Efficacy of a Hydrotherapy Program in the Neonatal Intensive Care Unit (NICU)

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Author Note

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Abstract

15 million infants are born premature each year leading to increased neonatal and childhood morbidity and mortality (de Oliveira Tobunaga et al. ,2016). While in the neonatal intensive care unit (NICU), these infants are exposed to a noisy environment, daily manipulation, and painful procedures that have the potential to impact their clinical stability and neuro-psychomotor development (Novakoski et al., 2018). A level III NICU, located in Carmel, Indiana, developed a hydrotherapy program to mitigate the harsh environment of the NICU and address neuro-motor development in these pre-term infants. The doctoral capstone experience (DCE) aimed to determine the efficacy of the program in improving psychological stability and reducing pain. Pre-and-post data, including physiological parameters and pain, were collected before and after each session. The results showed an overall increase in axillary body temperature, heart rate (HR), respiration rate (RR) with a reduction in oxygen saturation (SPO2). Pain was also assessed before and after the intervention. The results, of this current study, suggest hydrotherapy may promote slight irritation. Though hydrotherapy is a safe, low-cost intervention offering several benefits, further studies should be completed and include a larger sample population and randomization before determining efficacy in the NICU.

Keywords: Hydrotherapy, NICU, pre-term infants

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Efficacy of Hydrotherapy in the Neonatal Intensive Care Unit

Indiana University-North (IU North) is an extension of Riley Children's Health Hospital offering primary, specialty, inpatient or emergency care to children and their families in Carmel, Indiana. IU North houses a 23-bed level III Neonatal Intensive Care Unit (NICU). Level III NICU care involves intensive services such as high levels of respiratory support, parenteral feedings, and surgical interventions (Kuhaneck & O'Brien, 2019). Preterm infants make up the largest group in the NICU setting presenting with challenges related to physiologic and neurobehavioral functioning (Kuhaneck & O'Brien, 2019). Later in life, these infants are at high risk for developing learning disabilities, language and cognitive delays, behavioral problems, and issues with executive functioning (Kuhaneck & O'Brien, 2019). However, current literature suggests that developmental care, provided in the NICU, could have a significant impact on mental and motor development of preterm infants (Soleimani et al., 2020).

Developmental care includes tactics that are used to adjust the NICU environment by diminishing stress, support behavioral organization, improve physiological stability, ensure sleep rhythms, and promote neural growth and maturation of the preterm infants (Soleimani et al., 2020). Included in this definition are programs, like hydrotherapy, that begin in NICU with the purpose of supporting and promoting development. The hydrotherapy program, at IU north, uses the aquatic environment as a therapeutic intervention to facilitate neuro-motor development. In turn, this decreases anti-gravity work and energy expenditure, increases range of motion (ROM), organizes midline patterns, and promotes movement at lumbar spine and pelvis. Furthermore, hydrotherapy contributes to physiological stability, improved behavior modulation, and better feeding efficiency.

The purpose of this doctoral capstone experience (DCE) was to determine the efficacy of hydrotherapy on improving physiological stability and pain in a level III NICU. The project aimed to identify and address limitations to consistently implementing the program in the NICU. Through the experience and project, the DCE student gained advanced clinical skills in the NICU by way of hands-on experience, mentorship, and observation

Needs Assessment

To better understand and prioritize the needs of the site, a comprehensive needs assessment was conducted. The needs assessment process consisted of an initial interview exploring the feasibility of the partnership and the scope of the project, development of a community/service profile, and on-site observations at the start of the project.

Initial Interview

A virtual interview took place with the primary pediatric physical therapist at IU North on March 3, 2022 to explore the feasibility of the partnership and the scope of the doctoral capstone project. The doctoral capstone student asked questions related to the hydrotherapy program and other interventions and assessments that were being used at that time in the NICU. Through the interview, it was identified that IU North was the first in the state of Indiana to develop a hydrotherapy program (S.Bushur, personal communication, March 3, 2022). Since its inception in 2020, the program had faced several barriers mostly related to tracking outcomes and standardization of practice (S.Bushur, personal communication, March 3, 2022). To participate hydrotherapy, the baby must be medically stable, able to maintain body temperature, and have a healed circumcision (if applicable) (S.Bushur, personal communication, March 3, 2022). If a baby is not eligible for hydrotherapy, other interventions such as manual therapy, facilitation of positioning needs, facilitation of normal movement patterns, and splinting, if

