Physiological effects of bucket hydrotherapy for premature newborns

ORIGINAL ARTICLE

Efeitos fisiológicos da hidroterapia em balde em recém-nascidos prematuros

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ABSTRACT: *Objective*: This study examined the effects of bucket hydrotherapy on physiological parameters and weight gain in hospitalized premature newborns. *Methods*: Thirty stable premature newborns (221.13±2.74 days of gestation) participated, having at least 1.500 kg of body weight, with increasing gain in latest days. Hydrotherapy was administered in two sessions in alternated days, held with the newborn in a bucket with warm water, up to the height of clavicles, during 10 min. Assessments were conducted three times *per* session: pre-intervention (15 min before the hydrotherapy), post-intervention (immediately after hydrotherapy) and follow-up test (30 minutes after post-intervention). Comparative analyses were conducted considering the heart rate (HR), respiratory rate (RR), oxygen saturation (SpO_2) and body weight variables. *Results*: The newborns' BW increased from 1983.00±55.70 to 2044.00±57.44 grams throughout the sessions ($p<0.001$). The HR in the follow-up test was lower than in the pre- and post-intervention measures in both sessions ($p<0.05$). The RR and SpO_2 remained constant. *Conclusions*: Bucket hydrotherapy with warm water may have promoted better behavioral functioning in premature newborns. This may have resulted in lower HR. The therapy was safe, because the physiological parameters and body weight gain were not negatively affected.

DESCRIPTORS: Newborn; Premature newborn; Hydrotherapy.

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RESUMO: *Objetivo*: Este estudo examinou os efeitos da hidroterapia em balde em parâmetros fisiológicos e ganho de peso em recém-nascidos prematuros hospitalizados. *Métodos:* Participaram 30 recém-nascidos prematuros estáveis (221,13 ± 2,74 dias de gestação), com pelo menos 1,500 kg de peso corporal com ganho crescente nos últimos dias. A hidroterapia foi administrada em duas sessões em dias alternados, realizada com o recém-nascido em um balde com água aquecida, até as clavículas, durante 10 min. As avaliações foram realizadas três vezes por sessão: pré-intervenção (15 min antes da hidroterapia), pós-intervenção (imediatamente após) e seguimento (30 minutos após). As análises comparativas foram realizadas considerando as variáveis: freqüência cardíaca (FC), freqüência respiratória (FR), saturação de oxigênio (SaO_2) e peso corporal (PC). *Resultados:* Houve aumento do PC dos recém-nascidos de 1983,00 ± 55,70 para 2044,00 ± 57,44 gramas durante as sessões ($p <0,001$). A FC foi menor no seguimento do que nas medidas pré e pós-intervenção em ambas as sessões ($p <0,05$). A FR e a SaO_2 permaneceram constantes. *Conclusões:* A hidroterapia em balde com água aquecida pode ter promovido melhor funcionamento comportamental nos recém-nascidos prematuros. Isso pode ter resultado em menor FC. A terapia foi segura, uma vez que os parâmetros fisiológicos e o ganho de peso corporal não foram afetados negativamente.

DESCRITORES*:* Lactente; Recém-nascido prematuro; Hidroterapia.

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INTRODUCTION

Every year, about one in every 10 births occurs prematurely worldwide, i.e., before the 37th gestational week[1,2]. Of all premature births, 60% are concentrated in certain countries, including Brazil and United States. These numbers state prematurity as a global health problem. When associated with low birth weight, prematurity is the leading cause of morbidity and mortality in the neonatal period, affecting families and health systems all around the world[1]. Thus, the proper care to premature newborns has been one of the major health challenges, with the increasing need for measures to reduce the rates of morbidity and mortality in this population.

