Comparing accuracy of body temperature measurement using axillary and nasopharyngeal thermometer

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Abstract:
Introduction: Measurement of body temperature is widely used in clinical medicine. Accurate and precise measurement of body temperature, as a vital sign, sets the beginning of diagnosis and is the key to treatment. The present study aimed to determine the accuracy and precision of axillary measurement of body temperature as compared with nasopharyngeal method.

Materials and Methods: This descriptive analytical study was conducted on 200 patients admitted to the Teaching Hospital in the city of Bushehr in 2014 using convenient sampling. After obtaining informed consent, measurements were done using nasopharyngeal and axillary methods on both sides, and recorded along with patient demographics.

Results: The mean age of the participants was 37.34±17.72 years old. Their mean body temperature was 37.04±0.83 and 36.79±0.83 °C in nasopharyngeal and axillary methods, respectively. The best cut-off point was 37.6 °C in axillary method with the sensitivity of 88.8% and specificity of 94.5%. No significant difference was observed between right and left axillary temperature (p=0.06). A high correlation was observed between the nasopharyngeal temperation and both right (r=0.90) and left (r=0.85) axillary temperature.

Conclusion: Digital axillary thermometer is accurate for measuring body temperature.

Keyword: Axillary, Nasopharyngeal, Body Temperature, Thermometer

Introduction
A routine method for the diagnosis and assessment of treatment is measurement of body temperature in order to determine body core temperature (1). Patients’ body temperature can be measured through different body parts, including the mouth, axilla, rectum, pulmonary artery, esophagus, pharynx, bladder, and ear canal (tympanic membrane) (2,3). Each measurement method has its advantages and disadvantages. An ideal method is one that best represents core body temperature and is fast, simple, hygienic, non-invasive, patient-friendly, and cost-effective (4,5). In many medical and nursing texts, nasopharyngeal thermometry has been introduced as an accurate and appropriate method for adults (6,7). The pulmonary artery temperature is the most accurate
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indicator of core body temperature due to indicating the mean blood temperature coming from the major organs of the body to the lungs, but these methods are invasive and costly (8,9). The axillary thermometry is widely used, because it is easy to access and safe, especially for certain groups, including children, older adults, and critically ill patients in intensive care units (10,11). However, since this region is not close to main arteries of the body and variation of the results, there are doubts about its accuracy and precision (12,13). Several studies have examined the accuracy and precision of axillary measurement of body temperature as compared with other parts of the body. According to a comparative study conducted by Bernardo on the accuracy of different methods of temperature measurement in pediatric trauma patients, it was reported that although the axillary method is non-invasive, it does not reflect the core body temperature and is greatly affected by ambient temperature and vasoactive factors (14). After comparing tympanic, axillary, oral, and rectal thermometry, Dzarr et al. reported that there is less agreement on axillary temperature compared to tympanic and rectal temperature (15). Losun et al. reported that in continuous measurement, axillary temperature is less precise compared to the pulmonary artery temperature. Jean-Mary et al. also suggested that although axillary thermometers have low sensitivity for the diagnosis of fever compared to core temperature measurement methods, they are non-invasive and have no side effects (16). Due to inconsistencies in axillary measurement of body temperature, this study aimed to determine the accuracy and precision of digital axillary thermometer compared to nasopharyngeal thermometer.

Materials and Methods

This descriptive analytical study recruited all patients admitted to intensive care units of Shohadaye Khalije Fars Hospital in Bushehr, Iran. Inclusion criteria were being over 17 years old, having no problems, wounds or surgery around the nose, throat, and axilla. The sample size was calculated 200 patients using PASS software and equality of output data test with the power to detect a difference of 0.05 between temperatures measured by different methods, and test power of over 80%. Before measuring the temperature, thermometers used in the study were calibrated and written informed consent was obtained from patients or their accompaniments. The temperature was then measured using axillary and nasopharyngeal methods. To measure both right and left axillary temperature, a digital thermometer (Omron flex temp CE 0197) was used. After covering the tip of the thermometer with a disposable cover, it was placed in the mid-axillary line in parallel to the body and upon hearing the beep sound, the number appearing on the thermometer screen was recorded as the fixed axillary temperature. To measure nasopharyngeal temperature, the tip of the thermometer was covered with a disposable plastic cover (bf Alborz model), and inserted to a depth of 5-8 cm in the patient’s throat through the nose. The fixed number appearing on the screen was then recorded. The room temperature was also measured and recorded using a regular thermometer mounted on the wall. The data were entered into SPSS-21 and analyzed using Spearman’s correlation test. To verify the accuracy of measurements, the means difference was analyzed using t-test, and the sensitivity and specificity of axillary and nasopharyngeal methods were determined based on the ROC curve. The significance level was considered P<0.05.

Results

Of the 200 patients participating in the study, 167 (83.50%) were male. The mean age of the participants was 37.34±17.82 years old. The mean room temperature was recorded 27.57±2.36 °C using a wall
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The mean body temperature was measured using right and left axillary and nasopharyngeal thermometers and is presented in Table 1. According to the results of this study, no significant difference was observed between gender and different methods of temperature measurement (P=0.81).