indicated, can be used (S.Bushur, personal communication, March 3, 2022). The Bayley Scales of Infant and Toddler Development (BSID III) was identified as the assessment most frequently used in the NICU follow-up clinic (S.Bushur, personal communication, March 3, 2022). The BSID III is a comprehensive tool used to detect developmental delay in early childhood (Balasundaram & Avulakunta, 2021). Any pre-term infant that is seen in the NICU, is referred to the NICU follow up clinic 3 months following their original due date to assess their gross motor, fine motor, and cognition development (S.Bushur, personal communication, March 3, 2022). A list of the interview questions that were asked can be found in Appendix A.

On Site Observation

At the beginning of the on-site capstone project, the DCE student spent one week observing hydrotherapy. It was noted that in addition to tracking outcomes and a lack of standardization of practice, time was also a huge barrier to implementing the use of hydrotherapy at the site. The other primary therapist, an occupational therapist, floated to several other units in the hospital throughout the day including outpatient pediatrics. Because hydrotherapy requires two handlers, the two therapists had to coordinate their schedules to allow for co-treatment sessions. Unfortunately, the two schedules did not always align and allow for collaboration. In the past, the therapists had attempted utilize the rehabilitation technicians to mitigate this issue. However, with little coverage and high turnover rates, there was still minimal change within the program. These observed barriers were used to help inform the creation of a hydrotherapy workflow.

Literature Review

A literature review was completed to analyze the most current research regarding hydrotherapy in the Neonatal Intensive Care Unit (NICU). This information was used to

determine the gap and helped develop this capstone project. A systematic approach was used to select the articles included in this review. The databases used were CINAHL complete, PubMed, Google Scholar, and Medline. The primary search terms were NICU, hydrotherapy, aquatic therapy, physiotherapy, and occupational therapy (OT). To obtain the most current research, the search was limited to articles published within the past 10 years. Articles were appraised and included in this review based on relevance to the project's focus, purpose, and goals.

Prematurity

To best understand and develop a comprehensive project that meets the needs of neonates and their families in the NICU, it is important to understand prematurity and its impact on typical infant development. In their article, Ross and colleagues (2017) discussed prematurity and its prevalence in the United States. Prematurity is a public health concern in the United States affecting a half million infants per year (Ross et al., 2017). As a result of prematurity, neonates are more susceptible to long-term developmental issues, such as, attention deficit hyperactivity disorder, learning disabilities, motor delays, visual perception and visual motor problems, executive functioning deficits, cerebral palsy, and vision and hearing impairments (Ross et al., 2017). However, developmental challenges may also arise prior to being discharged from the NICU. When compared to full-term infants, preemies, at term equivalent age, are more likely to present with alterations in neurobehavioral with abnormal reflexes, hypotonic and hypertonia, poorer quality of movement, poorer orientation, more abnormal signs, lower tolerance of handling, poorer self-regulation, increase excitability, and increased stress (Ross et al.,2017).

Though the mortality rates of premature infants have reduced due to advanced perinatal care, Soleimani and colleagues (2020) identified remarkably high developmental morbidity amongst this population. A fourth of neonates born between 28 and 32 weeks of gestation have

developmental disorder by two years of age (Soleimani et al., 2020). By the age of 10, this ratio reaches 40% (Soleimani et al., 2020). Long-term follow up studies, on preterm infants, show high incidences of cerebral palsy, hearing loss, visual impairment, and growth retardation amongst this group (Soleimani et al., 2020). With proper care and supports in the NICU, however, the motor and mental development of these infants can be significantly impacted in a positive way (Soleimani et al., 2020).

Outcomes of Hydrotherapy

Authors of a systematic review found strong evidence to support the use of hydrotherapy in the NICU (Aranha et al., 2022). This feasible, low-cost intervention has been proven to be effective in normalizing muscle tone, active movements, postural organization, improving sleep pattern and quality, promoting thermal and cardiorespiratory adaptations, weight gain, and reducing pain and stress in neonates (Anjos et al., 2022; Aranha et al., 2022; de Oliveira Tobunaga et al. ,2016; Novakoski et al., 2018).

