Effect of Swaddle Bathing on Neonatal Thermal Stability and Cardio-Respiratory Parameters

Awatif Aly Hassan Elsharkawy, Assistant professor
Pediatric Nursing, Faculty of Nursing, Alexandria University
Kamilya Ahmed Abd Al-latif, Clinical instructor
Pediatric Nursing, Faculty of Nursing, Alexandria University
Marwa Mohamed Farag Mohamed, Lecturer
Pediatric and Neonatology, *Faculty of Medicine*, *Alexandria University*
Noha Mohamed Arafa Mohamed, Assistant professor
Pediatric Nursing, Faculty of Nursing, Alexandria University

Abstract

Background: *Swaddle bathing is one of the best practice types of bathing that recommended by Association of Women's Health, Obstetric and Neonatal Nurse. In this respect, nurses in NICUs play a proactive role in ongoing monitoring and stabilization of temperature as well as cardio-respiratory parameters of the neonates.* ***Objective****: to determine the effect of swaddle bathing on neonatal thermal stability and cardio-respiratory parameters.* ***Setting****: The study was conducted at Neonatal Intensive Care Units (NICUs) of the Specialized University Hospital at Smouha and El Raml Children's Hospital in Alexandria.* ***Subjects****: A convenient sample of 60 neonates comprised the study subjects.* ***Tools****: Two tools were used to collect the data. Tool one: Neonatal Biological and Clinical Characteristics Record. Tool two: Neonatal Body Temperature and Cardio-Respiratory Parameters Record.* ***Results:*** *The present study revealed that none of the neonates in the study group had low body temperature in all study periods. All neonates of the study and the control groups had normal respiratory rate along all periods of measurements after bathing. None of the neonates in the study group had low oxygen saturation (<95%). None of the neonates in the study group had decreased heart rate (< 120 beat / minute) compared to 13.3% of the neonates in the control group. Moreover, none of the neonates in the study group had increased heart rate compared to 10% and 6.7% in control group in that order.* ***Conclusion****: it was concluded that neonates who received swaddle bathing exhibited stable temperature and cardio-respiratory parameters more than those who received routine bathing except respiratory rate.* ***Recommendations:*** *In-service training program should be provided for nurses in NICUs about swaddle bathing technique that includes preparation, duration and how to use positive touch.*

Keywords: swaddle bathing, thermal stability, cardio-respiratory parameters and neonates.

Introduction

Neonatal temperature and cardio-respiratory parameters such as respiratory rate, heart rate and oxygen saturation are the key elements to evaluate physiological function of vital organs (Swapna, 2016). Maintaining a neutral thermal environment is one of the physiological challenges that the neonate faces after delivery. Normal body temperature reflects the optimum thermal condition required to maintain internal body function. Moreover, gas exchange and maintenance of adequate respiratory effort are the most crucial component of lung function (Hockenberry et al., 2021;Hillman et al., 2012).

Neonates are communicating with numerous sensory stimulations in Neonatal Intensive Care unit (NICU) by expressing certain changes in temperature and cardio-respiratory parameters. When the neonates failed to adapt to environmental stimulation, they exhibit instability in thermal and cardio-respiratory parameters. Neonates undergo various stressors in NICU environment such as sudden noise, bright light and common procedures including endotracheal suctioning, chest physiotherapy, nasogastric feeding and bathing (Kanagasabai et al., 2016; Tambunan & Mediani, 2019). Bathing is considered an extreme stressful form of stimulation to neonates as a result of touching and excessive handling that elicits multiple disturbance in temperature and cardio-respiratory parameters (Lee & Lee, 2021). Bathing is one of the neonates' skin care practices which applied in NICU. Its main purposes are removing wastes, providing aesthetic appearance, and reducing the colonization of microorganisms (Gunay & Coskun, 2018).

Neonatal morbidity and mortality can be influenced by bathing. It can leads to disturbances in temperature and cardio-respiratory parameters. Worldwide, the mortality rate of neonatal hypothermia due to bathing was 17 deaths per 1,000 live births in 2020 (World Health Organization [WHO], 2020). In Egypt, a study was conducted by Darmstadt et al. who found that 40.3% of the neonates had hypothermia that caused by bathing in 2017.

Swaddle bathing is one of the bathing methods that incorporate developmental principles into a routine care-giving practice (Edraki et al., 2014). It has multiple benefits for neonates including reduction in physiological and motor stress, conserving energy and decreasing crying. Swaddle bathing also facilitate social interaction by keeping the neonate in a calm, quiet alert state and encourage feeding immediately after bathing (dos Santos & da Silva, 2020).

The pediatric nurses in NICU play a proactive role in ongoing monitoring of temperature and cardio-respiratory parameters of the neonates and diminishing the stress inducing factors such as bathing. Preparations of equipment and environment as well as adjustment of water temperature and consideration of duration of bathing are the main goals to be achieved to maintain neonatal temperature during bathing. Hence, the pediatric nurses will be able to design comprehensive individualized and developmental care plans to maintain the stability of temperature and cardio respiratory parameters for hospitalized neonates (McGrath & Vittner, 2015; Kanagasabai et al., 2016).