Due to scientific and technological advances in neonatal intensive care, the survival rates of premature newborns have been increasing[1,3]. Despite such progresses, the quality of survival is not always satisfactory. The organic immaturity compromises particularly the efficiency of gas exchange[4], in addition to early exposure of the lung to oxygen and mechanical pulmonary ventilation, often invasive. These breathing difficulties may compromise the brain oxygenation and, consequently, the development of the central nervous system in a period of intense neural structuring[5]. Furthermore, the immaturity of the autonomic nervous system, which is responsible for the body thermoregulation, facilitates the occurrence of hypothermia, since it impairs the balance between mechanisms of production and elimination of heat in an extrauterine environment with thermal variability. In turn, associated with gastrointestinal immaturity and the frequent oral dysfunctions that hinder nutrition, these systemic demands necessary to the newborn's adaptation to the extrauterine life require great energy expenditure, which usually hampers body weight gain and, in turn, the proper development of the premature newborn[6].

In addition to the organic factors, the risk of mortality and morbidity of premature newborns is accentuated by the often-prolonged period of hospitalization in neonatal units, which is characterized by exposure to several external factors, such as invasive and non-invasive procedures required for monitoring and treatment of the newborn (puncture, aspiration, ventilation, etc.), but that can promote excessive sensory stimuli (sound, light, painful, etc.). These stimuli may trigger a generalized response to stress, including cardiorespiratory, hormonal and behavioral alterations. Such physiological responses are followed by endocrinomethabolic reactions with consequent homeostatic imbalance. This physiological imbalance can decrease the saturation of oxygen and raise heart and respiratory rates[7].

Thus, if on the one hand, in the intrauterine period the fetus was in a satisfactory environment, with ideal temperature and proper light and sound stimuli without need for additional efforts to maintain its physiological functioning, on the other hand, the abrupt exposure to the extrauterine environment of the neonatal unit requires a sudden and immediate adaptation, which favors the disorganization of the yet developing systems and puts at risk the newborn's physiology and overall growth[8].

Given the complexity of the care for premature newborns in neonatal units, there is an urgent need for therapeutic techniques and measures based on humanized assistance, which may minimize the negative impact of prematurity in physiological parameters of premature newborns. One of the therapeutic techniques most applied in Brazilian neonatal units is the bucket hydrotherapy, in which the newborn is immersed up to the shoulder/clavicles in a bucket filled with warm water and then, through assisted floating, is softly and passively mobilized. Although this technique refers to humanized bath for hygiene, popularized as "ofuro bath," the therapist uses the action of the buoyancy force of the aquatic environment to promote spontaneous movement, proprioception, postural organization and/or muscle lengthening, joint mobilization and rhythmic movement of the newborn. In addition, the physical properties of water combine with the therapeutic properties of heat application. According to Cunha and Caromano[9], such properties favor not only the musculoskeletal system, but also the behavioral and physiological state of the organism.

Some studies have indicated that humanized neonatal bath techniques may be beneficial in the care of premature newborns in neonatal units regarding physiological and behavioral responses[10-12]. However, apart from the study of Vignochi et al.[13], little is known on the effects of this care as an aquatic therapy technique. These authors found improvement on the state of sleep and decrease in pain score in premature newborns immediately after a 10-minute hydrotherapy session, held in acrylic bathtub. In addition to that study, we know about positive pilot-experiences in several Brazilian neonatal units using similar techniques, however performing bucket hydrotherapy. Despite these experiences, publications that can scientifically support the application of this technique have not been found. The bucket is an interesting component because it mimics the intrauterine space and promotes vertical positioning to the premature newborn, who has few opportunities to experience spontaneous movement in this posture because of the extended period in bed.

Thus, this study reports the effects of bucket hydrotherapy for premature newborns. The aim of our study was to verify, throughout two sessions, whether this technique favors physiological parameters and body weight of clinically stable premature newborns hospitalized in a neonatal unit.

METHODOLOGICAL PROCEDURES

Participants

This is a quantitative and longitudinal study, conducted from January 2015 to January 2016 in the Intermediate Care Unit (UCINCo – *Unidade de Cuidados Intermediários*) of the Regional Hospital of Mato Grosso do Sul, in Campo Grande, MS, Brazil. The initial sample had 50 premature newborns of both sexes, born in this same hospital or sent from another service.