Stress

Stress is an adverse stimulus that can affect individuals differently, especially preterm newborns (PTNBs). A study, conducted by de Oliveira Tobunaga and colleagues (2016), used salivary cortisol measurements, the Neonatal Infant Pain Scale (NIPS), and physiological parameters (heart rate (HR), respiratory rate (RR), peripheral capillary oxygen saturation (SPO2)) to measure the stress responses in 15 PTNBs. There was a significant statistical improvement in the quality of sleep and wakefulness ($p=<0.05$) and salivary cortisol levels ($p=0.004$) before and after the intervention (de Oliveira Tobunaga et al.,2016). In fact, the cortisol levels of the PTNBs in this study were similar to those of term infants on the unit during the same period (de Oliveira Tobunaga et al., 2016). Though there was not a significant difference in the NIPS scores before and after the intervention, a score of zero was seen in all the

PTNBs (de Oliveira Tobunaga et al.,2016). This shows an absence of pain and adverse responses to the hydrotherapy intervention. Overall, there was a significant reduction (within normal parameters) in HR and RR and an increase in SPO2 following the hydrotherapy. However, there was no significant change in body temperature for the neonates. These changes, or lack thereof, are associated with a shift in behavior to a state of comfort due to the properties of the water (de Oliveira Tobunaga et al.,2016). The results of this study mostly aligns with those of a quasi-experimental clinical trial, done by Novakoski and colleagues (2018) to determine the effects of aquatic physiotherapy in reducing pain, improving sleep and wakefulness, and physiological variables. Data was collected and evaluated at three different moments: five minutes before the intervention, immediately after the intervention, and 10 minutes following the aquatic physiotherapy intervention. The results show statistically significant reductions in pain ($p=<0.001$) and improvement in sleep and wakefulness ($p=<0.05$) at all three points of evaluation (Novakoski et al., 2018). While there was a reduction in HR and an increase in SPO2 between each period of evaluation, the axillary body temperature remained relatively the same (Novakoski et al., 2018).

Physiological Variables

In addition to stress, physiological variables and the quality of sleep and wakefulness, intake is closely watched in the NICU. A randomized control trial conducted by Dos Anjos and colleagues (2022) compared hydrotherapy and tactile-kinesthetic simulation (TKS), a procedure used to stimulate growth and development in preterm infants. When comparing the intragroup values over five days, food intake values were significantly higher on the last day for both groups. Though the exact mechanism is unknown, the increase in weight may be attributed to clinical stability and improvements in quality of sleep (Dos Anjos et al., 2022). Contrasting

evidence was reported in a different randomized control trial by Tedesco and colleagues (2022). When comparing the hydrotherapy experimental group to the control group, they did not find a statistical difference in weight gain. They also did not find a statistical difference in behavioral state as Novakoski and colleagues found. They did, however, find that there was no difference in temperature between the groups thus suggesting hydrotherapy does not cause a loss of temperature in newborns just as the other studies showed.

Role of Occupational Therapy

Occupational therapists (OTs) provide holistic, client-centered care to clients, across the lifespan, to improve quality of life and other health outcomes. The profession of occupational therapy is rooted in holism and client-centered care with strong educational roots in mental health. Because of their unique perspective and educational background, OT practitioners are essential members of the NICU team. OTs, in the NICU, primarily focus on the neonate's sensory experiences during their hospitalization (Kuhaneck & O'Brien, 2019). An example of this includes modifying caregiver practices and the infant's environment to conserve energy and allow for participation in developmentally appropriate interactions (Kuhaneck & O'Brien, 2019.

Neonatal therapists seeking a role in the NICU are required to undergo specialized orientation, training, continuing education, and mentoring (Ross et al., 2017). Furthermore, there are discipline-specific competencies in place to ensure the unique needs of neonates and their families are being met in such a complex treatment environment (Ross et al., 2017). According to a statement by the American Journal of Occupational Therapy (2018), "neonatal practice requires advanced clinical reasoning skills: the flexibility to recognize and respond to unfamiliar situations and nuances of behavior, the ability to anticipate future directions of intervention, and the ability to perceive the clinical condition as a whole."