Many studies confirm the effectiveness and safety of swaddled immersion bathing for neonates such as stability of temperature and cardio-respiratory parameters. In contrast to conventional bathing which leads to temperature loss among neonates(Edraki et al., 2014; Paran et al., 2016; Swapna et al., 2017; Freitas et al., 2018; dos Santos & da Silva, 2020). consequently, swaddle bathing will be utilized ideally to overcome changes in temperature and cardio-respiratory parameters of neonates.

Aim of the Study

The study aimed to determine the effect of swaddle bathing on neonatal thermal stability and cardio-respiratory parameters.

Research hypotheses

- Neonates who receive swaddle bathing exhibit thermal stability more than those who don't.
- Neonates who receive swaddle bathing exhibit stable cardio-respiratory parameters more than neonates who don't.

Materials and Method

Materials

Design: A Quasi-experimental research design was used to accomplish this study.

Settings: The study was conducted at Neonatal Intensive Care Units (NICUs) of the Specialized University Hospital at Smouha and El Raml Children's Hospital in Alexandria.

Subjects: A convenient sample of 60 neonates who fulfilled the following criteria comprised the subjects: Gestational age was ranging from 36-42 weeks, feeder and grower neonates, have stable vital signs, not receiving analgesic, sedative, or muscle relaxant medications and free from septicemia. The study sample was estimated based on Epi info program which was used to estimate the sample size using the following parameters: Total population approximately was 60 neonates. Confidence level was 95%. Error level 5 %. Expected frequency 50%. The minimum sample size was 52 neonates. The final sample size was 60 neonates for possible non response. The neonates were randomly assigned into two equal groups namely the study and the control groups (30 neonates for each), both groups were received routine care of hygiene. The control group was received routine bathing and the study group was received swaddle bathing.

Tools: Two tools were used to collect the necessary data:

Tool one: Neonatal Biological and Clinical Characteristics Record.

This tool was developed by the researcher after reviewing recent and relevant literature to assess biological and clinical characteristics of the neonates (Andresen & Saugstad, 2020; Hockenberry et al., 2021), it included two parts:

Part I: Biological characteristics of neonates involved gestational age, postnatal age, gender and classification of neonates according to intrauterine growth chart.

Part II: Clinical data of neonates that composed of diagnosis, duration of hospitalization, attachment with invasive lines or tubes and type of delivery.

Tool two: Neonatal Body Temperature and Cardio-Respiratory Parameters Record which included body temperature, respiratory rate, heart rate and oxygen saturation (SPo_2).

Method

Approval from the Research Ethics Committee of the Faculty of Nursing was obtained before carrying out this study. An official permission to conduct the study was obtained from the Faculty of Nursing to responsible authorities of Neonatal Intensive Care Unit (NICU) at the specialized University Hospital at Smouha and El-Raml Children Hospital to conduct the study after explaining the aim of the study. Tools were developed by the researcher after thorough reviewing of current and relevant literature. Content validity of tools were tested by five experts in the pediatric nursing field. A pilot study was carried out on 6 neonates (10% of sample size) in order to assess feasibility of the tools. No modification was done, so they were included in total sample size. Reliability of tool II was ascertained using Cronbach's alpha Coefficient. It was 0.754. The researcher started with the control group to avoid contamination of the sample. The neonates in the control group were exposed to the routine bath which was done by the assigned nurse. The neonates in the study group were exposed to swaddle bathing by the researcher. Neonatal biological and clinical characteristics in both groups were assessed at the beginning of data collection. Before bathing of neonates in both groups, temperature and the cardio-respiratory parameters including respiratory rate and heart rate were measured in full minute beside oxygen saturation (SPO_2).

- Temperature was measured axillary by mercury thermometer, while the respiratory rate was calculated by observing the neonatal abdomen.
- Heart rate was measured through cardiac monitor in NICU while oxygen saturation (SPO_2) was measured by pulse oximeter.

Body temperature and Cardio-respiratory parameters of all neonates in both groups were measured four times as follow immediately, 5, 10, and 15 minutes after bathing.

For neonates of the study group:

The equipment was prepared by the researcher including two dry towels, wash tub, neutral PH mild neonate wash (baby shampoo), new diaper and temperature strip digital water thermometer. The bath water temperature was adjusted by the researcher between 37.5-38 ^{o} C using the temperature strip digital water thermometer. The researcher prepared the environment by closing doors, windows and air conditioning in the unit. Safety of the neonates was maintained by placing the bathtub in a safe place and on hard surface. The researcher prepared himself by washing hands using standard precautions and wearing personal protective equipment such as disposable gloves, apron and surgical masks that are included in NICU policy. The neonates were prepared before bathing by removing diaper and any connected objects to the neonates such as leads, pulse oximeters. The researcher put the towel on a flat dry surface in the incubator or the bed of the neonates and folded down the top corner of the towel. The neonates were placed on the towel and kept in natural mid-line position

