which are funded projects of Ministry of Health and Long Term care and the Ministry of Youth and Social Services. One can also possibly tap into the existing funds as this program may help to enrich the service delivery of the existing health initiatives through the city of Hamilton. This request can be directed to the Ministry of Health Promotion and the Ministry of Children and Youth Services as the initiative funding for “Healthy Babies, Healthy Children” comes from these two ministries (Ontario, 2003). Other possible sources include the Ontario Trillium Funds and Affiliated Services for Child and Youth can be explored.

In the community, some funding can be sought through the United Way, especially if it is for printing and maintenance of the project. The local Lion’s Clubs, Rotary Clubs and the Zonta Clubs in the area are also possible organizations to explore funding possibilities. Within the hospital, it is also possible to establish a Community
Kiosk through the Public Relations Department of the hospital for dissemination of information in the public lobbies of 3 hospitals (sites). The community kiosk is a free service to the public by the Hamilton Health Sciences and allowed community news or posters to be displayed in the lobbies of the hospitals for the week to increase public awareness on certain health topics. It is also possible to have bake sale or craft/greeting card sale to raise funds for this project which can be put towards as Angel Capitol. Both bake sale and greeting cards crafted by this author had been done before in church to raise funds for good causes. Both events had been done with good success. Crowd-funding was a possibility before July 1, 2014. However, since Bill C-28, the Canada Anti-Spam Law was passed; it will be difficult to send out unsolicited e-mails to potential sponsors without incurring a fine. The process of using this as a fund-raising platform will need some consideration and exploring around the legal aspect before it can be put into place.

Table 3. Funding Opportunities

<table>
<thead>
<tr>
<th>Funding Type</th>
<th>Funding Source and Description</th>
<th>Implementation or Dissemination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal grants</td>
<td>Within the Ministry of Health and Long Term Care, Ministry of Youth and Children Services, there are many funds available for research. There is also the possibility to partner with programs with Healthy Babies, Healthy Mom to help implement the program.</td>
<td>Implementation</td>
</tr>
<tr>
<td>Provincial grant</td>
<td>Allied Health Professional Development Fund (AHPDF) provides grants for professional development activities which enhance skill, knowledge, practice, and service delivery. The maximum amount of grant funding for any professional in any funding year is $1,500. This grant can provide funding to attend conferences</td>
<td>Dissemination</td>
</tr>
<tr>
<td></td>
<td>Under the Ministry of Health and Long Term Care – Ontario Ministry of Health Promotion; the Healthy</td>
<td>Implementation</td>
</tr>
</tbody>
</table>
Communities Fund. Under the resource stream, it can fund up to 60% - 80% of total eligible project cost. Local and provincial not-for-profit organizations. Funded projects generally fall under one of four types: planning, implementation, development, or a combination thereof.

<table>
<thead>
<tr>
<th>Corporate funds</th>
<th>Hamilton Health Sciences Education Funds - up to $750 per fiscal year that help with conferences and registration.</th>
<th>Dissemination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamilton Health Sciences Foundation &amp; Research Funds - first investigator will be eligible to apply.</td>
<td>Implementation &amp; Dissemination</td>
<td></td>
</tr>
<tr>
<td>Hamilton Health Sciences Volunteer Association Family Services Funds - can provide funding to enhance the services to patients and families</td>
<td>Implementation</td>
<td></td>
</tr>
<tr>
<td>Occupational Therapy Education Funds - up to $250 per fiscal year that will help with conferences registration and travels.</td>
<td>Dissemination</td>
<td></td>
</tr>
<tr>
<td>University grants</td>
<td>Dr. John V. Basmajian Rehabilitation Science Travel Award - award given to faculty staff to offset costs related to travel when presenting at a conference. Maximum up to $500</td>
<td>Dissemination</td>
</tr>
<tr>
<td>Masonic foundations of Ontario - founded in 1964 funding projects in the community for relief of poverty, the advancement of education and the advancement of other purposes beneficial to the community. They had funded projects and programs in the past that helps children.</td>
<td>Implementation &amp; dissemination</td>
<td></td>
</tr>
<tr>
<td>United Way - they make multi-year funding commitments, collectively design long-term strategies for program delivery, share research and provide assistance to improve governance and administration practices. Welcome funding application for research projects that will bring changes to the community. One area of funding is called “All that kids can be” and they provide funding on parent and infant relationships and for children between ages 0 to 6. The applications are reviewed program by program, and it had funded community programs up to thousands of dollars by partnering with local community agencies. Though they had not funded anything for babies yet in Greater Hamilton, this initiative will probably fall into the “All that kids can be” focused. (United Way, 2014)</td>
<td>Implementation &amp; dissemination</td>
<td></td>
</tr>
</tbody>
</table>
Community grants

Hamilton District Society for Disabled Children - had funded different projects in the past that our program at McMaster Children’s Hospital had not funded. They had helped kick start some programs we had not had before and had given support in resources, and staffing. Each project and proposal will be discussed at their meetings before being passed by the board for funding.

| Personal Capitol | Use funds from salary earned by this author to help with dissemination efforts at conferences and professional meetings. The author can also use bake sale and craft sale to raise funds. | Dissemination |
| Angel Capitol    | Funding and assistance from friends and colleagues. The funds can also be raised through bake sale and craft /card sale. These funds can be used as seed money for initial printing costs for educational package and also for travels to conferences and speaking to community groups. | Dissemination |

Table 4: Implementation and Program Delivery Budgets

Year One Budget: Program implementation & program delivery costs

***Currency quoted in CDN dollars

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ITEMIZED BUDGET</th>
<th>RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel - Therapists</td>
<td>$100 per family= 3x $100= $300 (Gas at $ 1.45 per liter as of July 14, 2014)</td>
<td>During the first year and initial phase, three families are involved in a pilot study.</td>
</tr>
<tr>
<td>time for visits and assessments</td>
<td>$ 0.00</td>
<td>During the first year, this author will conduct the training and another therapist will volunteer for the assessment</td>
</tr>
<tr>
<td>(salary and benefits)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultants - information</td>
<td>$12 per hour, a total of 10 hours = $120</td>
<td>A stipend for an information technology consultant friend to provide support on using social media for communication and maintenance of websites.</td>
</tr>
<tr>
<td>technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Cost</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>Consultation - gift vouchers to colleagues who volunteer to act as experts to review items in package</td>
<td>$20 \times 5 = $100</td>
<td>A $20 gift voucher from Chapters/Indigo bookstore for 5 persons</td>
</tr>
<tr>
<td>Program assistant (part time) - To help with data management, communication with subjects etc</td>
<td>$0.00</td>
<td>Not required the first year as only three families are involved in the project.</td>
</tr>
<tr>
<td>Equipment and supplies - Sony digital video camera with SD card</td>
<td>$500</td>
<td>Digital video camera for recording 15 minutes of weekly play session</td>
</tr>
<tr>
<td>Equipment and supplies - video editing equipment</td>
<td>$0.00</td>
<td>Access the hospital patient education department for assistance</td>
</tr>
<tr>
<td>Equipment and supplies - Dell computer</td>
<td>$700</td>
<td>Require for making up education package, data collection and data management</td>
</tr>
<tr>
<td>Equipment and supplies - appropriate computer software for data entry</td>
<td>$300</td>
<td>Require for making up education package, data collection and data management</td>
</tr>
<tr>
<td>Equipment and supplies - printer and cartridges</td>
<td>$0.00</td>
<td>Use existing printers in the hospital</td>
</tr>
<tr>
<td>Artist to draw the pictures</td>
<td>$0.00</td>
<td>Waived as one of the author’s graduate student was willing to volunteer her time to help.</td>
</tr>
<tr>
<td>Printing of education material</td>
<td>$0.00</td>
<td>As part of a patient education program at McMaster Children’s Hospital, the author can engage the help of the Education Department of Hamilton Health Sciences for Family Education Material</td>
</tr>
<tr>
<td>4 GB thumb drives</td>
<td>$2.5 \times 3 = $7.5</td>
<td>Thumb drive for 3 families to store all the education package and log books.</td>
</tr>
<tr>
<td>Communication - telephone reimbursement</td>
<td>$0.00</td>
<td>To contact families and booking appointments using hospital phone lines (local phone calls are free)</td>
</tr>
<tr>
<td>Communication - postage</td>
<td>$0.00</td>
<td>Not required for the first phase as the 3 families can be contacted by phone.</td>
</tr>
</tbody>
</table>
## Attending conference - Registration fees - Ontario Association of Children Rehabilitation Service Annual Conference in November 2014 (Toronto)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Rationale</th>
</tr>
</thead>
</table>
| Registration fees                         | $400 + $50 = $450 | Registration for early bird. Poster presentation  
| Travel & parking                          |            | Travel & parking                                     |

