

# Comparison of Infrared Tympanic Thermometer with Non-Contact Infrared Thermometer

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## Abstract

**Objective:** Non-contact infrared thermometer (NCIT) is a quick, non-invasive, and easy-to-use method to measure body temperature, not requiring sterilization. We aimed to evaluate the reliability of NCIT in the first assessment of patients in a hospital.

**Material and Methods:** The study was carried out in Hacettepe University İhsan Doğramacı Children's Hospital between August and September 2013 with patients older than 4 months who were admitted to the infectious disease outpatient clinic or hospitalized. Body temperature of patients was measured with a tympanic infrared thermometer that is routinely used and with NCIT at the same time. Temperature values, age, and disease of patients were recorded.

**Results:** During the study, 220 measurements were obtained from 76 patients. Fifteen (6.8%) of 220 tympanic measurements were  $>38.0^{\circ}\text{C}$ , and 7 of them were also  $>38.0^{\circ}\text{C}$  with NCIT measurements. The difference between tympanic and NCIT measurements for each reading was calculated. Positive and negative values were obtained when tympanic readings were higher and lower than NCIT readings, respectively. Mean difference was  $-0.5^{\circ}\text{C}$  ( $\pm 0.3$ ) for negative values and  $0.6^{\circ}\text{C}$  ( $\pm 0.4$ ) $^{\circ}\text{C}$  for positive ones.

**Conclusion:** NCIT can be preferred for screening of fever, but before routine use in hospitals, more expanded studies with NCIT should be performed.

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**Keywords:** Fever, infrared, thermometer

## Introduction

Measurement of body temperature is crucially important in the assessment of clinical picture and follow-up of patients with regards to clinical monitoring. Even though body temperature was considered as one of the most important parameters of clinical investigation for clinicians since 1800s, the discussion of where the temperature would be taken started together with the clinical assessments and it has still been an inconclusive ongoing debate. Although the measurement of the internal body temperature through esophagus, pulmonary artery, nasopharynx or the catheter placed in the urinary bladder are considered as the golden standard methods, the fact that these are the methods used in limited number of clinical research-oriented studies or in invasive monitoring under

intensive care conditions involving very small number of patients has caused a research for alternative and practical measurement domains, and methods (1). In parallel to technological developments, various methods of body temperature measurement have been developed. In many parts of the body, measurement can be made via mercuryinglass, electronic, digital, transtympanic, single-use thermometers and thermal cameras. Measuring body temperature with mercuryinglass has become the most common way of measurement in everyday use for over a century. However, due to the risk of heavy metal toxicity, it has gradually come to be used less and its clinical use has in recent years been officially banned because of its intoxication risk (2-4). It has still been a controversial issue regarding the most appropriate method of body temperature measurement in

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children; the ideal method has to be a reliable and cost-efficient one that well reflects internal body temperature, easy to use, quick on the results and one that does not transmit the infection amongst the patients (2). Even though there is no mention of the presence of an ideal method today, the use of infrared tympanic thermometer is recommended for followed-up outpatient and hospitalized infants older than four weeks under the hospital conditions (5). However, regarding the conditions such as occlusion of the external auditory canal or the presence of earwax, or hyperemia in the tympanic membrane, it is reported the measurement can be faulty. Furthermore, due to the fact that the thermometer will have to contact the eardrum by using the infrared method in tympanic measurement may cause faulty measurements at home.

Non-contact infrared thermometer has been developed as a promising alternative method. Measurement can be taken by the frontal bone or temporal artery. In order to produce quick results, it is also preferred by the parents since it is a non-invasive method, easy-to-use and portable (6). The fact that the device does not need sterilization before its use by different individuals or that it does not have single-use accessories make one think that contact-free infrared thermometers are strong contenders for use in hospitals (7). The use of infrared thermometers in tympanic measurement in the first assessments in an hospital environment, despite the existence of faulty measurements results, is still today the preferred method of measurement; and in this study, our aim was to compare the infrared tympanic measurement and non-contact measurement by the frontal bone and evaluate their reliability of use in the first assessment.

## Material and Methods

The study was carried out between August and September of 2013 at the Pediatric Infectious Polyclinics and Pediatric Infection ward of Hacettepe İhsan Doğramacı Pediatric Hospital. The patients already hospitalized in the Infection Service or applied as outpatients who were older than four months and consented to take part in the research were included in the study. The age, diagnosis and underlying diseases, if there is one, were all recorded. The readings of the tympanic infrared thermometer (Genius<sup>TM</sup> 2, Covidien, Mansfield, USA) routinely used in the hospital and non-contact infrared thermometer (Visiofocus, model 06400, Tecnimed, Vedano, Italy) used in the study were simultaneously taken and the resulting body temperatures were recorded down. Measurement by the non-contact thermometer was taken by the frontal bone and the distance specified by the device was considered as the appropriate range. The

measurements were taken by two different nurses especially trained for the use of both devices. The data obtained was evaluated by the SPSS 21 (SPSS Inc., USA) statistics program and the values of number, percentage, average, standard deviation, median and range were calculated.