The neonates were immersed slowly in the tub to their shoulders by ensuring their feet were supported at the bottom corner of the tub (foot bracing). The neonates were maintained in the tub by the non-dominant hand of the researcher. The researcher put some amount of soap on the wrist to wash the neonate's arm with gentle non-stroking touch or neonatal massage (positive touch) that doesn't over stimulate the neonates after gently unwrapping the towel. The arm was rinsed and re-swaddled. The researcher washed all extremities, chest, abdomen, genital region, and back consequently. The neonate's eyes were cleaned and wiped by plain warm water from inner to outer canthus of the eye using moist cotton balls with no soap. Then clean the neonate's ears using a new cotton ball for each ear and wipe the entire face gently. The bathing was ended with hair washing through wetting the neonate's head by the soapy water and gently rubbing the scalp with the researcher's fingers.The hair was rinsed gently by flowing the water on the top of the head and back ward to avoid the water squirting into the neonate's eyes. The neonates were unwrapped in the tub while the neonates were holed by molding and nestling into the contours of the researcher's body (cuddling) in a dry towel and leaving the wet swaddled towel in the tub. The researcher returns the neonates to the incubator or the bed and quickly dried and dressed with a new diaper (clothes).The new leads and pulse oximeter on the neonates were reattached to the monitor. This procedure was accomplished within 8 minutes. The data were collected during the period of 5 months which started from the beginning of May to the end of September 2021.

Ethical Considerations:

Informed written consent was obtained from the neonates' parents after explaining the aim of the study for participating in the research. The neonate's privacy was maintained. Confidentiality of collected data was assured. Parents had the right to withdraw from the research of their neonates at any time.

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**.** Qualitative data were described using number and percent. Kolmogorov-Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation. Significance of the obtained results was judged at the 5% level.

Results

Table 1 portrays biological and clinical characteristics of the neonates in the study and the control groups. It illustrates that the mean gestational age of the neonates among the study group was 36.93± 1.17 weeks of gestation, while it was 37.03 ± 1.07 weeks of gestation in the control group. It was obvious that the postnatal age among 43.3% of the neonates in the study group was from one to less than seven days, whereas in the control group it was 46.7% from seven to less than fourteen days. Moreover, two thirds of the neonates (66.7%) in the study group were male compared to 50% of the neonates in the control one.

It is clear from the table that the mean birth weight of the neonates in the study group was 2220.33 ± 628.13 gms, whereas it was 2325.0 ± 698.63 gms in the control group. The minimum current weight in the study group was 1620 gm while in the control group it was 1700 gm. On the other hand, 3450 gm was the maximum current weight of the neonates in the study group compared to 3950 gm in the control group. The same table shows that 56.7% of the neonates in the study group were full term compared to 63.3% of the neonates in the control group.

Concerning the classification of the neonates according to their birth weight, it was noticed that 36.7% of the neonates in the study group had low birth weight compared to slightly more than half of the neonates (53.3%) in the control group. It is illustrating from the same table that respiratory distress syndrome and hyperbilirubinemia represent 53.5% and 26.6% of diagnoses in the study group compared to 56.8% and 29.9% in the control group respectively. There were no statistically significant differences between the two groups regarding all biological and clinical characteristics.

Table 2 reveals temperature measurements of the neonates in the study and the control groups. It was observed that the majority of the neonates (86.6%) in the study group and (93.4%) in the control group had normal body temperature before bathing. The mean body temperature in the study and the control groups were 36.87 ± 0.29 and 37.04 ± 0.34 respectively.

It was found that none of the neonates in the study group had low body temperature in all study periods. Whereas, it was observed that 26.7% immediately, 20% at 5 minutes, 6.7% at 10 minutes and 6.7% at 15 minutes after bathing of the neonates in the control group had low body temperature. The minimum temperature measurements of the neonates in the study group was 36.50 C^{o} in all study periods after bathing while it was 36.20 C^{o} immediately and at 5 minutes after bathing as well as 36.30 C^{o} at 10 and 15 minutes after bathing in the control group.

There were statistically significant differences between both groups in all study periods after bathing where p= 0.005 immediately, 0.012 at 5 minutes and 0.046 at 10 minutes respectively except at 15 minutes there was no statistically significant difference after bathing where p= 0.325.

The respiratory rate measurements of the neonates in the study and the control groups are presented in **Table (3)**. Before bathing, it was observed that all of the neonates in the study and the control groups had normal respiratory rate (between 30-60 cycle / minute). Moreover, the mean respiratory rate of the neonates in the study and the control groups were 46.20 ± 6.21 and 42.0 ± 3.36 respectively. it was obvious that all neonates of the study and the control groups had normal respiratory rate along all periods of measurements after bathing. The minimum respiratory rate measurement of the neonates in the study group was 31 cycle / minute immediately after bathing and increased to 32 cycle / minute at 5, 10 and 15 minutes after bathing while, it was varied from 36-39 cycle / minute in all study periods after bathing in the control group. In the study group, it was observed that the mean values of respiratory rate in all study periods were ranged from 38.80 ± 3.82 to 40.97 ± 5.18. Whereas in the control one it was ranged from 44.07 ± 3.30 to 50.37 ± 5.90 with statistically significant differences between two groups in all periods after bathing where p=<0.001.

