Review Article
Artigo de Revisão
Artículo de Revisión

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

Thermoregulation strategies in premature newborns: a scoping review

Estratégias de termorregulação em recém-nascidos prematuros: uma revisão de escopo

Estrategias de termorregulación en recién nacidos prematuros: una revisión de alcance

José Antonio de Sá Neto[I]; Marialda Moreira Christoffel[I]; Gláucia Cristina Lima da Silva[I]; Adriana Teixeira Reis[II]; Aline Cerqueira Santos Santana da Silva[III]; Elisa da Conceição Rodrigues[I]

[I]Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; [II]Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil; [III]Universidade Federal Fluminense, Rio das Ostras, Brazil

ABSTRACT

Objective: to map strategies for controlling and regulating body temperature in premature newborns. **Method:** scope review on premature thermoregulation, guided by the recommendations of the Joanna Briggs Institute, developed in eight electronic databases. The search, synthesis and analysis of the results took place in December 2022. **Results:** the review was made up of 15 studies, which were grouped into two categories: Heat sources and use of measurement packages/bundle. As strategies for maintaining the body temperature of preterm infants, the following stand out: adequate maternal and environmental temperature; plastic wrap; double bonnet; heated cloths; air heating in respiratory support; skin-to-skin contact; heated cribs and incubators. It was evident that the combined resources were more effective than when used separately. **Conclusion:** the scoping review results pointed to strategies that can be used to mitigate the risks of hypothermia in premature newborns.
Descriptors: Patient Safety; Infant, Premature; Body Temperature Regulation; Hypothermia; Health Strategies.

RESUMO

Objetivo: mapear as estratégias para o controle e regulação da temperatura corporal em recém-nascidos prematuros. **Método:** revisão de escopo sobre termorregulação do prematuro, orientada pelas recomendações do Instituto Joanna Briggs, desenvolvida em oito bases de informações eletrônica. A busca, síntese e análise dos resultados ocorreu em dezembro de 2022. **Resultados:** compuseram a revisão 15 estudos que foram agrupados em duas categorias: Fontes de calor e uso de pacotes de medidas/bundle. Como estratégias para manutenção da temperatura corporal do prematuro, destacam-se: temperatura adequada materna e do ambiente; envoltório plástico; touca dupla; panos aquecidos; aquecimento do ar no suporte respiratório; contato pele a pele; berços aquecidos e incubadoras. Evidenciou-se que os recursos conjugados foram mais efetivos do que quando usados isoladamente. **Conclusão:** os resultados da revisão de escopo apontaram para estratégias que podem ser utilizadas para mitigar os riscos de hipotermia em recém-nascidos prematuros.
Descritores: Segurança do Paciente; Recém-Nascido Prematuro**;** Regulação da Temperatura Corporal; Hipotermia**;** Estratégias de Saúde.

RESUMEN

Objetivo: mapear estrategias para el control y regulación de la temperatura corporal en recién nacidos prematuros. Método: revisión de alcance sobre la termorregulación prematura, siguiendo las recomendaciones del Instituto Joanna Briggs, desarrollada en ocho bases de datos electrónicas. La búsqueda, la síntesis y el análisis de los resultados se llevaron a cabo en diciembre de 2022. Resultados: la revisión fue conformada de 15 estudios, agrupados en dos categorías: fuentes de calor y uso de paquetes de medidas/bundle. Como estrategias para mantener la temperatura corporal del prematuro se destacan: temperatura adecuada materna y ambiental; envoltura de plástico; gorro doble; paños tibios; calentamiento del aire en soporte respiratorio; contacto piel a piel; cunas calefaccionadas e incubadoras. Se evidenció que los recursos combinados fueron más efectivos que si usados de forma individual. Conclusión: los resultados de la revisión de alcance señalaron estrategias que pueden usarse para mitigar los riesgos de hipotermia en recién nacidos prematuros.
Descriptores: Seguridad del Paciente; Recién Nacido-Prematuro; Regulación de la Temperatura Corporal; Hipotermia; Estrategias de Salud.

INTRODUCTION

Prematurity represents one of the main causes of neonatal morbidity and mortality, as it is related to the morphological and functional immaturity of organs and systems. Preterm newborns (PTNBs) are more susceptible to hypothermia, for example, which causes sometimes irreversible complications and harms. PTNBs' low body temperature can increase the morbidity and mortality indicators, hindering the physiological adaptations they undergo in the first hours of life[1].

The normal range of a newborn (NB) body temperature is from 36.5ºC to 37ºC and can be stratified according to its intensity into potential cold stress (mild hypothermia), characterized by temperature values between 36.0ºC and 36.4ºC; moderate hypothermia, between 32.0ºC and 35.9ºC; and severe hypothermia, where temperatures lower than 32.0ºC are evidenced[2].

Corresponding author: José Antonio de Sá Neto. E-mail: jas.neto2009@gmail.com
Editor in chief: Cristiane Helena Gallasch; Associate Editor: Magda Guimarães de Araujo Faria

Received: Apr 18th 2023 – Accepted: Aug 10th 2023

Review Article
Artigo de Revisão
Artículo de Revisión

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

Neonatal hypothermia is considered a serious event that needs to be avoided, preventing drastic consequences in this population segment. Therefore, the lower the temperature, the greater the morbidity and mortality risks and the more the problems in the child's growth and development, whether of a biological, behavioral, emotional, social or learning nature[3,4].

