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Guest Author

A REVIEW OF NEONATAL LITERATURE TO IDENTIFY CRITICAL ATTRIBUTES FOR HYPOTHERMIA NURSING DIAGNOSES

UMA REVISÃO DA LITERATURA NEONATAL PARA IDENTIFICAR ATRIBUTOS CRÍTICOS PARA DIAGNÓSTICOS DE ENFERMAGEM DE HIPOTERMIA

UNA REVISIÓN DE LA LITERATURA NEONATAL PARA IDENTIFICAR LOS ATRIBUTOS CRÍTICOS PARA LOS DIAGNÓSTICOS DE ENFERMERÍA DE HIPOTERMIA

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The aim of this study was to explore diagnostic indicators in the neonatal population for one nursing diagnosis approved by NANDA International, Inc., hypothermia, and for a proposed diagnosis, risk for hypothermia. In this integrative review, 23 articles were reviewed from the Cinahl, PubMed, and LILACS databases during the period of January through April, 2013. Data were drawn from the articles and synthesized to develop a list of potential related and/or risk factors, and defining characteristics. Potential newborn-related defining characteristics and related factors were identified for clinical testing in hypothermia, (23 and 17, respectively). Twenty-three risk factors were identified for risk for hypothermia. Diagnostic indicators for nursing diagnoses that place newborns at risk of morbidity and mortality will enable risk screening and more adequate assessments. These newly identified diagnostic indicators require research to validate their clinical usefulness.
Descriptors: Hypothermia; Infant, Newborn; Nursing Diagnosis.

O objetivo deste estudo foi explorar indicadores diagnósticos na população neonatal para um diagnóstico de enfermagem aprovado pela NANDA International, Inc., hipotermia, e para um diagnóstico proposto, o risco de hipotermia. Nesta revisão, 23 artigos foram revisados a partir da CINAHL, PubMed e Lilacs no período de janeiro a abril de 2013. Os dados foram extraídos dos artigos e sintetizados para desenvolver uma lista de potenciais fatores relacionados e/ou de risco e características definidoras. Potenciais características definidoras e fatores relacionados associados a recém-nascidos foram identificados para testes clínicos em hipotermia, (23 e 17, respectivamente). Vinte e três fatores de risco foram identificados para o risco de hipotermia. Indicadores diagnósticos para diagnósticos de enfermagem que colocam os recém-nascidos em situação de risco de morbidade e mortalidade permitirão triagem e avaliação de riscos mais adequadas. Estes indicadores diagnósticos recentemente identificados exigem investigação para validar a sua utilidade clínica.
Descritores: Hipotermia; Recém-nascido; Diagnóstico de Enfermagem.

El objetivo del estudio fue explorar indicadores diagnósticos en neonatos para diagnóstico de enfermería aprobado por NANDA International, Inc., hipotermia, y para uno diagnóstico propuesto, el riesgo de hipotermia. En esta revisión integradora, 23 artículos fueron revisados de CINAHL, PubMed y Lilacs, de enero a abril de 2013. Los datos fueron extraídos de los artículos y sintetizados para desarrollar una lista de potenciales factores relacionados y/o de riesgo y características definitorias. Se identificaron potenciales características definitorias y factores relacionados asociados a los recién nacidos durante las pruebas clínicas en hipotermia (23 y 17 respectivamente). Veintitrés factores de riesgo se identificaron para el riesgo de hipotermia. Indicadores diagnósticos para diagnósticos de enfermería que ponen a los recién nacidos en riesgo de morbilidad y mortalidad permitirán detección y evaluación de riesgos más apropiadas. Estos indicadores diagnósticos recientemente identificados requieren investigaciones para validar su utilidad clínica.
Descriptores: Hipotermia; Recién-nacido; Diagnóstico de Enfermería.

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INTRODUCTION

When considering nursing practice, it is critical that nurses are able to identify those phenomena of concern to their discipline in a manner that is clear, concise, accurate and efficient. This requires that those phenomena (nursing concepts) are well understood, that diagnostic criteria are clearly established and accurate for various populations in which the phenomena occur, and that diagnostic accuracy can be supported and ensured by means of predictive criteria that have been clinically validated.

