FEVER AND CLINICAL THERMOMETRY: WHAT DO PHYSICIANS AND NURSES REALLY KNOW?

ABSTRACT

Introduction: Fever is a leading cause of Pediatric visits. However, most studies used as reference for fever assessment had a cross-sectional design and were conducted in adults. Different and more precise fever definitions exist within the field of knowledge known as clinical thermometry.

Aims: To assess basic knowledge of health professionals working in Pediatrics regarding fever physiopathology and clinical thermometry.

Material and Methods: A cross-sectional analytical study was performed between February and July 2014 through application of an anonymous closed-end questionnaire to health professionals.

Results: From 426 questionnaires applied, 29% were completed by nurses and 71% by physicians. Within the whole group, 89% did not know how human “normal temperature” was determined, 70% did not recognize the “individual definitions” of fever, 33% acknowledged a “subfebrile” status, 39% did not recognize the most and least accurate anatomical sites for temperature measurement, and 57% did not recognize the dynamic difference between core and peripheral temperatures. Hyperthermia and fever definitions were confounded by 78% of nurses and 56% of physicians.

Conclusions: Most health professionals surveyed had a limited knowledge of fever and clinical thermometry. The traditional oversimplification of this subject can lead to underestimation of true febrile statuses.

Keywords: Clinical thermometry; fever; healthcare professionals; normal temperature

RESUMO

Introdução: A febre é uma das principais causas de consulta pediátrica. Contudo, a maioria dos estudos utilizados como referência para avaliação da febre tiveram um desenho transversal e avaliaram populações adultas. Existem outras definições de febre, mais precisas, que se enquadram numa área de estudo designada por termometria clínica.

Objetivos: Avaliar os conhecimentos básicos dos profissionais de saúde atuantes na área da Pediatria sobre fisiologia da febre e termometria clínica.

Material e Métodos: Estudo analítico, transversal, conduzido entre fevereiro e julho de 2014, efetuado por aplicação de um questionário anonimizado, com perguntas fechadas, a profissionais de saúde.

Resultados: De um total de 426 questionários, 29% foram preenchidos por enfermeiros e 71% por médicos. Considerando o grupo total, 89% desconheciam como a “temperatura normal” em humanos tinha sido determinada, 70% não reconheciam as “definições individuais” de febre, 33% acreditavam no estado “subfebril”, 39% não reconheciam os locais anatômicos mais e menos precisos para a medição da temperatura e 57% não reconheciam a diferença dinâmica entre as temperaturas periférica e central. As definições de febre e hipertermia foram confundidas por...
78% dos enfermeiros e 56% dos médicos.

Conclusões: A maioria dos profissionais de saúde que responderam ao questionário evidenciou conhecimentos limitados sobre febre e termometria clínica. A tradicional simplificação do tema pode contribuir para a subestimativa de verdadeiros estados febris.

Palavras-chave: febre; profissionais de saúde; termometria clínica; temperatura normal

INTRODUCTION

Fever is the most frequent cause of Pediatric Emergency Department visits (approximately 20% of cases), accounting for more than 30% of urgent Pediatric private practice consultations. Several studies have investigated caregivers’ knowledge of clinical thermometry, fever and its treatment, largely focused on misconceptions regarding the concept of fever phobia. Many health professionals have fever phobia and pass it on to caregivers. This phobia can be justified by their misconceptions about “normal temperature”, different fever definitions, and clinical thermometry.

A healthy human body regulates its core temperature to values within ±0.2ºC of the “average” and peripheral temperature narrowly varies between 1.0ºC (1.8ºF) or ±2.0ºC (3.6ºF) of the average, aside from environmental temperature changes.

The various peripheral (or external) body temperatures do not reflect the core temperature and vary according to anatomical site of measurement. Fever is difficult to define. The traditional definitions of “normal temperature” originated from cross-sectional populational studies and described temperatures above the 99th or 97.5th percentiles of the population’s body temperature. The consideration that a single number, currently acknowledged to vary according to measurement site, can represent the thermal status of the entire body is inaccurate. Only with an individual-centred definition can the concept of fever take into account the temperature variability within a single person. Thus, one possible fever definition can refer to the temperature above the individual’s normal daily variation, depending on the anatomical site of measurement.