A national study in a public university hospital evaluated the prevalence of hypothermia after birth and in the first hours after admission to the Neonatal Intensive Care Unit (NICU), associated maternal and neonatal factors and the possible relationship with morbidity and mortality in PTNBs and newborns with very low birth weight (VLBW NBs). Hypothermia in the delivery room, on admission to the NICU and from two to three hours after admission was 25.8%, 41.5% and 40.2%, respectively. NB temperature was directly proportional to gestational age, birth weight and Apgar score, and was also associated with maternal factors and increased morbidity and mortality. It was observed that intracranial hemorrhage, late-onset sepsis and death were associated with hypothermia in PTNBs and VLBW NBs on admission to the NICU[5].

In order to reduce this incidence, some hypothermia prevention measures for PTNBs are already implemented in the Delivery Room (DR), Rooming-In (RI) and Neonatal Unit (NU). The goal of these measures is to maintain body temperature, as well as to reduce harms caused by thermal imbalance[6].

Preventing harms to the patient should be the goal of all health care measures, even in neonatal units. PTNBs represent an extremely vulnerable population to temperature variations, rendering it essential to focus on preventing incidents for this clientele. Given its magnitude and impact on NBs, we can consider hypothermia as a serious incident in this population segment. An incident is "any event or circumstance that could have resulted, or did result, in unnecessary harms"[7]. One of the actions for the development of patient safety is to promote a safe environment and guarantee good practices in health services[8].

Based on these reflections, the objective of this study was to map diverse scientific evidence on strategies for controlling and regulating body temperature in preterm newborns.

METHOD

A scoping review conducted following the methodology proposed by the Joanna Briggs Institute, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis-Extension for Scoping Reviews (PRISMA-ScR), registered in the Open Science Framework (OSF) as xfh86.

The method proposed by the JBI has five stages: 1) Identification of the research question; 2) Identification of the relevant studies; 3) Selection of the studies; 4) Data analysis; and 5) Data grouping, synthesis and presentation[9].

To formulate the research question, the PCC (Population, Concept and Context) mnemonic was used: P – It included studies involving preterm newborns before the 37th gestation week; C – Strategies for temperature control; C – Assistance provided to the patient in a hospital environment, which may be in a Delivery Room, Rooming-In (RI), Neonatal Unit (NU), Intensive Care Unit (ICU) and other sectors identified in this review. The research question formulated was as follows: "Which are the strategies used to regulate body temperature in preterm newborns in the hospital environment?"

The search strategy was carried out in three stages, as recommended by the JBI. The preliminary stage was the search in the BVS and MEDLINE/PubMed information sources using keywords, descriptors, alternative terms and/or synonyms that may be relevant to the question. The second stage considered the preliminary search results to identify new terms found in the documents. The third and final stage (analysis) had the objective of identifying potential studies in the references to be included in the Scoping Review.

From the research question, the search terms, descriptors and their synonyms in Portuguese, English, Spanish and French were identified in the controlled vocabularies from the Descriptors in Health Sciences (*Descritores em Ciências da Saúde*, DeCS), Medical Subject Headings (MeSH) and Embase Subject Headings (Emtree). The terms "Preterm Newborn", "Health Strategies", "Body Temperature Regulation", "thermal regulation" and "hospital environment" were organized to elaborate search strategies in the information databases, with quotation marks ("") used to restrict and establish the order of compound terms, as well as the AND and OR Boolean operators, the former for intersection of terms and the latter for grouping/sum of synonyms.

The search was performed on December 12th, 2022, in the following data sources: Regional Portal of the Virtual Health Library (*Biblioteca Virtual em Saúde*, BVS) and its main databases - Latin American and Caribbean Literature in Health Sciences (*Literatura Latino-Americana e do Caribe em Ciências da Saúde*, LILACS), Spanish Bibliographic in Sciences (*Índice Bibliográfico Español en Ciencias de la Salud*, IBECS), and National Collection of Information Sources of the Unified Health System Health (ColecionaSUS). The following multidisciplinary databases were accessed at the CAPES Journals Portal: Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Academic Search Premier (Ebsco); Scopus and Embase (Elsevier) and Web of Science (Clarivate Analytics). The following sources were also used: PubMed portal, MEDLINE database of the National Library of Medicine (NLM), Scientific Electronic Library Online

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

(SciELO) and the Cochrane Library (Wiley). Gray Literature (GL) databases were not used, only considering the GL from the Scopus, WHO and Embase databases.

The time frame between 2017 and 2022 was considered, when new neonatal resuscitation guidelines were established for NBs younger than 34 weeks of gestational age (GA). During this period, temperature became a predictor of outcomes and a care quality indicator[10].

Experimental studies were used, including randomized controlled trials, non-randomized controlled trials, before-and-after studies, and interrupted time-series studies. Analytical observational studies, including prospective and retrospective cohort studies, case-control studies, and analytical cross-sectional studies, were also employed. Descriptive observational studies were also accessed, including case series, individual case reports and descriptive cross-sectional studies. Chapters from books and E-books, letters to the editor, abstracts in annals, incomplete articles, and studies in the project phase or without results were excluded from the search.

The set of references identified in the databases was added to Endnote to identify duplicates and then imported into the Rayyan® – Intelligent Systematic Review system, a free web app for review selection.

The selection process was carried out independently by two reviewers and, in case of disagreement, a third reviewer was called. In the first stage, the titles and abstracts of the documents were read. Potentially eligible articles were retrieved in full for reading and selection in the second stage.

To extract data from the documents included, an instrument developed by the reviewers was used, based on the model available in the JBI manual. Data extraction was performed independently by two reviewers with the assistance of a third one.