## Fact sheets and printing poster

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation for conference poster presentation</td>
<td>$10.00 + $150 = $160</td>
<td>Preparing for conference poster presentation</td>
</tr>
</tbody>
</table>

## Translation of material in French

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 hours of translation work at $50 per hour = $500</td>
<td></td>
<td>Done by professional translator</td>
</tr>
</tbody>
</table>

## Printing posters for physician office and clinics

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>to promote “Prone to Play” program</td>
<td>$120</td>
<td>Printing posters for physician office and clinics</td>
</tr>
</tbody>
</table>

## Total budget for the first year

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total budget for the first year</td>
<td>$3257.50</td>
<td></td>
</tr>
</tbody>
</table>

## Year Two Budget: Program implementation & dissemination costs

***Currency quoted in CDN dollars

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ITEMIZED BUDGET</th>
<th>RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel - Therapists involvement in training &amp; assessment phase: Travel costs for home visits</td>
<td>$5 per family = $150.00 (Gas at $ 1.45 per liter as of July 14, 2014)</td>
<td>During the second year, 30 more families will be recruited and will be seen at McMaster Children’s Hospital. Home visits will be done only once to help family set up program at home.</td>
</tr>
<tr>
<td>Personnel - Therapist time for visits and assessments (salary and benefits); also includes follow up appointments at 6, 9, 12 months of age</td>
<td>$0.00</td>
<td>During the second year, other therapists from the Children Developmental Rehabilitation Programme will conduct the training and one therapist will volunteer for the assessment.</td>
</tr>
<tr>
<td>Consultants - information technology</td>
<td>$12 per hour, a total of 10 hours = $120</td>
<td>A stipend for an information technology consultant friend to provide support on using social media for communication and maintenance of websites.</td>
</tr>
<tr>
<td>Program assistant (part time) - To help with data</td>
<td>$15.00 per hour, requiring 100 hours of</td>
<td>Required to help manage the data of 30 families and assist in data.</td>
</tr>
<tr>
<td>Activity Description</td>
<td>Cost</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Management, communication with subjects etc</td>
<td>workload = $1500</td>
<td>To engage graduate student from OT program can be recruited to help.</td>
</tr>
<tr>
<td>Equipment and supplies: video editing equipment</td>
<td>$0.00</td>
<td>Access the hospital patient education department for assistance.</td>
</tr>
<tr>
<td>Equipment and supplies: printer and cartridges</td>
<td>$0.00</td>
<td>Use existing printers in the hospital.</td>
</tr>
<tr>
<td>Printing of education material</td>
<td>$0.00</td>
<td>As part of a patient education program at McMaster Children’s Hospital, the author can engage the help of the Education Department of Hamilton Health Sciences for Family Education Material</td>
</tr>
<tr>
<td>4 GB thumb drives</td>
<td>$2.5 \times 30 = $75</td>
<td>Thumb drive for 30 families to store all the education package and log books.</td>
</tr>
<tr>
<td>Communication - telephone reimbursement</td>
<td>$0.00</td>
<td>To contact families and booking appointments using hospital phone lines (local phone calls are free).</td>
</tr>
<tr>
<td>Attending conference - Registration fees - Canadian Association of Occupational Therapy annual conference May 27-30, 2015 (Winnipeg, Manitoba)</td>
<td>$500 + $620 + $700 + $10 = $1830</td>
<td>Registration for early bird. Flight and accommodation Photocopying etc.</td>
</tr>
<tr>
<td><strong>Total budget for the second year</strong></td>
<td><strong>$3675.00</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Total cost for the whole project (first and second year)** =

$3257.50 + $3675.00 = $6932.50
Funding Plan References:

Affiliated Services for Children and Youth. Downloaded from https://www.ascy.ca/

Allied Health Professional Development Funds. Downloaded from
http://www.ahpdf.ca/

American Occupational Therapy Association (2013). Establishing tummy time routines
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/media/Corporate/Files/AboutOT/consumers/Youth/Tummy-Time-tip-sheet.pdf

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CanChild Center for Childhood Disability and Research. Downloaded from http://www.
canchild.ca/en/

Hamilton District Society for Disabled Children. Downloaded from http://www.hnhb
healthline.ca/displayservice.aspx?id=80641

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drives.html?ibp- adgroup=ppc&gclid=C1-K6JGjxr8CFc07MgodWR4AIQ

Masonic Foundation of Ontario. Downloaded from http://www.masonicfoundation.on.ca/

Downloaded from http://www.children.gov.on.ca/htdocs/English/topics/early
childhood/health/index.aspx

Ontario Trillium Foundation. Downloaded from http://www.otf.ca/en/

Rotary Club of Hamilton. Downloaded from http://rotaryclubhamilton.ca/

CHAPTER SIX

Dissemination Plan

Project Description

Since the promotion of the “Back to Sleep” campaign in 1992, parents had been putting infants to sleep on their back. At the same time, the infants who are supine sleepers ended up playing in supine when awake as many were accustomed to being in supine (Jones, 2004). It was also noted that it became very difficult for some parents to implement prone play for their infants because the infant cried and tried to get out of the prone position. Research has shown that decreased experience in prone positioning results in slower rate of motor development in the first year of life (Majnemer & Barr, 2006). Occupational therapists play an important role in educating parents in prone play with their infants. There is limited evidence-based literature that focuses on how prone play affects fine motor development through improvement in postural control.

The educational package created in this doctoral project utilized a theoretical framework that is grounded in dynamic systems, sensory integration, and biomechanical theories. The educational program provides opportunities for enhanced handling and different positions for play to influence an infant’s fine motor development. This project focused on the development and implementation of a prone play positioning program to provide opportunities for infants to experience prone position in play during wake hours. A large component of the program is the education of the parents and families to use the prone position in play.

The program consists of a weekly 45-minute prone play session for 7 weeks. The
education material designed is part of the education package that helps parents to focus on prone play with their infants. It is being used during the play session and also during the wake time in the day. Parents will be taught to use these materials in their daily prone play with their infants. Multi-media resources are also utilized, including using thumb drives, You-tube, and podcasts to disseminate information. Brochures, flyers and written educational packages are also ways to help with dissemination. Putting the information on professional websites that provide information for parents (e.g., Hamilton Health Sciences website, Best Start initiatives, Public Health of Ontario, CanChild, Canadian Association of Occupational Therapists (CAOT)) is another way to reach out to the communities and professionals. Finally, a long-term project can be an on-line module for parents and caregivers so that the information can be accessed at any time twenty-four hours, seven days a week. If it is done through the CAOT, continuing education credits can also be given if professionals take it on-line.

**Dissemination Goals**

- **Long Term Goal:** The program results will strengthen the theory that prone play can bring changes in fine motor progression through bearing weight on the shoulders and upper extremities.

- **Long Term Goal:** The program results will enable health care professionals to encourage parents to incorporate prone play time into the daily routine for infants.

- **Long Term Goal:** The educational program will help increase the awareness and the importance of putting babies in prone while they are awake as a best practice for fine motor development for infants.
• **Short Term Goal:** The educational program will help parents to understand the importance of prone play and its effect on fine motor development

• **Short Term Goal:** The educational program will help parents to spend more prone play time with their infants by expanding their play repertoire and provide ideas to structure their environment to encourage prone play

**Target Audiences**

• **Primary Audience:** The primary audience for this education package will be the parents and caregivers of infants that have been supine sleepers. The infants are can be full term or preterm. Most of the parents may have found difficulty in prolonging the prone play time as the infants tend to fuss and cry. By using the educational package, the parents and caregivers are shown different ways to put infants in prone and help them to enjoy their play-time in prone.

• **Secondary Audience:** The secondary audience is the health care professionals that see the infants and families and who are interested in their development. These professionals can be family doctors of well baby clinics, pediatricians, home visiting nurses, mid-wives, therapists and anyone who is in contact with new born infants. These professionals are the front line workers who will be one of the first people in contact with the family when or after the infant is born. They will be the first people to educate the parents on “Tummy Time” when the parents bring the babies to see them after their discharge from hospital.

