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Research on the Impact of Early Oral Motor Intervention on Babies' Oral Feeding and Growth: A Comprehensive Review and Meta-Analysis

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Abstract

Background: Prior to 32–34 weeks of gestation, preterm newborns did not develop the ability to coordinate sucking and swallowing. Reduced hospital stays are the result of enhanced oral motor musculature and neurobehavioral synergy, which speeds up the process of being ready to feed orally, increases weight growth, and so on. One kind of oral motor therapy that has shown promise in improving clinical outcomes for premature newborns is PIOMI, or Premature Infant Oral Motor Interventions. There has never been a systematic evaluation of PIOMI's effects on early infants' weight gain, length of hospital stay (LOS), or oral feeding progression. This review was so premeditated.

Methods: We searched databases such as PubMed/Medline, Embase, Ovid, Clinical Key, Academia, Google, and Google Scholar (from the start of PIOMI to October 2020) to compile this review. Research publications detailing randomized controlled trials and clinical trials were composed.

Findings: Meta Analysis (MA) comprised six trials including 301 preterm newborns. The results showed that PIOMI was effective in achieving feeding progression early on (MD = −4.63 days at 95% CI = −4.97 to −4.29), transitioning from gavage to independent oral feeding (MD = −2.54 days at 95% CI = −3.13 to −1.95, $p < 0.001$), demonstrating weight gain at discharge (MD = 51.61 grams at 95% CI = 19.84 to 83.38, $p = 0.001$), and reducing LOS (MD = −2.81 days at 95% CI = −3.51 to −2.10, $p < 0.001$).

Conclusions: PIOMI was found to be helpful in reducing LOS, promoting weight gain upon discharge, and increasing oral feeding progression and early attainment of gavage to independent oral feedings.

Keywords- *Premature infants, incubators, parents, and solicitations that appeal to one or more senses*

1. Introduction

Approximately 15 million children are affected by premature birth each year, which accounts for 1 out of every 10 births worldwide [1]. The improved survival rates of these preterm newborns with low birth weights can be attributed to the medical progress in prenatal treatment since 2000, resulting in longer hospital stays [2].

The duration of a preterm baby's stay in the neonatology unit, their age, birth weight, and fetal experience all contribute to sensory and perceptual impairments [3]. As a result of these abnormalities, their abilities to explore and interact with their environment using their senses and motor skills are compromised [4,5]. Brain abnormalities, particularly those impacting cognitive abilities, focus, communication, and social understanding,

are more prevalent in premature infants compared to those born at full term [5,6,7,8]. The implications of premature delivery are causing an increasing worry for public health [9].

The primary objective of early therapy in the Neonatal Intensive Care Unit (NICU) is to restrict atypical developmental pathways. Since the 1980s, there has been a shift in focus from just guaranteeing the survival of children to actively promoting the well-being of both children and their parents. This transformation occurred with the introduction of early, customized developmental care. Preterm babies, at their critical stage of physiological immaturity and mental development, have inadequate stimulation in the incubator, resulting in aberrant sensory experiences. The technological environment of the NICU and the fragile developmental period of premature infants can lead to strained interactions between parents and their infants [10]. Consequently, the management of neonates born preterm involves investigating the dynamics between parents and their infants [11,12].

This study examines the influence of parents and caregivers on the sensory development of preterm infants. It focuses on the impact of incubator conditions and the specific types of multi-sensory stimulation that are most advantageous for these infants.

Over the past 20 years, the number of babies born too soon has been steadily increasing around the world.[1] almost 10% of all babies are born prematurely each year, affecting about 15 million babies. Tragically, almost 1 million children die each year as a result of complications related to premature delivery. Cognitive deficits, along with visual and hearing abnormalities, are challenges that many prematurely born persons must overcome. Here is the compilation: (2, 3). When it comes to children younger than five years old, prematurity is second only to pneumonia in terms of overall mortality, and it is the primary cause of death in the critical first month of life. Different groups of gestational age babies reach milestones in their breastfeeding journey at different postmenstrual age (PMAs). Nevertheless, infants born prematurely (with a GA of less than 2 weeks) may start nursing a little later than expected. Moderately premature neonates attained exclusive breastfeeding at approximately 36.4 weeks postmenstrual age (PMA), but very premature newborns initially experienced complete nursing at a mean age of 35.5 weeks PMA. Text entered by the user is "[4]". In places like India, Egypt, and China, oral feeding can begin at around 34 weeks of postmenstrual age (PMA), whereas in the US it can begin at 29 weeks. However, a baby's ability to feed themselves orally cannot be reliably predicted by gestational age (GA) or postmenstrual age (PMA). This evaluation takes into account not just the child's weight but also their oral motor development, feeding methods, and history of feeding.

