



ORIGINALES

Profile of risky newborns related to thermoregulation in a Neonatal Intensive Care Unit

Perfil de recém-nascidos de risco relacionado à termorregulação em Unidade de Terapia Intensiva Neonatal

Perfil de los recién nacidos de riesgo relacionados con la termorregulación en una Unidad de Cuidados Intensivos Neonatales

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ABSTRACT:

Objective: To analyze the temperature pattern of low birth weight newborns admitted to a Neonatal Intensive Care Unit

Methodology: This is a cross-sectional and quantitative study conducted in a Neonatal Intensive Care Unit of a maternity hospital in Northeastern Brazil. The sample consisted of 45 low birth weight, very low birth weight or extremely low birth weight newborns admitted to the unit.

Results: At admission, we obtained an axillary temperature average of 34.98°C with a standard deviation of 1.12. The hypothermia rate at the time of admission was considerably severe, so that in the first hour, with 06 hours and with 12 hours of hospitalization, the percentages of hypothermic newborns (<36.5°C) were respectively: 93.33%, 73.33 % and 57.78%.

Conclusion: We found flaws in the processes when it comes to thermoregulation, given that almost the entire sample arrives with potential cold stress.

Keywords: Hypothermia; Newborn; Low Weight Newborn; Risk Factors; Neonatal Intensive Care Units.

RESUMO:

Objetivo: Analisar o padrão de temperatura dos recém-nascidos de baixo peso internados em uma Unidade de Terapia Intensiva Neonatal.

Metodologia: Trata-se de um estudo transversal e quantitativo realizado numa Unidade de Terapia Intensiva Neonatal de uma maternidade no Nordeste do Brasil. A amostra foi constituída de 45 recém-nascidos de baixo peso, muito baixo peso ou extremo baixo peso admitidos na unidade.

Resultados: Na admissão obteve-se uma média de temperatura axilar de 34,98°C com desvio padrão de 1,12. A taxa de hipotermia na admissão foi consideravelmente grave, de forma que na primeira hora, com seis horas e com 12 horas de internação a porcentagem de recém-nascidos hipotérmicos (<36,5°C) foi respectivamente: 93,33%, 73,33% e 57,78%.

Conclusão: Verificou-se falhas nos processos quando se trata de termorregulação, haja vista que quase a totalidade da amostra chega com potencial estresse ao frio.

Palavras-chave: Hipotermia; Recém-nascido; Recém-nascido de Baixo Peso; Fatores de Risco; Unidades de Terapia Intensiva Neonatal.

RESUMEN:

Objetivo: Analizar el patrón de temperatura de recién nacidos de bajo peso al nacer ingresados en una Unidad de Cuidados Intensivos Neonatales.

Metodología: Este es un estudio transversal y cuantitativo realizado en una Unidad de Cuidados Intensivos Neonatales en un hospital de maternidad en el noreste de Brasil. La muestra consistió en 45 niños de bajo peso al nacer, muy bajo peso al nacer o extremadamente bajo peso al nacer ingresados en la unidad.

Resultados: Al ingreso se obtuvo una temperatura axilar promedio de 34.98°C con una desviación estándar de 1.12. La tasa de hipotermia al ingreso fue considerablemente severa, por lo que en la primera hora, con seis horas y con 12 horas de hospitalización, el porcentaje de recién nacidos hipotérmicos (<36.5°C) fue respectivamente: 93.33%, 73.33 % y 57.78%.

Conclusión: Hubo fallas en los procesos cuando se trata de termorregulación, dado que casi toda la muestra llega con potencial estrés por frío.

Palabras clave: Hipotermia; Recién nacido; Recién nacido de bajo peso; Factores de riesgo; Unidades de cuidados intensivos neonatales.

INTRODUCTION

Body temperature is the result of the balance between heat production and elimination mechanisms. Nevertheless, in premature and low birth weight newborns (NB), maintaining a normothermic state is a difficult task, as this group has limited physiological characteristics to maintain the homeothermic state according to the temperature variations of the environment and often end up developing hypothermia with potential for cold stress⁽¹⁾.

Care regarding the body temperature of NB should start in the delivery room, before birth, remaining during transport and admission to the Neonatal Intensive Care Unit (NICU). In addition, neonatal intrahospital transport, from the delivery room to the NICU, despite being a short journey, constitutes an additional risk to the health of NB^(1,2).