RESULTS

Presentation of the results follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses-Extension for Scoping Reviews (PRISMA-ScR). The format to present the results was conducted in order to provide an overview of the results. The search and selection results are described in the PRISMA-ScR flowchart (Figure 1)[11].

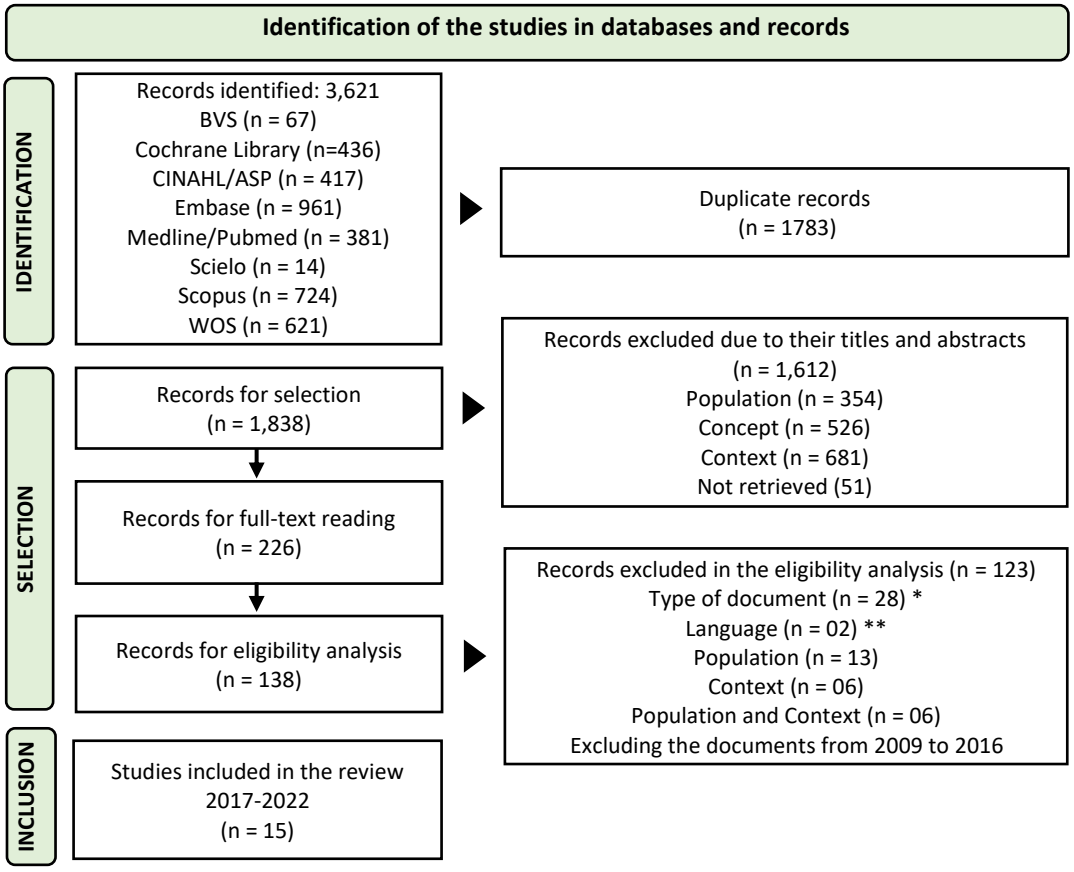

FIGURE 1: Flowchart corresponding to the search and selection of articles. Rio de Janeiro, RJ, Brazil, 2022.

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

The search in the databases resulted in 3,621 documents, of which 1,783 were duplicates, leaving 1,838 documents to read their titles and abstracts. After applying the PCC strategy, 1,612 records were excluded, totaling 226 studies for full-reading and peer selection in the RAYYAN software. After a thorough reading, productions that did not meet the context of the place of delivery and birth and admission (Delivery Room/ICU or NICU) and incomplete and duplicate texts were excluded, extracting 54 articles. Considering the study time frame, in the end there were 15 productions for this scoping review.

Most of the studies analyzed were published in English, from the Asian continent, Europe, North America and Oceania. Iran and England stand out with two multicenter studies, followed by one between the United States and the United Kingdom and another between Germany, France and Sweden. There was predominance of international publications, in high-impact journals, randomized clinical trials, and of the before-and-after type. The main objectives were to study isolated or combined warming strategies, and bundles in the prevention of neonatal hypothermia in PTNBs (Figure 2).