Problems with temperature regulation, feeding (due to poorly coordinated sucking and swallowing reflexes as a result of an immature central nervous system), breathing (due to immature lungs), and infection (due to an underdeveloped immune system) are just a few of the obstacles that premature babies must overcome in order to survive.the third The rates of survival vary greatly from one region to another. Because of a lack of practical, affordable care—including warmth, breastfeeding support, and basic treatment for infections and breathing problems—nearly half of the preterm infants born in low-income nations who are born below or around 32 weeks—two months early—do not survive. We could save 75 percent of the lives lost due to 15 million preterm births if we used the current low-cost interventions.[2] in A prolonged hospital stay is sometimes necessary for preterm children as they transition from tube (gavage) feeding to oral feeds; this places an additional strain on families and society as a whole, as only a small percentage of premature infants are able to adequately feed themselves orally from birth. A recent Southeast Asian paper reported that the median consumables cost per premature newborn varied from 18,1.00 to 10,149.8 Malaysian Ringgit (1 MYR = 17.98 Indian Rupee) in extremely early critical care.5, 6 When feeding by mouth, it's necessary to coordinate breathing, sucking, and swallowing while maintaining general motor stability and paying attention to external sensory cues. The rate at which neonates are exclusively breastfed is improved by oral motor therapy, which improves the oral-motor musculature and neurobehavioral organization. The commencement of therapy varied among studies, ranging from 29 to 33 weeks postmenstrual age (WPMA). According to the available evidence, the therapy consistently reduced the length of time it took to go from gavage to complete feedings (8–13 days vs. 13–26 days without therapy), resulting in lower LOS. Babies need to develop smooth motor control in their jaw, lips, tongue, palate,

pharynx, upper trunk, and respiratory systems so they can safely swallow. They also need to have normal sensory functioning in their reflexes, such as rooting, gag, and an intact swallow reflex, as well as sensation in their throat and mouth. Only then can they begin to feed themselves successfully. It seems that rooting and Non-Nutritive Sucking (NNS) are better indicators of when a baby is ready to eat. These signs and symptoms may appear in some babies as early as 28 weeks postmenstrual age.

2. Premature Infant Oral Motor Interventions (PIOMI)

One OMI approach, known as Premature Infant Oral Motor Interventions (PIOMI), builds on the oral structure developed with the Beckman Oral Motor Intervention (BOMI) by using resistance movement to strengthen the jaw and assisted movement to trigger muscle contraction. Not meant for use with premature infants because they have trouble enduring the treatments without showing symptoms of stress; originally, BOMI was planned as a 15-minute intervention for full-term babies, kids, and adults with developmental delays leading to feeding issues. On top of that, it's not easy to devote the entire fifteen minutes to the various oral areas (palate, tongue, upper gum, lower gum, etc.) because the premature infant's mouth cavity is so little. To make it suitable for use with premature infants as early as 29 weeks postpartum, Dr. Lessen revised the original BOMI in collaboration with Debra Beckman, cutting the number of stages from 11 to 8, and shortening the duration from 15 to 5 minutes. The techniques were adjusted slightly to fit the tiny mouth of the premature baby, and special consideration was given to their placement to guarantee that their head and neck would be properly supported. To stimulate the oral structures, such as the tongue, gums, lips, and cheeks, particular finger strokes were utilized. The transactional model was utilized to develop PIOMI. This model is a standardized oral motor therapy for preterm infants that has been extensively researched and proven to have excellent intervention fidelity.1, 7 After achieving a certain level of competence, any health care provider, including parents, neonatologists, occupational therapists, nurses, or other developmental specialists, can easily administer PIOMI. Although there have been no reported side effects of PIOMI, feeding stress symptoms such as apnea, bradycardia, and oxygen desaturation may be noticeable.

