INTRODUCTION

Temperature is one of the vital signs assessed in the triage of outpatients as well as admitted patients. Methods of temperature recording vary depending upon the working environment and availability of the resources. Traditionally oral, axillary or rectal temperature recordings have been obtained using mercury thermometers or digital temperature recording devices. Temperature recording should record the core temperature and should be accurate, less time consuming, atraumatic and physically and psychosocially acceptable to the patients. Core temperature recording through a pulmonary catheter is considered gold standard in critical care setting. However, this cannot be used in OPD patients. In such situations rectal temperature recording is the next ideal core reading.

METHODOLOGY

A comparative observational study was conducted at the Outpatient Department of ENT, Surgery, Medicine and Paediatrics, Shifa International Hospital, Islamabad, from June to September 2008.

ABSTRACT

Objective: To observe and compare the Tympanic Temperature (TT) readings with the Oral Mercury Thermometer (OMT) in an OPD setting.

Study Design: Observational comparative study.

Place and Duration of Study: The Outpatient Department, Shifa International Hospital, Islamabad, from June to September 2008.

Methodology: By consecutive sampling, 2000 OPD patients were included in the study. Both tympanic membrane and oral cavity temperatures were recorded in each patient. Patients were grouped into four age classes i.e. 5-16, 17-40, 41-60 and above 60 years. Taking the oral temperature as a standard, tympanic temperature recordings were analyzed in each age group for afebrile and febrile temperature ranges. An intra-class Pearson’s correlation coefficient (r) was calculated for closeness of correlation of TT with OMT in each group.

Results: Mean age of the sample was 31.84±19.42 years. Mean temperature reading from the OMT was 36.732 ±0.66°C, while the mean TT reading was 36.575±0.71°C. Overall correlation between OMT and TT readings was 0.871 (p < 0.001); higher correlation was found in children as compared to adults. In the febrile range, a strongly positive correlation of TT with OMT in the 5-16 years age group (r=0.945) was seen. A poor correlation of TT with OMT was noted for 41-60 and 60 plus groups (r=0.394 and 0.342 respectively). TT was found to have very high specificities in all age groups; highest of 100 in 17-40 years age group. The sensitivities were generally low, the lowest being 33.33 in 60 plus age group.

Conclusion: TT measurement is a quick method for temperature recording in a busy OPD. However, it is reliable mainly for a younger population.

Paediatrics at Shifa International Hospital, Islamabad from June to September 2008. A consecutive sample of 2000 patients of age 5 years and above, of both genders, presenting to four departments were included with their consent. Exclusion criteria included children under 5 years (oral temperature not recommended), patients with oral cavity lesions (oral temperature not feasible), ear discharge and otalgia (tympanic temperature recording not feasible) and patients not willing to undergo these methods of temperature recording. Two nurses, trained by the principal investigator, collected the data on indexed charts by taking a single tympanic membrane temperature (TT) reading from the right ear, followed by an oral mercury thermometer (OMT) reading. A Beurer® FT25 thermometer was used for tympanic temperature readings while ear tug and mercury thermometer was used for taking oral temperature.

For the purpose of this study, patients were divided into four age groups. Group 1 included patients aged 5-16 years; group 2 included those aged 17-40 years; group 3 included those aged 41-60 years and group 4 included those above 60 years of age. Collected data was the statistically analyzed on SPSS version 13. Oral and tympanic temperatures were calculated as means ± SD.

Taking the oral temperature as standard, fever was defined as temperature more than 37.7°C.7 The main outcome variables i.e. correlation between the two readings in normal (oral temperature equal to or less than 37.7°C) as well as febrile range (oral temperature more than 37.7°C) for these age groups of patients were recorded. Stratified comparative analysis was done for further validation of the TT with OMT calculating sensitivity, specificity, positive predictive value and negative predictive values.

RESULTS

A total of 2000 patients, comprising 1149 (57.7%) males and 851 (42.6%) females were included in the study. The age distribution in the sampled patient population ranged from a minimum of 5 years to a maximum of 85 years, with a mean age of 31.84±19.42 years. Patients were subdivided into four age groups for the purpose of the study. Six hundred and twenty six (31.3%) were between 5-16 years, 730 (36.5%) were between 17-40 years, 478 (23.9%) between 41-60 years and 166 (8.3%) were 60 years and above.