Year/Continent/Country	Type of study	Objective
2017/Asia/Malaysia[11]	Randomized controlled clinical trial	To determine if polyethylene caps are more effective than cotton caps as adjuvants to polyethylene occlusive body wraps in reducing hypothermia in PTNBs
2017/Asia/Iran[12]	Randomized controlled clinical trial	To investigate the effects of using plastic covers on vital signs regulation in PTNBs
2017/Asia/Iran[13]	Randomized controlled clinical trial	To compare the effects of plastic covers versus blankets combined with heated cribs
2018/Asia/Korea[14]	Clinical trial	To determine the impact of reducing hypothermia at admission in PTNBs through an improvement bundle
2018/North America and Europe/United States and United Kingdom[15]	Multicenter randomized controlled clinical trial	To evaluate the efficacy and safety of interventions intended to prevent hypothermia in preterm and/or low weight newborns
2018/Oceania/Australia[16]	Randomized controlled clinical trial	To determine if using heated and humidified gases for respiratory support reduces the hypothermia rates at NICU admission
2018/Europe/Germany, Paris and Stockholm[17]	Prospective, multicenter and time-series cohort study	To investigate the different strategies used in 11 European countries to prevent hypothermia
2019/Europe/England[18]	Randomized controlled clinical trial	To determine the efficacy of polyethylene wraps in thermal regulation in preterm neonates.
2019/North America/Canada[19]	Randomized controlled clinical trial	To describe the effect of the occlusive bandage treatment applied immediately after birth in PTNBs
2019/Asia/Iran[20]	Randomized controlled clinical trial	To compare the efficacy of two polyethylene covers on PTNB body temperature and oxygen saturation
2020/Asia/Israel[21]	Case-control study	To develop a multifactorial approach to reduce the incidence of neonatal hypothermia at NICU admission
2021/Asia/Pakistan[22]	Quasi-experimental study	To establish the efficacy of polyethylene wraps in preventing neonatal hypothermia in preterm and low weight newborns
2021/Europe/England[23]	Randomized controlled clinical trial	To implement a thermal care bundle for PTNBs
2022/Europe/Scandinavia[24]	Randomized controlled clinical trial	To investigate the impact of immediate skin-to-skin contact with the parents after birth in PTNB thermal regulation
2022/Asia/China[25]	Prospective, multicenter and time-series cohort study	To evaluate the efficacy of a Quality Improvement (QI) targeted project that applied hypothermia prevention measures to PTNBs and VLBW NBs in tertiary-level NICUs from China

FIGURE 2: Synthesis of the results obtained. Rio de Janeiro, RJ, Brazil, 2022.

The scope was divided according to its variables, so that its nature, objective, methodology and, mainly, the recommendations, guidelines, strategies and directions for controlling and regulating PTNB temperature could be understood. The population studied in this review was predominantly extremely preterm NBs with a mean age between 28 and 30 weeks, with most studies developed in the Delivery Room and NICU environments and within the first hour of life[13-15,17-19,20-25]. Figure 3 presents the categorization of the data extracted from the bibliographic survey, according to Stage 4 of the JBI method.

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

Scope categories	Strategies	Population	Context	Outcome
HEAT SOURCES	Polyethylene x Cotton cap combined with body wrap [12]	PTNBs 24-34 weeks	DR and NICU	The polyethylene body wrap and polyethylene cap combination was associated with a higher post-stabilization mean temperature when compared to polyethylene body wrap and cotton cap
	Plastic cover x Blanket [13]	PTNBs 28-30 weeks	NICU	Using a plastic cover during the NICU hospitalization prevented hypothermia in preterm newborns, with oxygen saturation within the normal limits
	Plastic cover x Blanket [14]	PTNBs 28-30 weeks and birth weight 800-1,250 g	NICU	The plastic cover in the first NICU hospitalization days resulted in regulation of the PTNB body temperature when compared to the blanket
	Polyethylene wraps x Heated field combined with heated crib [19]	PTNBs <34 weeks	DR and NICU	The polyethylene wraps achieved faster thermal control and proved to be effective in preventing hypothermia in PTNBs
	With polyethylene wrap or without wrap [20]	PTNBs 24-28 weeks	DR and NICU	There was a trend towards increased baseline temperature in the wrap group
	Polythene cap x Polythene bag x Routine care measures* [21]	PTNBs 28-36 weeks	NICU	The polyethylene cap and polyethylene bag association maintained body temperature and oxygen saturation in PTNBs transferred to the NICU
	Polyethylene wrap vs Conventional blankets [23]	PTNBs 28-36 weeks and birth weight between 1,000 and 2,500 g	DR and NICU	Using polyethylene wraps in PTNBs and low birth weight newborns potentially offers a useful intervention in preventing neonatal hypothermia
	Skin-to-skin contact x Routine care measures [25]	PTNBs 28-32 weeks	DR and NICU	Regardless of clinical stability, extremely preterm neonates do not develop hypothermia during immediate skin-to-skin contact after birth
	Use of heated and humidified conditioned gases x Unconditioned gases [17]	PTNBs <30 weeks	DR and NICU	Using heated and humidified gases in the delivery room significantly reduces hypothermia at NICU admission in PTNBs.
USE OF BUNDLES	Combined interventions: Bag or plastic bag x Routine care measures; Skin-to-skin contact x Routine care measures; Thermal mattress x Routine care measures [16]	PTNBs <37 weeks and/or birth weight ≤2,500 g	DR and NICU	The meta-analysis showed that, when compared to the routine care measures, combining interventions improves PTNBs' core body temperature
	Combined interventions: Plastic bags; Heated cloths; Caps; Exothermic heat; Thermal mattresses [18]	PTNBs 22-32 weeks	DR and NICU	Systematic use of one or more prevention strategies reduced the hypothermia rates in PTNBs
	Quality Improvement (QI) combined interventions: Occlusive wrap; Exothermic mattresses; Higher ambient temperatures in the operating and delivery rooms [26]	PTNBs <32 weeks	DR and NICU	Occlusive bandage, exothermic mattresses and adequate room temperature can reduce neonatal hypothermia at admission
	Quality Improvement (QI) multimodal approach with low-fidelity simulations; *In situ* simulations, protocol for thermal care measures and performance feedback; Incorporation of practice and maintenance of performance [24]	PTNBs <30 weeks	NICU	The Quality Improvement multimodal approach achieved a sustained improvement in normothermia. Continuous temperature monitoring during stabilization allows the resuscitation teams to plan interventions to treat hypothermia and hyperthermia
	Plan-Do-Study-Act (PDSA) consecutive action cycles, with combined interventions: Transport incubator; Pre-heated cap; Polyethylene wrap; Team training and education; Temperature documentation and workflows [22]	PTNBs <32 weeks	DR and NICU	Targeted interventions can reduce hypothermia at admission and improve outcomes in preterm and very low birth weight newborns
	Combined interventions for Quality Improvement (QI): Occlusive bandages, Warm blankets and caps; Delivery room temperature above 23.0˚C; Checklists. [15]	PTNBs 24-34 weeks	DR and NICU	A significant reduction was evidenced in hypothermia at admission after introducing a standardized protocol into our QI effort.