Among the clinical complications found during neonatal intrahospital transport, hypothermia is the most frequent. Its higher incidence is directly related to low birth weight, which, depending on the context where it is being studied, increases the probability of neonatal mortality by 20 times, in relation to those born with adequate weight when comparing underdeveloped countries with developed countries⁽³⁾. The

protocols of the Ministry of Health of Brazil recommend that neonatal transport should only happen after the thermal and hemodynamic stabilization of NB, and some studies reinforce this caution, as some services do not have adequate materials to care for NB during the transport process⁽⁴⁻⁶⁾.

This concern regarding the control of body temperature levels within the normal range (between 36.5°C and 37.5°C) is due to the severity of the cases of hypothermia that entail decreased surfactant production, as well as increased metabolic rate, which triggers increased consumption of oxygen and depletion of caloric reserves. Hypotension, bradycardia, irregular breathing, dehydration and hydroelectrolytic disorders can also take place, among other complications that, when left untreated, can lead to death^(1,7,8).

Hypothermia is a potentially preventable clinical complication that reflects on the quality of care provided to NB, but it is considered a worrying factor, since it still appears frequently in studies as a very present clinical complication. For this reason, we should highlight the importance of continuously monitoring body temperature, as well as intervening in possible care failures or even lack of material inputs, thereby ensuring the application of protocols aimed at improving prognosis and reducing neonatal morbidity and mortality rates^(1,2,7).

We should emphasize that the control of temperature levels largely depends on a committed and trained multiprofessional team that has professionals specialized in neonatology, in addition to material inputs. Temperature is one of the quality markers of care provided to NB, where the team is responsible for monitoring and maintaining this vital sign⁽⁷⁾.

Especially in premature NB, hypothermia is a matter of great concern, because besides occurring frequently, it is a risk factor for a worse prognosis, thereby increasing neonatal morbidity and mortality⁽¹⁾. The temperature below 35°C on admission to the neonatal ICU took place, respectively, in 58%, 43% and 30% of premature NB with 23, 24 and 25 weeks of gestational age⁽¹⁾. Another group that has a significant value in morbidity and mortality rates is the LBWNB, depending on the context where it is being studied, since in less developed, because they have less favorable socio-economic conditions compared to developed countries, the LBW factor increases by 20 times the probability of neonatal mortality in relation to those born with adequate weight⁽⁵⁾.

Accordingly, the group most vulnerable to hypothermia comprise preterm newborns (PTNB) and low birth weight newborns (LBWNB). In them, the capacity for heat production and retention is reduced due to the smaller stock of brown fat, less thermogenic response by hypoxia, greater body surface area, non-keratinized epidermis, less extracellular water (higher evaporation), less capacity for cutaneous vasoconstriction, among others⁽¹⁾. In addition, environmental factors, excessive handling and transport can increase the risks^(1,7). We should ensure the necessary support for these risky NB. Transport largely depends on a set of factors, such as: work processes, structure, material inputs, as well as qualified and trained team of professionals⁽⁷⁾.

Body temperature is a relevant factor for the vitality and prognosis of NB, then it became part of one of the elements in the scores that assess the risk of neonatal

morbidity and mortality, whether the *Clinical Risk Index for Babies* (CRIB) or the *Score for Neonatal Acute Physiology – Perinatal Extension* (SNAPPE).

In this context, there is a need to know the thermoregulation profile during admission and the indications for transferring low-weight NB to the intensive care unit, as it raises reflection on the causes of thermal instability and allows us to investigate its persistence, as well as the related complications during the first hours of admission to the NICU. Accordingly, this study was intended to analyze the temperature pattern of low birth weight newborns admitted to a Neonatal Intensive Care Unit.

METHODOLOGY

This is a cross-sectional and quantitative study conducted in a NICU of a maternity hospital in Northeastern Brazil. The institution is a reference in pregnancy and care for high risk NB, comprising the tertiary level within the Unified Health System (SUS, as per its Portuguese acronym), where it provides medium and high complexity care, containing, on average, 23 NICU beds.

