AXILLARY TEMPERATURE IN RELATION TO ORAL TEMPERATURE IN A GROUP OF CHILDREN IN SRI LANKA

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Summary: The relationship between the oral temperature (OT) and the axillary temperature (AT) is not clearly established. The measurement of the OT could be an unhygienic procedure. Therefore, a study was done to determine the nature of relationship between OT and AT and whether AT could be used in place of OT. The OT and AT were measured in a group of children with OT's ranging from 97°F (36°C) to 105°F (40.5°C). The average difference of OT minus AT was statistically determined to be 0.3°F (0.15°C) throughout the range of temperatures tested. The correlation (r) between OT and AT was 0.99 (p<0.001). The AT is recommended as a reliable measure to be used in routine assessment of body temperature.

Key words: oral temperature axillary temperature relationship

INTRODUCTION

The oral temperature is a commonly used parameter of body temperature and is said to relate closely to the 'core' body temperature. It is determined by keeping the thermometer in the mouth (5). The axillary temperature (AT), obtained by placing the thermometer in the axillary fold is also used as a measure of body temperature (5). In children the AT is stated to be less than the OT by 1°F (4). There is no mention, however, of the temperature range within which this relationship held good. On preliminary observation we found that the average difference between the oral and axillary temperature to be much less than 1°F. A study (1) had been done in Ceylon (Sri Lanka on oral, rectal and axillary temperature on healthy adult subjects, but no information regarding the relationship of the oral and axillary temperature in children is available.

The oral temperature is measured in a large number of patients with the same thermometer, in the hospital wards. It was felt that this procedure could be unhygienic

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if the thermometer was not properly sterilized after each measurement. Whenever the axillary temperature is measured instead of oral temperature 1°F (0.5°C) is usually added to the AT to obtain the corresponding OT.

Therefore, we decided to find out the nature of the relationship of the two measures of temperature (OT & AT) over wide range of temperature in children. The possibility of using the axillary temperature to replace the oral temperature in routine temperature measurement in children was explored.

MATERIALS AND METHODS

Subjects:

The subjects were 100 male and 100 female children between the ages of 5 and 12 years. These children were randomly selected from among the patients of the Paediatric wards of the General Hospital, Kandy. Children with temperatures between 97°F (36°C) and 105°F (40.5°C) were studied. They did not have any local pathology which could have affected the temperature from either site. Loose fitting cotton garments were the commonest type of clothing worn by these children. Occasionally some children (the younger ones) wore either only a sleeveless vest or were bare bodied. This study was conducted between November 1979 and March 1980.

Thermometry:

A half minute clinical thermometer (G.H. Zeal, England made in Japan) was used in this study. The same thermometer was used throughout the study to obtain both the oral and axillary temperature. The temperature measurements were made with the subjects comfortably resting on a bed in the hospital ward. Necessary explanations were given to the patient (and the bystander with the patient when the need arose) to allay the anxiety of the patient and to obtain his/her maximum cooperation. It was ensured that the children had not consumed any food (solid or liquid) that could have transiently altered the OT, for at least 20 min prior to the measurement of the temperature. Garments covering the upper torso were removed and the axilla was dried (if any evidence of sweat was observed in the axilla) prior to the measurement of AT.

Since the same thermometer was used throughout the study and our main purpose was to compare two sets of readings (instead of obtaining absolute values) the instrument was not calibrated against a standard thermometer.
The thermometer was kept under the tongue as far back as possible and the subject was instructed to close his lips taking care not to bite the thermometer. It was placed deep in the right axillary fold and the arm was firmly held down to measure the axillary temperature. The arm was held close to the body of the subject. The thermometer was left in situ for a minimum period of two minutes at each site. The oral and axillary temperature were taken with one assessment following the other, i.e. if the oral temperature was measured first in one subject then the axillary temperature was ascertained first for the next subject. This procedure was used throughout the study to overcome any effects of body temperature changes due to experimental stress which may arise despite the precautionary measure observed.

The time taken for the thermometer to reach a constant value was determined by repeatedly taking the oral and axillary temperatures in a few male and female children until constant. Initially the thermometer was placed in situ and read in 15 sec. It was then shaken down and placed again at the same site and read in 30 sec. This procedure was followed increasing the time by 15 sec. after each reading. This was done until three consecutive readings which gave the same value were obtained.

All the readings were obtained in Farenheit since this was the unit of measure commonly used in Sri Lanka. Data analysis were carried out using the data in Farenheit units. The thermometer was read accurately to 0.1°F.

Environmental conditions:

The dry bulb temperature during the period of study ranged from 25°C to 31.7°C. The effective temperature (E.T.) which is a sensory scale of warmth, combining air temperature, humidity and air movement into a single index (7) ranged from 23.9°C to 27.5°C over this period. These figures were obtained from our laboratory which is in proximity to the hospital.

RESULTS

The thermometer showed a gradual rise of temperature at each 15 sec intervals up to 2 min. Thereafter, the thermometer reading remained constant.

The difference between oral and axillary temperature (OT-AT) was obtained for each set of datum. The mean (\(\bar{x}\)) and standard deviation (s.d.) for the OT-AT were obtained for males and females separately. A t test done to test the significance of the difference between the means indicated that there was no statistically significant difference between these two means (t=0.77, d.f. 198, N.S.). Therefore, the overall mean and s.d. were for all the data taken together.
From this data we see that the average difference between oral and axillary temperature is 0.3°F (0.15°C) with the axillary temperature having the lower value.