NANDA International, Inc. (NANDA-I) identifies nursing diagnoses about nursing knowledge, representing phenomena of interest to the discipline: actual or potential human responses to health conditions/life processes that can impact human health. However, within the terminology there are diagnoses that are based on concepts that share similar origins (e.g., thermal stability: hypothermia, ineffective thermoregulation, hyperthermia; respiratory stability: ineffective breathing pattern, ineffective gas exchange, ineffective airway clearance) but which represent differences that are perceived to be critical for ensuring effective and efficient interventions. Likewise, there are diagnoses containing multiple defining characteristics and/or related factors, which is not clinically useful for diagnosis. Other diagnoses lack diagnostic indicators for particular populations (e.g., neonates, elderly, children). The ability to identify those critical defining characteristics/related factors (e.g., those that must be present for diagnosis) that support clinical reasoning and decision-making regarding differentiation of related, although different, diagnoses is critical to enhanced decision making among nursing professionals.

Although many studies have focused on identification of defining characteristics, very few have focused on the related, or etiologic, factors of these same diagnoses. This is somewhat disturbing, since nursing intervention should be primarily aimed at reducing or eliminating related factors whenever possible, whereas a focus on defining characteristics should be a secondary emphasis to achieve symptom control or to support chronic diagnoses that cannot be fully resolved. While at that point, intervention turns toward symptom management with a focus on defining characteristics rather than related factors, it remains important to identify those related factors, as keys to treatment differentiation may be found therein (e.g., etiology of chronic pain may lead to a difference in treatment options). However, the current NANDA-I definition of related factors is also confusing as it compiles a list of conditions or situations that might be causative, or that might be associated with, the nursing diagnoses. It is important to clarify this definition to enable us to better define our related factors, and develop methodologies for testing causality.

Instances of thermal instability have been demonstrated to be relatively common within the newborn intensive care unit (NICU) environments, especially within preterm and low birth weight (LBW) infants, and have been linked to morbidity and mortality[1]. This is a critical issue because preterm LBW neonates can only maintain an active thermoregulatory response for a short period of time without diverting energy that is needed for growth and development. However, thermal instability is not specific to preterm neonates, but rather has been found to have a significant incidence in normal newborns as well[2]. For example, hypothermia has been found to occur in normal newborns after home or emergency births (e.g., births in transit to hospital), but it also occurs in hospitals in developed and developing countries alike[3-9]. In many countries, situations exist in which accurate measurement of temperature via standardized means simply do not exist. Therefore, awareness of all potential assessment criteria (defining characteristics) is critical; we cannot solely rely on the temperature value itself. Likewise, awareness of risk or etiological factors is

critical to understanding how we can best intervene in all environments, be it in high tech NICUs or the most rural and/or low-resource environments. Additionally, educational interventions can be developed that address behavioral, cultural and environmental practices to prevent and/or quickly respond to hypothermic events. However, these interventions need to be directed at etiologic or risk factors in order to be effective at more than symptom control, which emphasizes our need to clearly identify these within this high risk neonatal population.

NANDA-I defines hypothermia (Code 00006) as, "body temperature below normal range"[10:469]. This definition is not specific and therefore not very clinically useful. The World Health Organization[11] classified categories of thermal regulation related to neonatal hypothermia in the following manner: normothermia = 36.5°C; mild hypothermia = 36.0 – 36.4°C; moderate hypothermia = 32.0 – 35.9°C; severe hypothermia = ≤32°C. However a more recent study[12] recommended modifications to this definition, based on large-scale population studies (Table 1). This definition is far more precise and can help to direct assessment of, and the treatment plan for, these infants.

Table 1 - Recommended modifications to WHO classification of hypothermia in neonates[12]

Classification	Temperature range (°C)
Normal	36.50-37.50
Grade 1	36.00-36.50
Grade 2	35.00-36.00
Grade 3	34.00-35.00
Grade 4	<34.0

In a prospective, observational Brazilian study[13], conducted to determine the incidence of adverse events, 29% of infants studied experienced thermoregulation disorders. In this study, adapted from an earlier study in the USA[14], 16 adverse events were measured in the NICU population; of interest, thermoregulation disorders were added to the original instrument and were found to occur at a higher prevalence than any of the 14 events trended in the original research. Of those infants with thermal stability disorders, 65.9% presented hypothermia. A study in 15 North American NICU settings found that 36% of 5,277 preterm LBW infants developed hypothermia (temperature <35.9°C)[15]. Incidence of hypothermia was shown to be 25% in infants <2500g, and 56% in infants <750g among four NICUs in the USA in 2006 and 2007[16]. Another US study of preterm infants (<34 weeks) found a hypothermia rate of 54% among the 2,183 infants studied[17].