• **Secondary Audience:** The other secondary audience is program administrators and policy makers who will be involved in funding and advocating policy for a
healthy beginning for the infants. The result of this program will help program administrator and policy makers to be aware of the importance of prone play in infants. They are the key persons that will help to fund and to provide a platform to implement the program.

Key Messages

- **Primary Message:** The primary message for parents and caregivers will be on the importance of prone play and its effect on motor development. Parents tend not to put the infant in prone when they fuss or cry. Infants on the other hand, are accustomed to be in supine during sleep time and so are not comfortable to be in prone during play time. The message to parents is that they can incorporate prone activities into their babies’ daily routine and play. The prone activity time need not be long, but needs to be consistent and occur daily so that the child can experience variability of movement other than being in prone. Parents can also structure their home environment so that it is conducive to letting the infants experiment with different movement and positioning.

- **Secondary Message:** The message to the health care professionals, that includes doctors, therapists and nurses, is to continue to balance “Back to Sleep” time with “Tummy Time” In doing so the prone and supine positions are balanced throughout the day and sleep time. The prone play time will provide a position for strengthening postural muscles and shoulder stability to impact fine motor development. The educational program will also act as a resource to the health professionals when teaching the parents how to go about Tummy Time.
• **Secondary Message:** The message to administrators and policy makers is to confirm the necessity of a “Prone to Play” program as a health and wellness initiatives and to help babies to experience an early start and intervention when they are at risk for developmental delay. This is in-line with the health and wellness promotion initiatives that the Ministry of Health, Ministry of Youth and Social Services and Ministry of Health Promotion (2014) are involved in provincially and federally. This is an important message as these ministries provide funding support and sometimes legislative mandate for programs to be carried out. The Tummy Time program can be incorporated as a component of the existing “Healthy Babies, Healthy Children.

**Sources/Messengers**

**For parents and caregivers that care for infants**

• Written materials with illustrations will be created in the education package. These materials will be user friendly and of a literacy level that is easily understood by all parents. Flyers and brochures about “Prone to Play” and its importance for fine motor development can be placed in physicians’ offices for families to take away. They can also be given to midwives and visiting nurses who will be seeing infants and parents when they do follow-up visits with the family.

• The use of a community kiosk within the premise (lobby) of McMaster Children’s Hospital (HHS, 2014) will allow and provide space for the needed information to be exhibited and disseminated. Mothers-to -be who come into
the hospital for prenatal classes and check-ups will have access to this information.

- Provincial conference for treatment centers in Ontario - the annual conference of the Ontario Association of Children’s Rehabilitation Services also has family forums and parents are welcomed to attend. The 2014 annual conference will be held in Toronto, Ontario this year in November.

- As a community service, stores that sell baby cribs and baby products can also participate in projects like this as a health and wellness initiatives

- Parents and the Hamilton community use social media, such as Facebook. A Facebook page can be created to disseminate information to parents with newborn infants. Another useful social media tool is LinkedIn. It provides a professional network with therapists and clinicians, allowing possible group discussions for people that are interested in certain topics. Information on this education program can also be posted in the group forum.

- Through CanChild Center for Childhood Disability Research – This organization is an expert on knowledge translation for parents, and has already put a lot of parental resources and useful information on their website under a tab for parents and families.

**For health care professionals**

- In-service with health care professionals during hospital education rounds within Hamilton Health Sciences provide a venue for discussion and information dissemination to the frontline workers.
• Professional organizations for health care professionals (neonatal and pediatric therapists, pediatricians, nurse practitioners, midwives) that deal with newborns are involved in evidence based research and provide resources to support credible, evidenced based interventions for infants. Most of these organizations are also involved in health and wellness promotion and encourage best practices for their clients that they see. Information can be disseminated through these organization’s conferences, publications, websites, online modules or resources.

• Professional journals for occupational therapists, physiotherapists, pediatricians and midwives are good platforms to reach these health care front-line workers especially to present evidence based effective interventions.

• Research consortium like CanChild Center for Childhood Disability Research has a website with a section on knowledge translation for professionals. These are all evidence based and credible resources that health care professionals can use when talking with families or when they are researching for effective service delivery.

For hospital administrators and policy makers

• Presentations can be given to hospital administrators, medical directors of programs and units that see newborn and neonates. The chief of service in pediatrics and the ward managers will be interested in programs that are evidence based and proven to be effective with positive outcomes. Executive summaries with proposed program plans and estimated budget would be
helpful for these leaders to consider the funding of a new program especially if it is demonstrated to be cost effective, follow best practice guidelines, and with evidence based positive outcomes.

- Policy makers and government ministry are involved in funding new programs and initiatives. National and provincial professional organizations can have positive dialogues with the government ministries as they will pay attention to credible research institutions that provide evidence based results and recommendations. CanChild Center for Childhood Disability Research and McMaster University are in a unique position to disseminate information to these officials.

**Dissemination Activities**

Most of the dissemination activities can be completed without cost. For example, connecting with the offices of family physicians that care for newborn babies, midwives and community clinics can be done through e-mails and phone calls. A part-time volunteer or project manager can assist in handling these calls and e-mails. However, we may need to find a volunteer to handle some of these logistics. Otherwise, a part-time project manager will need to be found. The dissemination of the program evaluation results may be in the form of face-to-face forums in professional conferences. Costs of round-trip travels to such conferences, registration to the conferences, lodging and meals will have to be budgeted (see Table 2). Poster presentation and workshops are both possible considerations. Printing of fact sheets and related handouts will need to be factored in as well. The other venue for dissemination can be through writing articles for
journals and parental magazines, creating fact sheets and conducting podcasts can all be done as part of the dissemination activities. There will be minimal costs for these activities without additional budgeting (see Table 2). A breakdown of dissemination activities for various audiences is as follows:

- **For Parents: The education package** - This will go with the seven weeks of intensive 45-minute weekly sessions for parents. The sessions consist of seven modules. The first two sessions will discuss the background of Back to Sleep (AAP, 1992) and how it affects the infant; how prone play times can improve postural control and how it affects motor development. These materials can also be put on a thumb drive or on a website. A technological expert can be hired to put the material on a website and to make it interactive digitally. The key points of the programs can also be put on a facebook page as most parents are using the social media for communications and for accessing the internet for information. Flyers, leaflets and brochures on prone play can be made available to parents and caregivers at doctors’ office or well baby centers. Online modules had been done by the American Academy for Pediatrics to disseminate information, and this kind of delivery of information can be an effective in this century especially it is an interactive module. This will need the help of an internet technology expert as this would be beyond this author’s technical expertise. An interactive websites will also provide a forum for discussion among parents. As a service to the community, Hamilton Health Sciences had been generous in the past to lend out the lobby area of the
hospital to allow display of health information to the general public and community. This dissemination method can be applied through the hospital public relation and booths can be set up in the lobby to help parents to understand the importance of prone play. Sometimes, parent forums in some professional conferences can also be a way to allow parents to explore and learn new initiatives. The annual conference of the Ontario Association of Children’s Rehabilitation Services also has family forums and parents are welcomed to attend. The 2014 annual conference will be held in Toronto, Ontario this year in November.

• **For Health Care Professionals:** Another national conference of the Canadian Association of Occupational Therapy in 2015 is in Winnipeg, Manitoba. It will be an excellent platform to present the program, the findings and evaluation. Written articles can also be submitted to journals for publication. Journal articles will summarize the program, program evaluation results and the longitudinal follow-up, if any. It is anticipated that it will be completed within two years. Both peer reviewed articles and non-peer reviewed articles are important in reaching a wide audience of professionals. Examples are: Occupational Therapy Now published by CAOT and OT Practice published by AOTA. Other professional peer-reviewed journals, the American Journal of Occupational Therapy and the Canadian Journal of Occupational Therapy published by AOTA and CAOT respectively, provided excellent resources for OT practitioners. There are education rounds in the
hospital that the authors can participate and provide a forum for introducing this innovative project to health care professionals. Therapist and other professionals rely also on social media to access information. One possibility is to provide an app on the I-pad or android phone so that it is can be easily accessed by the parents and the professionals alike. However, this is quite expensive, and depending on the budget, it will involve more technology support and hiring an app developer. This had not been budgeted for in this project, but a friend who works at IBM may be able to provide some volunteer work. If there is a team of volunteers willing to assist the author in dissemination, it will be great. If not, using the other tradition ways are adequate too.

