Research article

Study of continuous temperature recording in various opportunistic infections in people with HIV

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ABSTRACT

Introduction and Aim: Fever patterns in various infections can give important clues in arriving at an early diagnosis. As most recordings of temperature are not continuous the full utility of this parameter has never been given its due importance. The infections that occur in HIV individuals have varied presentations and hence leads to a delay in its diagnosis and necessitating many investigations. If 24 hours’ temperature monitoring could give reliable patterns of temperature in these various diseases, it would be an inexpensive tool that could be used in these patients as the initial diagnostic approach of these patients.

Materials and Methods: In this study on patients with HIV and fever, continuous tympanic temperature monitoring was done. The visual characteristics patterns were compared with the various categories of infections that occurred in these HIV individuals. Results were expressed using mean (standard deviation), median (inter quartile range) and proportion. ANOVA was used to find the statistical difference between various opportunistic infections and a P value <0.05 was considered to be statistically significant.

Results: A total of 65 HIV patients were included in the study. The type of jerky temperature pattern could differentiate between bacterial, intracellular, tuberculosis and parasitic infections (Pearson Chi-Square =16.4, P= 0.058). The type of plateau phase could also distinguish these categories of diseases. The Pearson Chi-Square value for plateau phase was 10.511 with p-value 0.015.

Conclusion: When these temperature patterns were applied for diagnosing the various categories of diseases in HIV their accuracies were as follows: For bacterial diseases (62.5%); intra-cellular (50%); tuberculosis (82.1%); parasitic (64.3%). The overall accuracy was 71%, showing that the temperature patterns could be used as an important starting point in the diagnostic approach in these patients.

Keywords: Infections; HIV; temperature; tympanic; patterns.

INTRODUCTION

G lobally, the prevalence of HIV is increasing. India has third highest number of people living with HIV, with prevalence rate of 0.26%. Prevalence in Karnataka is 0.45% (1). Pyrexia of unknown origin in HIV patients is a diagnostic challenge because of unusual presentation of common diseases in this population (2). While there has been an increase in the number of diagnostic tests available and an improvement in the accuracy of existing test, there are multiple diagnostic dilemmas. It includes the fact that these patients frequently have multiple causes of fever, as well as altered diagnostic test results due to suppressed immune response. This leads to multiple false positive or negative test results. The choice of the appropriate test in these patients is therefore difficult. Recent technical advancements in the form of continuous monitoring of pulse and blood pressure have revealed dynamic changes in the host in response to a number of disease states (3). Recent advances have also added new insights to the understanding of the disease process that was previously unknown.

Extension of this concept to clinical thermometry has been attempted. While classic definitions of fever patterns are based on intermittent temperature control, this is typically a small part of a continuous process and the degree to which this small part reflects the entire series is questionable (4). Studies that monitored continuous tympanic temperature in immune-competent patients have reported newer, more subtle trends that help to define the cause of fever (5). However, there are not many studies that have continuously recorded temperatures among HIV patients with fever. In this study, we attempt to establish the effectiveness of continuously measuring temperature in patients with HIV by recording 24-hour continuous tympanic temperature.

MATERIALS AND METHODS

Study design and materials

The aim of the study was to record and analyse a 24-hour continuous tympanic temperature and evaluate its utility in the diagnosis of various causes of fevers in an HIV positive patient. The study design was a
Cross-sectional study was done in a tertiary care center in south India. The permission from the local ethics committee was obtained. Informed consent was obtained from all participants.

**Inclusion criteria**

Participants who were aged more than 18 years, patients diagnosed to have HIV and presented with fever, and individuals with an intact tympanic membrane.

**Exclusion criteria**

Patients with history of hyperthermia or malignant hyperthermia. Individuals with ear-related problems (including discomfort, pain, and discharge) who are currently taking medication. Subjects on regular antipyretic or anti-inflammatory drug therapy. Women/pregnant women taking oral contraceptives. Subjects who were on antibiotics therapy 2 days prior to temperature recording. Subjects who have poor compliance with ear probe.