Table 4 shows oxygen saturation measurements of the neonates in the study and the control groups. It was found that the oxygen saturation was normal before bathing among 76.7% of the neonates in the study group and 80% in the control one. The minimum oxygen saturation measurement of the neonates in the study group was 92% while it was 90% in the control group. The mean oxygen saturation in the neonates in the study and the control groups were 96.17 ± 1.74 and 94.53 ± 16.23 respectively.

It was observed that none of the neonates in the study group had low oxygen saturation (<95%) immediately and at 5 minutes after bathing compared to 56.7%, 13.3% of them in the control group at the same times. There were statistically significant differences between the two groups where p=<0.001 immediately and p=0.002 at 5 minutes. It was clear that none of the neonates in both groups had low oxygen saturation after 10 minutes and 15 minutes of bathing.

Concerning the minimum oxygen saturation of the neonates immediately after bathing was 96% and increased to 99% at 15 minutes after bathing in the study group compared to 83% immediately after bathing and increased to 98% at 15 minutes after bathing in the control group. On the other hand, the maximum oxygen saturation of the neonates was 100% in all periods after bathing in the study group, while it was 98% immediately, 99% at 5 minutes, 99% at 10 minutes and 100% at 15 minutes after bathing in the control group.

Table 5 presents heart rate measurements of the neonates in the study and the control groups. It was observed that heart rate was normal among all neonates in the study and 96.7% in the control groups before bathing.

Immediately after bathing, it was found that none of the neonates in the study group had decreased heart rate (< 120 beat / minute) compared to 13.3% of the neonates in the control group. Moreover, the mean heart rate of the neonates in the study and the control groups were 137.30 ± 7.13 and 146.63 ± 21.43 respectively. There was statistically significant difference between the two groups where p=0.001. It was obvious that none of the neonates in the study group had increased heart rate compared to 16.7% of the neonates in the control group and there were statistically significant differences between two groups where p=0.030.

Concerning measurement of heart rate at 5 and 10 minutes after bathing, it was found that none of the neonates in the study group had increased heart rate compared to 10% and 6.7% in control group in that order. It was found that none of the neonates in the study group had decreased heart rate (< 120 beat / minute) compared to 13.3% of neonates in the control group at 15 minutes after bathing. Moreover, all neonates in the study group had normal heart rate (120-160) compared to 80% of neonates in the control one with statistically significant differences between two groups where p=0.007.

It was found that the mean measurements of heart rate among neonates in the study group were less than those in the control one all over the study periods. It was noticed that the mean was 137.30 ± 7.13 and 146.63 ± 21.43 immediately, 133.43 ± 7.99 and 140.57 ± 16.18 at 5 minutes, 127.97 ± 6.66 and 139.23 ± 15.83 at 10 minutes and 128.07 ± 5.49 and 136.33 ± 14.94 at 15 minutes in the study and the control groups after bathing respectively.

Discussion

Daily bathing of neonates is a process that is usually done routinely in NICU. It is one of nursing practices that increase manipulation and induce adverse effects on the stability of the physiological parameters. Swaddle bathing is one of the best practice types of bathing that is recommended by Association of Women’s Health, Obstetric & Neonatal Nurse (AWHONN) (Huang et al., 2022) Hence, it was important to study the effect of swaddle bathing on neonatal temperature and cardio-respiratory parameters.

Hypothermia is considered as silent killer for the neonates. Thus, the World Health Organization (World Health Organization [WHO], 2017 recommends bathing 24 hours after birth to prevent hypothermia (Ruschel et al., 2018;Ceylan & Bolisik, 2018). In the light of the current study, it was revealed that none of the neonates in the swaddle bathing group had low body temperature compared to the routine bathing group after bathing in all study periods except at 15 minutes after bathing with statistically significant differences (Table 2). This finding could be justified by the fact that neonates are prone to hypothermia because of many reasons such as thinness of the skin, large body surface area, low brown fat deposits and low protection mechanisms. Additionally, maintenance of body temperature of neonates during swaddle bathing due to cover and immersing the neonates with a soft thick towel that can conserving energy and decreases the chance of body heat loss through evaporation. Another aspect is due to the technique of each type of bathing, the head was exposed to evaporation for longer period during routine bathing compared to swaddle bathing in which washing the head is latest step. The current findings are supported by Mohamed and Elashry (2022) who found that there was stability in the mean score of body temperature of neonates in the swaddle bathing group compared to traditional bathing group. On the contrary, Tambunan et al. (2019) reported that there were no significant differences between the two groups on thermal stability of neonates.

Respiration is one of the cardio-respiratory parameters that can be affected by the type of bathing among neonates (Huang et al., 2022). The findings of the current study revealed that all neonates in the study and the control groups had normal and stable respiratory rate along all the periods of measurement after bathing, there were statistically significant differences between the two groups (Table 3). These findings could be explained in the light of the fact that the neonates who had exposed to swaddle bathing became more comfortable and less distressed which in turns leads to stability of respiratory rate. Tambunan and Mediani (2019) supported the results of the current study where statistically significant difference was found between swaddle bathing and conventional bathing groups regarding respiratory rate.