Though therapy usage is well-understood following discharge from the NICU, there is very little literature to support services during hospitalization. Ross and colleagues (2017) collected preliminary data to describe the role of neonatal therapists within the NICU environment, identify when neonatal therapy should be initiated, and provide descriptions of appropriate interventions to conduct across post menstrual age (PMA). Though there was some overlap in the therapeutic interventions provided in the NICU, OTs were the only discipline to address upper extremity function, visual development, head control, and non-nutritive sucking (Ross et al., 2017). Furthermore, it is within the OT scope of practice to address sensory needs and promote therapeutic handling and positive touch for preterm infants (Kuhaneck & O'Brien, 2019)

Best Practices

To further support the understanding of hydrotherapy, other adjacent best practices were explored, such as aquatic therapy. There were discrepancies in the literature regarding the description and implementation of aquatic therapy. The two most used approaches involved an acrylic crib or ofuro, a plastic bucket. In both instances, the infant was immersed in water ranging in temperature between 36-37°C for 10 minutes. Once submerged in the water, gentle passive mobilization was provided to the infant's upper and lower limbs to promote head in midline, body organization and a flexed posture (Aranha et al., 2022; Novakoski et al., 2018). Once removed from the water, the infants were swaddled in a warm blanket or towel before being positioned supine in the crib. Dos Anjos and collogues (2021) discussed the main difference between the techniques stating, "the ofuro in a plastic bucket seeks to stimulate sensations experienced inside the maternal uterus, providing relaxation, security and body limit

to the premature infant." (pp.158) Comparatively, hydrotherapy is described as "the application of water with movements for therapeutic purposes."(pp.1598)

Gap Analysis

While there is strong evidence to support the use of hydrotherapy in the NICU, there is limited research on best practices for implementation. Not only is there a gap in the literature, but a gap in knowledge when it comes to a hydrotherapy protocol in the NICU at IU North. Therefore, this project aims to address the gap by determining the efficacy of hydrotherapy in the NICU and developing a workflow for a hydrotherapy protocol.

Guiding Theory and Model

The Person-Environment-Occupational- Performance (PEOP) model describes the dynamic relationship between person factors, environment factors, and occupation (Hinojoa et al., 2017). The PEOP model emphasizes characteristics including client-centeredness and person, environment, and occupation as key as elements that influence the biological, psychological, and social interactions and thus the person-environment fit (Hinojoa et al., 2017). The person can be described as the combination of the physical self, cognitive and affective self, and spiritual self (Hinojoa et al., 2017). Occupational performance involves personality, self-concept and perceived worth, cultural and individual context, and abilities and competencies (Hinojoa et al., 2017). Lastly, the environment is a total sum of what surrounds the individual (Hinojoa et al., 2017). This model will be critical in guiding the process of explaining why hydrotherapy is a crucial intervention as it alters the harsh sensory environment of the NICU to allow for more optimal participation in acquisition and apprentice occupations. Acquisition occupations are those that allow the infant to learn contextually through their daily interactions and environment while apprentice occupations are those that require specific teaching and practice (Kuhaneck &

O'Brien, 2019). The use of hydrotherapy can be used to mitigate health and developmental challenges in neonates, while staying in the NICU, through the manipulation of intrinsic and extrinsic factors.

Project Plan and Process

Project Plan

Project Goal 1: The student will gain and utilize knowledge about hydrotherapy to create a workflow.

Objective 1: The student will use literature to review the history, efficacy, and the process of hydrotherapy to better understand the intervention.

Objective 2: The student will identify resources, lists out tasks, and create a diagram to outline the process.

Objective 3: The student will test the workflow that was created to ensure usability.

Project Goal 2: The student will track the progress of a hydrotherapy program in the NICU.

Objective 1: The student will collect, organize, and analyze data related to outcomes associated with hydrotherapy in the NICU.

Objective 2: The student will organize and analyze previously collected data related to outcomes associated with hydrotherapy in the NICU.

Project Goal 3: The student will obtain advanced clinical knowledge of the neonatal and pediatric population.

Objective 1: The student will observe PT, OT, and SLP to increase specialized clinical knowledge regarding the

inpatient care of the neonatal and pediatric population.

Objective 2: The student will observe PT and OT outpatient at the NICU Follow-Up Clinic 1-2x/month.