This study was attended by all low birth weight, very low birth weight and extremely low birth weight newborns consecutively admitted to the NICU, from September to November 2017, totaling 45 NB. As for the eligibility criteria, we included newborns weighing less than 2,500g in the sample, according to the classification of the Ministry of Health⁽¹⁾, that is, all live births weighing less than 2,500g, very low weight (1,499g to 1,000g) and extremely low weight (<1,000g). Those transferred to other sectors or hospitals were excluded before completing 12 hours of admission to the NICU.

The data were extracted from the medical charts of the participants, through the application of an instrument specifically adapted for NB admitted to the NICU, validated in Brazil⁽¹¹⁾. It includes variables related to pregnancy, delivery and admission to the NICU.

Moreover, the data were collected from information in the medical charts, extracting sociodemographic variables related to the mother, such as age group, number of prenatal consultations, route of performed delivery and most frequent maternal diagnoses of complications during pregnancy. With regard to newborns, we collected: gender, age at the time of admission, type of referral, transport accommodation, weight assessment, most frequent diagnoses, axillary temperature, heart and respiratory rates and hemoglucotest. We analyzed the values related to the axillary temperature obtained in the first hour of admission, with 06 hours of hospitalization and with 12 hours of hospitalization. We should underline that the measurement of axillary temperature is a routine, performed with a digital thermometer, a procedure held by nursing technicians every 03 hours and recorded in the medical chart of the patient.

In order to outline the thermal profile, we used the definition of hypothermia provided by the World Health Organization as a reference, which consists of an axillary temperature below 36.5°C, with its respective subdivisions according to the degree of severity: mild hypothermia from 36.0°C to 36.4°C, considered worrying, potential cold stress; moderate hypothermia: from 32.0°C to 35.9°C, requires urgent heating; severe hypothermia: axillary temperature <32.0°C⁽¹⁾.

The database was prepared using *Microsoft Excel 2010*. In order to analyze data, we used the *Statistical Package for the Social Sciences* software, version 20.0. We applied the Chi-Square test to assess whether the variables are related to a certain level of significance. Nevertheless, for the case of expected values below five, we used the Fisher Exact test. In order to determine statistical significance, we adopted a p -value <0.05 . The research was approved by the Research and Ethics Committee of the Federal University of Rio Grande do Norte under opinion nº 2151757 and Certificate of Presentation for Ethical Appreciation nº 69051317.0.0000.5292, as determined by Resolution nº 466/12 of the National Health Council.

RESULTS

As for the sociodemographic data of the mothers, we found an average age of 26.3 years and that 62.07% of the patients had less than six prenatal consultations, where the majority consisted of surgical deliveries (71.11%). The most frequent maternal diagnoses of complications during pregnancy were: urinary tract infection (22.22%), gestational hypertension (15.56%) and premature placental abruption (8.89%).

Regarding the characteristics of NB, most were male (55.56%); 95.56% were born in that maternity hospital and were transferred to the NICU in a heated transport incubator. None of these patients were transferred before completing 12 hours of hospitalization in the NICU during the months from September to November. Accordingly, newborns were not excluded from the sample. There was also no death in the study group.

Table 1 shows the sample with regard to sociodemographic and clinical characterization, including birth weight in more details, where 40.0% (n=18) were LBWNB ($<2,500\text{g}$ and $\geq 1,500\text{g}$).

Table 1: Distribution of sociodemographic and clinical variables of mothers and newborns. Natal, Rio Grande do Norte, Brazil, 2017.

Characteristics	F	%
Mothers		
Age		
< 18 years	7	15.55
≥ 18 years	38	84.44
Number of prenatal consultations		
6 or more consultations	16	35.55
Less than 6 consultations	13	28.88
Without records in the medical chart		
Did not perform prenatal care	3	6.66
Route of delivery		
Abdominal	32	71.11
Vaginal	13	28.89
Newborns		
Gender		
Male	25	55.56
Female	20	44.44

Age at the time of admission		
<12 hours	42	93.33
>12 hours	3	6.67
Type of referral		
OSC	33	73.34
HDU	10	22.22
Others	2	4.44
Transport accommodation		
Incubator	44	97.78
Arms of professionals	1	2.22
Weight assessment		
Low weight	18	40.00
Very Low Weight	15	33.33
Extreme Low Weight	12	26.67
Total	45	100.00

OSC: Obstetric surgical center; HDU: Humanized delivery unit

As this is a research with neonates with birth weight below 2,500g, the prematurity factor was present in 97.78%, where other most frequent medical diagnoses related to the transfer of the newborn to the NICU were: respiratory distress syndrome (n=41) 91.11% and infectious risk (n=25) 55.56%, with 100% of cases of infectious risk appearing associated with the diagnosis of respiratory distress. We should underline that, in this variable, newborns could present more than one diagnosis.