Oxygen saturation monitoring via pulse-oximetry is standard practice in NICUs that assess the physiological stability of the neonates (Vali & Lakshminrusimha, 2020). The study findings reflected that none of the neonates in the study group had low oxygen saturation immediately and at 5 minutes after bathing compared to more than half and only13.3% of neonates in the control group at the same time respectively. Furthermore, oxygen saturation in most of the neonates in the study group and less than half of neonates in the control group reached normal immediately after bathing. Moreover, their percent in both groups was sustained stable within normal limits all over study periods (Table 4). The low oxygen saturation measurement of the neonates in control group immediately after routine bathing could be interpreted by exposure of neonates to hypothermia leads to increased oxygen consumption and consequently decreased oxygen saturation. While, swaddle bathing stimulate blood circulation, relieve stress and pain symptoms of neonates that conserve the energy, reduces oxygen consumption and maintain oxygen saturation .The study findings were consistent with the findings of Huang et al. (2022) who found that swaddle bathing was effective in maintaining the neonate's body temperature, oxygen saturation levels, and heart rate within the normal range.

The result of the current study revealed that none of the neonates in the study group had decreased heart rate (< 120 beat / minute) immediately after bathing compared to 13.3% the neonates in the control group. It was obvious that none of the neonates in the study group had increased heart rate compared to 16.7% of the neonates in the control group immediately after bathing. Moreover, it was found that the mean measurement of heart rate among neonates in the study group were less than those in the control one all over the study periods (Table5). These findings could be due to swaddle bathing had positive effects on stability of respiratory status and increasing oxygen saturation through stimulating blood circulation which maintain heart rate in normal ranges among neonates in the study group. The finding of the present study was in the same line with the findings of Mohamed and Elashry (2022) who found that the mean score of heart rate was higher in traditional bathing group but in swaddle bathing group was maintained stable immediately and at 10 minutes after bathing.

Finally from the ongoing discussion, it can be noted that swaddle bathing had a positive effect on maintenance and stability of neonatal body temperature and cardio-respiratory parameters. In this respect, nurses in NICUs have an active role to add and implement swaddle bathing as a modality to promote the developmental supportive care for neonates.

Conclusion

Based upon the findings of the current study, it can be concluded that the temperature of neonates who exposed to swaddle bathing were more stable all over the study periods than those who exposed to routine bathing. The neonates who received swaddle bathing exhibited stable cardio-respiratory parameters more than those who received routine bathing except respiratory rate. While, the respiratory rate of all neonates was stable in both groups during study periods.

Recommendations

Based on the results of the current study, the following recommendations are suggested:

- In - service training program should be conducted for nurses in NICUs about swaddle bathing technique that includes preparation, duration and how to use positive touch.
- Health classes should be conducted for mothers and caregivers about swaddle bathing.
- The swaddle bathing procedure should be included in the practical part of pediatric nursing course for undergraduate nursing students in nursing faculties.
- Simplified and illustrated booklet or CD about swaddle bathing application should be available for nurses in NICU and mothers.

Table (1): Neonatal Biological and Clinical Characteristics in the study and the control groups

Biological characteristics of neonates	Study group (n=30)		Control group (n=30)		Test of significance
	No.	%	No.	%	
Gestational age (weeks) :					
▪ Min – Max	36.0 – 41.0		36.0 – 39.0		U= 414.50
▪ Mean ± SD	36.93 ± 1.17		37.03 ± 1.07		P= 0.574
Postnatal age (days):					
▪ 1 - < 7	13	43.3	9	30.0	χ^2=6.171
▪ 7 - < 14	7	23.3	14	46.7	
▪ 14 - < 21	3	10.0	5	16.7	^{MC}P= 0.102
▪ 21 - < 30	7	23.4	2	6.6	
Gender:					
▪ Female	10	33.3	15	50.0	χ^2= 1.714
▪ Male	20	66.7	15	50.0	P= 0.190
Birth weight (gm):					
▪ Min – Max	1000.0 – 3400.0		1500.0 – 4500.0		t= 0.610
▪ Mean ± SD	2220.33 ± 628.13		2325.0 ± 698.63		P= 0.544
Current weight (gm):					
▪ Min – Max	1620.0 – 3450.0		1700.0 – 3950.0		t=0.202
▪ Mean ± SD	2366.93 ± 551.87		2396.67 ± 588.08		P=0.841
Classification according to gestational age:					
▪ Preterm	13	43.3	11	36.7	χ^2=0.278
▪ Full term	17	56.7	19	63.3	P=0.598
Classification according to birth weight:					
▪ Normal birth weight	12	40.0	9	30.0	χ^2=1.688
▪ Low birth weight	11	36.7	16	53.3	
▪ Very low birth weigh	7	23.3	5	16.7	P=0.430
Diagnosis:					
▪ Prematurity	3	10.0	3	10.0	^{MC}P=0.533
▪ Hypoxic ischemic encephalopathy	3	9.9	1	3.3	
▪ hyperbiliruinemia	8	26.6	9	29.9	
▪ Respiratory distress syndrome	16	53.5	17	56.8	