Fever is the most frequent cause of Pediatric Emergency Department visits (approximately 20% of cases), accounting for more than 30% of urgent Pediatric private practice consultations. Several studies have investigated caregivers’ knowledge of clinical thermometry, fever and its treatment, largely focused on misconceptions regarding the concept of fever phobia. Many health professionals have fever phobia and pass it on to caregivers. This phobia can be justified by their misconceptions about “normal temperature”, different fever definitions, and clinical thermometry.

Thermometry, which includes clinical thermometry, is the science that studies body temperature as well as methods and accuracy of anatomic sites for temperature quantification.

If in fever research studies it is mandatory to provide a number to define fever, in clinical evaluation and treatment of a patient with fever it is key to correctly recognize the individual “normal temperature” and to accurately evaluate temperature in the anatomical peripheral site that most accurately reflects his core temperature. Some experts have sought to devise formulas for converting axillary and oral temperatures into rectal temperature. However, the changeable nature of thermoregulation justifies the dynamic and Gaussian differences observed between core and peripheral temperatures.

The aim of this study was to evaluate physicians’ and nurses’ knowledge on human “normal temperature”, fever, and clinical thermometry.

MATERIAL AND METHODS

A cross-sectional analytical study was conducted between February and July 2014 by application of an anonymous closed-end questionnaire to physicians and nurses. The questionnaire was developed by the authors and initially validated in a small sample (thirty-eight physicians and one nurse), with subsequent modifications if required. The questionnaire was then e-mailed or personally distributed, using a convenience sample. Only questionnaires with more than 90% of questions answered were considered valid.

Three fever definitions were considered: 1) traditional temperature, i.e. above the populations’ “normal temperature” at a specific anatomic site (above the 97.5th or 99th percentiles); 2) temperature above the individual “normal temperature” at a specific anatomic site; and 3) temperature 1.0ºC (1.8ºF) above the individual average temperature at a specific anatomic site.

The ‘subfebrile’ status was considered an erroneous or non-existing concept. The traditional fever definition for each anatomical evaluation site were adopted: rectal temperature ≥38.0ºC (100.4ºF), axillary temperature ≥37.4ºC (99.9ºF), tympanic temperature ≥37.6ºC (99.7ºF), oral temperature ≥37.5ºC (99.5ºF), and temporal temperature ≥37.7ºC (99.9ºF).

The non-invasive methods for temperature assessment that theoretically better correlate with core temperature are the rectal and tympanic temperatures; rectal was considered the standard and most reliable non-invasive measurement method, while tympanic was considered the least reliable method. Within the same individual, rectal temperature was assumed to be the highest and tympanic temperature was assumed to be higher than axillary temperature; rectal temperature was assumed to be, on average, about 1.0ºC (1.8ºF) above the axillary temperature by electronic thermometers, both in apyrexia and fever, varying between 0.0ºC (0.0ºF) and 2.0ºC (3.6ºF) in apyrexia and between 0.0ºC
(0.0°F) and 3.0°C (5.4°F) in fever, as they depend on skin dynamic thermoregulation mechanisms.\textsuperscript{2,4,17,18,22,23,28,35}

Hyperthermia was defined as exogenous warming beyond thermoregulatory center control, different from the thermoregulatory center-controlled endogenous heating that characterizes fever.\textsuperscript{2,6,15}

Statistical analysis was performed with SPSS® version 22, using χ² test for large groups and Fisher’s exact test for small groups, considering a p-value <0.05 as statistically significant. Two group samples were compared: physicians versus nurses.

RESULTS

From 723 questionnaires delivered, 426 (58.9%) with more than 90% of questions answered were returned: 125 (29.3%) from nurses and 301 (70.7%) from physicians. Fifty-six percent of nurses worked in the Pediatric department compared to 54.2% of Pediatric physicians. In total, 89.4% of responders did not know how human “normal temperature” was determined; only 11.9% were aware of the three definitions of fever; only 36.3% accurately defined core temperature; and 73.5% acknowledged subfebrile body temperatures. Approximately one third of health professionals were not aware of the most and least reliable anatomical sites for temperature measurement (33.4% and 38.6%, respectively); 56.5% ignored the dynamic difference between rectal and axillary temperature and 62.4% mistook hyperthermia for fever (Table 1).