The mean overall temperature reading from the OMT was 36.732°C (range 34.2-40.4, SD ± 0.66) while the mean TT reading was 36.575°C (range 34.1-40.0, SD ± 0.71). The graphic bivariate correlation of oral and tympanic temperature readings is shown in Figure 1, indicating closely related OMT and TT readings.

Further analyzing the temperature readings in four age groups, taking OMT as standard, the temperature recordings were further divided into two temperature ranges i.e. below or equal to 37.7°C (normal) and more than 37.7°C (febrile). In all 97 patients (4.85%), out of 2000 were identified as febrile.

Overall correlation of TT with OMT was positive (p < 0.001) for all 1903 patients in the normal temperature range and remaining 97 patients in the febrile range. The intra-class Pearson's correlation (r) was calculated in the four age groups. There was a positive correlation between the TT and OMT, for normal temperature range in all age groups (p < 0.001). In the febrile range, there was a strongly positive correlation of TT with OMT in the 5-16 years age group (r=0.945) followed by 17-40 years age group (r=0.590). There was a poor correlation of TT with OMT in the remaining two groups of above 40 years (r=0.394 and 0.342 respectively for 41-60 and 60 plus groups, Table I). However, the number of patients with fever in these groups was too small to draw any meaningful conclusion (N = 24 and 7 respectively).

Stratified analysis for further validation of tympanic temperature (TT) recording was done with oral temperature (OMT) taken as standard. Sensitivity and specificity of TT for all age groups, along with positive predictive values (PPV) and negative predictive values (NPV) were calculated (Table II). TT was found to have very high specificities in all age groups; the lowest of 99.37 for 60 plus age group and highest of 100 in 17-40 years age group. Similarly, the NPVs were quite high (related to specificities). The PPV's ranged from 80 (95%, confidence interval=28-96) in the 60 plus age group to the highest of 100 (95%, CI=71-95). The sensitivities were generally low, the lowest of 33.33 in 60 plus age group and highest of 88.88 in 5-16 years age group.
DISCUSSION

Studies have found that normal body temperatures range from 35.5 to 37.7°C. A patient is labeled as febrile if the recorded temperature is higher than 37.7°C. In the present study, 4-5% of patients in each age group or overall 2000 patients were febrile, as picked up with oral thermometer. The present study noted a positive correlation of TT with OMT in all age groups in the normal temperature range (< 37.7°C). The correlation remained positive for the paediatric and adult age groups in the febrile range. The correlation was poor in the older population. This trend is comparable to other published data. These correlations have ranged from 0.62 to 0.95. In the present study, the correlation was highest at 0.945 in the 5-16 years age group, in the febrile temperature range. The remaining groups, had values at 0.826-0.858 in the normal temperature range.

Most of the studies have compared the TT with rectal or axillary temperature recordings especially in the paediatric age groups. These studies found TT more effective and accurate than axillary thermometers but inferior to rectal temperature recordings. Studies done in the older populations have reported variable results. In one study, there was good correlation of 0.845 of TT with OMT in adult postsurgical patients. However, another study found a very poor correlation between the two in the adult population. In the geriatric population, the TT was found to be a very handy tool for repeated temperature measurements with high sensitivity and specificity when compared with rectal or OMT. In this study, there was poor correlation of TT with OMT in the febrile range in the geriatric population, with low sensitivity of 33.33. Varney, et al. found low sensitivity and specificity in the geriatric population and concluded that the tympanic thermometer was not a valid tool.

Stratified analysis of tympanic temperature recording revealed a fairly high positive predictive value for fever. However, there was wide deviation of the mean as depicted by 95% confidence interval that was best at 85-100 in the 17-40 years age group and worst at 28-99 in the geriatric population. The negative predictive value, however, was quite high ranging from 95 (geriatric group) to 99.32 (paediatric group) with a narrow 95% confidence interval. The instrument had a high specificity in recording temperature in all age groups but a low sensitivity, lowest of 33.3 in age 60 years plus and best at 88.88 in the paediatric age group. Therefore, judged alone, the device may not be good at screening for fever in a population other than the younger population. These interpretations must be viewed within limitations of the study, which involve a less than adequate percentage of febrile patients, potential measurement errors and equipment errors.