According to Table 1, most NB (73.34%) came from the obstetric surgical center, 22.22% from the Humanized Delivery Unit and only 4.44% had other places of delivery. We should highlight that 93.33% of neonates arrived at the NICU with less than 12 hours of life, 97.78% transported in a heated transport incubator, for a short journey and, therefore, a short period. Only 33.33% of the newborns had some type of venous access at admission, 24.44% with umbilical catheter and 8.89% with peripheral venous access.

At birth, NB are welcomed and accommodated in radiant heat cribs, under previously heated sheets, sometimes cotton caps and polyurethane bags are placed, and they are monitored in relation to oxygen saturation and heart rate. However, delivery rooms do not have an environmental thermometer, and then temperature is maintained by air conditioning.

Table 2: Variation of vital signs. Natal, Rio Grande do Norte, Brazil, 2017

Variables	Median	Average±SD
Axillary temperature in the first hour of admission	35.20	34.98±1.12
Axillary temperature with six hours of hospitalization	35.60	35.48±1.50
Axillary temperature with twelve hours of hospitalization	36.30	36.04±1.05
Heart rate*	134.00	135.44±18.38

Respiratory rate*	48.00	45.62±12.60
Hemoglucotest*	55.00	64.33±25.70

SD: Standard deviation; *Parameters at the time of admission to the NICU.

As for the body temperature results at the time of admission to the NICU, we obtained an axillary temperature average of (34.98°C±1.12). The hypothermia rate at the time of admission was considerably important, about 93.33% of newborns arrived at the NICU with temperatures below normal parameters, of which 37 had moderate hypothermia, 04 with mild hypothermia. Only 03 arrived normothermic and 01 with hyperthermia.

The data also shows a gradual reduction in the hypothermia rate as the hospital stay is prolonged, and then the hypothermia rate after 06 hours of hospitalization drops to 73.33% and, subsequently, to 57.78% with 12 hours of hospitalization, being the average temperature equal to 36.04°C considered mild hypothermia.

We should underline that the LBWNB obtained a better thermoregulation response during the 12 hours of hospitalization when compared to the groups of very low weight and extremely low weight (Table 3).

Of the NICU accommodations, 05 newborns remained in a heated crib with radiant heat, 03 of them being of low weight, 01 of very low weight and 01 of extremely low weight.

As there is no reception room, the newborns are directly accommodated inside the NICU in a heated and humidified incubator according to the degree of maturity and needs of NB or in radiant heat cribs – RHC. In addition, polyurethane bags, cotton caps and cotton blankets wrapped with film paper made by the nursing team are used. We should underline that the NICU does not have thermometers to regulate the temperature fluctuation that is maintained by means of air conditioning according to the needs of the professionals.

Despite the existence of minimal handling protocols, due to the severity of this population, the need for invasive procedures that are essential to life, but that interfere with the maintenance of temperature, is frequent, because with the opening of the incubator, there is circulation of air currents that entail heat loss.

Table 3: Characterization of the profile of body temperature with the categories of birth weight and heart rate. Natal, Rio Grande do Norte, Brazil, 2017.

General characteristics	Temperature		P-value
	<36.5°C	≥36.5°C	
Weight x T1			
LBWNB	100.00% (n=18)	0.00% (n=0)	0.300*
VLWNB	86.67% (n=13)	13.33% (n=2)	
ELWNB	91.67% (n=11)	8.33% (n=1)	
Weight x T2			
LBWNB	55.56% (n=10)	44.44% (n=8)	0,087*
VLWNB	86.67% (n=13)	13.33% (n=2)	
ELWNB	83.33% (n=10)	16.67% (n=2)	

Weight x T3			
LBWNB	44.44% (n=8)	55.56% (n=10)	
VLBWNB	60.00% (n=9)	40.00% (n=6)	0,246 *
ELBWNB	75.00% (n=9)	25.00% (n=3)	
Heart rate			
<120bpm	100.00% (n=8)	0.00% (n=0)	
120-160bpm	80.00% (n=16)	20.00% (n=4)	0,031*
>160bpm	52.94% (n=9)	47.06% (n=8)	

*Chi-square; LBWNB: low birth weight newborns; VLBWNB: very low birth weight newborns; ELBWNB: extremely low birth weight newborns; T1: axillary temperature in the first hour of admission; T2: axillary temperature with six hours of hospitalization; T3: axillary temperature with twelve hours of hospitalization.