Project Process

Once on-site, the capstone student developed an outline of the process for carrying out the DCE and project. The first two weeks on site were spent orienting to the site, creating the project plan and process, and updating the needs assessment and literature review with the most current information. By the third and fourth week, the implementation of the project was underway. In addition to collecting data, the DCE student had begun drafting a hydrotherapy protocol workflow using a digital platform called Miro. The workflow can be found in Appendix B. The next four weeks involved editing and finalizing the workflow and project report based on feedback from the DCE's site and faculty mentor. Week 10 through 12 were spent analyzing data, finalizing the workflow and meeting with the DCE's facility mentor for a final evaluation of performance. The last two weeks of the DCE were spent finalizing the capstone report and preparing for dissemination. The full outline of the process can be found in Appendix C.

Project Implementation

The implementation of this project began in week two and continued throughout the remainder of the project. Prior to the start of the DCE, the project was submitted to Indiana University's institutional for review who determined it as exempt status for human subject design. Overall, the project went according to the plan and process described in the previous sections.

Protocol

Babies who met the following inclusion criteria were considered candidates for hydrotherapy: medically stable, have had no significant apnea or bradycardia events, discharged

from intravenous lines or respiratory support, healed circumcision (if applicable), no umbilical cord or stump, and able to regulate body temperature. If a baby met the above inclusion criteria, they were automatically considered for the hydrotherapy program. The intervention was administered bi-weekly, on Tuesdays and Thursdays, to coordinate with the baby's bath schedule and preserve skin integrity. Pre-and-post data was collected for 15 babies over the course of 14 weeks. The largest barrier to implantation was low census on the unit. For several weeks, there was a small number of babies in the NICU and even fewer babies who met the listed inclusion criteria.

Before initiating hydrotherapy, the therapist and DCE student collaborated with nursing to ensure the baby is an appropriate candidate. Next, physiological variables are recorded. The baby is unclothed and provided with a clean diaper. The pulse oximetry and the electrocardiogram (ECG) leads are then removed using an adhesive remover. Then, the baby is swaddled and their lower extremities (LE) are immerged in the water first. Their upper extremities (UE) are immersed shortly after and the baby is provided with gentle passive mobilization to their UE, LE, trunk and pelvis. The last two minutes of the session are reserved for a therapeutic bath with a caregiver or staff member. The baby is removed from the water following the bath and swaddled in warm blankets. Lastly, the baby is provided with another lead diaper and the ECG leads and pulse oximetry are reattached. Physiological variables are collected once more. The collected data is then added to an Excel spreadsheet.

Project Evaluation

The outcome evaluation method was used to analyze this DCE project. Quantitative data related to physiological stability and pain were collected before and after each hydrotherapy session. HR, RR, and SPO2 were measured using pulse oximetry, a Welch Allyn digital

thermometer was used to measure body temperature, and the Neonatal Pain, Agitation, and Sedation Scale (N-Pass) was used to assess pain. The N-Pass uses two measures based on five different criteria: crying/irritability, behavioral state, facial expression, extremity tone and vital signs (Hilman et al., 2015). The score for pain/agitation, ranging from 1 through 10, was assessed through observation without intervention (Hilman et al., 2015). Neonates who participated in hydrotherapy were only assessed using the pain segment of the tool. To determine the efficacy of hydrotherapy, pre-and-post values were averaged and analyzed for trends. Though one study, by Novakoski, collected data at 3 fixed times, majority of the studies collected pre-and-post data only. According to the literature, hydrotherapy should increase HR, RR, and SPO2 while also decreasing pain (Anjos et al., 2022; Aranha et al., 2022; de Oliveira Tobunaga et al. ,2016; Novakoski et al., 2018). There were discrepancies between studies regarding outcomes of body temperature. While one study by Novakoski and colleagues (2018) found a significant increase in body temperature, de Oliveira Tobunaga and colleagues (2016) found a significant reduction.

Results

In total, 15 hydrotherapy sessions were completed with 9 babies over the course of the DCE experience. Their mean corrected ages were 38+2 weeks. Before hydrotherapy, the preterm infants had a mean body temperature of 36.7 ± 0.4. After hydrotherapy, the mean axillary body temperature increased to 37.1± 0.3. Similarly, the mean HR increased from 152 ± 15.9 beats/minute to 168 ± 16.7 beats/minute following hydrotherapy. RR rate also increased from 41± 11.9 breaths/minute to 49 ± 12.7 breaths/minute after hydrotherapy. N-Pass scores increased from 0 ± 0.5 to 2 ± 2.0 following hydrotherapy. SPO2, however, remained relatively same before

and after hydrotherapy from 98% ± 1.6 to 98% ±1.6. The results of the study can be found in Table 1.