In a Nigerian study of 111 infants admitted to NICU, in their first 72 hours of life, researchers identified that 75 (67.6%) were hypothermic. In a study in a tropical area of Africa, in 313 consecutively admitted newborns to the NICU, the prevalence of hypothermia on admission was 85%[18-19]. Likewise, a study of 300 consecutively born infants in Uganda, with a mean birthweight of 3218g, included temperatures taken at 10, 30, 60, and 90 min post-delivery and found that 29, 82, 83, and 79 percent of the newborns, respectively, were hypothermic[5]. In a cohort study of 23,240 infants conducted in Nepal, 25.6% and 31.6% were classified as mildly or moderately hypothermic, respectively[12].

Hypothermia has been found to be a major factor in morbidity and mortality of LBW preterm infants, and can include overall negative clinical outcomes, including implications to the respiratory, circulatory, metabolic systems, and has been linked to mortality. In one recent study of ventilated neonates, the authors identified hypothermia as a statistically significant ($p<0.001$) predictor of mortality among these neonates[20]. Indeed, hypothermia was one of only two independent predictors of fatality during neonatal mechanical ventilation in this prospective study of infants ≥750g and ≥28 weeks gestation; this is consistent with findings from Watkinson's study[21], which associated low body temperature as an independent risk factor for preterm infant mortality upon NICU admission. This also corresponds to results of a study in which infants found

to be hypothermic on admission to the NICU (defined as <35.5°C) had a significant association with neonatal illness severity, in a study including six regional tertiary referral NICUs[22].

The adaptation from intra-uterine to extra-uterine environment can be impacted due to circulatory changes, resulting in persistent pulmonary hypertension[23-24]. Hypothermia has been demonstrated to be an etiological factor for respiratory distress, increased oxygen consumption and hypoxia in these infants, and can delay the initiation of spontaneous respiration[22,25-31]. Metabolic effects including hypoglycemia[27,32-34], metabolic acidosis[23], and impaired coagulation[35] have also been identified. Other consequences include high metabolic rate, jaundice and kernicterus, increased susceptibility to infection, neonatal cold injury, and poor weight gain[27]. According to a recent study[22] for every 1°C decrease in admission temperature, the odds of late onset sepsis was increased by 11% and the risk of death increased by 28%. In infants with severe hypothermia, cold stress may lead to renal insufficiency and necrotizing enterocolitis and death[32]. Moderate and severe hypothermia has also been associated with a higher risk of grade 3–4 intraventricular hemorrhage (IVH) and death in LBW infants below 1500 grams[25,32,36].

Most of these complications are directly related to immature preterm neonatal organ systems, a reality that nurses must recognize and intervene upon effectively and efficiently, to reduce risk of adverse events within these infants.

Given the above discussion on incidence and significance, the diagnoses that are the focus of interest for this paper are: hypothermia (00006) and a potential new diagnosis, risk for hypothermia. The NANDA-I hypothermia diagnosis was initially accepted into the NANDA-I taxonomy in 1986, with only one revision in 1988[10], and the current list of defining characteristics and related factors do not reflect the clinical picture of the newborn infant exhibiting this response. Therefore, it is important to clinically validate key diagnostic criteria in this population, to provide better decision support for nurse diagnosticians and improve the body of knowledge regarding these diagnoses in the newborn infant.

However, before clinical validation can occur, it is important to review current research on these concepts within the population of interest (newborns) to determine whether or not additional defining characteristics and related factors might exist for hypothermia, and to identify potential risk factors for the recommendation of a new diagnosis, risk for hypothermia. Therefore, the aim of this study was to explore the diagnostic indicators (related factors and defining characteristics, or risk factors) identified in the research literature for the neonatal population (birth to one month of age), for the hypothermia nursing diagnosis approved by NANDA International, Inc. Additionally, risk factors will be proposed for a new diagnosis, risk for hypothermia. The results of this integrated review will then be used to develop a clinical validation study within this population.

METHOD

In this literature review, a search was conducted for articles in the CINAHL, PubMed, and LILACS databases during the period of January through April, 2013. Based on the criteria, studies that did not address assessment criteria, including related (etiological) factors, antecedents, risk factors, defining characteristics (signs/symptoms) or clinical referents (measurement tools) were excluded. These inclusions included: articles dealing with infants beyond the age of 1 month, intervention articles, articles related to therapeutic hypothermia, incidence or outcome articles. Articles selected were indexed in LILACS, PubMed and CINAHL using the search terms: "hypothermia" NOT "hypothermia, induced" AND "infant" OR "newborn". All research articles were searched using the following

filters: published in the last 10 years; humans; publication language of English, Portuguese or Spanish; newborn: birth-1 month; and, with full text availability. Integrated and systematic reviews were included in the sample. Duplicates were removed from the database searches.