- **Hospital Administrators and policy makers:** They are influential people because funding and policy making comes from them. Naturally with the group of leaders, a concise executive summary will ignite their interest. The information presented to them has to be well laid out plans with estimated budget. Evidenced based practice and research will help the administrators to consider the feasibility of funding the program this year or in the future. Within the hospital, it is important to present this to the pediatricians and nurses in the neonatal wards at rounds. They will also be advocate for the project once they see the changes in the infants. The Chief Executive Officer also has morning breakfast sessions with groups of selected employees. Though selected randomly by human resources, one is able to attend by
invitation only. This can potentially be a venue to present the project at the Children’s Developmental Rehabilitation Programme.

- The annual 2014 and 2015 conferences of the Ontario Association of Children’s Rehabilitation Services in Toronto, Ontario will gather together all the hospital administrators and chief executive officers from the province to discuss programs and funding issues. Besides presenting a poster, it will be a good venue for networking. Evidenced based occupational therapy or other intervention will become part of the preventive measures and activities that will be disseminate to the whole audience. Teleconference and discussion panels may be another forum for dissemination of the information with policy makers and professions. Members of Provincial Parliament (MPP) are an elected member of the Legislative Assembly of the province of Ontario. Those that have a concern with health care are identified and a meeting can be scheduled so that they can also advocate for this best practice at a ministerial level. This can become part of the already provincial sponsored “Healthy Babies, Healthy Children” initiatives.

**Dissemination Costs**

The cost to disseminate the information in the education package includes the dissemination of information to parents and to the general community. Some of the dissemination cost will include the presentation of the program evaluation results at appropriate annual professional conferences (see Table 2). The cost for dissemination of
the project is not expensive, but involves a lot of networking and collaboration with various person and organization.

**Table 5: Budget for dissemination in the first year**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attending conference - Registration fees- Ontario Association of Children Rehabilitation Service Annual Conference in November 2014 (Toronto)</td>
<td>$400</td>
<td>Early bird conference registration for poster presentation</td>
</tr>
<tr>
<td>Attending conference: travel to Toronto</td>
<td></td>
<td>(Gas at $ 1.45 per liter as of July 14, 2014) Round trip +parking = $50.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No accommodation is required as Hamilton to Toronto is about 1 ½ hours away.</td>
</tr>
<tr>
<td>Fact sheets to distribute (photocopying) at the Toronto conference</td>
<td>$10.00</td>
<td>100 sheets required. Mass photocopying at 10 cents</td>
</tr>
<tr>
<td>Poster for the Toronto conference</td>
<td>$150</td>
<td>Color Printing of poster at Staples</td>
</tr>
<tr>
<td>Other - Dissemination-Publication</td>
<td>$0.00</td>
<td>Peer reviewed journals and CAOT (OT Now) do not charge for article submission</td>
</tr>
<tr>
<td>Other - Dissemination-parental magazine</td>
<td>$0.00</td>
<td>Editors usually would not charge for article submission once quality articles are accepted by the editorial board</td>
</tr>
<tr>
<td>Other - Dissemination-hospital family resource center</td>
<td>$0.00</td>
<td>Family Resource Center at McMaster Children’s Hospital will welcome the addition of the education package to their shelves free of charge</td>
</tr>
<tr>
<td>Other -Dissemination- using the community kiosk at the hospital lobby to advertise the education program</td>
<td>$0.00</td>
<td>Have to apply to the Public Relation Department ahead of time to get schedule for free display</td>
</tr>
<tr>
<td>Other - Dissemination - translation of material in French</td>
<td>$0.00</td>
<td>Done by professional translator</td>
</tr>
</tbody>
</table>
Other - Dissemination - manning the community kiosk | $0.00 | Volunteers mobilized from own department to man the kiosk
---|---|---
Other - Dissemination - contact with physicians’ offices, midwives, visiting nurses etc | $0.00 for phone calls, $120 for printing posters, volunteers donate time | Through local phone calls which are free when done through hospital, expenses mainly for printing posters

**Dissemination Cost of the First Year = $1230**

**Budget for dissemination in the second year**

| Attending conference - Registration fees- Canadian Association of Occupational Therapy annual conference May 27-30, 2015 (Winnipeg, Manitoba) | $500 | Early bird conference registration for a presentation
---|---|---
Attending conference - travel to Winnipeg | Round trip airfare = $570.00 | Economy fare on West-jet
Attending conference - travel to and from airport | Round trip = $50.00 | Winnipeg hotel to airport round trip. (Family will drive me to Toronto airport from Hamilton and back).
Attending conference - accommodation in Winnipeg | 4 nights at $152 per night plus tax =$700 | 4 nights’ accommodation at the Winnipeg Fairmont Hotel booked through hotels.com. There may possibly be a conference rate that will be cheaper (available only at registration)
Fact sheets to distribute (photocopying) at the Winnipeg conference | $10.00 | 100 sheets required. Mass photocopying at 10 cents
Other : Dissemination - Publication | $0.00 | Peer reviewed journals and CAOT (OT Now) do not charge for article submission
Other : Dissemination - parental magazine | $0.00 | Editors usually would not charge for article submission once quality articles are accepted by the editorial board
<table>
<thead>
<tr>
<th>Other: Dissemination - hospital family resource center</th>
<th>$0.00</th>
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</thead>
<tbody>
<tr>
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<td>$0.00</td>
<td>Apply to the Public Relation Department ahead of time to get schedule for free display</td>
</tr>
<tr>
<td>Other: Dissemination - manning the community kiosk</td>
<td>$0.00</td>
<td>Volunteers mobilized from own department to man the kiosk</td>
</tr>
<tr>
<td>Other: Dissemination - translation of material into Chinese</td>
<td>$0.00</td>
<td>Completed by this author who is fluent in oral and written Chinese</td>
</tr>
<tr>
<td>Other: Dissemination - CAOT webinar</td>
<td>$0.00</td>
<td>Contact CAOT - once accepted, CAOT will arrange for date and time free of charge.</td>
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</tbody>
</table>

**Dissemination Cost of the Second Year = $1830**

**Total dissemination cost for two years = $3060**

**Evaluation**

**Dissemination for parents and caregivers**

The number of attendees at parental workshops and requests for more flyers from doctors’ office will be an indication of the interest people have in the project. Hits on a website (at CanChild for example) can also an indication of the number of people searching for information. The number of people requesting for thumb drives and education packages will also allow the author to understand if these materials are used for teaching if a return survey is filled by the people that request it.

**Dissemination for professionals**

The number of interested professionals stopping in front of the poster and asking
questions will definitely be a clear indication of the acceptance of the information. A sign-in document at the poster site will help generate a mailing list for e-mailing can also provide a count of interested individuals. The attendees at the presentation in Winnipeg will again be an indication people’s interest. Number of attendees, questions raised, surveys or questionnaires returned after rounds, conferences, workshops and seminars are good indicators of the success of dissemination. Number of hits on websites (tabs for professionals or members only) may also indicate how many enquirers or browsers are professionals. Another potential good indicator will be the number of treatment centers or communities in Ontario that are interested or willingness to adopt this program and use it in their centers or communities. One of my graduate students who had contributed to the package is working in a children center in the next county and is willing to ask if her supervisor think it is something they can adopt in their setting. Acceptance for publication in peer reviewed or parental journals also are evidence that the information is disseminated to the right people. Comments that people leave on websites, blogs etc are also reviewed to see if the dissemination is successful.

**Dissemination for administrators and policy makers**

Success of dissemination to administrators and policy makers is obvious when there is funding or change in policy approved. When administrators and policy makers are in agreement with the project, the ongoing running of the project is ensured. If the Member of the Provincial Parliament (MPP) is interested, he will also grant a meeting to meet with his constituents. Therefore, if the MPP or the chief executive officer of the hospital can spare the time to listen, it shows that they are interested and is the first step
before any funding is considered. This author would count that as a positive sign that the dissemination of the material has reached the targeted people.
CHAPTER SEVEN

Conclusion

The focus of this doctoral project was to design an education program for educating parents on putting infants into prone play. The program, titled “Prone to Play” is targeted for infants that are typically developing and also those that are at risks for developmental delays. The goal of the program is to provide evidence-based material for prone play for infants to improve postural control and fostering fine motor development in the upper extremities. The program is based on theories and evidence from occupational therapy, developmental psychology and motor learning. It was created to address the needs of infants and parents by providing activities that can be incorporated into play while the infant is weight bearing and playing in a prone position. Parental education is considered important in order to facilitate the changes in everyday practice and play (Lekskulchai & Cole, 2001). Through the evaluation results from this project, they can help to provide program design feedback and evidence of the benefits of prone play position and subsequently its effect on fine motor development. The project’s results will contribute to the field of occupational therapy: (1) to help infants to develop healthy patterns of movement and development in the motor domain; (2) to help infants to participate in their daily occupation of play in a prone position; (3) through parental education, to help parents to promote healthy concepts of play and activity in prone for their infants; (4) to provide evidence-based practice in occupational therapy when working with clients of this age group.

