

Comparison of Axillary Temperature with Rectal or Oral Temperature and Determination of Optimum Placement Time in Children

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The present study was done to compare axillary temperature (AT) with rectal temperature (RT) in 100 infants and with oral temperature (OT) in 100 children aged 6 to 12 years and also to find out the optimum placement time of the mercury thermometer at the above sites. Simultaneous AT and RT recording was done in infants while sequential AT and OT recording was done in older children by different investigators using calibrated Hick thermometers. The placement time recorded was when 3 consecutive readings at one minute interval remained unchanged. Significant correlation was observed between RT and AT ($r=0.95$, $p < 0.01$) and between OT & AT ($r = 0.97$, $p < 0.01$). Equations were derived to calculate RT & AT from AT. The mean placement time for RT, AT and OT was 2.3 minutes, 4.8 minutes and 3.1 minutes respectively. The study showed a high degree of correlation between OT or RT and AT.

Key words: Axillary temperature, comparison, placement time.

Axillary site is commonly used for temperature recording in children as it is safe and convenient. However, conflict remains regarding its accuracy and there is no universally accepted equation to predict the core temperature from axillary temperature(1,2). Few studies done in this regard have used improper methodology like use of electronic or uncalibrated thermometers and unsatisfactory data analysis(1). The thermometer placement time required to accurately reflect the stabilized body temperature is also unclear and varies between seconds to 15 minute in various studies(2-6). The present study was done to compare the axillary temperature with rectal or oral temperature in children and to find out the optimum placement time at these sites for conventional mercury in glass thermometer.

Subjects and Methods

This prospective study was carried out on 100 infants (age less than one year) and 100 children (aged between 6 and 12 years) reporting with fever. Children between 1 to 6 years were not included as they were unlikely to co-operate for recording rectal or oral temperature. Children who were uncooperative or crying, preterm (<37 weeks gestation) or low birth weight (<2.5 kg), unconscious, tachypneic or malnourished (weight for age <70% of median) were excluded from the study. Temperature were measured with ordinary clinical mercury in glass thermometer (HICKS) in rectum and axilla in infants (Group I) and in the oral cavity and axilla in older children (Group II). Both rectal and oral/axillary thermometers were calibrated in a water bath adjusted to 37°C

using a standard laboratory mercury thermometer. Calibration was repeated periodically to ensure agreement within $\pm 0.1^\circ\text{C}$ of laboratory thermometer. Subjects wore light clothes during temperature measurements. For rectal temperature, thermometer prelubricated with sterile petroleum jelly was placed at a depth of 2 cm in the case of neonates and 3 cm in children older than 4 weeks(7). For axillary temperature, oral thermometer was placed in the axilla with the bulb of the oral thermometer in the right or left posterior sublingual pockets(7). The temperatures were recorded at one minute interval starting from 2 minutes after insertion until the reading remained unchanged for three consecutive times. AT and RT in Group I were measured simultaneously by different investigators. AT and OT in group II were measured sequentially without any time lag. The data were analyzed using Microsoft Excel and EPI Info software. Bland and Altman statistical method(8) was used to assess agreement between two methods of temperature measurement. With the help of regression analysis, a linear equation was derived to predict the RT or OT from AT.

Results

The mean age of subjects in Group I was 4.3 months with 47% neonates (<1 month of age). Females (55%) outnumbered males (45%). Mean (SD) RT was 37.5°C (0.8°C) and mean (SD) AT was 37.1°C (0.7°C). The mean (SD) temperature difference between RT and

AT was 0.3 (0.2) with 95% confidence limits of -0.8 to 0.76 . In group II the mean age was 8.7 years with 49% males. The mean (SD) OT in this group was 37.5°C (0.8°C) while the mean (SD) AT was 37.3°C (0.8°C). The mean SD temperature difference between OT and AT was 0.1 (0.2) with 95% confidence limits of -0.2 to $+0.5$. Significant positive correlation ($r = 0.95$; $p = 0.01$) was observed between RT and AT in group I. A linear relationship between RT and AT was derived by regression analysis. The equation derived was:

$$\text{Rectal temperature } (^\circ\text{C}) = 0.98 \times \text{axillary temperature } (^\circ\text{C}) + 0.8^\circ\text{C}$$