Table 1

Hydrotherapy Outcomes

Parameter	Before Hydrotherapy		After Hydrotherapy	
	Mean ± Standard Deviation	**Range**	**Mean ± Standard Deviation**	**Range**
Heart rate (beats/min)	152 ± 15.9	127-190	168 ± 16.7	140-199
Respiratory Rate (breaths/min)	41± 11.9	127-190	49 ± 12.7	30-68
Oxygen Saturation (%)	98 ± 1.6	94-100	98 ±1.6	94-100
Axillary temperature (˚C)	36.7 ± 0.4	35.0-37.2	37.1± 0.3.	36.6-37.7
N-Pass Score	0 ± 0.5	0-2	2 ± 2.0	0-5

N-Pass: Neonatal Pain, Agitation, and Sedation Scale

Discussion

The overall goal of this DCE experience was to collect preliminary data to determine the efficacy of a hydrotherapy program in the NICU. Of the studies found that support the use of hydrotherapy in NICU, 2 report that the intervention decreases HR and increase SPO2. While 1 found that hydrotherapy also decreased RR and pain. The shift in HR is likely due to the shift in behavioral states as the physical properties of the water promoted comfort and relaxation (de Oliveira Tobunaga et al., 2016). The evidence was conflicting regarding axillary body temperature.1 study found that the axillary body temperature decreased slightly following the intervention while another study found an increase in axillary body temperature. One of the study suggests that the insignificance in temperature difference is because the temperature of the water is close to that of the neonate resulting in no loss of heat (de Oliveira Tobunaga et al,

2016). 1 study assessed pain, using the Neonatal Infant Pain Scale (NIPS), did not find a significant difference suggesting an increased pain threshold following the hydrotherapy intervention (de Oliveira Tobunaga et al, 2016). From this preliminary study, it can be concluded that hydrotherapy is a low-cost, easily administered, and effective treatment option to address the needs of neonates in the NICU. However, further studies should be conducted with a larger sample size and with randomization, crossover, and blinding to determine the true efficacy of the program.

Impact and Sustainability

This project provided preliminary data to support the use of hydrotherapy in the NICU. Additionally, the DCE provided the capstone student with clinical skills in the NICU and PICU through observation and hand-ons experience. At the end of the experience, the site was left with a workflow that outlined a protocol for hydrotherapy. Also, an excel spreadsheet was created to track physiological variables and intake. Included in the excel spreadsheet, were bar graphs that depicted and compared the averages of the physiological variables and intake times pre-and-post hydrotherapy.

Conclusion

The purpose of his project was to determine the efficacy of a hydrotherapy program in the NICU on improving physiological stability and reducing pain. This project supported the idea that hydrotherapy is a low-cost, easily administered, intervention that can be used to meet the needs of neonates. The project fulfilled its purpose by identifying barriers and limitations to consistently implementing the program and attempted to mitigate said barriers by creating a hydrotherapy protocol.. This ensures that hydrotherapy can be done in the absence of the primary

PT and OT. Additionally, the workflow can be utilized by other DCE or fieldwork students allowing them to assist with the administration of hydrotherapy.

References

American Occupational Therapy Association. (2018). Occupational therapy's role in the neonatal intensive care unit. American Journal of Occupational Therapy, 72 (Suppl.2), 7212410020. http://doi.org/10.5014/ajot.2018.72S204

Aranha, V. P., Chahal, A., & Bhardwaj, A. K. (2022). Neonatal aquatic physiotherapy in neonatal intensive care units: A scoping review. *Journal of Neonatal-Perinatal Medicine*, *15*(2), 229-235.

Balasundaram, P., & Avulakunta, I. D. (2021). Bayley scales of infant and toddler development. In *StatPearls [Internet]*. StatPearls Publishing.

Cardin, A. D. (2020). Parents' perspectives: An expanded view of occupational and co-occupational performance in the neonatal intensive care unit. *The American Journal of Occupational Therapy*, *74*(2), 7402205030p1-7402205030p12.

de Oliveira Tobinaga, W. C., de Lima Marinho, C., Abelenda, V. L. B., de Sá, P. M., & Lopes, A. J. (2016). Short-term effects of hydrokinesiotherapy in hospitalized preterm newborns. Rehabilitation Research and Practice, 2016.