Sample size was estimated to be 65 when computing for 95% confidence level and 80% power. Sampling strategy followed was convenient sampling. 24-hour temperature monitoring was done for all the patients. Evidence for giving antipyretics for fever in previously published studies has shown that even though there is a popular belief that antipyretics have superior role in treatment of fever, there is no proven data to support this hypothesis. In fact, fever being a host response to the actual underlying pathology, several hypothetical benefits are suggested for not initiating antipyretics till 41°C especially in patients with no organ damage and in those who are not at extremities of age (6,7).

However, since this was an observational study, the decision to give antipyretics in patients with fever was left to the discretion of the treating physician and those patients who have taken antipyretics during the time of temperature recording were excluded from the study population. Measurement of 24-hour tympanic temperature was done with the help of Ther-com device. A T-clinic Ther-Com is a portable device used to obtain and store or transmit in real time single body temperature data. It has temperature sensors, signal conditioner and amplifier for each channel, an analogue to digital converter, a microcontroller, flash memory, and a Bluetooth module. Tympanic probe: Adult tympanic temperature sensor is a disposable tympanic temperature probe has soft sponge material to protect the ear canal from internal injury and to avoid the external air entering into the auditory canal. All the stored temperature data of the subjects in Ther-Com device was downloaded to the computer through USB cable. Processing of the data was done with the help of machine Learning algorithm and classification. Collected data was processed with Ther-com application and individual 24 hour monitoring charts was prepared, compared and classified with the help of visual pattern analysis by feature extraction. Visual characteristic features: The following visual features were observed from the temperature signal of each subject for visual pattern analysis.

We defined important visual characteristic features of the temperature tracings. A) Steep rise: The rise of temperature up to 2°C where the peak temperature is attained within 4 hours. B) Steep fall: The fall in temperature from the peak temperature as it reaches the baseline temperature within the duration of ≤ 4 hours. C) Early morning moderate surge: The secondary minimal temperature surge up to 1.0°C that occurred between 1:00 am and 5:30 am, which is less prominent than the major peak temperature. D) Slow temperature elevation/slow rise: The slow rise of temperature up to 2°C where the peak temperature is attained within the duration of 8 hours. E) Slow temperature fall / slow fall: The temperature falls from the peak temperature and reaches the baseline temperature within the duration of ≥ 6 hours. F) Plateau phase: The temperature elevated to a certain level, and remains at the same degree for more than 3 hours with minimal fluctuations not exceeding than 0.3°C. G) Jerky fluctuations: The continued temperature fluctuations at every 3 to 4 hours. Further jerky fluctuations are sub classified as mild, moderate, and high fluctuations. i. Mild jerky fluctuations: The continued temperature fluctuations of ≤ 0.5°C every 3 to 4 hours. ii. Moderate jerky fluctuations: The continued temperature fluctuations of 0.5°C and <1.5°C every 3 to 4 hours. iii. High jerky fluctuations: The continued temperature fluctuations of ≥ 1.5°C every 3 to 4 hours. Only diagnosed cases were considered for final interpretation. For the purpose of analysis the cases were divided into 4 groups: Bacterial infections, intra-cellular infections, tuberculosis and parasitic infections. The temperature patterns were then compared with these 4 groups of infection.

**Table 1: Number of peaks**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of peaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial</td>
<td>5 10 1 0 0</td>
</tr>
<tr>
<td>Intracellular</td>
<td>2 2 3 0 0</td>
</tr>
<tr>
<td>Tubercular</td>
<td>13 11 3 1 0</td>
</tr>
<tr>
<td>Parasitic</td>
<td>2 6 4 1 1</td>
</tr>
<tr>
<td>Total</td>
<td>22 29 11 2 1</td>
</tr>
</tbody>
</table>

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Ethical clearance

Ethical clearance was taken from the institutional local ethics committee before the start of the study (IEC KMC MLR 09-18/244).

Statistical analysis

Data was entered and analysed in SPSS 17.5. Results were expressed using mean (standard deviation), median (inter quartile range) and proportion. To calculate the difference between various opportunistic infections ANOVA was used. P values <0.05 was considered to be statistically significant difference.