The initial search yielded 848 articles through the initial PubMed and CINAHL search; 50 unique articles were obtained through LILACS, after removing duplicates obtained through these searches. This resulted in a total number of 898 articles for title review. Initial review of titles resulted in a total of 221 articles initially selected for review of abstracts. Of these, 99 articles were then selected for complete review of the article; a final selection of 23 articles was selected for this review (20 from PubMed/CINAHL and 3 from LILACS).

RESULTS

Articles identified for the final sample represented studies conducted in Africa (Nigeria, Uganda, n=4), Asia (India, Nepal, n=5), Europe (France, Germany, Slovenia, Sweden, n=4), Middle East (Islamic Republic of Iran, n=3), North America (USA, n=3), and South America (Brazil, n=1). Three of the articles included in the sample were integrated reviews of existing studies; these are not included in this regional description, since the studies reviewed crossed a variety of regions. Only two of the 23 articles were authored by nurses. The majority of the original study authors came from medicine (n=9); others included the disciplines of medicine and public health (n=5), medicine and epidemiology (n=2), public health and epidemiology (n=1), or medicine and biostatistics (n=1). Additionally, all three review articles were from the medical discipline. Of the sample articles, only six (26.1%) specifically addressed signs or symptoms of hypothermia (defining characteristics) other than temperature measurement, whereas 21(91.3%) identified risk or etiologic (related) factors.

After reviewing the obtained data, it was determined that all related factors or risk factors identified by at least 10% of the articles that identified these factors would be chosen to move forward to the clinical validation phase. Therefore, the related factors for the hypothermia diagnosis and the risk factors for the risk for hypothermia diagnosis, that are relevant to the newborn infant, can be seen in Table 2. It should be noted that, of the 23 related / risk factors identified, only four are currently found in the NANDA-I terminology (exposure to cool environment = cold ambient temperature; evaporation from skin in cool environment = evaporation; inadequate clothing; decreased ability to shiver = ineffective nonshivering thermogenesis). One potential related / risk factor that was not added to this list was the use of oil massage, because this cultural practice is not relevant in the Brazilian population where the clinical validation research will occur.

Table 2 - Literature review conducted for related factors for the nursing diagnosis, hypothermia, and risk factors for the proposed nursing diagnosis, risk for hypothermia

Related factor or risk factor	Study number
Adolescent mother	5; 37
Cesarean delivery	26; 38
Cold ambient temp	37; 39-42
Conduction	37; 40
Convection	37; 40
Delayed breastfeeding	18; 37; 39-40; 43-44
Early bathing	37; 39-40; 44-45
Evaporation	37; 40; 45
Greater surface-to-mass ratios	37; 40
Inadequate clothing	37; 40-41
Infant received CPR	37; 42; 46
Lack of caregiver awareness of hypothermia concerns	5; 37; 39-40; 44-45
Limited vasoconstriction capability	5; 47
Low APGAR scores	26; 37; 42; 46
Low body weight	5; 12; 18; 26; 37; 42-44; 46-50
Multiple gestation	37; 42; 46
No body (skin-to-skin) contact	5; 37
Out of hospital birth	37; 44; 50-51
Poverty	37; 44
Prematurity	12; 18; 26; 37; 42-43; 46-50; 52-53
Radiation	46; 48
Seasonality (Warm versus cold seasons)	12; 37; 39; 41; 43
Wet skin	37; 47

Infants, especially LBW preterm infants, are predisposed to hypothermia, even when using radiant heaters/incubators, because they lack a sufficient supply of subcutaneous fat, have an increased body surface area to weight ratio, and, they have an inability to shiver[54-61]. Inefficient vascular control in preterm infants also predisposes them to hypothermia[21]. Brown and white adipose tissue (BAT and WAT, respectively) is present in lower quantities in preterm infants, as these are developed in the third trimester of gestation[27,60]. In an early study of BAT in infants who died prior to the age of four weeks, and premature infants at risk for thermoregulatory deficiency, the authors proposed a relationship between these outcomes and the lack of well developed BAT and WAT[60], which researchers suggest may be related to the immaturity of the body temperature regulating mechanisms[62].