The beginning chapters in this thesis have focused on the impact of sleeping in
supine and its effects on the development of the infant (Mildred et al., 1995; Barlett & Fanning Kneale, 2003). This is followed by the need for a prone play activity program which has been done in developmental and pediatric settings. This project places an emphasis on the development of a theoretical framework for practice, and how theory and evidence from the developmental, occupational therapy, psychology and kinesiology literature were integrated to provide the foundation for the design of the program. Next, the program was presented and a design for program evaluation was discussed to prepare for a wider implementation after the pilot program. Finally, the implication of the project on occupational therapy practice was considered.

**Theory Integration**

Three theoretical frameworks- the dynamic system theory (Zwicker & Harris, 2009), sensory integrative theory (Ayres, 1972) and biomechanical model (Kielhofner, 2009), were used in this project to understand and to provide the foundation for the identified problem. These theories and model are drawn from the field of occupational therapy, psychology, motor learning and kinesiology. The Dynamic Systems Theory (Smith & Thelen, 2003; Kamm, Thelen & Jensen, 1990; and Heriza, 1991) is congruent with the Person, Environment and Occupation (PEO) model used in occupational therapy in which the person, environment and occupation interact (Kielhofner, 2009) to enable occupational performance. The Dynamic Systems Theory proposes that new forms of behaviors may emerge from interactions within the context of the task (Smith & Thelen, 2003; Thelen, 2005). Motor behaviors are seen as “softly assembled” and will change within the contextual constraints of task and environment influencing developmental
changes or motor outcomes. Therefore, by putting the infants in a prone position to play (different environmental parameters), infants are offered opportunities that allow them to self-explore, experience challenges and variations in movement and undergo trial and error with movement patterns. From the Sensory Integrative Theory perspective (Ayres, 1972), the environment is enriched with proprioceptive and tactile input when the infant bears weight and plays in prone. The infant organizes the sensory information and uses it to learn and perform to interact with environmental challenges with parents facilitating the process of integration. As new sensory information is taken in, integrated and organized, new motor behavior develops in the form of new gross and fine motor skills. Lastly, the biomechanical model provides a kinetic and kinematic background in which the structure of the glenohumeral, scapula-humeral joints and surrounding muscles provide the range, the strength and endurance to maintain postural control and produce movement (Kielhofner, 2009). Based on these theories as a framework, an explanatory model was proposed to explain the influence of prone play and weight bearing in prone on fine motor development.

**Evidence-Based Integration**

The search for evidence-based literature for this project was guided by looking at (1) whether evidence exists that prone play (bearing weight on forearms and upper body) can effect muscle strength and strengthening in the shoulder girdle; (2) whether evidence exists that the amount of time in prone play can affect fine motor development and (3) if evidence exists that proprioceptive and tactile input can affect joint stability in the shoulder girdle and fine motor development. The search yielded limited amount of
evidence based literature that directly points to improvements in fine motor abilities when infants play in prone (Dudek-Shriber & Zalazny, 2007; Monson, Deitz & Kartin, 2003; Salls, Silverman & Gatty, 2002). However, evidence-based literature did support that the best practice of putting children in prone play improves postural control and motor development (Bridgewater et al., 1999; Salls et al., 2002). Literature also showed the positive effect of weight bearing on shoulder stability (Uhl, Carver, Mattacola, Mair & Nitz, 2003). Shoulder stability helps to improve reaching (Gilfoyle et al., 1990; Shin, Park, Lee, Lee & Kim, 2010) and through weight bearing, the proprioceptive and tactile input in the upper extremity has an impact on the development of fine motor development (Majnemer, Bourbonnais & Frak, 2008; Schneck, 1991; Laszlo & Bairstow, 1983).

**Program Description**

A parental education program that focuses on prone play was created based on evidence-based literature and best practices that were mentioned in the previous sections. The program consists 7 weeks of hands on education session and an education package titled “Prone to Play” with step by step written instructions. This written material is geared towards a low literacy level with video-tape saved on a thumb drive as reference for parents and caregivers. A video called “Heads up and Prone to play” a 6 ½ minute video on Dr. Anne Zachry Tummy Time’s website (2014) will also be used as a teaching tool. The program will be first piloted on three infant-parent dyads. The results will further help to support the need to do a large scale study. Throughout the training, the parents will have an understanding of the importance and need for prone play in relation to motor development in the upper extremities. They will also have learnt practical prone
play activities to practice at home with their infants.

**Implication for Occupational Therapy**

The main objective of this project is to change parental practices in regards to prone play. Majnemer & Barr (2006) reported that positioning practices affects the rate of motor development and motor lags are associated with less time in prone while awake. There is a need for this information to be disseminated to parents, caregivers and pediatric occupational therapists working with infants. Though the present literature has not yet shown a positive correlation between prone play and fine motor development, this project will contribute to the evidence and best practice in occupational therapy when working with infants in prone position.

This project will provide evidence-based support to occupational therapists for advocating “supine to sleep and prone to play” for infants under one year of age. On a wider scale, occupational therapists will also be able to use evidence based research to advocate for health promotion and wellness in the infant population to prepare them for healthy development.
APPENDIX A - THEORETICAL FRAMEWORK

Within the occupational therapy or physical therapy literature, there is limited evidence that demonstrate to caregivers or therapists that prone activities or lying in prone while awake affects fine motor development. Fine motor development is defined as reaching, midline finger play, grasping and any upper limbs movement seen in the first year of life. Presumably, spending time in prone (factor 1) will inevitably provide an indirect casual relationship to factor 2 (increase the time the infant put weight onto the forearms and upper body). Another indirect casual relationship is Factor 2 causes stability in shoulder (Factor 3) leading to the final outcome, fine motor development in the infant. It is important to note that along the way, 2 elements, proprioceptive input and tactile input have modulating effects in producing shoulder stability.

This program will include identification of fine motor and postural assessments and evidence based prone activity program that can facilitate fine motor development in infants. The program is aimed at improving fine motor development in normal and at risk infants and also parental satisfaction after participation in the program.
APPENDIX B - PARENT EDUCATION PROGRAM

Prone To Play!  
Parent Education Package

Prepared by:

Sarah Cain, MSc OT Student Candidate 2012,
Mallory Carson, MSc OT Student Candidate 2012,
& Lowana Lee, OT Reg. Ont.
APPENDIX C - DEVELOPMENT OF EDUCATION MATERIAL POSTER

### Development of Education Material for Parents:
Play Positions to Enhance Upper Limb Development in Infants:
Lowana Lee, OT Reg. Ont, Sarah Cain, MSc. OT Candidate, Mallory Carson, MSc. OT Candidate

#### Abstract
The researchers conducted a literature review and held discussions with clinicians to identify the optimal position for children to be in during awake or "play" time that promotes upper limb development, and to identify caregivers' current knowledge of the topic. With this information, the researchers created a first draft of a parent education package.

#### Introduction
In 1995, a public awareness campaign entitled "Back to Sleep" was created to give guidelines for parents for the recommendation of placing infants on their backs to sleep to avoid the risk of Sudden Infant Death Syndrome (SIDS) (Zachary, & Kitzmann 2011). With the increasing amount of attention on SIDS, and prone sleeping being one number one risk factor, caregivers of infants have avoided putting their infants in prone all together (2011).

Teuchaylo et al. (2012) published a systematic review to create Canadian recommendation guidelines for activity of children from birth to four years old. The guidelines that were developed stated that infants (less than 1 year of age) should be physically active several times a day, particularly through floor-based play (i.e. in prone) (2012).