RESULTS

A total of 65 HIV patients were included in the study. Males formed 70.8% of the subjects. Majority of the patients were in the age group of 40-59 years. 52.3% of the patients had fever of duration of 1-7 days whereas 47.3 % of patients had fever duration more than 7 days. Out of the 65 patients, 16 had CD4 count >500, 24 had CD4 counts between 200 – 499, 11 patients had CD4 count between 100 -199 and 7 patients had CD4 counts between 50-99. The distribution of cases was as follows: Bacterial infections: 16 patients (24.6%); intra-cellular infections:7 patients (10.7%); tuberculosis: 28 patients (43%); parasitic infections: 14 patients (21.5%).

On comparing the various visual characteristics of the temperature recordings with the four categories of the diseases the following observations were made. Peak numbers analyzed using Pearson Chi square test was found to be statistically not significant (x² =15.465, p= 0.217). As seen in Table 1, the numbers of peaks in the temperature pattern were not useful in distinguishing the various diseases. Jerky temperature: Pearson Chi-Square value was 16.4 with P value 0.058, which is statistically significant. As seen in Table 2, the number of jerky temperature fluctuation can differentiate between bacterial, intracelluler, tuberculosis and parasitic infections. Rise in temperature: Pearson Chi-Square test value for rise in temperature was 5.62 with p-value 0.466 which was not statistically significant. As shown in Table 3, the pattern of rise in the temperature was not helpful in differentiating the various diseases. Plateau phase: Pearson Chi-Square value for plateau phase was 10.511 with p-value 0.015 which is statistically significant. As seen in Table 4, the type of plateau phase was helpful in differentiating the 4 group of diseases. When these temperature patterns were applied for diagnosing the various categories of diseases in HIV their accuracies were as follows: For bacterial diseases (62.5%); intra-cellular (50%); tuberculosis (82.1%); parasitic (64.3%). The overall accuracy was 71%.

DISCUSSION

This study was done on 65 HIV patients who presented with fever. A 24 hour tympanic temperature was recorded and the temperature pattern was analyzed based on visual feature analysis. Most of the patients in our study belonged to the age group of 40-59. In another study on HIV patients with fever in India the median age was 31years (8). Most patients in our study had CD4 counts between 200-499. In the study done by Sharma et al., the mean CD4 count was 200 (9). Among the diseases seen in HIV, tuberculosis was found to be the most common disease. Similar findings were observed by Chakravarthy et al., in their study where tuberculosis formed 38.8% of the cases (10). In our study the number of peaks in the temperature and the pattern of rise in the temperature did not correlate with the various diseases. The patterns that were found useful in distinguishing the varying types of diseases were the jerky fluctuation in the temperature and the type of plateau phase of fever. Most of the tuberculosis patients hardly had any jerky pattern of fever. Parasitic infections had mild jerky pattern of fever. Whenever there was absence of severe jerky pattern it was suggestive of either bacterial or intra-cellular infection. A study by Dakappa et al., reported 82.1% of tuberculosis patients to show single peak temperature and 71.0% of non-tuberculous patients to exhibit two peaks (11). The study also showed that in comparison to non-HIV patients, most HIV patients had no peak of rise in temperature, had less jerky temperature fluctuation, no plateau phase and had slow raise in temperature (11).
Tuberculosis patients showed a sustained temperature increase in the late evening followed by a rapid temperature drop in the morning. No consistent significant pattern was observed when they had both HIV and tuberculosis (11). By using visual defined features of temperature patterns, classification of HIV patients with fever could be done with 71% of accuracy in our study. Dakappa et al., in their study were able to achieve an accuracy of 83.5% in classifying fever among patients without HIV (11).

CONCLUSION

Based on our study, 24 hours temperature recording helps in diagnosis of opportunistic infections in HIV. It is a simple cost-effective method and is non-invasive. To increase its accuracy, artificial neuronal intelligence can be tried for analysing the temperature patterns and classifying the diseases based on the patterns.

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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