χ^2: **Chi square test** MC: **Monte Carlo** **t: Student t-test** **U: Mann Whitney test** *: Statistically significant at $p \le 0.05$

Table (2): Temperature measurements of the neonates in the study and control groups

Temperature measurements (C°)	Study group (n=30)		Control group (n=30)		Test of significance
	No.	%	No.	%	
Before bathing					
Low (<36.5)	4	13.4	2	6.6	χ^2=1.090
Normal (36.5– 37.6)	26	86.6	28	93.4	^{MC}p=0.746
Min – Max.	36.40 – 37.70		36.50 – 38.0		U=299.0*
Mean ± SD.	36.87 ± 0.29		37.04 ± 0.34		P=0.021*
Immediately after bathing					
Low (<36.5)	0	0.0	8	26.7	χ^2=9.231*
Normal (36.5– 37.6)	30	100.0	22	73.3	^{FE}p=0.005*
Min – Max.	36.50 – 37.40		36.20 – 37.50		U=263.50*
Mean ± SD.	36.71 ± 0.20		36.59 ± 0.30		P=0.005*
5 Minutes after bathing					
Low (<36.5)	0	0.0	6	20.0	χ^2=6.667*
Normal (36.5– 37.6)	30	100.0	24	80.0	^{FE}p=0.024*
Min – Max.	36.50 – 37.0		36.20 – 37.20		U=283.0*
Mean ± SD.	36.69 ± 0.16		36.58 ± 0.25		P=0.012*
10 Minutes after bathing					
Low (<36.5)	0	0.0	2	6.7	χ^2=2.069
Normal (36.5– 37.6)	30	100.0	28	93.3	^{FE}P=0.492
Min – Max.	36.50 – 37.0		36.30 – 37.0		U=318.0*
Mean ± SD.	36.70 ± 0.16		36.62 ± 0.18		P=0.046*
15 Minutes after bathing					
Low (<36.5)	0	0.0	2	6.7	χ^2=2.069
Normal (36.5– 37.6)	30	100.0	28	93.3	^{FE}P=0.492
Min – Max.	36.50 – 37.10		36.30 – 37.0		U=384.50
Mean ± SD.	36.73 ± 0.17		36.68 ± 0.19		P=0.325

χ^2: **Chi square test** FE**: Fisher Exact** MC: **Monte Carlo** **U: Mann Whitney test** *: Statistically significant at p ≤ 0.05

Table (3): Respiratory rate measurements of the neonates in the study and the control groups

Respiratory rate measurements (C/M)	Study group (n=30)		Control group (n=30)		Test of significance
	No.	%	No.	%	
Before bathing					–
Normal (30– 60)	30	100.0	30	100.0	
Min – Max.	35.0 – 58.0		37.0 – 53.0		3.257*
Mean ± SD.	46.20 ± 6.21		42.0 ± 3.36		P=0.002*
Immediately after bathing					–
Normal (30– 60)	30	100.0	30	100.0	–
Min– Max.	31.0 – 53.0		37.0 – 57.0		6.557*
Mean ± SD.	40.97 ± 5.18		50.37 ± 5.90		P=<0.001*
5 Minutes after bathing					–
Normal (30– 60)	30	100.0	30	100.0	–
Min – Max.	32.0 – 52.0		36.0 – 56.0		5.767*
Mean ± SD.	39.80 ± 4.19		46.50 ± 4.79		P=<0.001*
10 Minutes after bathing					–
Normal (30– 60)	30	100.0	30	100.0	–
Min – Max.	32.0 – 52.0		39.0 – 50.0		5.650*
Mean ± SD.	39.13 ± 3.95		44.63 ± 3.59		P=<0.001*
15 Minutes after bathing					–
Normal (30– 60)	30	100.0	30	100.0	–
Min – Max.	32.0 – 52.0		38.0 – 51.0		5.716*
Mean ± SD.	38.80 ± 3.82		44.07 ± 3.30		P=<0.001*

U: Mann Whitney test *: Statistically significant at p ≤ 0.0

Table (4): O_2 saturation measurement of the neonates in the study and the control groups