To determine PIOMI's efficacy as a targeted oral motor treatment, multiple studies have been conducted. Weight gain, increased oral intake, decreased length of hospital stay (LOS), earlier full oral feeding, and improved growth velocity were all outcomes of the PIOMI study, according to the investigators. The study also found that it increased the mean Neonatal Oro-Motor Assessment Scale (NOMAS). One month and three months following discharge from the neonatal critical care unit, PIOMI also enhances the rates of direct breastfeeding. Consistent success has piqued the interest of researchers throughout the world in the PIOMI. However, the fact that feeding and care patterns may vary between cultures reduces the study's external validity. As a result, research involving preterm infants in many nations must be maintained.[1] Previous research using a small sample size did find that PIOMI caused weight gain, higher oral intake, lower LOS, and shorter transit times to full oral feedings. There have been limited reviews that have included PIOMI alongside other OMIs [5,13], but no reviews that have focused solely on PIOMI's effects have been conducted thus far. Therefore, the purpose of this systematic review (SR) and meta-analysis (MA) was to determine whether PIOMI was beneficial in helping premature infants advance through oral eating and gain weight.

3. How the NICU Incubator Affects the Preterm Infant's Sensory Development

Babies born extremely prematurely do not have the same opportunities for growth and development in neonatal intensive care units (NICUs) as they would have in the womb. Infants born prematurely and housed in incubators miss out on the prenatal stage, which puts them at conflict with the normal biological continuum and exposes them to a sensory milieu that is vastly different from what they would have experienced in the womb [13].

Numerous stress factors, including painful care procedures and frequent and unpleasant manipulations, will be encountered by these premature infants in their early days of life [13]. It is well-known that during the third trimester of gestation, a developing baby's senses—sight, sound, smell, and touch—develop in a specific order. At 14 weeks, a preterm infant in an incubator experiences atypical sensory input—both in terms of quantity and

quality—that is unsuited to his or her current stage of sensory maturation. From there, the baby moves on to vestibular sensitivity, which affects balance and movement, auditory sensitivity, which occurs at 26 weeks, and finally, visual sensitivity, which occurs at 28 weeks [14]. Indeed, the organism is prepared to interact with its sensory environment after birth by means of its prenatal sensory experience. The vestibular and tactile receptors, which are still developing, are not stimulated enough during an incubator stay due to the seclusion and reduced skin-to-skin contact [14]. On the other hand, the preterm infant's underdeveloped senses of sight and hearing are overstimulated by the incubator's amplification of background noise, such as bells, machinery, and distorted human voices [15,16,17,18]. Patients may experience tachycardia, bradycardia, apneas, reduced oxygenation, elevated muscular tension, blood pressure, intracranial pressure, and sleep disorders as a result of their early auditory experiences, which in turn impact brain development [19]. A child's hearing, their capacity to regulate their body temperature, and their overall energy expenditure are all negatively impacted by a noisy environment. A higher chance of hearing loss is associated with NICU stays longer than four days [20].

Technical gestures and nursing care include a lot of physical touch, most of which is not soothing and is sometimes accompanied by strange and unpleasant smells like disinfection [21,22,23,24]. When patients do not have enough good tactile experiences before undergoing painful procedures like blood testing, catheter placement, fundus, etc., it might lead to a decrease in the brain's ability to process (non-harmful) tactile stimuli upon discharge [25]. The preterm newborn's brain develops more slowly in the incubator due to sensory deprivation, excessive stimulation, and/or unhealthy, unpleasant, or inappropriate stimulation. When a preterm baby has a health condition like respiratory distress or ulcerative colitis, it puts a lot of strain on the parents and the baby. According to research [18,26], a child's health, development, and brain maturation are all severely impacted by these distressing and dissimulating situations. In fact, other processes, such tissue formation, suffer as a result of increased oxygen consumption due to stress responses, most noticeably an increase in the heart rate [26]. Additionally, it has been observed that the stress response, which includes vasoconstriction, can lead to an increase in intracranial pressure and hypoxia, which in turn can promote the formation of intraventricular haemorrhages [27].

2.1. Lessening the Impact of Sensory Cues

Reducing sensory input has been attempted due to the recognition that preterm newborns can be overwhelmed by sensory stimulation, which in turn increases physiological symptoms of stress [8]. Infants born prematurely have problems with homeostasis regulation and proper response to environmental stimuli, which impedes the maturation of their perceptual and self-regulatory capacities. Preterm infants are subjected to an excessive level of stimulation, according to the Newborn Individualized Developmental Care Assessment Program's (NIDCAP) theoretical approach. For the benefit of premature infants, there is a collection of measures known as NIDCAP [2]. In order to create a personalized care plan that takes into account each child's strengths and areas for improvement, these measures involve adjusting the environment so that preterm infants experience fewer stressful sensory stimuli, such as bright lights, loud noises, and sudden temperature changes [3-4]. The NIDCAP method considers the structure of four operational systems in connection to the outside world: the autonomic, motor, arousal, and interactional systems [3-4]. When stress disrupts one of these systems, it affects the others in a cascade effect. Rapid weight-bearing development, respiratory independence, and shorter hospital stays are some of the short-term benefits of NIDCAP [6,8,11]. By the two-week mark of Corrected Age (CA), NIDCAP had improved neurobehavioral and neurological development in premature infants compared to conventional care. However, the advantages of NIDCAP did not continue at12,18, or 24 months of age [36,38,39,40]. They were only noticeable at 9 months of age. The duration of hospitalization and the necessity of respiratory support are both decreased by the NIDCAP intervention [5]. Since NIDCAP necessitates substantial time and effort from caregivers in the form of training, it is not widely accessible to NICUs [6].