Inclusion criteria consisted of hemodynamically stable premature newborns, over 72 hours of life, in spontaneous breathing, without ostomies and/or peripheral venous access, with minimal weight of 1.500 grams and with increasing weight gain on the day, and with medical release for daily bath. In addition, the premature newborns could not have congenital malformations, peri-intraventricular hemorrhage above degree III or be under contact isolation or phototherapy. Twenty premature newborns were excluded from the research because they received medical discharge, or the parents gave up from the participation during the collection, resulting on a final sample of 30 premature newborns. Hence, thirty premature newborns were evaluated, with gestational age (GA) varying from 27 to 35 weeks, being the average GA 221.13±2.74 days (mean±standard error of mean). Of these, 56.7% (n=17) were male, while 43.3% (n=13) were female. Considering the newborns' birth weight, there was variation between 905.00 and 3245.00 grams, being the average weight 1736.10±100.01 grams.

The study was approved by the Research Ethics Committee with Human Subjects of the Federal University of Mato Grosso do Sul (no. 1006776/2015) following the Guidelines and Standards Regulating Researches Involving Human Beings (Resolution 466/2012) of the National Health Council. Parents/guardians read and signed the informed consent form.

Procedures and materials

Inclusion data of patients were recorded in an instrument previously elaborated by researchers. For the information collection regarding the mother's and the premature newborn's medical records, we used an assessment record used by the hospital. A bucket of "ofuro" type (Sanremo®) with capacity of 18 L, dimensions of 40.3 × 36.0 × 34.6 cm was used.

The premature newborns were subjected to two 10-min sessions of bucket hydrotherapy held in alternated days by only one researcher. Hydrotherapy was applied in both morning and evening periods. At the beginning of each session, the bucket was first sanitized with soap from the sector and then with 70% alcohol. Subsequently, plastic bags were placed inside for the protection of the premature newborn. Afterwards, a researcher added warm water to the bucket. Thereafter, the bucket was transported to the bed of the premature newborn, being positioned over a chair. Water temperature was monitored with a baby thermometer for bath (Kuka®). During these procedures, the mothers assisted in the preparation of the PI. When the thermometer indicated 36.5 to 37 °C, the premature newborn was immersed in the water to receive hydrotherapy.

Hydrotherapy was held with the premature newborn in vertical position, immersed in the bucket with water at clavicle level. The researcher positioned her hands between the premature newborn's mandible and the cervico-occipital region, favoring his/her fluctuation and allowing his/her free movement in the water. The aim was to encourage the premature newborn's body organization and proprioception through the spontaneous movement in the aquatic environment. Parents/guardians participated in the therapeutic process. The moment allowed exchange of knowledge between the researcher and the parents/guardians through explanations on the importance of the bath, followed by orientations so the technique could be performed after hospital discharge.

After the conclusion of the hydrotherapy, the premature newborn was snuggled and dried in swaddling clothes and parents/guardians changed the baby's diaper in the crib.

In each session, the premature newborns were assessed in three moments: a) pre-intervention, 15 minutes before hydrotherapy; b) post-intervention, immediately after hydrotherapy and change of diaper; and c) follow-up test, 30 minutes after the post-intervention. Thus, six assessments for each premature newborn were obtained.

Description of dependent variables

Physiological variables were: heart rate (HR), respiratory rate (RR), and oxygen saturation (SpO_2). The RR was measured by observing the movements of the rib cage for one minute with analog clock count. The HR

and SpO_2 were measured with a MX-300EMAI® pulse oximeter positioned on the neonate's plantar aspect.

The body weight variable (Kg) was collected through the daily collection record of the nursing staff, which weighted the premature newborns every morning.

Statistical treatment

The HR, RR, SpO_2 and body weight variables were analyzed by mean values and standard error. For the analysis of the effects of the day of intervention (between sessions: day 1, day 2) and of the moment of assessment (intrasession: pre-intervention, post-intervention, follow-up test), as well as interaction between these factors in HR, RR and SpO_2 variables, we applied the two-way ANOVA test of repetitive measures followed, when appropriate, by the Student-Newman-Keuls *post hoc* test. To compare the body weight between the two days of intervention, we applied the paired Student's *t*-test. Statistical analysis was performed with SigmaPlot 12.5 support, with a significance level of 5%.