O_2 saturation measurement (%)	Study group (n=30)		Control group (n=30)		Test of significance
	No.	%	No.	%	
Before bathing					
Low (<95)	7	23.3	3	10.0	χ^2=4.166
Normal (95– 99)	23	76.7	24	80.0	MCp=0.133
High > (99)	0	0.0	3	10.0	
Min – Max.	92.0 – 99.0		90.0 – 100.0		U=284.0*
Mean ± SD.	96.17 ± 1.74		94.53 ± 16.23		p=0.013*
Immediately after bathing					
Low (<95)	0	0.0	17	56.7	χ^2=27.390*
Normal (95– 99)	28	93.3	13	43.3	MCp<0.001*
High > (99)	2	6.7	0	0.0	
Min – Max.	96.0 – 100.0		83.0 – 98.0		U=22.0*
Mean ± SD.	98.47 ± 0.86		93.97 ± 2.88		p=<0.001*
5 Minutes after bathing					
Low (<95)	0	0.0	4	13.3	χ^2=9.862*
Normal (95– 99)	24	80.0	26	86.7	MCp=0.002*
High > (99)	6	20.0	0	0.0	
Min – Max.	96.0 – 100.0		90.0 – 99.0		U=169.0*
Mean ± SD.	98.93 ± 0.83		94.0 ± 16.23		p=<0.001*
10 Minutes after bathing					
Low (<95)	0	0.0	0	0.0	χ^2=7.925*
Normal (95– 99)	23	76.7	30	100.0	FEp=0.011*
High > (99)	7	23.3	0	0.0	
Min – Max.	97.0 – 100.0		95.0 – 99.0		U=229.0*
Mean ± SD.	99.10 ± 0.66		98.30 ± 0.99		p=<0.001*
15 Minutes after bathing					
Low (<95)	0	0.0	0	0.0	χ^2=5.455*
Normal (95– 99)	21	70.0	28	93.3	p=0.020*
High > (99)	9	30.0	2	6.7	
Min – Max.	99.0 – 100.0		98.0 – 100.0		U=292.50*
Mean ± SD.	99.30 ± 0.47		98.90 ± 0.48		p=0.003*

χ^2: **Chi square test** MC: **Monte Carlo** FE**: Fisher Exact** **U: Mann Whitney test** *: Statistically significant at p ≤ 0.05

Table (5): Heart rate measurements of the neonates in the study and the control group

Heart rate measurement (B/M)	Study group (n=30)		Control group (n=30)		Test of significance
	No.	%	No.	%	
Before bathing					
Low (<120)	0	0.0	1	3.3	χ^2=1.017 ^{FE}P=1.000
Normal (120– 160)	30	100.0	29	96.7	
High > (160)	0	0.0	0	0.0	
Min – Max.	133.0 – 159.0		112.0 – 158.0		t=4.417* p=<0.001*
Mean ± SD.	147.03 ± 7.81		136.30 ± 10.78		
Immediately after bathing					
Low (<120)	0	0.0	4	13.3	χ^2=10.145* ^{MC}p=0.001*
Normal (120– 160)	30	100.0	21	70.0	
High > (160)	0	0.0	5	16.7	
Min – Max.	122.0 – 151.0		90.0 – 183.0		t=2.263* P=0.030*
Mean ± SD.	137.30 ± 7.13		146.63 ± 21.43		
5 Minutes after bathing					
Low (<120)	1	3.3	4	13.3	χ^2=4.942 ^{MC}p=0.084
Normal (120– 160)	29	96.7	23	76.7	
High > (160)	0	0.0	3	10.0	
Min – Max.	117.0 – 149.0		104.0 – 166.0		t=2.166* P=0.036*
Mean ± SD.	133.43 ± 7.99		140.57 ± 16.18		
10 Minutes after bathing					
Low (<120)	1	3.3	3	10.0	χ^2=2.855 ^{MC}p=0.222
Normal (120– 160)	29	96.7	25	83.3	
High > (160)	0	0.0	2	6.7	
Min – Max.	119.0 – 141.0		111.0 – 178.0		t=3.592* P=0.001*
Mean ± SD.	127.97 ± 6.66		139.23 ± 15.83		
15 Minutes after bathing					
Low (<120)	0	0.0	4	13.3	χ^2=5.992* ^{MC}p=0.022*
Normal (120– 160)	30	100.0	24	80.0	
High > (160)	0	0.0	2	6.7	
Min – Max.	120.0 – 144.0		112.0 – 173.0		t=2.845* P=0.007*
Mean ± SD.	128.07 ± 5.49		136.33 ± 14.94		

χ^2: **Chi square test** MC: **Monte Carlo** FE**: Fisher Exact** **t: Student t-test** *: Statistically significant at p ≤ 0.05

References

Andresen, J. H., & Saugstad, O. D. (2020). Oxygen metabolism and oxygenation of the newborn. *Seminars in fetal & neonatal medicine*, *25*(2), 101078. https://doi.org/10.1016/j.siny.2020.101078.

Ceylan, S. S., & Bolisik, B. (2018). Effects of Swaddled and Sponge Bathing Methods on Signs of Stress and Pain in Premature Newborns: Implications for Evidence-Based Practice. *Worldviews on Evidence-Based Nursing, 15*(4), 296-303. https://doi.org/10.1111/wvn.12299.

Darmstadt, G., Huessin, M., Winch, P., Haws, R., Lamia, M. & El said, M. (2017). Neonatal home care practices in rural Egypt during the first week of life. *Tropical Medicine and International Health Journal*, 12 (6), 783-797.

dos Santos, H. M., & da Silva, L. J. (2020). Swaddle bathing in premature babies in a neonatal unit: the practice from the perspective of nurses. *Rev Ren, 21*, e42454. https://doi.org/10.15253/2175-6783.20202142454.