#### Literature Review

**Search Strategy**
Database: Searched: CINAHL, MEDLINE, OTSeeker, PEDro, EMBASE
Keywords: upper limb, upper extremity, play, positioning, tummy time, prone, infant, toddler, weight bearing
Inclusion Criteria: Articles had to be published after 1992, as this was when the AAP released sleep position guidelines, articles also had to be relevant to infants and toddlers. A total of 8 articles were appraised using the McMaster critical review forms for qualitative and quantitative research

**Main Findings**

**Physical Activity and Play Positioning for Infants**
Overall, the literature on positioning infants during awake (or play) time suggests that prone (or tummy time) is the most advantageous to motor development, especially in the earlier stages of infancy (Dudale-Schraber, & Zalany, 2007; Moston, Daity, & Karlson, 2003; Pta, Eldredge, & Galaa, 2007; Salls, Silverman, & Gatry, 2002).

**Caregiver Awareness**
Overall, caregivers of infants are not typically aware of the benefits of being in prone position for play and tummy time (Korean, Racoce, Kalim-D’angles, & Madeiros, 2010; Mildred, Beard, Dalhaimer, & Umwin, 1995; Zachary, & Kitzmann, 2011).

**Knowledge Dissemination**
Overall, parents do not typically receive a lot of information regarding play positioning. The most beneficial type of communication tool is the use of printed materials (Jennings, Sarbaugh and Payza, 2003).

**Conclusion**
There has been an identified need for infants to be engaged in physical activity for motor development and that playtime in the prone position helps infants reach developmental motor milestones quicker. Parents are not aware of the details of infant play positioning, and are more likely to have their children in a supine position due to the fear of SIDS. Overall, this review has identified the following gaps in the literature: play positions to promote upper limb development and how to disseminate this information to caregivers and those within their circle of care.

**Method**
To address the gaps within the literature, the researchers created questions to be discussed with an interprofessional group of clinicians that have experience with positioning to promote upper limb development with infants, and their caregivers. A total of two physiotherapists and three occupational therapists from Children’s Developmental Rehabilitation Program (CDRP) were contacted.

**Questions:**
1. What population of children do you work with? 2. Do you believe you work on upper or lower limb development more often in practice? 3. What techniques do you use to promote upper limb development? 4. Do you provide any upper limb development education packages to parents? 5. What evidence have you used to support your practices regarding upper and lower limb development?
   - Each discussion was between 30-60 minutes
   - Notes were taken by researchers during discussions
   - Notes were informally analyzed by researchers to identify common responses
   - Common utilized resources were given to researchers by the therapists
APPENDIX D - WEEKLY SAMPLE STRATEGY FOR PRONE PLAY

Week 1

Introduction

1. Find an area of the house where you can place a soft mat or blanket. If you use a mat, covered it with the baby’s blanket so that it is something the baby is familiar with.

2. When doing prone play, make sure it is supervised

3. Start with 15 minutes per day. Maintain the 15 minutes for a week; do not feel you have to increase during this week.

4. If your baby fusses, you can roll a towel and put it under your baby’s chest (working on baby’s head control too).

One of the components we will use in the teaching will be Dr. Anne Zachry’s video on her website on tummy time: http://www.tummytimetips.com/tummy-time-video/ Her 6 ½ minutes short video helps to explain the importance of tummy time and how it can help in development. There are some tips, but we will review again in week 2, including how to carry infant.

The session ended by having placing infants in prone for 15 minutes, using different toys to distract him, stretching the seconds on prone to minutes.

Week 2

Review last week’s material and Dr. Anne Zachry’s video.

Parents will feedback regarding the past week’s prone play time.
This week, the emphasis on integrating into daily routine:

2. after dressing and changing diapers: prone on lap

3. incorporate tummy time when during bath time: drying with towels, putting on lotions

4. holding infant so that the infant is prone on parent’s chest while interacting - parent can vary his/her position so that the recline can increase to being in supine.

5. place interesting toy or mirror in front of infant so he can look and focus

6. can use parent’s face and voice to maintain the interests of the infants to stay in prone.

If infants had tolerated well in the first week, consider increasing the time in one stretch to 20 minutes or more. If not, parents can still use short bursts of 10-15 minutes prone play at a time during this week.

**Week 3**

1. Another video “Heads up and Prone to Play” was also shown to the parent. The length of tummy time will be increased to 30 minutes. This will be the goal for this week. Parents are advised to end the Tummy Time when the infant starts to fuss, cry or when fatigued.

2. Discuss with parents the daily routine and how they have used the prone position during activities of daily living. Tummy Time tips from the American Occupational Therapy Association was used to help illustrate. This is downloaded from [http://www.aota.org/](http://www.aota.org/).
3. Review with parent their logbook and discuss difficulties when carrying out Tummy Time.

**Week 4**

Review things learnt in previous sessions. Give out package of written material on Tummy Time. Review the items on the package and AOTA tip sheets.

Report to the therapist regarding time spent on tummy and ways that have worked.

Work on carrying positions by caregivers and parents

Suggestions:

- use tummy time prone position for story telling
- make sure that weight is evenly distributed throughout both sides of body. Gently placed hand onto the infant’s bottom to give some stability to the lower part of the body to enable the upper body and trunk to extend and shift weight down the spine. This helps to build up trunk muscles.
- use parent’s body and lap to position child in prone for play - lying on parent’s chest with parent recline at different angle, and also lying on parent’s lap

**Week 5**

- Continue with sessions for the infant in prone activities. By this time, infant will be attempting to roll. Give infant opportunities to do so as well as different contacting surfaces. Use interesting toys, voices and faces to entice him/her to move.
• Encourage tracking while in this position

• Promote reaching in all direction by putting toys in different location and on both sides

• Initiate sounds, cooing and singing with infant. Wait for a response, whether it is an eye contact, a smile, a responding cooing sound to encourage communication from infant.

• Encourage head lifting and weight shifting if he/she starts to move.

**Week 6**

• Review with parents any difficulties they have during the prone play at home. By this time the infants is hoped to have done at least 30 minutes of prone play if not more each day. Review parental logs.

• Build on the skills of the infants by noting where he/she is at developmentally. Incorporate prone activities with reaching activities and weight shifting while in prone

**Week 7**

• Review the whole programme and encourage parents to continue Tummy Time even though the weekly sessions ended.

• Remind to hand in log books at the end of the week.

• Book time for post assessment and video-taping.

• Continue with the last session, encourage prone mobility and reaching.
APPENDIX E - Prone Markers for different age (Piper & Darrah, 1994)

Fig 1. Head turned to the side - $0^\circ$

Fig. 2. Head raised to $45^\circ$

Fig. 3. Head raised past $45^\circ$
APPENDIX F- Sample of Parental Log

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<th>F</th>
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<th>H</th>
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<tbody>
<tr>
<td>1</td>
<td>Appendix F</td>
<td>Prone Play Parent Daily Log</td>
<td>(week #__)</td>
<td>Parental Infant Dyad #</td>
<td></td>
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<td>2</td>
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<td>3</td>
<td>Day 1</td>
<td>Time Start</td>
<td>Time End</td>
<td>Total time (min)</td>
<td>highest head angle reached (degrees)</td>
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<td>Day 2</td>
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<td>Day 3</td>
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APPENDIX G - SURVEYS FOR PARENTS ON PERCEIVED EFFECTIVENESS OF THE PRONE PLAY PROGRAM

Questions (Parental/Caregiver surveys): Pre 7 week-sessions

I put my child on his or her tummy to play:

5) for at least 30 minutes per day
4) for less than 30 minutes but at least 15 minutes per day
3) for less than 15 minutes but at least 10 minutes per day
2) for less than 10 minutes per day
1) not every day or not at all

I understand that spending time playing on his or her tummy will help my child become stronger

5) fully
4) somewhat
3) a little bit
2) hardly at all
1) not at all

I think this education program will help me learn new play activities to use with my child in a different play position.

5) strongly agree
4) agree
3) not sure
2) disagree
1) strongly disagree

The second round of survey would be introduced at the end of the program:

Questions (Parents/caregivers surveys): Post 7 week-sessions

How practical do you think it is to teach this program in a person’s home or a daycare?

5) Very practical; no problem
4) Somewhat practical with just a couple of changes needed to fit each setting
<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
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<tbody>
<tr>
<td>3</td>
<td>Somewhat practical with more than a couple of changes needed to fit each setting</td>
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<tr>
<td>2</td>
<td>Not very practical because a lot of changes would be needed to fit each setting</td>
</tr>
<tr>
<td>1</td>
<td>Not practical at all</td>
</tr>
</tbody>
</table>

Since I have completed the education program, I put my child on his or her tummy to play:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>for at least 30 minutes per day</td>
</tr>
<tr>
<td>4</td>
<td>for less than 30 minutes but at least 15 minutes per day</td>
</tr>
<tr>
<td>3</td>
<td>for less than 15 minutes but at least 10 minutes per day</td>
</tr>
<tr>
<td>2</td>
<td>for less than 10 minutes per day</td>
</tr>
<tr>
<td>1</td>
<td>not every day or not at all</td>
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</tbody>
</table>

How satisfied are you with your child’s ability to balance and move since you have finished the education program?