Despite conflicting reports of reliability, the tympanic thermometer has been preferred by parents for rapid and quick temperature assessment method in children, due to ease of use and acceptance by the children as well. Studies suggest that vital sign measurements do not greatly influence triage destination for patients but play a greater role for the physicians managing the patients. As such, decreasing triage processing time by using TT can be augmented by providing for usage of OMT, where needed, once the patient has reached his assigned destination e.g. in geriatric patients. Rapid patient processing at triage and filter clinics has also been shown to have the added benefit of reducing the number of patients who leave the hospital without being seen. Clinical judgment is of paramount importance besides recording devices like TT or OMT in the detection of fever. Whenever in doubt, more than one method can be employed.

### Table I: Intra-class and overall Pearson’s correlation between OMT and TT.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of patients</th>
<th>Correlation (r) TT/OMT</th>
<th>p-value</th>
<th>Number of patients</th>
<th>Correlation (r) TT/OMT</th>
<th>p-value</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-16</td>
<td>597 (95.06%)</td>
<td>0.835</td>
<td>&lt; 0.001</td>
<td>31 (04.94%)</td>
<td>0.945</td>
<td>&lt; 0.001</td>
<td>628</td>
</tr>
<tr>
<td>17-40</td>
<td>693 (99.19%)</td>
<td>0.828</td>
<td>&lt; 0.001</td>
<td>35 (04.89%)</td>
<td>0.590</td>
<td>&lt; 0.001</td>
<td>728</td>
</tr>
<tr>
<td>41-60</td>
<td>454 (94.97%)</td>
<td>0.858</td>
<td>&lt; 0.001</td>
<td>24 (05.03%)</td>
<td>0.394</td>
<td>0.057</td>
<td>478</td>
</tr>
<tr>
<td>60 plus</td>
<td>159 (95.78%)</td>
<td>0.856</td>
<td>&lt; 0.001</td>
<td>7 (04.22%)</td>
<td>0.342</td>
<td>0.452</td>
<td>166</td>
</tr>
<tr>
<td>All ages</td>
<td>1903 (95.15%)</td>
<td>0.843</td>
<td>&lt; 0.001</td>
<td>97 (04.85%)</td>
<td>0.723</td>
<td>&lt; 0.001</td>
<td>2000</td>
</tr>
</tbody>
</table>

### Table II: Stratified comparative analysis of TT with OMT (OMT taken as standard).

<table>
<thead>
<tr>
<th>Age range*</th>
<th>PPV**</th>
<th>NPV**</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-16 (N=628)</td>
<td>86.48 (71-95)</td>
<td>99.32 (98-99)</td>
<td>88.88 (73-96)</td>
<td>99.15 (98-99)</td>
</tr>
<tr>
<td>17-40 (N=728)</td>
<td>100 (85-100)</td>
<td>98.01 (96-98)</td>
<td>63.15 (45-78)</td>
<td>100 (99-100)</td>
</tr>
<tr>
<td>41-60 (N=478)</td>
<td>91.66 (61-99)</td>
<td>96.99 (95-98)</td>
<td>44 (24-65)</td>
<td>99.77 (98-99)</td>
</tr>
<tr>
<td>60 Plus (N=166)</td>
<td>80 (28-99)</td>
<td>95.18 (90-97)</td>
<td>33.33 (9-65)</td>
<td>99.37 (96-99)</td>
</tr>
<tr>
<td>Overall (N=2000)</td>
<td>91.02 (82-96)</td>
<td>98.12 (97-98)</td>
<td>66.35 (55-75)</td>
<td>99.63 (99-99)</td>
</tr>
</tbody>
</table>

* N represents the number of patients in respective groups; ** Values in parentheses represent 95% Confidence Interval calculated with Binomial expansion.
CONCLUSION
In this study TT was found to be a good and quick tool in screening patients, specially children and young adults, in the OPD setting. This is particularly useful in a high load setting, where rapid temperature measurement decreases patient processing time. There was a poor correlation between TT and OMT in elderly patients. However, the number of elderly patients specially presenting with fever were very few in this study. A study of an elderly population with a larger number of patients can further explore this correlation.

REFERENCES