RESULTS

Heart rate

Considering the HR, there was effect of the moment of assessment (p=0.005). However, there was no effect of the day (p=0.964) nor interaction between these factors (p=0.844). Regardless of the day, the HR in the follow-up test (30 minutes after post-intervention) was lower than in pre-and post-intervention (p<0.05) (Table 1, Figure 1).

Table 1. Mean±standard error of the heart rate (HR), respiratory rate (RR) and oxygen saturation (SpO_2) according to day of intervention and moment of assessment in relation to the treatment.

Variable	Before	Right after	30 minutes after
HR (bpm)			
First day	152.23±3.13	154.83±2.34	146.53±2.92
Second day	152.10±2.83	153.47±3.32	147.70±2.24
RR (ipm)			
First day	55.57±2.21	51.27±2.00	53.00±2.05
Second day	55.37±2.39	56.10±2.81	55.00±1.83
SpO_2 (%)			
First day	96.20±0.39	96.63±0.37	97.20±0.32
Second day	96.60±0.44	97.00±0.41	96.70±0.47

Before = pre-intervention; Right after = post-intervention; 30 minutes after = follow-up test; bpm = beats per minute; ipm = incursions per minute.

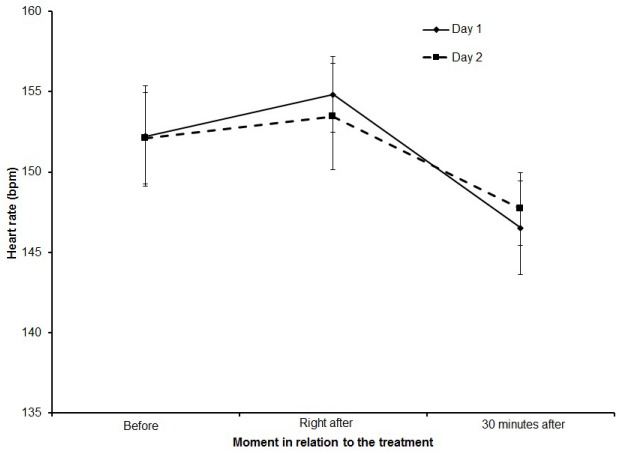

Figure 1 – Heart rate (mean and standard error) of newborns according to day of intervention and moment in relation to the treatment (intrasession assessment). Before = pre-intervention; Right after = post-intervention; 30 minutes after = follow-up test; *(p<0.05)

Respiratory rate

There was no effect of day (p=0.134), moment of assessment (p=0.569) nor interaction between these factors (p=0.167) for RR (Table 1, Figure 2).

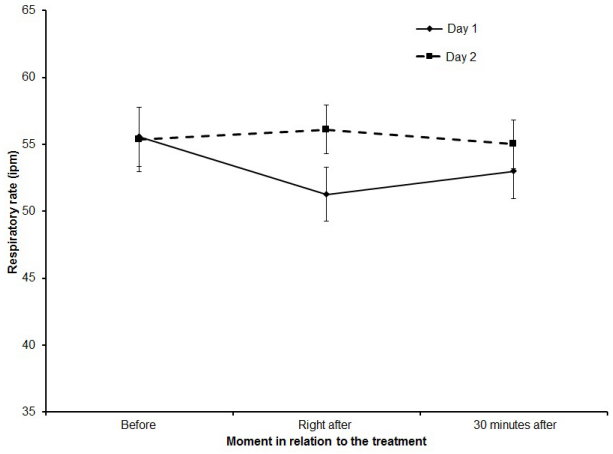

Figure 2 – Respiratory rate (mean and standard error) of newborns according to day of intervention and moment in relation to the treatment (intrasession assessment). Before = pre-intervention; Right after = post-intervention; 30 minutes after = follow-up test

Oxygen saturation

Regarding the SpO_2, there was no effect of day (p=0.689), moment of assessment (p=0.143) nor interaction between these factors (p=0.233) (Table 1, Figure 3).