Dos Anjos, F. R., Nakato, A. M., Hembecker, P. K., Nohama, P., & Sarquis, A. L. F. (2021). Effects of hydrotherapy and tactile-kinesthetic stimulation on weight gain of preterm infants admitted in the Neonatal Intensive Care Unit. Jornal de pediatria.

Hillman, B. A., Tabrizi, M. N., Gauda, E. B., Carson, K. A., & Aucott, S. W. (2015). The Neonatal Pain, Agitation and Sedation Scale and the bedside nurse's assessment of neonates. *Journal of Perinatology*, *35*(2), 128-131.

Hinojosa, J., Kramer, P., & Royeen, C. B. (2017). *Perspectives on Human Occupations: Theories Underlying Practice*. FA Davis.

Kuhaneck, H., O'Brien, J. C. (2019). Case-Smith's Occupational Therapy for Children and Adolescents - E-Book. United States: Elsevier Health Sciences.

Novakoski, K. R. M., Valderramas, S. R., Israel, V. L., Yamaguchi, B., & Andreazza, M.(2018).Back to the liquid environment: effects of aquatic physiotherapy intervention performed on preterm infants. Revista Brasileira de Cineantropometria & Desempenho Humano, 20, 566-575.

Ross, K., Heiny, E., Conner, S., Spener, P., & Pineda, R. (2017). Occupational therapy, physical therapy and speech-language pathology in the neonatal intensive care unit: Patterns of therapy usage in a level IV NICU. Research in developmental disabilities, 64, 108–117. https://doi.org/10.1016/j.ridd.2017.03.009

Rubio-Grillo, M. H. (2019). Performance of an occupational therapist in a neonatal intensive care unit. Colombia Medica (Cali, Colombia), 50(1), 30–39. https://doi-org.proxy.ulib.uits.iu.edu/10.25100/cm.v50i1.2600

Soleimani, F., Azari, N., Ghiasvand, H., Shahrokhi, A., Rahmani, N., & Fatollahierad, S. (2020). Do NICU developmental care improve cognitive and motor outcomes for preterm infants? A systematic review and meta-analysis. *BMC pediatrics*, *20*, 1-16.

Tedesco, N. M., Nascimento, A. L. F., Mallmann, G. D. S., Merey, L. S. F., Raniero, E. P., Gonçalves-Ferri, W. A., & Soares-Marangoni, D. (2022). Bucket hydrokinesiotherapy in hospitalized preterm newborns: a randomized controlled trial. *Physiotherapy Theory and Practice*, *38*(13), 2452-2461.