To verify the axillary temperature in the diagnosis of fever, nasopharyngeal temperature higher than 38 °C was considered a benchmark for fever and of the 200 patients studied, 36 (18%) were diagnosed with fever. The ROC curve was used to achieve the best cut-off point in terms of sensitivity and specificity in the diagnosis of fever. The cut-off point was 37.6 °C in right axillary temperature with the sensitivity of 88.8% and specificity of 94.5% (Figure 1) and this value was 37.6 °C in left axillary temperature with the sensitivity of 91.6%, and specificity of 94.5% (Figure 2).

Figure 1: The ROC curve for determining the sensitivity and specificity in right axillary temperature measurement

Figure 2: The ROC curve for determining the sensitivity and specificity in left axillary temperature measurement
The results of comparing axillary temperature measurements on both sides showed no statistically significant difference between sensitivity and specificity. The data related to the comparison of right and left axillary temperature measurement are presented in Tables 1 and 2 (P=0.292), (X²=1.11). The results showed the correlation between nasopharyngeal and (right and left) axillary methods was r=0.903 and r=0.859, respectively, and the correlation between right and left sides in axillary method was r=85% (P=0.001).

### Table 1: Comparison of the ROC curve data in right and left axillary temperature measurement methods

<table>
<thead>
<tr>
<th>Temperature measurement method</th>
<th>area under the curve</th>
<th>Standard error</th>
<th>Confidence interval of 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right axillary</td>
<td>0.978</td>
<td>0.0052</td>
<td>0.988</td>
</tr>
<tr>
<td>Left axillary</td>
<td>0.959</td>
<td>0.0092</td>
<td>0.977</td>
</tr>
</tbody>
</table>

### Table 2: Results of the ROC curve for the sensitivity, specificity, and accuracy of axillary thermometry compared to nasopharyngeal method

<table>
<thead>
<tr>
<th>Measurement method</th>
<th>Cut-off point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
<th>Accuracy</th>
<th>Kappa coefficient</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right axillary</td>
<td>37.6</td>
<td>88.8</td>
<td>94.5</td>
<td>78.04</td>
<td>97.4</td>
<td>93.5</td>
<td>79</td>
<td>0.000</td>
</tr>
<tr>
<td>Left axillary</td>
<td>37.6</td>
<td>91.6</td>
<td>94.5</td>
<td>78.5</td>
<td>98.1</td>
<td>94</td>
<td>80</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Discussion**

Temperature measurement can be considered one of the fastest diagnostic procedures in patients, on which many medical diagnoses are based (17, 18). The results given in Table 2 indicate high accuracy of axillary temperature in diagnosing fever, which is consistent with the comparative study of Jahanpour et al. conducted on tympanic, axillary, and rectal thermometry in children (12). The present study indicated that there is a relatively good correlation between axillary and nasopharyngeal methods and the correlation between right axillary and nasopharyngeal thermometry is greater than left axillary and nasopharyngeal methods. But, no statistically significant difference was observed between the left and right sides (P=0.85). In a study conducted by Hakim oghlu et al. (2012) on children, a statistically significant difference was observed between axillary and nasopharyngeal thermometry and axillary temperature was less than nasopharyngeal temperature (P>0.05). This result is not compatible with the present study which may be due to differences in statistical population (19).

According to a comparative study conducted by Ahmadnia et al. (2009) on axillary, intravesical, rectal, and oral thermometry in hospitalized patients, it was reported that the correlation between axillary and intravesical methods (as the gold standard) was greater than other methods and a high correlation was observed between different methods (20). According to Dzarr et al.’s comparative study (2009) conducted on the accuracy of tympanic, axillary, oral, and rectal thermometry on 60 adult neutropenic adults, little correlation was reported between axillary and rectal methods (gold standard ) (r=0.48) which could be due to insufficient sample size in the study (15). In the present study, given that the main objective was body temperature measurement and diagnosis of people with fever, the validity of axillary thermometry with the sensitivity of 88.8% was examined and the cut-off point of 37.6 °C was obtained. In Dzarr et al.’s study (2009), the results showed a sensitivity of 34% and specificity of 99% in the axillary method. In this study, a weak correlation was observed between rectal (gold standard) and axillary methods (15). This
result is inconsistent with the present study and this difference could be due to the small sample size in their study. 
In this study, after determining the accuracy, the kappa coefficient was used for determining non-random agreement coefficient. The results presented in Table 2 indicate that there is a good agreement between axillary and nasopharyngeal methods, which is compatible with the study of Jahanpour et al. suggesting a good agreement between axillary and rectal (as the gold standard) thermometry (12). Failure to investigate the effect of environmental factors on body temperature measurement is one of the limitations of this study. Another limitation is that this study was conducted on adults, the results of which cannot be generalized to children and infants.

**Conclusion**

According to the results of this study, calibrated digital axillary thermometer is recommended if it is applied correctly and in appropriate body parts.

**Acknowledgments**

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**Conflict of Interest**

The authors declare no conflicts of interest regarding the compilation/publication of this article.

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