The goal of some early intervention programs, like the one developed by Becker et al. [8], is to help preterm infants develop their self-regulation skills by reducing background noise. The occurrence of apneas, hypoxemia, and cardiac accelerations is reduced in extremely premature newborns with low birth weights when the noise level in the incubator and the unit is reduced [7]. You can boost your weight growth and sleep time by reducing

light and sound for 12 hours at night [3]. Neonatal Behavioral Assessment Scale scores improved, especially on the reflex and self-regulation subscales, and staturo-weight gain was better as a consequence of less noise and care consolidation that allowed for extended sleep duration and stress monitoring [3]. While earmuffs were shown to minimize auditory input for preterm newborns for two days, one study indicated no change in physiological parameters, which is somewhat contradicting [4]. The authors Autcott et al. [4] pondered the topic of how much and for how long noise is detrimental to a premature baby's developing auditory system. Researchers Caras and Sanes [5] and Ihlefeld et al. [6] used gerbils, a small rodent, to study the effects of a disruption to early auditory function on behavioural performance. The animals were partially silenced for 12 days, beginning 11 days after birth (using earplugs that reduced ambient noise by 40 dB SPL without blocking bone conduction or the animal's ability to hear its own biological sounds). Among gerbils' unusual sensory abilities was a lack of discrimination between different locations of sounds [44] and between different types of noises in a loud setting [7]. According to research by Mowery et al. [8], which is relevant to the developmental challenges experienced by preterm children, there are interactions between the critical periods of development of the visual and auditory systems. Specifically, it has been found that stimulating the visual system to function prematurely interrupts the critical period of development of the auditory system, while delaying the start of visual system function can prolong the critical period of development of the auditory system by a few days. According to these findings, changes may occur during the crucial period of auditory developmental plasticity if the normal progression of sensory function development is interrupted, as occurs in extremely premature infants [8].

2.2. Providing a Richer Environment for the NICU's Sensors

On the flip side, there are programs that provide calming sensory enrichment in the NICU, like music and therapeutic touch [7]. Early babies have developmental delays due to sensory deprivation, which is the theoretical foundation of these therapies. In order to make up for the dysstimuli in the newborn's surroundings, these stimuli should be given while considering the sequential development of the sensory system [5-9].

Infants exposed to sensory enrichment programs showed signs of better cognitive development, according to several studies. In order to provide ongoing early assistance, Scarr-Salapateck and Williams [9] brought a variety of sensory inputs to neonatal intensive care unit (NICU) neonates, including sight, sound, touch, and movement. At four and twelve months, the preterm infant in the intervention group outperformed the control group in terms of cognitive and social skills.

Improving the quality of parent-child relations begins with the first skin-to-skin session [13]. This is achieved by introducing a calming solicitation, like lullabies sung by the parent. Singing helps the mother maintain eye contact with her kid for longer, which promotes calm in the preterm baby. This is in contrast to skin-to-skin sessions where no music is played, as the baby is more likely to close their eyes during singing. When a mother and her premature infant are skin-to-skin, singing a lullaby can help bring the two of them into greater rhythmic harmony [13].

Research on the benefits of age-appropriate, positive sensory input for premature infants has been conducted by the Supporting and Enhancing Sensory Experiences (SENSE) program [14]. These interventions are offered every day while in the hospital by parents or a group of caregivers in the event that the parents are unable to do so. Massage, auditory (human voice and music), gustatory (fragranced fabric), and vestibular (low light) stimulation are all examples of such solicitations [15,16]. Mums reported increased self-assurance, while preterm babies who participated in the SENSE program performed better on the Hammersmith Neonatal Neurological Assessment and had less asymmetry on the NeoNatal Neurobehavioral Scale NNNS [10].