<table>
<thead>
<tr>
<th>1) Regarding population studies on human normal temperature (select the right answer?)</th>
<th>All respondents (n=426)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cross-sectional studies\textsuperscript{*}</td>
<td>84</td>
<td>10.6</td>
</tr>
<tr>
<td>Cross-sectional and longitudinal studies</td>
<td>7</td>
<td>17.6</td>
</tr>
<tr>
<td>All longitudinal studies</td>
<td>218</td>
<td>2.3</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>38</td>
<td>10.6</td>
</tr>
<tr>
<td>I don’t know</td>
<td>77</td>
<td>58.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2) Regarding studies on human normal temperature, which do we use daily? (select the right answer)</th>
<th>All respondents (n=424)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average individual normal temperature</td>
<td>128</td>
<td>19.8</td>
</tr>
<tr>
<td>Maximum individual normal temperature</td>
<td>78</td>
<td>1.6</td>
</tr>
<tr>
<td>Average population normal temperature</td>
<td>50</td>
<td>51.4</td>
</tr>
<tr>
<td>Maximum population normal temperature\textsuperscript{*}</td>
<td>63</td>
<td>9.0</td>
</tr>
<tr>
<td>I don’t know</td>
<td>102</td>
<td>18.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3) How many fever definitions do you know? (select the right answer)</th>
<th>All respondents (n=421)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>56</td>
<td>30.4</td>
</tr>
<tr>
<td>Two</td>
<td>59</td>
<td>18.5</td>
</tr>
<tr>
<td>Three\textsuperscript{*}</td>
<td>135</td>
<td>11.9</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>137</td>
<td>15.0</td>
</tr>
<tr>
<td>I don’t know</td>
<td>35</td>
<td>24.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4) About fever definitions (select the wrong answer)</th>
<th>All respondents (n=422)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher than normal for the individual, depending on the anatomic site of evaluation</td>
<td>19</td>
<td>13.3</td>
</tr>
<tr>
<td>More than 1°C above the average individual temperature, depending on the anatomic site of evaluation</td>
<td>90</td>
<td>14.0</td>
</tr>
<tr>
<td>Equal or higher than 37.4°C (99.3°F) axillary temperature</td>
<td>189</td>
<td>32.0</td>
</tr>
<tr>
<td>Equal or higher than 38.0°C (100.4°F) axillary temperature\textsuperscript{*}</td>
<td>113</td>
<td>32.4</td>
</tr>
<tr>
<td>I don’t know</td>
<td>15</td>
<td>8.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5) About subfebrile definition (select the right answer)</th>
<th>All respondents (n=426)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precedes fever</td>
<td>103</td>
<td>4.5</td>
</tr>
<tr>
<td>Temperatures between 37.1–37.5°C (98.8–99.5°F)</td>
<td>32</td>
<td>21.1</td>
</tr>
<tr>
<td>Temperatures between 37.5–38.0°C (99.5–100.4°F)</td>
<td>76</td>
<td>44.4</td>
</tr>
<tr>
<td>Does not exist\textsuperscript{*}</td>
<td>78</td>
<td>26.5</td>
</tr>
<tr>
<td>I don’t know</td>
<td>136</td>
<td>3.5</td>
</tr>
</tbody>
</table>
6) In ambulatory, how can we assess core temperature (select the right answer)       All respondents (n=425)  

<table>
<thead>
<tr>
<th>Temperature Measurement</th>
<th>All Respondents (n=425)</th>
</tr>
</thead>
</table>
| Body temperature               | 82                      | 24.2%
| Axillary temperature           | 7                       | 7.5%
| Rectal temperature             | 283                     | 17.9%
| Rectal or tympanic temperature | 1                       | 18.4%
| I don’t know                   | 52                      | 32.0%

7) What is the most reliable anatomic site for temperature measurement? (select the right answer) All respondents (n=425)  

<table>
<thead>
<tr>
<th>Anatomic Site</th>
<th>All Respondents (n=425)</th>
</tr>
</thead>
</table>
| Axillary            | 43                      | 19.3%
| Oral                | 82                      | 1.7%
| Rectal              | 7                       | 66.6%
| Temporal            | 258                     | 0.2%
| Tympanic            | 30                      | 12.2%

8) What is the least reliable anatomic site for temperature measurement? (select the right answer) All respondents (n=420)  

<table>
<thead>
<tr>
<th>Anatomic Site</th>
<th>All Respondents (n=420)</th>
</tr>
</thead>
</table>
| Axillary            | 258                     | 10.2%
| Oral                | 113                     | 19.5%
| Rectal              | 1                       | 1.7%
| Temporal            | 32                      | 61.4%
| Tympanic            | 21                      | 7.2%