## Results

During the study, a total of 220 readings were taken from 76 patients. 31 (40.1%) patients were female and 45 (59.9%) male and the median age was calculated as 4.3 (0.4-17) years.

Regarding the body temperature measurements; out of 220 tympanic measurements, 15 (6.8%) were recorded as higher than 38°C. Seven of the tympanic over 38°C-measurements out of 15 also turned out to be higher than 38°C in the measurements taken by the non-contact thermometer. In tympanic measurement, while six of the over 38°C-measurements taken by the device were measured between 37°C and 38°C by the non-contact thermometer, two of the readings were found under 37°C (Table 1).

In tympanic measurements, the body temperature in seven readings was found higher than 38.5°C; three of these measurements taken by the non-contact thermometer were between 38°C - 38,4°C and two were lower than 37.9°C (Table 2).

The difference between them was revealed by deducting the reading value of the tympanic measurement from the measurement by the non-contact thermometer. The differences in 83 (37.8%) readings were negative; in other words, the reading value taken by the non-contact thermometer was higher, the average of negative difference was -0.5 ( $\pm 0.3$ ) °C, and the median was -0.4 [(-1.7) - (-0.1)] °C. In 28 (12.7%) readings, the difference was zero; in other words, the measurements taken by the two thermometer were the same; in the rest of the 109 (49.5%) readings, since the tympanic measurements were higher, they were positive and the average was 0.6 ( $\pm 0.4$ ) °C, the median was measured as 0.5 (0.1 - 1.7) °C (Table 3).

## Discussion

Since the non-contact thermometers produce quick results, are easy to use, perform the measurements through non-invasive methods and are portable, they are preferred especially by parents. In addition to the characteristics, due to the fact that they can be used in different individual patients without increasing the risk of hospital infections, it is possible to think that this device can be used in hospitals as well.

**Table 1.** Distribution of tympanically measured body temperatures of over 38°C readings measured by non-contact thermometer

Readings measured by non-contact thermometer	Number (%)
≥38°C	7 (46.7%)
37°C - 37.9°C	6 (40%)
<37°C	2 (13.3%)
Total	15 (100%)

**Table 2.** Distribution of tympanically measured body temperatures of over 38.5°C readings measured by non-contact thermometer

Readings measured by non-contact thermometer	Sayı (%)
≥38.5°C	3 (42.8%)
38°C - 38.4°C	2 (28.6%)
<37.9 °C	2 (28.6%)
Total	7 (100%)

**Table 3.** Distribution of the difference obtained by deducting the tympanic measurement simultaneously from the reading performed by a non-contact thermometer

Difference °C	Number	%
(-1.7) - (-1.0)	10	4.5
(-0.9) - (-0.1)	73	33.2
0	28	12.7
(+0.1) - (+0.9)	84	38.2
(+1.0) - (+1.7)	25	11.4
Total	220	100.0

In our study, we compared the non-contact infrared thermometer measuring by the frontal bone and the tympanic infrared thermometer. In readings obtained by the tympanic infrared thermometer, in 15 (6.8%) of 220 measurements, the body temperature was recorded as higher than 38°C; in seven (46.7%) of these readings, as a result of simultaneous measurements taken by non-contact thermometer, temperature value higher than 38°C was recorded. While six (40%) of the body temperature the reading values measured by the tympanic thermometer as higher than 38°C were measured as 37°C - 38°C by the non-contact thermometer, the two (13.3%) were measured lower than 37°C. In the measurement assessment of the non-contact thermometers that are considered to be easy to use by the families and children, no faulty high measurement was seen in children with low body temperature; however, it was revealed that in 53.3% of children with high body temperature, low readings were taken and it turned out that the same trend continued in the follow-up measurements as well.

It was calculated that the average of the negative differences obtained by deducting the simultaneous reading of the tympanic measurement from the measurement by the non-contact thermometer was -0.5 (±0.3) °C, the median was -0.4 [(-1.7) - (-0.1)] °C; the average of the positive readings was 0.6 (±0.4) °C and the median was 0.5 (0.1 - 1.7) °C. It is stated in the use manual of the device that the highest level of tolerable laboratory error for the non-contact thermometer is ±0.3°C. However, in the comparison made between the mercuryinglass and other infrared thermometers as stated in previous studies, it was concluded that correct and replicable measurements could be taken by the other infrared thermometers (2, 7).

The most important limitation of our study is that body temperature measurement taken by the tympanic infrared thermometer used as a reference method was not the golden standard method. However, due to the ban for the use of mercuryinglass thermometers because of intoxication risk, the use of mercuryinglass thermometers in this study was not considered appropriate.

## Conclusion

In conclusion, even though the use of thermometers measuring through non-contact infrared method for screening is considered appropriate, there is a need for more comprehensive studies involving more febrile children in which measurements taken preferably by mercuryinglass thermometers used for body temperature are used as references in order to take a decision to use them for monitoring children in hospitals.

**Ethics Committee Approval:** Ethics committee approval was not received for this study, because the study didn't include any invasive procedure.

**Informed Consent:** Informed consent was obtained from patients and patients' parents who participated in this study.

**Peer-review:** Externally peer-reviewed.

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