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Comparison of Oral and Axillary Temperatures in Intubated Pediatric Patients☆

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ABSTRACT

Purpose: Accurate body temperature measurement is essential in providing timely care to critically ill patients. Current practice within the Pediatric ICU (PICU) at a Midwestern academic medical center is to obtain axillary temperatures in endotracheally intubated patients. According to research, axillary temperatures have greater variance than other forms of temperature measurement. Research in adult patients show that oral temperature measurement in endotracheally intubated patients is acceptable as the heated gases from the ventilator has no significant effect on measured temperatures. This study sought to determine if the same is true in pediatrics.
Design and Methods: Oral and axillary temperatures of endotracheally intubated pediatric patients were obtained during unit prescribed vital assessment intervals. Patients were divided into neonate, infant, and children age groups with 25 sets of temperatures obtained for each group. Descriptive statistics and Bland-Altman plot interpretation were performed to determine confidence intervals for each age group.
Results: Bland-Altman plot analysis of oral and axillary routes of temperature measurement showed a high positive correlation within all age groups studied. The infant age group showed lower correlation in comparison to neonates and children. The infant age group also had an outlier of data sets with lower oral temperatures as compared to the axilla.
Conclusions: Oral temperature measurement is a viable alternative to axillary temperature measurement in endotracheally intubated pediatric patients. Correction factors for age groups were calculated for prediction of axillary temperature based on measured oral temperature.
Practical implications: This study serves as evidence for practice change within the studied unit.

Introduction

Accurate body temperature measurement is essential in providing timely and specific care to all critically ill patients. Early detection of hyperthermia can lead to prompt responses to various disease processes, especially sepsis, medication reactions, and blood transfusion reactions. Early recognition of hypothermia, including infants who cannot thermoregulate or patients with brain injuries that affect the hypothalamus, can prompt healthcare professionals to implement changes in care early so as to maintain normothermia. There is a large variety of temperature measurement methods; however, there is not a generalizable consensus on the best practice across the entire age range of pediatric patients (Martin & Kline, 2004).

Measuring a true core body temperature can be problematic in many clinical situations. The pulmonary artery catheter is the "gold standard" in measuring a true core body temperature; however, this is not feasible for many patients in the hospital environment due to its invasive nature (Giuliano, Scott, Eliot, & Giuliano, 1999). Rectal temperatures are generally considered the most accurate core body temperature measurement in pediatric patients who have no invasive equipment or lines allowing temperature measurement, however, rectal temperatures also have their drawbacks. Many patients find this means of temperature measurement uncomfortable and embarrassing (Batra & Goyal, 2013). It has been shown that rectal temperatures also lag in reflecting rapid changes in core body temperatures (Greenes & Fleischer, 2004). With pediatric patients old enough to follow directions, oral thermometry is generally the preferred method of obtaining an accurate body temperature (Fallis, 2000). However, oral temperatures can be affected by ambient air temperatures and the temperature of food and drink consumed near the time of temperature measurement (Carroll, 2000). Research has shown that axillary temperature measurement has more variance than other routes, especially with patients that have compromised perfusion that shunts blood away from the periphery (Oravec Walter, 1997). One caveat to this variance in axillary temperature measurement is within the neonate population. Studies have shown that the temperatures of the left axilla and rectum are significantly correlated (Friedrichs et al., 2013).

Current standard practice within the studied Pediatric Intensive Care Unit (PICU) at a Midwestern academic medical center is to measure

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temperatures via the axilla. Previous practice at this site included oral temperature measurement of orally intubated patients. This practice's validity and reliability was questioned in recent years within the unit, causing a practice change back to the axillary route. Chaturvedi, Vilhekar, Chatervedi, and Bharambe (2003) studied the comparison of axillary and oral temperatures in children with high positive correlations, however, data were not collected in intubated subjects. Utilizing the sublingual pocket as an accurate source for core body temperature in orally intubated pediatric patients has been a question of concern due to heated air that is passed through the endotracheal tube from the ventilator and the effects this has on measured oral temperatures (Konopad, Kerr, Noseworthy, & Grace, 1994). Nursing has the discretion to utilize other means of temperature measurement if the resulting temperatures seem to be inaccurate, even though current guidelines emphasize utilizing the same method for consistency (Urden, Stacy, & Lough, 2006). The available thermometers at this institution cannot measure tympanic and temporal temperatures. With only axillary, oral, and rectal temperature measurement accessible for this patient population, the team wanted to determine whether oral temperature measurement is appropriate for the care of intubated pediatric patients.