9) Knowing that temperature differs according to anatomic evaluation site (select the right answer) All respondents (n=425)  

<table>
<thead>
<tr>
<th>Anatomic Evaluation</th>
<th>All Respondents (n=425)</th>
</tr>
</thead>
</table>
| Axillary < tympanic | 185                     | 60.7%
| Axillary = tympanic | 70                      | 26.6%
| Axillary = rectal   | 58                      | 0.2%
| Axillary = oral     | 69                      | 7.5%
| I don’t know        | 43                      | 5.0%

10) About the difference between rectal and axillary temperature: (select the wrong answer) All respondents (n=425)  

<table>
<thead>
<tr>
<th>Difference</th>
<th>All Respondents (n=425)</th>
</tr>
</thead>
</table>
| Varies between 0.5−1.0ºC (0.9−1.8ºF) | 62                      | 43.5%
| Varies on average ±1.0ºC (1.8ºF)        | 39                      | 16.5%
| Varies between 0−2.0ºC (0−3.6ºF) in apyrexia | 113                     | 13.7%
| Varies between 0−3.0ºC (0−5.4ºF) in fever | 160                     | 16.2%
| I don’t know        | 52                      | 10.1%

11) Regarding fever, hyperthermia and hyperpyrexia concepts (select the right answer) All respondents (n=426)  

<table>
<thead>
<tr>
<th>Concept</th>
<th>All Respondents (n=426)</th>
</tr>
</thead>
</table>
| Hyperthermia = fever | 62                      | 14.5%
| Hyperpyrexia = hyperthermia | 39                      | 9.2%
| Hyperthermia = endogenous warming | 113                     | 26.5%
| Hyperthermia = exogenous warming | 160                     | 37.6%
| I don’t know        | 52                      | 12.2%

Legend: #correct answer

Compared with nurses, physicians were more informed regarding fever definitions and clinical thermometry (Table 2). A higher proportion of physicians were more familiar with the temperature concept used in studies of “normal temperature” estimation (11.3% versus 3.2% of nurses, p=0.008) and an also higher proportion of physicians acknowledged the core temperature definition (46.4% versus 12.0% of nurses, p<0.001). Although 65.3% of physicians were not aware of the two “individual fever” definitions, this proportion was significantly higher for nurses (79.9%). A significantly higher proportion of physicians did not acknowledge a subfebrile status (29.9% versus 18.4%, p=0.014) and considered that fever definition varied according to anatomical site of measurement (28.3% versus 17.6%, p=0.020). Compared with nurses, more physicians considered rectal temperature as the most reliable (70.3% versus 57.6%, p=0.008) and were acquainted with the concept of hyperthermia (43.9% versus 22.4%, p<0.001).
### Table 2 - Comparison between physicians' and nurses' answers

