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RESEARCH

Comparison of Axillary and Temporal Artery Thermometry in Preterm Neonates

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ABSTRACT

Objective: To compare the accuracy of infrared temporal artery thermometry with axillary thermometry in a cohort of preterm neonates between 28 and 36 weeks postmenstrual age.

Design: Descriptive repeated measures design with randomization to temperature measurement order.

Setting: Level III NICU in the Central/Southeastern United States.

Participants: Sixty-eight neonates born between 28 weeks and 36 weeks postmenstrual age cared for in incubators or open cribs.

Methods: Neonates were randomly assigned to temperature measurement order (axillary followed by temporal artery or temporal artery followed by axillary). Temperature pairs were taken once during the day shift and once during the night shift. Behavioral states were assessed before, during, and after temperature measurement.

Results: Neonates were predominantly female (64.7%) with a mean age of 6.6 days and a mean gestational age of 32.7 weeks, and most were cared for in incubators ($n = 55$). Noninferiority was observed between the two temperature methods (Holm-Bonferroni criterion = .025, $p < .001$). There was no statistically significant difference in the behavioral states of the neonates between the two temperature methods. It took nurses significantly longer to use the axillary thermometer than to use the temporal artery thermometer ($p < .001$).

Conclusion: Temporal artery temperature measurements were as accurate as axillary temperature measurements in low-birth-weight neonates in the NICU. Nurses spent less time measuring with the temporal artery method than with the axillary method.

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Preterm neonates are unable to maintain their temperatures without exogenous humidified warm air and have increased mortality when the environmental temperature is not closely regulated (Silverman, Agate, & Fertig, 1963; Silverman, Fertig, & Berger, 1958). Factors that contribute to preterm neonate heat loss include a large surface area to body mass ratio, decreased amounts of insulating fat, thinner immature skin, and minimal brown fat (Knobel, Holdritch-Davis, Schwartz, & Wimmer, 2009). Frequent monitoring of preterm neonates' temperatures is necessary to detect when adjustments to incubator temperatures are needed so that neonates remain in a neutral thermal environment.

Neutral Thermal Environment

The neutral thermal environment is a range of ambient temperatures that maintains an infant's temperature within 36.5 to 37.5 °C and minimizes the neonate's oxygen consumption for metabolic processes (Sedin, 2011). The experience of thermal stress, specifically cold stress, causes a series of physiologic responses during which preterm neonates attempt to reduce heat loss and generate heat. Preterm neonates adapt to thermal stress in a pathologic manner through vasoconstriction, which constricts the vessels in peripheral circulation, and the release of norepinephrine. This stimulates fatty acid release and increases the metabolic rate and oxygen consumption, which leads to increased oxygen requirements and risk for hypoglycemia (Lyon & Freer, 2011; Sedin, 2011). Additionally, neonates in the NICU are at risk of developing sepsis, and changes in neonate temperature or temperature instability may be the first indicator of sepsis (Ussat et al., 2015). Therefore, frequent

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Temperature measurement in the NICU is a routine nursing activity that may disrupt the physiologic stability of neonates.

monitoring of temperature is a necessary aspect of neonatal care.

Temperature Measurement and Neonate Effects

Nurses take neonates' temperatures at frequent intervals, usually every 2 to 6 hours. Historically, rectal temperature measurement was considered the gold standard because it was believed to be a measure of core temperature. However, rectal temperature measurements in low-birth-weight neonates have been associated with rectal perforations (McIntyre & Hull, 1992; Wolfson, 1966). To accurately measure a rectal temperature, the thermometer must be inserted 5 cm from the anal margin into the rectum, a distance that increases the risk of perforation in the preterm neonate because of a much shorter rectum (Noerr, 2004). Because of the risk related to rectal temperature measurement and the advances in instrumentation, evidence supports axillary thermometry (AXT) as the current standard of care for neonates in the NICU (Smith, 2014). The axillary route of temperature measurement is an accurate measure of core temperature, is easy to obtain, and is safe for the neonate based on a number of well-designed studies; therefore, it is the current standard of care for preterm neonates (Carr et al., 2011; Duran, Vatansever, Acunas, & Sut, 2009; Haddad, Smith, Phillips, & Heidel, 2012; Lee et al., 2011).

Accuracy of temperature measurement is critical, but in the preterm neonate minimal disruption is a secondary goal of nursing care (Fumagalli et al., 2018). Temperature measurement should be quick, painless, and easy to perform so that there is minimal handling of the neonate. Although the axillary method has benefits, it is also intrusive, and neonates demonstrate signs of discomfort such as agitation, restlessness, crying, and increased respirations when the thermometer is placed in the axilla (Lee et al., 2011; Sim, Leow, Hao, & Yeo, 2016). Anecdotally, nurses have reported increased heart and respiratory rates and decreased oxygen saturation in preterm neonates with axillary temperature measurements. Physiologic changes such as these would be expected during painful stimuli (Hatfield & Ely, 2015). The use of infrared temporal artery thermometry (TAT) shows promise as a less intrusive method for the preterm neonate. However, the accuracy of this thermometer in preterm neonates between 28 and 36 weeks gestation compared with the standard axillary thermometer has not been determined.

The suggested use of infrared temporal artery thermometers differs; some are held 0.5 cm from the skin (Duran et al., 2009; Sim et al., 2016), and others are placed on the skin and swiped from the midforehead to the temporal artery (Syrkin-Nikolau, Johnson, Colaizy, Schrock, & Bell, 2017). Sim and colleagues (2016) studied 169 neonates who were born between 32 and 40 weeks gestation and found that temperatures taken with temporal artery thermometers were significantly higher those taken with axillary thermometers; differences ranged from −0.14 to 2.45 °C. This wide variability between methods does not support noninferiority of the temporal artery thermometer. The majority of neonates studied by Sim et al. (2016) were in open cribs, and their temperatures had the greatest agreement between the two temperature measurement devices. Temperatures of neonates cared for in radiant warmers and incubators had the poorest agreement between the two temperature measurement devices. These investigators found a significant increase in neonate distress during axillary temperature measurement compared with temporal artery temperature measurement. These findings supported the use of temporal artery thermometers in neonates born closer to term gestation but only when they are cared for in open cribs (Sim et al., 2016).

Duran and colleagues (2009) also used temporal artery thermometers in their study of 34 preterm neonates who were born between 26 and 31 weeks gestation, weighed less than 1,490 g, and were cared for in incubators. They compared 3 types of temperature measurement: midforehead, temporal artery, and axillary. They also used mercury glass thermometers to measure axillary temperature measurements. These thermometers are not used in many U.S. hospitals because of the risk of breakage and exposure to toxic mercury. Duran and colleagues reported significantly higher temporal artery temperatures compared with midforehead and axillary temperatures; however, the temperature readings would not be seen as clinically significant in the practice setting with only a 0.1 to 0.2 °C difference. These findings indicate support for the use of temporal

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