FIGURE 3 - Scope of the main warming strategies in preterm newborns. Rio de Janeiro, RJ, Brazil, 2023.
*Maintain temperature of the place of delivery and birth at 23-25ºC, and between 36.5-37.5ºC for the parturient woman; receive the NB in the field and heated crib, drying the body and cephalic pole with heated compresses; remove wet fields; NB vitality assessment[3,4].

Research Article
Artigo de Pesquisa
Artículo de Investigación

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

The scientific productions were categorized into two major thematic axes: Heat sources and Use of bundles.

Heat sources

This axis, the largest in the scoping review, included a compilation of nine scientific productions[12-14,19-21,23,25,27] that highlighted individual thermal protection methods for PTNBs. The use of polyethylene bags, thermal mattresses and resorting to the Kangaroo method stand out as recommended interventions.

Using plastic bags for PTNB thermal regulation was the strategy recommended by some authors[12-14,19-21,23]. Although using the same strategy and mechanisms, two different articles made a comparison between the use of plastic bags and blankets, which evaluated that only plastic bags prevented the incidence of hypothermia[13,14].

A clinical research study investigated the efficacy of polyethylene wraps in 151 PTNBs younger than 34 weeks of gestational age. In the Control Group, the newborns were transferred to the heated crib and wrapped in a heated field after the initial care measures. In the Intervention Group they were placed in the heated crib with a polyethylene bag. The mean temperature was significantly higher in the Intervention Group than in the Control Group ($p<0.001$). They concluded that significantly fewer PTNBs suffered hypothermia in the Intervention Group (67.6%) when compared to the Control Group (87%)[19].

Caps are also strategies mentioned for regulating PTNBs' body temperature[21]. One research study compared the use of a polyethylene cap and a cotton cap along with a polyethylene wrap to prevent hypothermia. It was verified that the combined use of the wrap and the polyethylene cap was more effective for PTNB thermal regulation[12].

The impact of immediate skin-to-skin contact after birth on the thermal regulation of PTNBs with between 28 and 32 gestational weeks was also described, showing that skin-to-skin contact was effective in preventing the incidence of hypothermia immediately after birth[25].

The application of heated and humidified air to reduce hypothermia rates on admission to the NICU was been described. In a randomized clinical study conducted with PTNBs over 30 weeks, it was found that the use of heated and humidified air significantly reduced the incidence of hypothermia in PTNBs upon admission to the NICU[17].

Use of bundles

In this thematic axis, six articles[15,16,18,22,24,26] were included that describe combined interventions for the prevention of hypothermia and use of good quality tools to improve thermal regulation processes in PTNBs. In a study carried out with extremely low birth weight PTNBs, the following strategies were described: occlusive plastic wrap; heated blankets and caps and maintaining temperature in the delivery room above 23.0°C. In a sample of 259 PTNBs, there was a 27% reduction in the incidence of hypothermia, with an increase in the PTNBs' mean body temperature in the NICU[26].

Another intervention was applied in the period of up to 10 minutes after birth, still in the delivery room: using a plastic bag, skin-to-skin contact and thermal mattress were effective measures for the prevention and thermal regulation in PTNBs[16].

Plastic bags, cloths and heated mattresses to prevent hypothermia in PTNBs were strategies used in a set of 11 European countries. It was evidenced that using of strategies, especially combined, was effective in PTNBs' thermal regulation in NICUs[18]. A multifactorial intervention using the occlusive plastic wrap and exothermic mattress strategies proved to be effective in reducing the incidence of hypothermia, especially for PTNBs with less than 32 gestational weeks. Similar successful results were also found in other studies[15,16].

In a multicenter intervention study[17] to improve quality in PTNBs with less than 32 gestational weeks and extremely low weight (less than 1,500 g), a significant reduction in hypothermia in the NICU and an increase in mean body temperature were observed. A multifactorial intervention was performed with the inclusion of a transport incubator, pre-heated caps and polyethylene wrap. An orientation guide for team training was also applied through consecutive improvement cycles, based on the Plan-Do-Study-Act (PDSA) tool.

DISCUSSION

As hypothermia is an important cause of increased neonatal mortality worldwide[27], it is a subject matter of fundamental importance for the review of good clinical practices, in search of qualified and risk-free care for NBs.

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

Safety in a NICU should be a priority care goal, involving professionals and families. Improving care quality is a one of the World Health Organization (WHO) priorities to reduce neonatal deaths[28]. Considering hypothermia as a serious and potentially fatal incident for PTNBs, from the perspective of patient safety and with so many resources available, we can assert that neonatal hypothermia is an avoidable incident.

The scoping review showed strategies[12-14,17,19-21,23,25] for thermal control in PTNBs, preventing the occurrence of hypothermia. These strategies are also mentioned in international manuals and guidelines[6,29]. In this way, mortality and many sequelae can be avoided from the delivery ward and even in the NU.