Similar comparison was done for Group II. OT and AT also showed a high degree of positive correlation ($r = 0.97$; $P < 0.01$). On regression analysis the equation of linear relationship between OT and RT was:

$$\text{Oral temperature } (^\circ\text{C}) = 0.96 \times \text{axillary temperature } (^\circ\text{C}) + 1.58.$$

Table 1 shows the placement time required for stabilization of temperatures recorded at various sites. On cumulative effect it was observed that 99% of RT readings stabilized at 3 minutes of the AT recordings, 92% stabilized by 5 minutes while 98% stabilized by 6 minutes; 97% of the OT recordings stabilized by 4 minutes. The mean placement time for stabilization of RT was 2.26 minutes (SD 0.46 minutes; 95% CI 1.4-3.2). The mean

TABLE I— Placement Time Required for Stabilization of Temperature.

Site of measurement	Number of subjects	Percentage of recordings stabilized				
		2 minutes	3 minutes	4 minutes	5 minutes	³ 6 minutes
Rectal	100	75	24	1	—	—
Axillary	200	2	8	14	68	8
Oral	100	21	51	25	3	—

Key Messages

- There is a good correlation between axillary temperature and oral or rectal temperature recorded by the conventional mercury in glass thermometer.
- Derived equation could be used to calculate rectal or oral temperature from axillary temperature.
- The placement time of the thermometer should be 3 minutes, 4 minutes and 6 minutes for rectal, oral and axillary temperature recordings respectively.

stabilization time for AT was 4.74 minutes (SD 0.84; 95% CI 3.1-6.4) whereas for OT it was 3.1 minutes (SD 0.8; 95% CI 1.6 - 4.6).

Discussion

Prediction of core temperature from axillary temperature measurement has always been of special interest to pediatricians because of convenience associated with AT recordings. A metaanalysis of various studies using the appropriate methodology for comparison of rectal with axillary temperature reported that mean temperature difference in °C between RT and AT and 95% limits of pooled fixed effects was 0.19 (-0.16 to 0.53) and the pooled random effects was 0.25 (0.15 to 0.65)(1). Most studies included in above metaanalysis showed that there was no constant relationship between RT and AT. A study(9) suggested that RT can be calculated by adding 1.1°F to AT. Another report(5) found that AT +1°C was a good guide to RT in children older than 1 month whereas in newborns the RT was equal to AT +2°C. An equation derived in an earlier study(2), *i.e.* $RT (^{\circ}C) = 0.99 X AT (^{\circ}C) + 0.82$ is very much similar to that derived in the present study. Most studies(10,11) comparing OT with AT have not used appropriate methods as mentioned in the metaanalysis(1). A single study using appropriate methods(2) reported mean (SD) of paired difference to be 0.6°C ± 0.5°C with 95% limits of agreement 0.4°C to 1.4°C and correlation coefficient (r) of 0.83.

The equation derived was $OT (^{\circ}C) = 0.7 X AT (^{\circ}C) + 1.1419$. The equation of the present study had a better correlation as compared to the above study(2). It is evident that there is no single value universally accepted to predict OT or RT from AT, even though there is a good correlation and agreement between them.

The placement time for stabilization of body temperature for RT in earlier studies ranges from 1 minute(9) to 15 minutes(6). Most studies(11-13) mention it to be 3 minutes as also reported in the present study. AT requires maximum placement time for stabilization of body temperature. A range of 4-7 minutes of placement time for stabilization of AT has been recorded by some(10-15) whereas others have found it to be unacceptably high at 12 minutes(16). The present study reported it to be 6 minutes. Majority of the studies(9-11) recommended OT placement time to be 3 to 4 minutes which is comparable to our findings of 4 minutes.

To conclude, there is a good correlation and agreement between AT and RT and AT and OT, but a single universal value to derive RT or OT from AT is still elusive. Equations derived from present study could prove useful to predict OT or RT from AT. The accuracy of temperature recording can further be enhanced by ensuring that placement time of the thermometer for RT to 3 minutes, for OT to 4 minutes and for AT to 6 minutes.

BRIEF REPORTS

Contributors: PC conceptualized the study was co-investigator and reviewed the manuscript. She will act as guarantor. KV supervised the study and helped in preparing the manuscript. DC collected and compiled the data and wrote the manuscript. MB helped in the statistical analysis.

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