<table>
<thead>
<tr>
<th>1) Regarding population studies on human normal temperature (select the right answer?)</th>
<th>Physicians (n=301)</th>
<th>Nurses (n=125)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cross-sectional studies*</td>
<td>37 (12.3%)</td>
<td>8 (6.4%)</td>
<td>0.072</td>
</tr>
<tr>
<td>Cross-sectional and longitudinal studies</td>
<td>48 (15.9%)</td>
<td>27 (21.6%)</td>
<td>0.337</td>
</tr>
<tr>
<td>All longitudinal studies</td>
<td>7 (2.3%)</td>
<td>3 (2.4%)</td>
<td>0.602</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>30 (10.0%)</td>
<td>15 (12.0%)</td>
<td>0.534</td>
</tr>
<tr>
<td>I don’t know</td>
<td>179 (59.5%)</td>
<td>72 (57.6%)</td>
<td>0.721</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2) Regarding studies on human normal temperature, which one do you use daily? (select the right answer)</th>
<th>Physicians (n=300)</th>
<th>Nurses (n=124)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average individual normal temperature</td>
<td>44 (14.7%)</td>
<td>40 (32.3%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Maximum individual normal temperature</td>
<td>5 (1.7%)</td>
<td>2 (1.6%)</td>
<td>0.968</td>
</tr>
<tr>
<td>Average population normal temperature</td>
<td>165 (55.0%)</td>
<td>53 (42.7%)</td>
<td>0.022*</td>
</tr>
<tr>
<td>Maximum population normal temperature*</td>
<td>34 (11.3%)</td>
<td>4 (3.2%)</td>
<td>0.008*</td>
</tr>
<tr>
<td>I don’t know</td>
<td>52 (17.3%)</td>
<td>25 (20.2%)</td>
<td>0.492</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3) How many fever definitions do you know? (select the right answer)</th>
<th>Physicians (n=297)</th>
<th>Nurses (n=124)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>73 (24.6%)</td>
<td>55 (44.4%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Two</td>
<td>56 (18.9%)</td>
<td>22 (17.7%)</td>
<td>0.789</td>
</tr>
<tr>
<td>Three*</td>
<td>47 (15.8%)</td>
<td>3 (2.4%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>47 (15.8%)</td>
<td>16 (12.9%)</td>
<td>0.444</td>
</tr>
<tr>
<td>I don’t know</td>
<td>74 (24.9%)</td>
<td>28 (22.6%)</td>
<td>0.610</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4) About fever definitions (select the wrong answer)</th>
<th>Physicians (n=298)</th>
<th>Nurses (n=124)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher than normal for the individual, depending on the anatomic site of evaluation</td>
<td>32 (10.7%)</td>
<td>24 (19.3%)</td>
<td>0.017*</td>
</tr>
<tr>
<td>More than 1°C above the average individual temperature, depending on the anatomic site of evaluation</td>
<td>47 (15.8%)</td>
<td>12 (9.7%)</td>
<td>0.100</td>
</tr>
<tr>
<td>Equal or higher than 37.4°C (99.3°F) axillary temperature</td>
<td>102 (34.2%)</td>
<td>33 (26.6%)</td>
<td>0.127</td>
</tr>
<tr>
<td>Equal or higher than 38.0°C (100.4°F) axillary temperature*</td>
<td>93 (31.2%)</td>
<td>44 (35.5%)</td>
<td>0.393</td>
</tr>
<tr>
<td>I don’t know</td>
<td>24 (8.1%)</td>
<td>11 (8.9%)</td>
<td>0.782</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5) About subfebrile definition (select the right answer)</th>
<th>Physicians (n=301)</th>
<th>Nurses (n=125)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precedes fever</td>
<td>12 (4.0%)</td>
<td>7 (5.6%)</td>
<td>0.569</td>
</tr>
<tr>
<td>Temperatures between 37.1–37.5°C (98.8–99.5°F)</td>
<td>48 (15.9%)</td>
<td>42 (33.6%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Temperatures between 37.5–38.0°C (99.5–100.4°F)</td>
<td>139 (46.2%)</td>
<td>50 (40.0%)</td>
<td>0.309</td>
</tr>
<tr>
<td>Does not exist*</td>
<td>90 (29.9%)</td>
<td>23 (18.4%)</td>
<td>0.014*</td>
</tr>
<tr>
<td>I don’t know</td>
<td>12 (4.0%)</td>
<td>3 (2.4%)</td>
<td>0.312</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6) In ambulatory, how can we assess core temperature (select the right answer)</th>
<th>Physicians (n=300)</th>
<th>Nurses (n=125)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body temperature</td>
<td>64 (21.3%)</td>
<td>39 (31.2%)</td>
<td>0.031*</td>
</tr>
<tr>
<td>Axillary temperature</td>
<td>15 (5.0%)</td>
<td>17 (13.6%)</td>
<td>0.002*</td>
</tr>
<tr>
<td>Rectal temperature*</td>
<td>71 (23.7%)</td>
<td>5 (4.0%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Rectal or tympanic temperature*</td>
<td>68 (22.7%)</td>
<td>10 (8.0%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>I don’t know</td>
<td>82 (27.3%)</td>
<td>54 (43.2%)</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7) What is the most reliable anatomic site for temperature measurement? (select the right answer)</th>
<th>Physicians (n=300)</th>
<th>Nurses (n=125)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary</td>
<td>46 (15.3%)</td>
<td>36 (28.8%)</td>
<td>0.002*</td>
</tr>
<tr>
<td>Oral</td>
<td>6 (2.0%)</td>
<td>1 (0.8%)</td>
<td>0.337</td>
</tr>
<tr>
<td>Rectal*</td>
<td>211 (70.3%)</td>
<td>72 (57.6%)</td>
<td>0.008*</td>
</tr>
<tr>
<td>Temporal</td>
<td>1 (0.3%)</td>
<td>0 (0%)</td>
<td>0.704</td>
</tr>
<tr>
<td>Tympanic</td>
<td>36 (12.0%)</td>
<td>16 (12.8%)</td>
<td>0.667</td>
</tr>
</tbody>
</table>
8) What is the least reliable anatomic site for temperature measurement? (select the right answer)