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
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<tbody>
<tr>
<td>5</td>
<td>I am extremely satisfied</td>
</tr>
<tr>
<td>4</td>
<td>I am pretty much completely satisfied</td>
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<tr>
<td>3</td>
<td>I am somewhat satisfied</td>
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<tr>
<td>2</td>
<td>I am a little bit satisfied</td>
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<tr>
<td>1</td>
<td>I am not satisfied at all</td>
</tr>
</tbody>
</table>

How effective do you think practicing what you have learned in this education program has in helping to improve your child’s ability to use his hands and fingers?

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
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<tbody>
<tr>
<td>5</td>
<td>Highly very effective</td>
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<tr>
<td>4</td>
<td>Very effective</td>
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<tr>
<td>3</td>
<td>Somewhat effective</td>
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<tr>
<td>2</td>
<td>A little bit effective</td>
</tr>
<tr>
<td>1</td>
<td>Not effective at all</td>
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</tbody>
</table>
APPENDIX H - PARENTAL LOG SUMMARY (DYAD 1)

### Parent Log of frequency of Prone Play in infant during the day (Dyad 1)

<table>
<thead>
<tr>
<th>Frequency of prone play during a 15 minute observation</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
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**Charting Key:**
- Red: Parents' observed frequency of prone play in infant in a 15 mins playtime per day (events per 15 mins)
- Green: Parents' observed total duration of prone play in infant daily (sec)
- Blue: Parents' observed highest degree of head lifting of infant during prone play (ideal)

### Parent Log of observed total duration of prone play in infants daily (mins)

<table>
<thead>
<tr>
<th>Total duration of prone play in minute daily</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
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**Charting Key:**
- Red: Parents' observed frequency of prone play in infant in a 15 mins playtime per day (events per 15 mins)
- Orange: Parents' observed total duration of prone play in infant daily (mins)
- Blue: Parents' observed highest degree of head lifting of infant during prone play (ideal)
<table>
<thead>
<tr>
<th>Degree of head lifting while in prone</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
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Charting Key:
- Red: Parents' observed frequency of prone play in infant in 15 mins playtime per day (events per 15 mins)
- Green: Parents' observed total duration of prone play in infant daily (mins)
- Blue: Parents' observed highest degree of head lifting of infant during prone play (idea)
APPENDIX I: Executive summary for Prone to Play-an Education Program for Parents and Caregivers to enhance Fine Motor Development

Introduction

Since 1992, infants have been sleeping on their backs due to the fear of Sudden Infant Death Syndrome (SIDS) per the recommendation of the American Academy of Pediatrics (AAP). By mid nineties, AAP started to recommend balancing sleeping in supine with prone play - also called Tummy Time-to encourage optimal, healthy infant development (Zachry & Kitzman, 2011). However, many infants have been accustomed to sleeping on their back and dislike the prone position (Jones, 2004). This habitual position on their back contributes to their fussing when they are put into prone position or when having tummy time for play. Therefore, parents avoid putting the infants in the prone position even when awake. The literature has shown that infants sleeping in supine without spending time in prone can lead to motor delay in development in their first year of life (Barlett & Fanning Kneale, 2003). Dudek-Shriber & Zelazny (2007) also found that spending more than two hours of prone time while awake is significantly associated with faster rate of attainment of prone, supine, and sitting milestones, as well as skill acquisition that require weight bearing against gravity in prone and other positions for 4 months old infants. Salls et al. (2002) stated that the same significant associations with motor development are seen in two months old infants when they spent greater than fifteen minutes daily in tummy time.

Evidence and Theoretical Support
Further review of the evidence-based literature shows that enhanced handling and positioning in early infancy can affect the advancement of emergence of certain motor skills like reaching and object exploration (Lobo & Galloway, 2012). Prone positioning has been correlated with gross motor development, but its effect on fine motor and upper extremity development has not been well documented. (Salls, et al., 2002). This project focuses on developing, implementing, and evaluating a prone play-positioning program. The goal is to provide opportunities for infants to experience prone position in play during waking hours and to explore the association of the prone play position with fine motor development.

Using motor skills to engage in play is within the domain of occupational therapy practice (AOTA, 2002; CAOT, 2009). This project focuses on the child’s occupation of play and is within the occupational therapy domain (CAOT, 2009). A systematic approach built on evidence-based literature and clinical reasoning is used to enable the infant to develop the means and opportunities to engage in and improve their function in the occupations of play and fine motor development. In addition, Tremblay, et al. (2012) published the Canadian guidelines for activity of children from birth to four years old. The guidelines recommended that infants (less than one year of age) should be physically active several times during the day, of which floor-based play in prone is highly recommended.

There is evidence to support that gross motor development in infants is affected by prone sleep position (Dudek-Schreiber & Zelazny, 2007). However, there is limited evidence that prone play or sleeping in prone affects fine motor and upper limb
development. Therefore, this project focuses on looking at prone play and its effect on fine motor and upper limb development based on sound theoretical framework and evidence. In this project, three theoretical frameworks, the dynamic system theory (Zwicker & Harris, 2009), sensory integrative theory (Ayres, 1972) and biomechanical model (Kielhofner, 2009), were used to provide the foundation for explaining the identified problem.

The Dynamic Systems Theory views the infant as dynamic and able to reorganize itself. Therefore the education program created is focused on providing information and motor experiences that will allow infants to undergo self-exploration, and to go by trial and error to practice a variety of motor skills. By challenging the infant to go through change in the task and environmental context, the infant will shift to a new phase and self organize to produce new motor behaviors. The intervention program recognizes that the new phases allow the infant to have more opportunities to explore and practice and to help parents to recognize these windows of opportunity for change. Since Law, et al. (1998) reported that transition periods are periods indicative of developmental readiness for change in motor abilities and for impacting motor changes, more practice and opportunities in alternate positions can be given to the infant at this time.

The Sensory Integrative Theory also reinforces the importance of the environment and the impact of sensory information on development. Proprioceptive and tactile sensory information are provided and received from the environment (Ayres, 1972). They are reorganized and processed in the brain, then converted to meaningful information and used to plan and execute motor behavior. Placing the infant in prone, meaningful sensory
information is provided to assist in the development of the new motor behavior. As development continues, the infant builds on previous adaptive behavior as a result of a new level of brain organization. New gross and fine motor skills emerge as new sensory information is taken in, integrated and organized to adapt to new behavior and environment.

Lastly, the biomechanical model is used to explain how weight bearing in prone position can affects the muscles and joints in the shoulder; contributing to the stability and building of postural muscle tone (Magrun, n.d.). The infant, the environment, and the functional significance of the task become a synthesized unit, and motor behavior is seen as a product of their interaction with tactile and proprioceptive input having moderating effects on the structures.

Project Overview

There is limited evidence-based literature that supports the causative effect that playing in prone position or “tummy time” will affect fine motor development. This project focuses on: (1) developing a theoretical framework to look at the associated effect of time spent in prone with fine motor development; (2) identifying evidence-based literature that supports the use of activities in the prone position and its effect on shoulder stability and fine motor development; (3) investigating the evidence literature and best practice in designing an education program on prone play with a three parent-infant dyads pilot study; (4) providing an overview of best practice for implementing a “Prone to Play” program among typical developing and high risks infants in the community; and (5) describing a detailed evaluation and a dissemination plan of the results to advocate for
further implementation and knowledge translation. Evidence from allied health, developmental psychology, and kinesiology and sport orthopedics journals were reviewed before designing the parent education program in this project.

Theories used in the fields of occupational therapy and developmental Psychology: i.e. Dynamic Systems Theory of Development (Thelen & Smith, 1998); Sensory Integration (Ayers, 1972) and Biomechanical Model as used in occupational therapy (Kielhofner, 2009), were used to frame the identified problem and project development. They provide the theoretical framework for looking at the important elements of the project: the infant and the parents; the play position the infant was put in; the amount of time spent in this position. The two theories and one model consider how all the elements interact with each other to affect the change in motor development.