Appendix A

1. What babies are eligible for hydrotherapy in the NICU?

2. What assessments are being used?

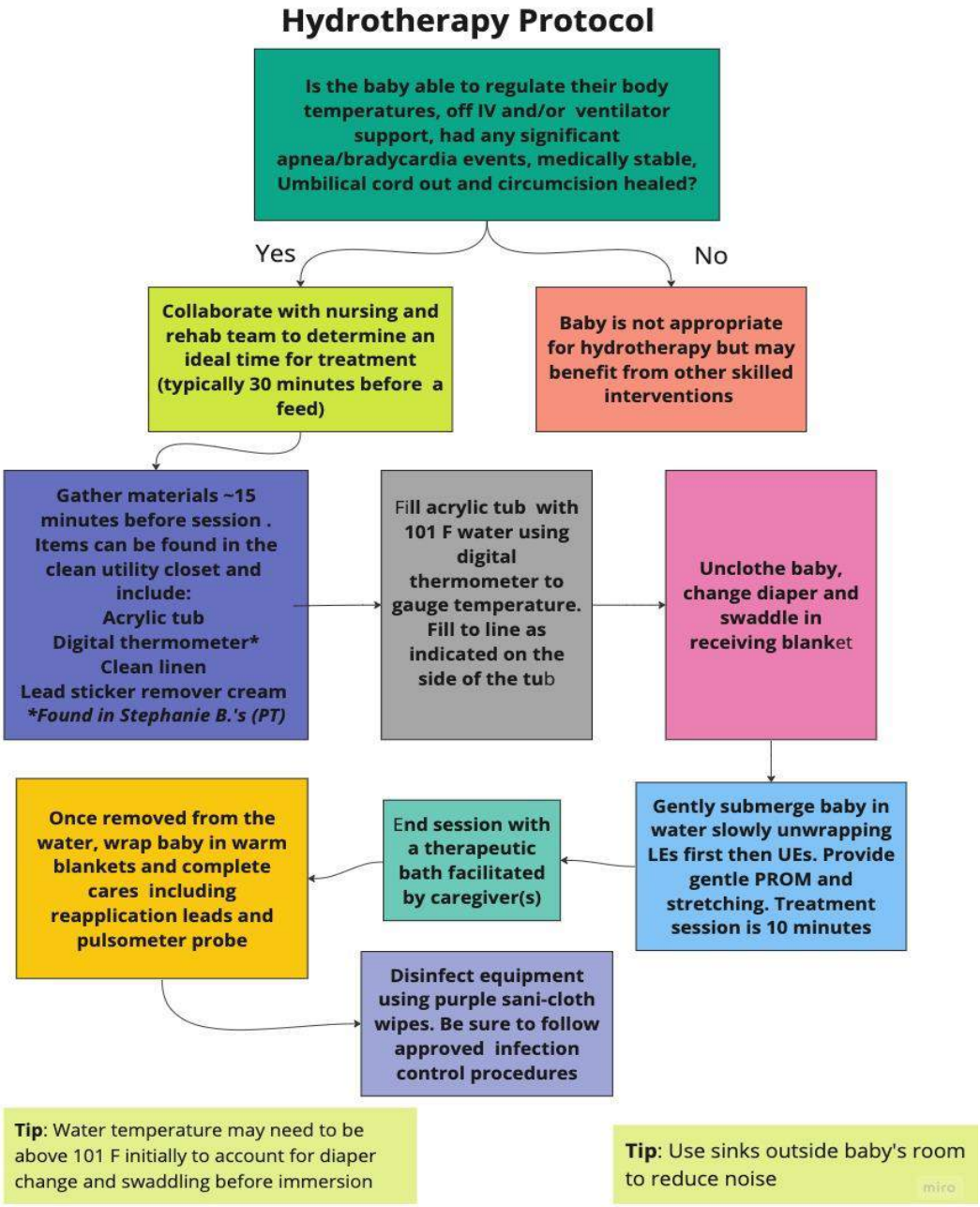
3. What specific outcomes are being measured?

4. What other interventions are used?

5. What, if any, are potential barriers to implementing this program statewide?

6. Is there additional training or certification required to provide hydrotherapy in the NICU?

Appendix B


Hydrotherapy Protocol
Is the baby able to regulate their body temperatures, off IV and/or ventilator support, had any significant apnea/bradycardia events, medically stable, Umbilical cord out and circumcision healed?
Yes
No
Collaborate with nursing and rehab team to determine an ideal time for treatment (typically 30 minutes before a feed)
Baby is not appropriate for hydrotherapy but may benefit from other skilled interventions
Gather materials ~15 minutes before session . Items can be found in the clean utility closet and include:
Acrylic tub
Digital thermometer*
Clean linen
Lead sticker remover cream
*Found in Stephanie B.'s (PT)
Fill acrylic tub with 101 F water using digital thermometer to gauge temperature. Fill to line as indicated on the side of the tub
Unclothe baby, change diaper and swaddle in receiving blanket
Gently submerge baby in water slowly unwrapping LEs first then UEs. Provide gentle PROM and stretching. Treatment session is 10 minutes
End session with a therapeutic bath facilitated by caregiver(s)
Once removed from the water, wrap baby in warm blankets and complete cares including reapplication leads and pulsometer probe
Disinfect equipment using purple sani-cloth wipes. Be sure to follow approved infection control procedures
Tip: Water temperature may need to be above 101 F initially to account for diaper change and swaddling before immersion
Tip: Use sinks outside baby's room to reduce noise
miro

Appendix C

Phase	Tasks
Phase 1: Week 1-2	• Orientation to site • Edit and finalize project process • Update needs assessment and literature review with relevant information
Phase 2: Week 3-4	• Begin project implementation • Update needs assessment and literature review with relevant information • Create draft of workflow
Phase 3: Week 5-9	• Meeting with facility mentor for mid-term evaluation • Edit and finalize workflow based on mentor's feedback • Edit and finalize project report
Phase 6: 10-12	• Analyze data • Finalize workflow • Meet with facility mentor for final evaluation
Phase 7: 13-14	• Finalize capstone report • Prepare for dissemination