<table>
<thead>
<tr>
<th>Anatomic Site</th>
<th>Physicians (n=296)</th>
<th>Nurses (n=124)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary</td>
<td>30 (10.2%)</td>
<td>13 (10.5%)</td>
<td>0.931</td>
</tr>
<tr>
<td>Oral</td>
<td>51 (17.2%)</td>
<td>31 (25.0%)</td>
<td>0.072</td>
</tr>
<tr>
<td>Rectal</td>
<td>5 (1.7%)</td>
<td>2 (1.6%)</td>
<td>0.655</td>
</tr>
<tr>
<td>Temporal*</td>
<td>186 (63.8%)</td>
<td>72 (58.1%)</td>
<td>0.318</td>
</tr>
<tr>
<td>Tympanic</td>
<td>24 (8.1%)</td>
<td>6 (4.8%)</td>
<td>0.229</td>
</tr>
</tbody>
</table>

9) Knowing that temperature differs according to anatomic evaluation site (select the right answer)

<table>
<thead>
<tr>
<th>Anatomic Site</th>
<th>Physicians (n=300)</th>
<th>Nurses (n=125)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary &lt; tympanic &lt; rectal*</td>
<td>173 (57.7%)</td>
<td>85 (68.0%)</td>
<td>0.047*</td>
</tr>
<tr>
<td>Axillary &lt; tympanic = rectal</td>
<td>91 (30.3%)</td>
<td>22 (17.6%)</td>
<td>0.007*</td>
</tr>
<tr>
<td>Axillary = tympanic = rectal</td>
<td>0 (0%)</td>
<td>1 (0.8%)</td>
<td>0.294</td>
</tr>
<tr>
<td>Axillary = oral &lt; rectal</td>
<td>24 (8.0%)</td>
<td>8 (6.4%)</td>
<td>0.569</td>
</tr>
<tr>
<td>I don’t know</td>
<td>12 (4.0%)</td>
<td>9 (7.2%)</td>
<td>0.165</td>
</tr>
</tbody>
</table>

10) About the difference between rectal and axillary temperature: (select the wrong answer)

<table>
<thead>
<tr>
<th>Temperature Difference</th>
<th>Physicians (n=300)</th>
<th>Nurses (n=125)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies between 0.5−1.0ºC (0.9−1.8ºF)*</td>
<td>137 (45.7%)</td>
<td>48 (38.4%)</td>
<td>0.169</td>
</tr>
<tr>
<td>Varies on average ±1.0ºC (1.8ºF)</td>
<td>51 (17.0%)</td>
<td>19 (15.2%)</td>
<td>0.648</td>
</tr>
<tr>
<td>Varies between 0−2.0ºC (0−3.6ºF) in apyrexia</td>
<td>36 (12.0%)</td>
<td>22 (17.6%)</td>
<td>0.125</td>
</tr>
<tr>
<td>Varies between 0−3.0ºC (0−5.4ºF) in fever</td>
<td>50 (16.7%)</td>
<td>19 (15.2%)</td>
<td>0.709</td>
</tr>
<tr>
<td>I don’t know</td>
<td>26 (8.7%)</td>
<td>17 (13.6%)</td>
<td>0.124</td>
</tr>
</tbody>
</table>

11) Regarding fever, hyperthermia and hyperpyrexia concepts (select the right answer)

<table>
<thead>
<tr>
<th>Concept</th>
<th>Physicians (n=301)</th>
<th>Nurses (n=125)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperthermia = fever</td>
<td>29 (9.6%)</td>
<td>33 (26.4%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Hyperpyrexia = hyperthermia</td>
<td>18 (6.0%)</td>
<td>21 (16.8%)</td>
<td>0.001*</td>
</tr>
<tr>
<td>Hyperthermia = endogenous warming</td>
<td>87 (28.9%)</td>
<td>26 (20.8%)</td>
<td>0.085</td>
</tr>
<tr>
<td>Hyperthermia = exogenous warming*</td>
<td>132 (43.9%)</td>
<td>28 (22.4%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>I don’t know</td>
<td>35 (11.6%)</td>
<td>17 (13.6%)</td>
<td>0.571</td>
</tr>
</tbody>
</table>

Legend: #correct answer; *p<0.05

Comparing physicians working in Pediatrics (residents included) with those working in other clinical departments (namely general practice), the second group was found to acknowledge only one fever definition (33.1% considered only one definition versus 18.1% of those working in Pediatrics, p=0.003; Table 3). Additionally, more pediatricians acknowledged the definition of core temperature (54.4% versus 37.3%) and considered that subfebrile temperatures do not exist (36.2% versus 22.2%, p=0.010) compared with physicians from other specialties.