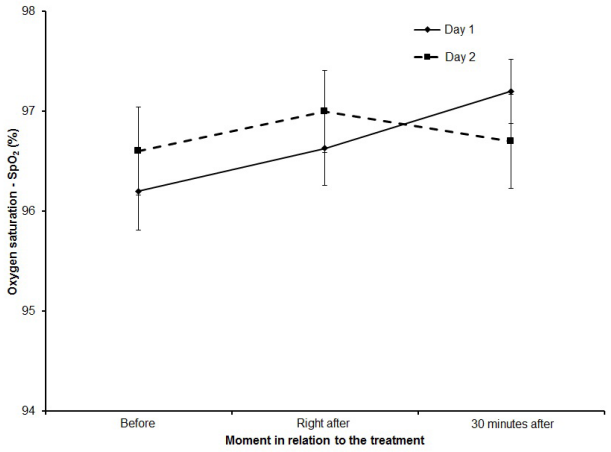

Figure 3 – Blood oxygen saturation (SpO_2) (mean and standard error) of newborns according to day of intervention and moment in relation to the treatment (intrasession assessment). Before = pre-intervention; Right after = post-intervention; 30 minutes after = follow-up test

Body weight

The premature newborns had significant gain of body weight throughout the two days of intervention ($p<0.001$), with gain of 1983.00±55.70 grams in the first session to 2044.00±57.44 grams in the second session (Figure 4).

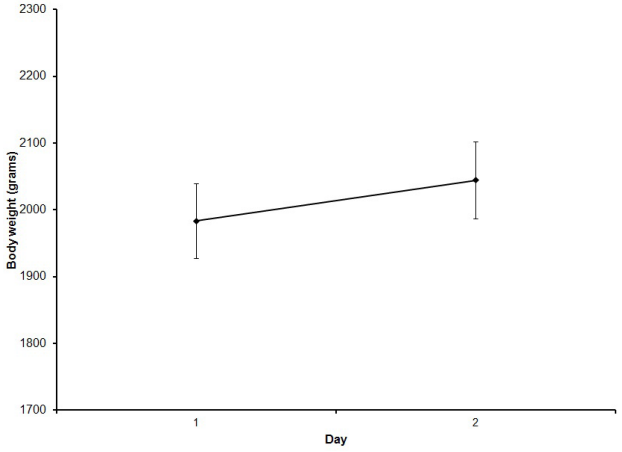

Figure 4 – Body weight of newborns according to day of intervention *($p<0.05$)

DISCUSSION

This study examined the influence of bucket hydrotherapy on physiological parameters and body weight gain in hospitalized premature newborns. In general, most physiological parameters remained constant and the heart rate decreased after treatment. Body weight increased throughout the two sessions of the technique.

Regarding physiological parameters, their constancy throughout each session suggests that bucket hydrotherapy is a safe technique for stable premature newborns in neonatal units, not resulting in instability of important vital parameters such as HR, RR, and SpO_2.

Considering RR and SpO_2, in particular, there were no changes after each intervention nor throughout the two days of implementation. In adults, hydrostatic pressure can lead to both increase in venous return and displacement of the abdomen and diaphragm[9,14], which reduces vital capacity. This happens because the increase in blood volume in the lung vessels also results in a short fall in the diffusing capacity of the alveoli, leading to the decrease of oxygen concentration in the blood. In addition, the forces exerted by pressure on the thoracic wall reduce the circumference of the rib cage in approximately 10%, resulting in drop of lung volume. As a consequence, the respiratory work increases[9,14,15]. This study, however, suggests that such respiratory alterations do not occur in bucket hydrotherapy for stable premature newborns. Possibly, the hydrostatic pressure in the bucket was low to increase venous return and significantly change the thoracic displacement. This absence of responses in respiratory parameters even right after the intervention can be related to the prematurity of lung structures, still in the process of formation and development on the gestational age assessed.