As for vital signs, when correlating temperatures in the first hour, with 06 hours and with 12 hours of hospitalization with weight and heart rate, we obtained a statistical difference only in the relationship between temperature and heart rate (HR). Moreover, we found that all newborns with HR below 120bpm showed low temperatures.

DISCUSSION

The period considered for the fetal-neonatal transition covers all the changes that took place in the first 24 hours of life and it is considered a critical period, taking into account that the newborn needs to perform the vital functions that were previously performed by the placenta. There are anatomical and physiological changes that favor the adaptation process to the new environment, such as cardiovascular and respiratory patterns that limit this transition. After birth, hypoxia and exposure to temperature stimulate the activation of the respiratory system⁽¹²⁾.

Low birth weight is considered the main isolated factor of neonatal morbidity and mortality, directly related to socioeconomic conditions and the access of the general population to health services. However, there is an increase in low birth weight in large urban centers that is related to the culture of technological interventions during pregnancy, as well as the insertion of female workforce in the job market^(13,14).

The low birth weight factor was the only isolated indicator in another study that indicated greater difficulty in reaching adequate body temperature, with hypothermia during transports. Cesarean section may have a protective effect in high risk pregnancies on neonatal morbidity and mortality rates, especially for risky, preterm and low weight NB. However, in this study, no significant differences were found regarding body temperature and delivery route⁽¹⁴⁾.

In this study, the prematurity factor was the most frequently related to the transfer of newborns to the NICU, in addition to other related medical diagnoses: respiratory distress syndrome and infectious risk. In a study conducted in a maternity hospital in Fortaleza – Ceará with 46 newborns in which 52.2% of the studied sample was full term newborns, the most prevalent medical diagnoses were: respiratory distress syndrome (26.1%), early jaundice (13%) and prematurity (6.5%)⁽⁷⁾.

Prematurity, as a morbidity, is related to respiratory disorders and infectious and neurological complications⁽¹³⁾. This information reflects the results found in this study, where respiratory distress was the first most cited diagnosis after prematurity.

As for the most frequent nursing diagnoses in the NICU, hypothermia appears more frequently at the time of the admissions, a finding unveiled in studies conducted in tropical countries such as Brazil. In addition, it is known that hypothermia increases the metabolic rate and oxygen consumption, which can further aggravate the respiratory distress already common in premature infants^(7,15).

Thermal instability is an important risk factor. Therefore, both hypothermia and hyperthermia need to be reestablished, since they entail severe metabolic wear and tear intrinsic to the newborn regardless of the associated disease, as they can cause severe changes in vital signs (including tachycardia or bradycardia, tachypnea and apnea) and increased energy consumption. A study that assessed the factors associated with hypothermia during intrahospital transport concluded that the most common risk factors were: axillary temperature below 36.5°C before starting transport and low birth weight^(4,8).

It is understandable that the lower the birth weight, the more vulnerable the newborn is. This arises from the immaturity of the organs and systems and implies greater interventions on the neonate, thereby increasing the risk of negative outcomes. In this research, there were no significant differences in hypothermia at the time of the admission to the NICU among the categories of low weight, very low weight and extremely low weight. However, the lower the body weight, the greater the incidence of axillary temperature below 36.5°C during the hours of hospitalization (check Table 3), which is in line with the other studies that indicate low weight as a relevant risk factor for hypothermia^(2-4,16).

This is due to the skin characteristics of the premature newborn, because, in addition to having less amount of adipose tissue that works as a thermal insulator, the stratum corneum is also immature, thereby entailing greater water loss through the epidermis and increased insensible losses, which results in cold skin, dehydration and thermal instability⁽¹⁷⁾.