Although the scope *corpus* did not mention the use of heated cribs and incubators as the main strategy for maintaining PTNBs' body temperature, they are direct heat sources to receive, transport and keep NBs warm. Most of the intervention strategies were combined with heated cribs in the delivery room and with transport incubators during transfer to or hospitalization in the NICU[6,30].

A randomized clinical study at a NICU in Pakistan compared the use of a plastic bag (Group A) with an incubator to an incubator (Group B) without a plastic bag in PTNBs younger than 37 weeks and birth weight between 1,000 and 2,500 grams. Efficacy was 52.5% in Group A and 47.5% in Group B. It was verified that the use of plastic bags together with the incubators was more effective than the incubators alone[31].

The mean age of the population studied in this review corresponded predominantly to extremely preterm NBs, from the 28th to the 30th gestational week, with most studies carried out in the delivery room and NICU environments and up to the first hour of life[13-15,17-19,20-25]. These data present an important differential regarding the probability of complications and death in relation to extreme PTNBs and those with extremely low birth weight, characterizing a population with greater vulnerability and exposed to some risks.

It was verified that polyethylene wraps achieved temperature control quickly and sustainably and that they were effective in preventing hypothermia. Their use is widely recognized, even by neonatal resuscitation manuals[6,20], representing a thermal protection strategy, but which may not always be available in maternity hospitals with few resources. The interventions found are already recognized worldwide, highlighting “Kangaroo method” skin-to-skin contact as a simple and low-cost measure[32].

Differences and similarities between the strategies found were evidenced, emphasizing that, when used together, they were more effective than when employed alone[15-16,18,22,24,26]. Applying checklists can be a tool that contributes to guaranteeing the execution of protocols and guiding actions for clinical decision-making[16].

Guidelines and interventions to minimize the hypothermia rates in PTNBs should be known to the entire multidisciplinary team. In addition to efforts to use preventive measures, which can lead to the application of heating technologies, we cannot forget the need for ongoing training, qualification and involvement of the teams.

The main strategies found indicate the use of a bundle (combination of strategies) to guarantee PTNB thermal regulation. The importance of standardized care was identified, in particular with the intervention of a multidisciplinary team (managers, neonatal nurses and physicians specialized in Neonatology, Obstetrics and Maternal-Fetal Medicine).

Allocating professionals devoted to monitoring neonatal temperature in the first hours of life was also a recommended action. Using bundles and external heat sources is effective and low-cost for neonatal units[15,22,24,26].

The scoping review showed that the predominant mean gestational age corresponded to extremely preterm NBs, from 28 to 30 gestational weeks, with most studies developed in the delivery room and NICU environments and within the first hour of life[13-15,17-19,20-25].

Encouragement to maintain normothermia should be present in institutional guidelines, through the discussion of protocols that can guarantee better practices that promote thermal protection, mainly based on the physicians' and nurses' sensitization[33].

It is emphasized that combining two or more interventions for PTNB body temperature regulation was considered more effective for thermal regulation in these groups.

It is noted that the standardization of care based on scientific evidence requires continuous learning from professionals, in order to improve adherence to the guidelines and, thus, reduce the rates of hypothermia cases[29,30].

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

Study limitations

The variability of methodological types and data collection contexts was considered a limitation of this study. This encourages us to reflect on variations in care among health professionals in the Brazilian context. Therefore, for future surveys, either national or international, the suggestion is to carry out studies using other methodologies such as cohort studies, case reports and literature reviews, in order to render the findings generalizable.

CONCLUSION

Recognition of hypothermia and its association with increased mortality of PTNBs were identified in the studies that are part of this review. It is concluded that the joint action of a multidisciplinary team, the use of the Plan-Do-Study-Act tool, am adequate temperature of the environment, plastic wraps, double caps, heated cloths and blankets, heated and humidified air in respiratory support, skin-to-skin contact, heated crib for receiving preterm newborns at the place of delivery and birth, and preheated incubators for transport to the NICU are effective strategies for body temperature control and regulation in preterm newborns.

The studies showed that combined strategies may offer more effective results in the thermal regulation of preterm newborns than isolated strategies. This is known as using “bundles” and associating strategies and resources together in search of better results.

The scoping review pointed to strategies that can be used to mitigate the hypothermia risks in preterm newborns, as well as harmful consequences for this population segment, presenting diverse evidence to guide better clinical practices, reducing the incidence of morbidity and mortality resulting from thermal imbalance in this clientele. The results can also contribute to the development of training programs, forums, debates and discussions, thus updating and qualifying health teams.