These considerations were critical in setting up a project that helps to provide parent training and education program of prone play activities to promote the fine motor development of infants.

The educational program consists of seven weeks of play sessions and a multi-media educational package of prone play for parents to continue the play program at home. The educational package for the family will consist of prone play activities. As a demonstration project, the program will be delivered to three dyads of parents of young infants aged two months at the time of recruitment. Inclusion criteria will be full-time, typically developing infants who are supine sleepers and whom have never been put to play in prone position. The infant-parent dyads will be recruited directly from the nursery and are from white, middle socioeconomic two- parent families in the Hamilton-
Wentworth area. Baseline measurements of fine motor, posture and head angle of the infants are done before the start of the intervention program using the Alberta Infant Motor Scales (Piper & Darrah, 1994), fine motor section of Peabody Developmental Motor Scales-2 (Folio & Fewell, 2000) and Posture and Fine Motor Assessment in Infants (Case-Smith & Bigsby, 2000). The weekly sessions consist of seven weeks of 45 minutes play sessions for parents and caregivers of infants of which at least 20 minutes of playing in prone position in each session.

The packaged educational material is in written and digital formats. Three dependent variables that are associated with improved motor abilities will be targeted for intervention: (1) frequency of prone play, (2) duration of prone play, and (3) degree of head lifting by the infants. All these factors are noted to be associated with improved motor abilities. The parents will record the length of time the infant spends in prone play during each play session. This will be kept in a daily logbook for seven weeks during the intervention. Post program assessments that include standardized assessment for fine motor and postural control are done at the end of the intervention. A longitudinal follow-up using the same standardized measurements are used to track development at six months, nine months and 12 months. Following the success of the pilot study, the whole program will be implemented and the recruitment of 100 parent-infant dyads will occur on a larger scale.

*Evaluation, Funding & Dissemination Plan*

The program will be evaluated using a concurrent multiple-baseline single subject design across three infant-parent dyads. Phase A represents the baseline phase wherein
the participating infant and the parent will attend a regular 45 minutes session on regular play and stimulation without any emphasis on prone play. The therapist will emphasize on face-to-face interaction and supine play with the child. Phase B represents the experimental condition in which the pediatric occupational therapist conducts education sessions on prone play that includes activities that can be practiced at home each day. The educational package on prone play activities will be given to the parents during this phase. All three dyads will be enrolled into the study at the same time, but the introduction of Phase B will be staggered at one week apart. The efficacy and effectiveness of the program will be measured through parent satisfaction ratings and perceived usefulness of the program. The infants are also followed longitudinally with reassessment at 6th, 9th and 12th months for their motor assessment.

The proposed project starts with a pilot study with low implementation cost. One of the major costs is the construction and printing of the education material and the required qualified therapists for the training session when the program extend to the community. Technical support to get onto audio-visual and digital format may require more resources. Dissemination of the program also includes the presentation of the program and its evaluation at professional conferences. The registration, travel expenses and accommodation of presenter when it is out of town continues to present as the highest expense on the budget. To expand the program into communities other than English speaking also requires budget for translation for both the training and the educational package.
As the Children’s Developmental Rehabilitation Programme is closely associated with McMaster University and the CanChild Center for Childhood Disability and Research, this author can draw on some of their expertise to help in the proposed project. The education material can be linked with appropriate websites at the two institutions so that knowledge can be translated to the appropriate people. Financial resources can be obtained from both federal and provincial funding as well as from the Hamilton District Society for the Disabled Children. Other agencies, like the Hamilton Health Sciences Volunteer Services, United Way, the local Lion’s Clubs and Rotary Clubs, would be approached to help. Fundraising events can also be done any time in the year.

Conclusion

This doctoral project attempts to identify the links between prone activities, postural control and the fine motor development through research on evidence-based literature. Through the information gathered, it enhances the clinical practice with a redesigned educational package on prone play for typically developing and high risks infants. The qualitative and quantitative benefits of the parent education program will align with health promotion and wellness initiatives of the Ontario government. This project will also provide the theoretical foundation for designing motor programs for the developing infants as well as evidence-based research for clinical practice. Lastly but not least, it advocates best practice by addressing a lack of evidenced based literature and attempts to add to the knowledge base in regards to tummy time and its effect on fine motor development.
References for Appendix I


Prone to Play: An educational program to enhance postural control and upper extremities development

Lowana Lee, MS, OT Reg (Ont.)
OTD Candidate

Main issues addressed
- Evidence-based literature is limited with regards to prone position and its effect on fine motor development, though many papers discussed the effects on gross motor development.
- Limited systemic educational programs or materials that are based on sound theories to help parents integrate play in prone position into everyday activities
- Need to provide variability in play position other than sleep or play in supine
- Need for promoting health and wellness in the occupation of play in infants

Background
Since 1992, the American Academy of Pediatrics (AAP) advocated the “Back to Sleep” campaign to prevent Sudden Infant Death Syndrome (SIDS). Many infants became accustomed being on their backs and cried or fussed when they were put in prone play during their waking hours. Evidence-based literature revealed that parents adhered to guidelines for “Back to Sleep” but neglected or avoided the prone to play position (Zachry & Kitzmann, 2011)

Proposed Parent Educational Program in Project:
Baseline measurements of the infant before program starts
Seven weeks of 45 minutes play sessions for parents and caregivers of infants-at least 20 minutes of playing prone position in each session
Packaged educational material in written and digital formats
Post-program assessments
Longitudinal follow up of infant’s progress at 6 months, 9 months and 12 months

Proposed theoretical framework based on:
1. Dynamic Systems Theory
2. Sensory Integrative Theory
3. Biomechanical Model
Limited evidence demonstrated to caregivers or therapists that prone position affects fine motor development. Fine motor development is defined as reaching, midline finger play, grasping and any upper limbs movement seen in the first year of life. Presumably, spending time in prone will inevitably increase the time the infant puts weight onto the forearms and upper body. Another indirect causal relationship of prone activities promotes stability, which leads to the final outcome, fine motor development in the infant. It is important to note that along the way, two elements, proprioceptive input and tactile input, have modulating effects in producing shoulder stability. The theories and model together provide the theoretical framework for this project.
Messages for:

**Health professionals:**
- Continue to balance “Back to Sleep” with “Tummy Time.”
- Parental education on “Tummy Time” is also important for fine motor development to facilitate shoulder and postural stability.
- Educational program is a resource for teaching parents.

**Parents & Caregivers:**
- Prone play helps motor (gross and fine) development by strengthening postural muscles.
- Incorporate “Tummy Time” into daily routine and play
- Home environment structured to let infants try out movements in different positions

**Policy makers:**
- Promote “Prone to Play” as a health and wellness initiative for healthy babies.
- A funded educational program for infants with high risk for developmental delay
- Made available in local communities

---

**Objectives of the Project:**
- Identify through the evidenced based literature the effect of prone position on motor control and fine motor development
- Identify through the evidenced based literature if there is an optimal “tummy time” duration
- Develop an evidence based educational program on prone play activities for parents and caregivers
- Develop a dissemination plan to present to the Ministry of Youth and Social Services and to administrators of McMaster Children’s Hospital

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**Funding**
- Educational package in printed and digital format
- On-line educational module
- Posters printed for:
  - Family physician offices
  - Midwives & visiting nurses
  - Healthy Babies clinics
  - Prenatal clinics
  - Childcare and nurseries
  - Ontario Early Years Centers
- Collaborate with Best Start and Healthy Babies, Healthy Children, both health and wellness initiatives for children development (from the Ontario Ministry of Children and Youth Services)
  - [http://www.children.gov.on.ca](http://www.children.gov.on.ca)

**Implications for Occupational Therapy**
Occupational therapy supports health and participation in life through engagement in occupation (AOTA, 2014). Play in infants is considered their “their skills in the job of living” (CAOT, 2009). Under AOTA’s Occupational Therapy Practice Framework (OTPF), children that have poor motor performance (including fine motor skills) will have problems in participation and engagement in the occupation of play. When infants have obtained enough experience in the prone position during their waking hours, one can see positive changes in their fine motor development. The educational program and materials will provide parents and caregivers with the skills to facilitate prone play in the infants; and is built on philosophical frameworks and theories that optimize fine motor development and are consistent with occupational therapy domains.

**Who will benefit from program?**
1. Parents and caregivers of infants from 0-12 months
2. Infants that are developing normally or at risk for development delay
3. Pediatric therapists and health care professionals that see infants aged 0-12 months

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**References**


References


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