Research within adult intensive care units has shown that oral temperature is an acceptable site for temperature measurement in orally intubated patients as the heated gases from the ventilator have no significant effect on measured temperatures (Fallis, 2000). One recent study utilizing esophageal temperatures in orally intubated neonates undergoing whole body cooling showed that accurate temperatures were obtained despite heated gases passing through the endotracheal tube from the ventilator (Sarkar, Sarkar, Dechert, & Donn, 2015). Currently, there is no research examining the use of oral thermometry while orally intubated in the vast age range of all pediatric patients (Martin & Kline, 2004). This study was conducted to determine the effectiveness in measuring oral temperatures in intubated patients as compared to the standard axillary temperatures within the pediatric population.

Design and methods

The PICU is an 18 bed unit housed within a children's hospital inside a large Midwestern academic medical center. Because variable numbers of intubated patients were anticipated during the study period, a quasi-experimental design was used.

Sample

All consecutively intubated patients admitted to the PICU from 9/21/16 through 5/10/17 were included. The study was approved by the Institutional Review Board and received a waiver of consent. Convenience sampling was utilized for all patient included in the study. Data was collected for each age group until 25 sets of data were obtained. Data collection began in September 2016 and lasted until the planned number of data sets was collected. A total of 13 patients were included in this study.

Prior to the initiation of the study, the principal investigator trained and validated the temperature measurement skills of a core group of six pediatric intensive care nurses using a skills checklist developed according to the manufacturer's recommendations. The principal investigator first completed a didactic portion of instruction with the selected nurses. Teach back was then used to validate the nurses' competencies in measuring both oral and axillary temperatures. The competency based checklist, developed by the investigator, validated temperature collection techniques in 100% of the nurses chosen for the study. No more than two minutes were allotted for time between axillary and oral temperatures to minimize the chances of a change in clinical status that could affect patient temperatures. Data was collected on Mondays, Wednesdays, and Fridays at the following set times: 0000, 0400, 0800, 1200, 1600, and 2000.

Procedure

The MediChoice® Flexible Tip Digital Thermometer Oral: 916823 were used to obtain all axillary and oral temperatures for the study and is the device normally used in the unit. All patients were ventilated with either the Maquet servo-I or the Puritan Bennett 980. All ventilator heaters are set to 37.0 °C per protocol. Patient temperature values were reported in Fahrenheit degrees.

A total of 25 paired sets of oral and axillary temperatures were obtained for each of three age groups; neonates (<28 days), infants (>28 days to 12 months), and children (>12 months and < 18 years). Multiple data sets could be collected from the same patient at different times. Due to this, a total of 13 patients were included in this study (Table 1). Many of the samples were collected during the evening and night hours due to the availability of trained nursing personnel during these hours. All data sets for neonates, 22 infant data sets, and 24 child data sets were collected during the night shift hours from 1900 to 0700. No adverse events were encountered during the course of this study.

Data Analysis

SPSS version 19 (SPSS, Chicago, Illinois) was used to conduct the analysis. Descriptive statistics were determined for age and time of temperature taking. Bland-Altman analyses of individual oral and axillary measurements were obtained and scatter plots were created to assist with further analysis.

Results

The Bland-Altman Plot and Analysis for this data showed high positive correlation values for all age groups. The neonate population resulted in a Pearson correlation coefficient of 0.921, the infants 0.859, and children 0.932 as noted in Table 1. The infant population did show a lower correlation as compared to the neonates and children. The infant population exhibited an oddity in that 9 out of the 25 data sets had a higher axillary temperature as compared to the oral temperature. This variance between the age groups can be seen in the Bland Altman scatter plots with equivalue lines in Figs. 1 through 3.

The average correction factor from measured axillary to oral temperature was 0.6° Fahrenheit. Neonates exhibited the highest correction factor of 1° Fahrenheit, followed by children with a correction factor of 0.6° Fahrenheit and finally infants with a factor of 0.2° Fahrenheit. The temperature ranges and correction factors can be viewed in Table 2.

Discussion

The results of this study align with similar evidence within the adult ICU and neonatal ICU environments from previous studies. A previous study by Friedrichs et al. (2013) validated the use of the axilla as a method for core body temperature in the neonate population. Esophageal temperatures in intubated neonates were also shown to be a valid temperature source in a study by Sarkar et al. (2015). Research of oral temperatures in intubated adult patients is older than these neonatal studies, with the most recent study by Fallis in 2000. This study corroborates the evidence seen within these studies in different patient populations.

Table 1
Data sets per age category and resultant Pearson correlations.

Age category	Age range	# of data sets	# of patients	Pearson correlation
Neonates	<28 days	25	5	0.921
Infants	28 days to 12 months	25	3	0.859
Children	1 to 18 years	25	5	0.932

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