REFERENCES

1. Soares T, Pedroza GA, Breigeiron MK, Cunha MLC. Prevalence of hypothermia in the first hour of life of premature infants weighing ≤ 1500g. Rev Gaúcha Enferm. 2020 [cited 2023 Jun 10]; 41(spe):e20190094. DOI: https://doi.org/10.1590/1983-1447.2020.20190094.
2. Bernardino FBS, Gonçalves TM, Pereira TID, Xavier JS, Freitas BHBM, Gaíva MAM. Trends in neonatal mortality in Brazil from 2007 to 2017. Cien Saude Colet. 2022 [cited 2023 Jan 15]; 27(2):567-78. DOI: https://doi.org/10.1590/1413-81232022272.41192020.
3. Garcia KRS, Reis AT, Braga ES, Trugilho FC, Paiva ED, Marta CB. Intervention strategy for prevention of neonatal hypothermia: integration review. Nursing (São Paulo). 2019 [cited 2023 Mar 10]; 22(259):3426-30. DOI: https://doi.org/10.36489/nursing.2019v22i259p3426-3430.
4. Barreto GAN, Serafim ARMR, Pereira DG, Fontenele MMFT, Silva CF, Silva AVS. Efectiveness of interventions for the prevention of hypothermia in premature infants: na integrative review of the literature. Recima21. 2022 [cited 2023 Feb 4]; 3(7):e371707. DOI: https://doi.org/10.47820/recima21.v3i7.1707.
5. Cordeiro RCO, Ferreira DMLM, Reis H, Azevedo VMGO, Protázio AS, Abdallah VOS. Hypothermia and neonatal morbimortality in very low birth weight preterm infants. Rev paul pediatr. 2022 [cited 2023 Jan 14]; 40:e2020349. DOI: https://doi.org/10.1590/1984-0462/2022/40/2020349.
6. Guinsburg, Ruth. Reanimação do recém-nascido <34 semanas em sala de parto: diretrizes 2022 da Sociedade Brasileira de Pediatria. Rio de Janeiro: Sociedade Brasileira de Pediatria. 2022 [cited 2023 Jun 12]. DOI: https://doi.org/10.25060/PRN-SBP-2022-1.
7. Ministério da Saúde (BR). Portaria GM/MS nº 529, de 1º de abril de 2013. Diário Oficial da União: Seção 1. 2013 [cited 2023 Jan 15]. Available from: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2013/prt0529_01_04_2013.html.
8. Ministério da Saúde (BR); Fundação Oswaldo Cruz; Agência Nacional de Vigilância Sanitária (BR). Documento de referência para o Programa Nacional de Segurança do Paciente. Brasília: Ministério da Saúde. 2014 [cited 2023 Jan 15]. 40 p. Available from: https://www.gov.br/saude/pt-br/acesso-a-informacao/acoes-e-programas/pnsp/materiais-de-apoio/arquivos/documento-de-referencia-para-o-programa-nacional-de-seguranca-do-paciente/view.
9. Peters MDJ, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil, H. Chapter 11: Scoping reviews (2020 version). In: Aromataris E, Munn Z (Editors). JBI Manual for Evidence Synthesis. Adelaide, Australia: JBI; 2020 [cited 2023 Jan 14]. DOI: https://doi.org/10.46658/JBIMES-20-12.
10. Guinsburg R, Almeida MFB. Reanimação do prematuro <34 semanas em sala de parto: diretrizes 2016 da Sociedade Brasileira de Pediatria. Sociedade Brasileira de Pediatria. 2016 [cited 2023 Jun 13]. Available from: https://www.sbp.com.br/fileadmin/user_upload/DiretrizesSBPReanimacaoPrematuroMenor34semanas26jan2016.pdf.
11. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med. 2009 [cited 2023 Jan 15]; 339:b2535. DOI: https://doi.org/10.1136/bmj.b2535.
12. Shafie H, Syed Zakaria SZ, Adli A, Shareena I, Rohana J. Polyethylene versus cotton cap as an adjunct to body wrap in preterm infants. Pediatr Int. 2017 Jul [cited 2023 Jan 5]; 59(7):776-80. DOI: https://doi.org/10.1111/ped.13285.
13. Valizadeh L, Mahallei M, Safaiyan A, Ghorbani F, Peyghami M. The Effect of plastic cover on regulation of vital signs in preterm infants: a randomized cross-over clinical trial. Iran J Neonatology. 2017 Jun [cited 2023 Mar 5];8(2). DOI: http://dx.doi.org/10.22038/ijn.2017.15546.1174.