The axillary temperature average at the admission to the NICU, that is, right after the intrahospital transport from the delivery room to the NICU, was 34.98°C. We should underline that all were transferred before 12 hours of life, and despite this, the occurrence of hypothermia is considerable. Studies have shown that, for each decrease of 1°C in the admission temperature below 36°C, there is an increase in mortality by 28% and delayed sepsis by 11%^(2,18).

A study conducted in California with premature newborns with birth weight below 1,500g sought to implement routines in the delivery room, transport and admission to the NICU. The primary outcome of this study showed that the overall percentage of hypothermia was reduced from 44% in early 2006 to 0% in 2009. There was a slight increase to 6% in 2010, but the rate returned to 0% in 2011; and, as a secondary result during this period, increased survival without severe morbidity was obtained⁽²⁾.

Simple measures such as managing the delivery room temperature, using heated cloths, polyethylene wrap, radiant heat, heated and double-walled transport incubator,

preparing the NICU admission room and well established protocols for all who care for the newborn may be essential to eliminate hypothermia and significantly improve the quality of care offered^(4,7,18).

A case-control study that assessed whether the rates of neonatal hypothermia in the admission rooms were influenced by the increase in the ambient temperature of the surgery room showed that the presence of moderate to severe hypothermia was not frequent when the temperature of the surgery room was 23°C (5%); in contrast, such hypothermia took place in 19% in the group in which the surgery room maintained temperatures around 20°C, $p < 0.001$ ⁽¹⁸⁾.

As for the use of humidified incubators, the pertinent literature has shown that there have been no great benefits regarding their use in maintaining body temperature, although an additional benefit of high humidity for extremely premature newborns has been described by several authors regarding the decrease hydroelectrolytic disorders. Therefore, it is ideal to use double-walled incubators with humidification from 80% to prevent mainly insensitive losses of heat through evaporation and hypothermia⁽¹⁹⁾.

We should highlight that, for very low birth weight and extremely low birth weight newborns, care will be of better quality the less handling happens. The implementation of protocols for minimal handling and grouping of care aims to reduce not only intracranial hemorrhage and other complications, but also enables a reduction in temperature variation inside the incubator, thereby maintaining the homeothermic environment and preventing additional stress for NB⁽¹⁹⁾.

The multiprofessional team should be cooperative and pay attention to the establishment of a more humanized and patient-centered care. Nursing is an essential profession in improving care processes, as well as managing sectors and accomplishing the continuing education process of the health team⁽⁷⁾.

It becomes necessary to implement protocols for the prevention of hypothermia not only at the time of admission to the NICU, but also throughout the journey from the delivery, in order to eradicate rates of severe hypothermia with difficult management and prevent the onset of associated morbidities.

With respect to the limitations of this study, the analysis was restricted to low birth weight NB in an NICU, which reduces the potential for the generalization of its results. Nevertheless, the limitation does not invalidate the study, thereby providing an adequate response to what was proposed.

CONCLUSION

From this research, we can perceive that there are flaws in the processes when it comes to body temperature, as it was obtained that almost the entire sample arrives at the NICU with potential cold stress, often in stages of difficult reversion. Accordingly, it is essential to implement new protocols in delivery rooms that describe the standard surgical procedures to guide medical and nursing professionals and residents so that the continuing education team can routinely assess whether there has been any benefit, such as improvement in temperature levels and, by means of a feedback, define what still needs to be improved in the procedures in delivery rooms, in the

transport and in the admission in intensive care centers, in order to ensure harm-free care, since hypothermia is a potentially avoidable clinical complication.

Among the approachable measures for maintaining the temperature of NB in this reality, we highlight the temperature control in the delivery room and the training of the team, from the delivery room to the transport to the NICU, thereby raising awareness of the importance of temperature, continuous parameter verification, use of incubators, polyurethane wraps and cotton caps.

We can conclude that there is a certain devaluation of the diagnosis of hypothermia and its clinical complications in view of the routines established for the care processes. The act of ensuring quality care for high risk NB can be very complex and largely depends, among other things, on a multiprofessional team trained and committed to reducing exposure of the newborn to cold and, consequently, to reducing the rates of hypothermia and its complications. Some studies already show that hypothermia can be totally avoided, as well as the benefits that this may bring.

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