2.3. The Critical Zone: Finding the Sweet Spot Between "Too Much" and "Not Enough"

The fact that preterm children benefit from programs that attempt to either reduce or increase stimulation may appear paradoxical [11]. Experiments on newborn neurobehavioral features, long-term assessments of higher cognitive function, and short-term physiological measurements (including alertness system development) have

all shown promising outcomes with both increased and decreased stimuli [12]. This level of vigilance is going to be the focus of certain programs' efforts to better organize preterm states. A rise in awake states is induced by stimulatory programs, while an increase in sleep is the outcome of demand reduction programs. On a broader note, Horowitz [13] argues that preterm infants can achieve homeostasis with the help of any intervention that takes into account their sensory development level. The phrase "too much and not enough" comes from Feldman's description in [14] of the negative effects of both excessive and insufficient stimulation.

Current interventions have conflicting recommendations [15] based on competing theories about preterm children's sensory processing abilities and the harm that can result from denying them the stimulation they should have had while still in the womb. The interventions and ward stays of these programs have their limits.

The goal of these interventions, regardless of their theoretical foundation, is not to make up for the experiences a preterm child has lost, but rather to assist him or her in learning from his or her surroundings through the coordinated use of adaptive stimulation and rest periods [16].

We need to make sure to follow all of the suggestions and give the preterm baby plenty of time to adapt so their developing nervous system doesn't get overwhelmed [16]. To aid in early growth, the generally accepted wisdom states that preterm infants should be exposed to stimuli that are just right—not "too much nor too little" but somewhere in the middle—so they can adapt their senses to what they need. Because of this, preterm infants can feel better when some environmental cues are muted, such as lights, vibrations, and noises, and when they are surrounded by familiar, comforting scents and touches [15].

4. Conclusions

One of the variables that supports the neurobehavioral development of the preterm baby is the quality of the parental engagement, which is why their involvement during care is a crucial recommendation that should be cherished. Therapists (such as paediatricians, nursery nurses, psychomotor therapists, or psychologists) can help parents cope with their fears by teaching them the right signs to use when comforting a premature infant, and they can also aid in the establishment of routines for the baby's care and development by supplying educational materials. In 73 percent of the trials, it was helpful to teach parents to look for warning signals of their premature baby. Better attachment is promoted when parents are actively involved in this multi-sensory care.

Hence, it appears prudent to push for specific guidelines from the perspective of the neonatal intensive care unit (NICU) and the parent-preterm baby dyad. However, it is important to keep in mind that the biggest obstacle to implementing these guidelines is subtle, arising from differences in qualitative and quantitative degrees, application method, and duration. The perceptual developmental phases of a preterm child should be considered when introducing and gradually providing sensory stimuli, and the infant's reactive condition should be monitored continuously. Everyone in the NICU who works with premature babies and their families should know these suggestions. In order to accommodate the timing of technical gestures, it is important that people understand what a premature baby needs.

Here are some suggestions for the NICU setting: speak quietly, wear shoes with good shock absorption, don't use the tops of incubators as tables, gently close porthole doors, react fast to alarms, and don't use personal radios too often [19,20]. It is ideal to keep the premature newborn in dim light as much as possible in the neonatal intensive care unit (NICU), avoid using lights that are too intense, and face the baby at all times. Preterm infants benefit from moderate, consistent, rhythmic rocking because it mimics the vestibular rhythms experienced when in the womb, especially the mother's motions [18]. Avoid contacting the premature baby if at all possible; instead, opt for open and restrained contact, made with a hot palm of the hand, to stimulate the baby's tactile sensitivity [14]. Reducing the early separation caused by premature birth can be achieved by using the aroma of the mother. Babies often find comfort in the aroma of breast milk as they learn to make precise and intrusive movements [21]. Research into lullabies that combine horizontal vestibular sounds with soft humming sounds is warranted.

This is why a new study has been designed to bring together tactile, olfactory, auditory, and vestibular (often missing) stimulations. The study will involve preterm infants aged 26 to 32 weeks and will be funded by a Hospital Program for Nursing and Paramedical Research with authorization number 20-0271. What makes this multicentre comparative study unique is that the parents will be the ones to administer the multi-sensorial solicitations themselves, following a training and practice session on the sensory-motor needs of preterm newborns. For ten days, they will be cared for twenty minutes a day, with the solicitations progressively introduced while the baby's reactionary state is continuously monitored. In order to assess the quality of parent-child interactions and the neurodevelopment of the premature infant, the Coding Interaction Behaviour (CIB) [22] and the NNNS [23] will be administered at the end of the hospitalization.

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