<table>
<thead>
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<th>Category</th>
<th>Number</th>
<th>$\bar{x}$</th>
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<tbody>
<tr>
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<td>0.28</td>
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<tr>
<td>Female</td>
<td>100</td>
<td>0.26</td>
<td>0.19</td>
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<td>200</td>
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A paired sample $t$ test was done to test the significance of the difference between the mean oral and mean axillary temperatures. This test indicated a highly significant difference between the two sets of data ($t=19.8$, d.f. 198, $p<0.001$).

There was however, a very high degree of correlation for the oral and axillary temperatures ($r=0.99$, $p<0.001$). On regressing the oral on axillary temperature the regression co-efficient was 1.00 and the intercept was 0.27. The analysis of variance computed from the regression yielded a highly significant $F$ value ($F=9873$, d.f. 1.198, $p<0.001$). Initially the data for males and females were regressed separately and these two regressions were compared using the $F$ statistic. The two separate regressions did not yield a statistically significant difference from the regression done using all the data together ($F=0.8$, d.f. 2, 196; N.S.). Hence the model incorporating all the data was retained.

The formula to be used in converting the axillary temperature to the oral temperature could be represented thus:

\[
\text{Oral temperature } ^\circ F = \text{Axillary temperature } ^\circ F + 0.3
\]

If the conversion is to be done for centigrade units then the formula would be:

\[
\text{Oral temperature } ^\circ C = \text{Axillary temperature } ^\circ C + 0.15
\]

This implies that the addition of 0.3 to the axillary temperature would yield the value of the corresponding oral temperature if the unit of measure is Farenheit and if the unit of measure is Centigrade, the addition of 0.15 would yield the same result. There was no appreciable correlation between OT and OT minus AT ($r = 0.15$).
DISCUSSION

The manufacturer claimed the thermometer to be a \( \frac{1}{2} \) min. clinical thermometer but it took nearly two minutes to reach a constant reading in both the oral and axillary sites. The fact that the thermometer may take more than the stipulated time to reach a constant maximum temperature (C.M.T.) has been reported (2,4,5). These texts state that it may take 4-7 min for the thermometer to reach the C.M.T. However, the shorter time taken by our thermometer to reach the C.M.T. value is probably due to the mechanical differences in construction of the modern thermometer when compared to the thermometers used in the earlier studies.

The correlation of OT and AT \( (r = 0.99) \) indicated an almost perfect, positive and linear relationship between the two sets of variables. Cullumbine (1) correlating OT & AT obtained a statistically significant \( r \) value of only 0.5. This is probably due to the fact that he studied the oral and axillary temperatures only in 'normal' adult individuals whereas our study was done in the paediatric age group with a wider range of temperatures.

A correlation co-efficient gives information regarding the nature and strength of relationship between the two variables under study but does not indicate how the value of one variable may be predicted from the other. The regression equation helps us to do same and the analysis of variance computed from the regression gives information regarding the goodness of the regression model. In view of the high degree of correlation and our interest in trying to predict the OT from AT over a wide range of temperatures linear regression analysis was performed, since it was the most appropriate technique. The OT was used as the dependent variable and the AT was used as the independent variable in the regression because we were interested in predicting the OT from AT. The \( F \) value obtained from the analysis of variance for the regression model tells us of its high degree of accuracy and of its usefulness as a model for prediction of OT from AT. The lack of correlation between OT and OT - AT lends further confirmatory evidence of the fact that the difference is uniform over the range of temperatures measured.

Since the regression co-efficient was unity the addition of the intercept (0.3) to the axillary temperature (in °F) would give an accurate estimate of the OT (in °F) over the range of temperatures used in this study i.e. from 97 °F (36 °C) to 105 °F (40.5 °C). The conversion of centigrade units is done by the addition of 0.15 as the value of the intercept is 0.15 if the data analysis were carried out with the readings in centigrade. The gradient and correlation co-efficient would remain unchanged.

It is a common belief that the axillary temperature is about 1°F (0.5°C) lower than the oral temperature. Our study confirms that the AT is lower than the OT but the average difference between the two is much less than 1°F. This figure of 1°F probably represents
a figure applicable to western countries with lower ambient temperatures. Hence these children may be exposed to lower temperatures and this would tend to lower the surface body temperatures to some extent. The variation of the skin temperatures with the environmental temperature has been described by Hardy & DuBois (3) in their classical work on surface body temperature. Our children acclimatized to exposure of a relatively warmer climate may have a relative vasodilatation which would decrease the gradient between the 'core' temperature and that of the axilla. This is a probable reason for the AT being only 0.3°F (0.15°C) less than OT in the children studied.

The significant differences between the mean values of the OT and AT of the entire groups of subjects indicate that those are two distinct entities. One value could be used to predict the other with great accuracy because of the high degree of correlation of the two variables.

Children below the age of 5 yrs, were excluded from the study as the oral temperature could not be determined because of the potential risk of injury from the child biting the thermometer. It is sometimes said that the AT could be unreliable but this may be due to improper placement of the instrument sweat in the axilla or the thermometer being left in the axilla for an inadequate length of time.

In view of our findings we suggest that the thermometer should be kept for at least 2 min in situ to allow it to reach a constant value; despite the claims of the manufacturer. We also suggest that the AT be used in routine assessment of body temperature in children of the age group of 5-12 yrs* because our results convincingly show that the AT is as reliable a measure as OT in the assessment of body temperature, within the range of temperatures encountered in our study.

In conclusion it could be said that the oral temperature is on an average 0.3°F (0.15°C) higher than the axillary temperature. The oral and axillary temperatures are two distinct entities, but they are linearly related.

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*Work is in progress among adults to assess the relationship of OT & AT.
REFERENCES