It has been noted that the preterm LBW infant's immature stratum corneum is deficient in keratin content, which means his skin has a higher level of permeability to heat and water[58,61]. A newborn can lose heat through four primary methods: conduction, convection, evaporation and radiation. The primary initial etiology is evaporation of the amniotic fluid from the neonate's body surface. However, being born into a cool room can lead to convection losses as the body is exposed to cooling air temperatures, and by radiation and conduction if the infant is placed on a cold surface or near cooler objects. A drafty room, with a temperature $\leq$30°C, also poses a risk for loss of body heat in these infants. If heat loss is not prevented, and hypothermia occurs, the risk of mortality increases[11,63].

A statistically significant association was noted ($p<0.001$) between thermal stability disturbances and body weight, presenting an occurrence inversely proportional to birth weight[12], with a higher prevalence among infants aged <6 hours (80.6%), preterm infants (88.9%), LBW infants (89.1%), those with birth asphyxia (76.3%), and those who had not been breastfed (79.2%). Low-birth-weight ($p=0.000$) and lack of breastfeeding ($p=0.028$) were found to be significant risk factors for early neonatal hypothermia at admission[18].

Diagnostic indicators / defining characteristics

The defining characteristics, or diagnostic indicators, of cold stress or prolonged hypothermia in the LBW preterm infant can be difficult to recognize, and may be subtle or nonspecific. After reviewing the obtained data, it was determined that all defining characteristics identified in the articles that identified these factors would be chosen to move forward to the clinical validation phase, due to the low number of articles (n=6) that addressed assessment criteria other than body temperature. Those characteristics for this diagnosis that are relevant to the newborn infant can be seen in Table 3. It is of note that only one of the identified neonatal characteristics is currently found in the NANDA-I terminology (cool skin = cold to the touch).

Table 3 - Potential defining characteristics identified by literature review for the nursing diagnosis, hypothermia

Defining characteristic	Study number
Acrocyanosis	40
Bradycardia	64
Cold to the touch	40
Decreased peripheral perfusion	40
Decreased ventilation	65
Facial erythemia	40
Hypoglycemia	37; 46
Increased metabolic rate	40; 65
Increased oxygen consumption	65
Intraventricular hemorrhage	25
Jaundice	37; 46; 65
Metabolic acidosis	37; 46; 65
Peripheral vasoconstriction	37; 40; 65
Pulmonary hemorrhage	40; 46
Respiratory distress	37; 46; 65
Tachyarrhythmia	64
Tissue ischemia	65

Cold stress has been defined as the state in which the rate of heat loss to the environment exceeds that of heat produced within the body or by interventions within

the neonate's immediate environment. When this occurs, the energy that would normally be used for growth must be diverted in an attempt to maintain a normal body temperature[1-2,6,20,21,29,66]. Adaptation of the preterm LBW infant to hypothermia occurs through two major mechanisms: peripheral vasoconstriction and non-shivering thermogenesis. As hypothermia begins, a neonate may become cold to the touch, restless and irritable, or lethargic and/or hypotonic. He may present as a poor feeder with gastric distension or increased aspirates, and with bradycardia. As the condition progresses, the clinical picture may include apnea, hypoglycemia, hypoxia, metabolic acidosis, and tachypnea.

DISCUSSION

This study was justified because the NANDA-I hypothermia diagnosis was initially accepted into the NANDA-I taxonomy in 1986, with only one further revision (in 1988)[10]. Additionally, the current list of defining characteristics and related factors does not reflect the clinical picture of the newborn infant. Currently, no risk diagnosis is available within NANDA-I's terminology, yet the neonatal population is clearly at risk for this response, as is evident from clinical practice which was supported by the review of literature. It will be important to clinically validate key diagnostic criteria in this population, to provide better decision support for nurse diagnosticians and improve the body of knowledge regarding these diagnoses in the newborn infant.

It is critically important to conceptualize these concepts beyond the simple temperature reading, as infants who are at high risk for hypothermia are born daily in areas that do not have access to temperature devices. The awareness of additional defining characteristics can enable rapid diagnosis and treatment of hypothermia. Awareness of related and risk factors can enable the provision of protective and proactive interventions, especially in those infants who may be more vulnerable to hypothermia.

The next phase of this study is the development of operational definitions for each of the related factors, defining characteristics and risk factors to enable their clinical validation.

COLLABORATION

Herdman TH contributed to the design, collection, analysis, interpretation of data, drafting and final approval of the version to be published.

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