Edraki, M., Paran, M., Montaseri, S., Nejad, M. R., & Montaseri, Z. (2014). Comparing the effects of swaddled and conventional bathing methods on body temperature and crying duration in premature infants: a randomized clinical trial. *Journal of caring sciences*, *3*(2), 83. https://doi.org/10.5681/jcs.2014.009.

Freitas, P. d., Munhoz, M. M. B., Costa, P., & Kimura, A. F. (2018). Effect of two immersion bathing techniques on the axillary temperature of preterm newborns: a pilot study. *Texto & Contexto-Enfermagem*, *27*(1), 2. https://doi.org/10.1590/0104-070720180000580016

Gunay, U., & Coskun, D. (2018). The Effect of tub bathing on the newborns' Pain: a Randomized clinical trial. *International Journal of Caring Sciences*, *11*(2), 1132-1140.

Hillman, N. H., Kallapur, S. G., & Jobe, A. H. (2012). Physiology of transition from intrauterine to extrauterine life. *Clinics in perinatology*, *39*(4), 769-783. https://doi.org/10.1016/j.clp.2012.09.009.

Hockenberry, M. J., Wilson, D., & Rodgers, C. C. (2021). *Wong's Essentials of Pediatric Nursing - E-Book*. Elsevier Health Sciences.p.p. 398-427.

Huang, Y., Zhou, L., Abdillah, H., Hu, B., & Jiang, Y. (2022). Effects of swaddled and traditional tub bathing on stress and physiological parameters of preterm infants: A randomized clinical trial in China. *Journal of Pediatric Nursing*, *64*, e154-e158. https://doi.org/10.1016/j.pedn.2021.11.028.

Kanagasabai, P. S., Lewis; Mohan; L. E., & Rao, B. K. (2016). Behavioral Responses to Multisensory Stimulation in Preterm Infants. *Journal of Nepal Paediatric Society*, *36*(2), 110-114. https://doi.org/10.3126/jnps.v36i2.14850.

Lee, J., & Lee, Y. (2021). Physiologic Changes during Sponge Bathing in Premature Infants. *International journal of environmental research and public health*, *18*(5), 2467. https://doi.org/10.3390/ijerph18052467.

McGrath, J., & Vittner, D. (2015). Behavioral assessment. *Physical Assessment of the Newborn: A Comprehensive Approach to the Art of Physical Examination. Petaluma, CA: NICU Ink*, 193-219.

Mohamed, S. S., & Elashry, R. S. (2022). Effect of Swaddle Bathing versus Traditional Bathing on Physiological Stability and Comfort level among Neonates. *Assiut Scientific Nursing Journal, 10*(28),68-79. https://doi.org/10.21608/asnj.2022.114551.1293.

Paran, M., Edraki, M., Montaseri, S., & Razavi Nejad, M. (2016). A comparison between the effects of swaddled and conventional bathing methods on some behavioral responses in premature infants. *Iranian Journal of Neonatology*,*7*(4),35-40. https://doi.org/10.22038/ijn.2016.7778.

Ruschel, L. M., Pedrini, D. B., & Cunha, M. (2018). Hypothermia and the newborn's bath in the first hours of life. *Revista gaucha de enfermagem*, *39*, e20170263. https://doi.org/10.1590/1983-1447.2018.20170263.

Swapna, G. (2016). *Relative effectiveness of swaddle bath and conventional bath on level of thermal stability and crying duration among preterm infants at selected hospital, Surat, 2015* [Doctoral Thesis]. Chennai, Omayal Achi College of Nursing.

Swapna, G., Nandhini, P., Ruthrani, J., Kanchana, S., & Celina, D. (2017). Relative effectiveness of swaddle bath and conventional bath on level of thermal stability and crying duration among preterm infants. *International Centre for Collaborative Research Journal of Nursing Research*, *2*(1), 34.

Tambunan, D. M., & Mediani, H. S. (2019). Bathing Method for Preterm Infants: A Systematic Review. *KnE Life Sciences*, 1-11. https://doi.org/10.18502/kls.v4i13.5220.

Tambunan, D. M., Mediani, H. S., & Nurjanah, N. (2019). Effectiveness Of Swaddle And Conventional Tub Bath On Thermal Stability In Premature Infants At Dustira Hospital Cimahi. *School of Health Sciences Jenderal Achmad Yani, 3*(1), 134-137.

Vali, P., & Lakshminrusimha, S. (2020). Chapter 14 - Oxyhemoglobin Saturation Targets in Newborns and the Role of Automated Oxygen Delivery Systems. In S. G. Kallapur & G. S. Pryhuber (Eds.), *Updates on Neonatal Chronic Lung Disease* (p.p. 207-223). Elsevier.

World Health Organization. (2017). *WHO recommendations on newborn health: guidelines approved by the WHO Guidelines Review Committee* (No. WHO/MCA/17.07). World Health Organization.

World Health Organization [WHO]. (2020). *Newborn Mortality*. Geneva: Switzerland: WHO.