In fact, the blood flow of newborns seems to have suffered no increase in our study, because there were no immediate alterations in HR. In fact, it is interesting that, without reduction below the normal parameters, the HR decreased 30 minutes after the hydrotherapy. This result contrasts with effects of hydrotherapy in adults. In adults, the immersion promotes blood displacement from the lower extremities to the thorax[9]. Consequently, there is increase of the pressure of the right atrium and the pulmonary artery pressure, resulting in increase of the cardiac debt, which achieves 30% in immersion up to the neck[15]. In our study, therefore, the hydrostatic pressure in the immersion in the bucket does not seem to have been enough to increase the HR of the newborns.

On the other hand, the warmth of the water may have been an important factor to decrease the HR until 30 minutes after the conclusion of the intervention. Barbosa[16] suggests that hydrotherapy in warm water

at thermoneutral temperatures reduces stress-related hormone levels. These responses are hypothetically associated with the decrease of activation of the sympathetic nervous system, promoting a state of psychophysiological relaxation[9]. In addition, the fluctuation reduces the amount of sensory stimuli, which can act in the reduction of muscle tension. According to Gleige et al.[17], when decreasing the effects of the gravitational force, the buoyancy of water reduces the activation of weight and joint pressure receptors, softening the kinesthetic stimulation and, consequently, the perception of weight discharges. Thus, the reduction of sensory stimuli that affect musculoskeletal activity may have played a role in a possible behavioral relaxation of newborns.

In fact, in this study, the mothers spontaneously reported behavioral changes in the newborns, such as extended sleep and less irritation after the intervention. This is in line with the observed by Vignochi et al.[13], who found decrease in HR 30 and 60 minutes after a 10-minute hydrotherapy session in acrylic bathtub with warm water in premature newborns These authors attributed this result to the change in the newborns' behavioral state of crying to deep sleep. In our study, although newborns were not crying before the intervention, we suggest that immersion in warm water may have promoted a behavioral change, favoring relaxation and therefore decreasing the HR.

Considering weight, the newborns showed a significant gain throughout the two days of treatment. This suggests that the intervention did not lead to losses regarding the energy expenditure, being possibly viable for premature newborns in increasing weight gain. However, we cannot state that the weight gain observed throughout our study results from hydrotherapy, because most newborns made use of probe, had changes in diets or had speech, language and hearing therapies during their hospitalization, not allowing us to directly associate the weight gain with the intervention applied.

The fact that our results are not generalizable is noteworthy. As the absence of a control group limits the interpretations suggested, it is important that future studies extend the knowledge on the effects of the protocol used. There were some limitations during the collection period of the research, which caused the loss of 20 newborns. Among them, we highlight weight loss and hemodynamic instabilities, which are expected conditions given the liability of premature newborns. The resistance against the inclusion of new techniques in the routine of the sector was also a factor that inhibited the collection, because the unit where the research was conducted had a continuity of work and a fixed schedule for each conduct; with that, supporting therapies for newborns were very time-constricted. This reinforces a reality of care in which professionals focus their actions on performing often harsh and non-comprehensive techniques.

CONCLUSIONS

Bucket hydrotherapy in neonatal units seems to be a safe technique for physiological parameters and body weight gain in clinically stable premature newborns. Therapeutic properties of the warm water, such as decrease of neurological activity, may have promoted behavioral relaxation in these newborns for at least 30 minutes after the intervention, possibly contributing to a decrease in their HR. Overall, these information serve as preliminary base on a technique still unpublished in several countries, yet increasingly used in the care of Brazilian premature newborns. Apparently, it has potential for clinical application, especially as controlled clinical trials provide information for evidence-based practice.

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Authors' contribution: *Hullyana Aguiar Aguiar da Silva* e *Karina Candia da Silva* conducted data collection and wrote the introduction, methodology, results and part of the discussion. *Mariane de Oliveira Nunes Reco* conducted data collection and contributed intellectually in the discussion regarding the neonatal physiology. *Ariele dos Santos Costa* provided intellectual contribution in the discussion regarding the neonatal physiology. *Daniele de Almeida Soares-Marangoni* provided intellectual contribution to the writing part of the introduction, results and final version of the discussion. *Leila Simone Foerster Merey* coordinated and directed the study and contributed intellectually in the methodological planning and general writing of the manuscript.

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