DOI: http://dx.doi.org/10.12957/reuerj.2023.75112

14. Valizadeh L, Mahallei M, Safaiyan A, Ghorbani F, Peyghami M. Comparison of the effect of plastic cover and blanket on body temperature of preterm infants hospitalized in NICU: randomized clinical trial. J Caring Sci. 2017 [cited 2023 Mar 5]; 6(2):163-72. DOI: https://doi.org/10.15171%2Fjcs.2017.016.
15. Choi HS, Lee SM, Eun H, Park M, Park KI, Namgung R. The impact of a quality improvement effort in reducing admission hypothermia in preterm infants following delivery. Korean J Pediatr. 2018 [cited 2023 Mar 22]; 61(8):239-44. DOI: https://doi.org/10.3345/kjp.2018.61.8.239.
16. McCall EM, Alderdice F, Halliday HL, Vohra S, Johnston L; Cochrane Neonatal Group. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database of Syst Rev. 2018 [cited 2023 Jan 14]. 2018(2):CD004210. DOI: https://doi.org/10.1002/14651858.cd004210.pub5.
17. McGrory L, Owen LS, Thio M, Dawson JA, Rafferty AJ, Malhotra A, et al. A randomized trial of conditioned or unconditioned gases for stabilizing preterm infants at birth. J Pediatr. 2018 [cited 2023 Jan 14]; 193:47-53. DOI: https://doi.org/10.1016/j.jpeds.2017.09.006.
18. Wilson E, Zeitlin J, Piedvache A, Misselwitz B, Christensson K, Maier RF, et al. Cohort study from 11 European countries highlighted differences in the use and efficacy of hypothermia prevention strategies after very preterm birth. Acta Paediatr. 2018 [cited 2023 Feb 4]; 107(6):958-66. DOI: https://doi.org/10.1111/apa.14230.
19. Nimbalkar SM, Khanna AK, Patel DV, Nimbalkar AS, Phatak AG. Efficacy of polyethylene skin wrapping in preventing hypothermia in preterm neonates (<34 weeks): a parallel group non-blinded randomized control trial. J Trop Pediatr. 2019 [cited 2023 mar 5]; 65(2):122—9. DOI: https://doi.org/10.1093/tropej/fmy025.
20. Reilly MC, Vohra S, Rac VE, Zayack D, Wimmer J, Vincer M, et al. Parallel exploratory RCT of polyethylene wrap for heat loss prevention in infants born at less than 24 weeks' gestation. Neonatology. 2019 [cited 2023 Jan 5]; 116(1):37-41. DOI: https://doi.org/10.1159/000497253.
21. Salmani N, Dehghan Z, Mandegari Z, Aryaee A, Dehghan S. Comparison of effectiveness of two polyethylene covers on body temperature and oxygen saturation of neonates transferring to NICUs. Iran J Neonatology. 2019 [cited 2023 Mar 5]; 10(2). Available from: https://ijn.mums.ac.ir/article_13087_c79626ce62ea2072e701fcac029043f7.pdf.
22. Schwarzmann Aley-Raz, Talmon G, Peniakov M, Hasanein J, Felszer-Fisch C, Weiner SA. Reducing neonatal hypothermia in premature infants in an israeli neonatal intensive care unit. Isr Med Assoc J. 2020 [cited 2023 Jan 15]; 22(9):542-6. Available from: https://pubmed.ncbi.nlm.nih.gov/33236551/.
23. Khan G, Riaz U, Aziz T, Iqbal S, Qureshi T, Shafaat H. Effectiveness of polyethylene skin wrap in prevention of hypothermia in preterm and low birth weight neonates. PAFMJ. 2021 [cited 2023 Mar 23]; 71(3):810-3. DOI: https://doi.org/10.51253/pafmj.v71i3.3569.
24. Young A, Azeez F, Godad SP, Shetty P, Sharma A. A multimodal quality improvement approach to promote normothermia in very preterm infants. Acta Paediatr. 2021 [cited 2023 Mar 14]; 110(10):2745-52. DOI: https://doi.org/10.1111/apa.16009.
25. Lode-Kolz K, Hermansson C, Linnér A, Klemming S, Hetland HB, Bergman N, et al. Immediate skin-to-skin contact after birth ensures stable thermoregulation in very preterm infants in high-resource settings. Acta Paediatr. 2023 [cited 2023 Jan 5]; 112(5):934-41. DOI: https://doi.org/10.1111/apa.16590.
26. Wang L, Liu Z, Liu FM, Yu YH, Bi SY, Li B, et al. Implementation of a temperature bundle improves admission hypothermia in very-low-birth-weight infants in China: a multicentre study. BMJ Open Qual. 2022 [cited 2023 Mar 5]; 11(2):e001407. DOI: https://doi.org/10.1136%2Fbmjoq-2021-001407.
27. Pinheiro JM. Preventing hypothermia in preterm newborns - simple principles for a complicated task. J Pediatr. 2018 [cited 2023 Jun 15]; 94:337-9. DOI: http://doi.org/10.1016/j.jped.2017.06.016.
28. Shahkolahi Z, Irajpour A, Jafari-Mianaei S, Heidarzadeh M. Developing patient safety standards for health-care quality promotion in neonatal intensive care units: a mixed-methods Protocol. J Educ Health Promot. 2022 [cited 2023 Jun 15]; 11:291. DOI: https://doi.org/10.4103%2Fjehp.jehp_1409_21.
29. Harer MW, Vergales B, Cady T, Early A, Chisholm C, Swanson JR. Implementation of a multidisciplinary guideline improves preterm infant admission temperatures. J Perinatol. 2017 [cited 2023 Jan 14]; 37(11):1242-7. DOI: https://doi.org/10.1038/jp.2017.112.
30. Lee ES, Lee HN, Park JN. Comparison of the effect of applying polyethylene wrap and aircap in maintaining body temperature of preterm infants. Journal of Korean Clinical Nursing Research. 2020 [cited 2023 mar 23]; 26(2):232-9. DOI: https://doi.org/10.22650/JKCNR.2020.26.2.232.
31. Fardous Y, Bedford H, Winyard P, Palit V. Effectiveness of plastic bags versus incubator in preterm and low birth weight neonates. Arch Dis Child. 2018 [cited 2023 Mar 5]; 103:A114. DOI: http://dx.doi.org/10.1136/archdischild-2018-rcpch.272.
32. Conde-Agudelo A, Díaz-Rossello JL. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. Cochrane Database of Systematic Reviews. 2016 [cited 2023 Jun 15]; 16(3):CD002771. DOI: https://doi.org/10.1002/14651858.cd002771.pub2.
33. Singh TS, Skelton H, Baird J, Padernia AM, Maheshwari R, Shah DM, et al. Improvement in thermoregulation outcomes following the implementation of a thermoregulation bundle for preterm infants. J Paediatr Child Health. 2022 [cited 2023 Jun 16]; 58(7):1201-8. DOI: https://doi.org/10.1111/jpc.15949.

Authors' contributions:

Conceptualization, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Methodology, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Validation, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Formal analysis, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Investigation, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Resources, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Data curation, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Manuscript writing, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Manuscript review and editing, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Visualization, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. | and E.C.R.; Supervision, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.; Project administration, J.A.S.N., M.M.C., G.C.L.S., A.T.R., A.C.S.S.S. and E.C.R.. All authors have read and agreed to the published version of the manuscript.