When comparing pediatricians with their residents, results were similar (Table 4) except for the less reliable anatomical site for temperature assessment, with specialists denoting more knowledge than residents.

Table 3 - Comparison between answers of physicians working in Pediatrics (pediatricians/pediatric residents) with other physicians

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Pediatrics (n=163)</th>
<th>Other physicians(n=134)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cross-sectional studies*</td>
<td>26 (15.9%)</td>
<td>10 (7.5%)</td>
<td>0.026*</td>
</tr>
<tr>
<td>Cross-sectional and longitudinal studies</td>
<td>20 (12.3%)</td>
<td>28 (20.9%)</td>
<td>0.044*</td>
</tr>
<tr>
<td>All longitudinal studies</td>
<td>5 (3.1%)</td>
<td>2 (1.5%)</td>
<td>0.463</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>12 (7.4%)</td>
<td>18 (13.4%)</td>
<td>0.084</td>
</tr>
<tr>
<td>I don’t know</td>
<td>100 (61.3%)</td>
<td>76 (56.7%)</td>
<td>0.419</td>
</tr>
</tbody>
</table>

2) Regarding studies on human normal temperature, which one do you use daily? (select the right answer)

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Pediatrics (n=162)</th>
<th>Other physicians(n=134)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cross-sectional studies*</td>
<td>26 (15.9%)</td>
<td>10 (7.5%)</td>
<td>0.026*</td>
</tr>
<tr>
<td>Cross-sectional and longitudinal studies</td>
<td>20 (12.3%)</td>
<td>28 (20.9%)</td>
<td>0.044*</td>
</tr>
<tr>
<td>All longitudinal studies</td>
<td>5 (3.1%)</td>
<td>2 (1.5%)</td>
<td>0.463</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>12 (7.4%)</td>
<td>18 (13.4%)</td>
<td>0.084</td>
</tr>
<tr>
<td>I don’t know</td>
<td>100 (61.3%)</td>
<td>76 (56.7%)</td>
<td>0.419</td>
</tr>
</tbody>
</table>
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### Average individual normal temperature
- 26 (16.1%)
- 18 (13.4%)
- 0.529

### Maximum individual normal temperature
- 1 (0.6%)
- 4 (3.0%)
- 0.180

### Average population normal temperature
- 86 (53.1%)
- 76 (56.7%)
- 0.532

### Maximum population normal temperature
- 19 (11.7%)
- 15 (11.2%)
- 0.886

### I don’t know
- 30 (18.5%)
- 21 (15.7%)
- 0.519

#### 3) How many fever definitions do you know? (select the right answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=160)</th>
<th>Other physicians (n=133)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>29 (18.1%)</td>
<td>44 (33.1%)</td>
<td>0.003*</td>
</tr>
<tr>
<td>Two</td>
<td>34 (21.2%)</td>
<td>22 (16.5%)</td>
<td>0.307</td>
</tr>
<tr>
<td>Three</td>
<td>22 (13.8%)</td>
<td>22 (16.5%)</td>
<td>0.505</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>29 (18.1%)</td>
<td>18 (13.6%)</td>
<td>0.286</td>
</tr>
<tr>
<td>I don’t know</td>
<td>46 (28.8%)</td>
<td>27 (20.3%)</td>
<td>0.096</td>
</tr>
</tbody>
</table>

#### 4) About fever definitions (select the wrong answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=161)</th>
<th>Other physicians (n=133)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher than normal for the individual, depending on the anatomic site of evaluation</td>
<td>20 (12.4%)</td>
<td>10 (7.5%)</td>
<td>0.167</td>
</tr>
<tr>
<td>More than 1°C above the average individual temperature, depending on the anatomic site of evaluation</td>
<td>27 (16.8%)</td>
<td>18 (13.5%)</td>
<td>0.443</td>
</tr>
<tr>
<td>Equal or higher than 37.4°C (99.3°F) axillary temperature</td>
<td>56 (34.8%)</td>
<td>46 (34.6%)</td>
<td>0.972</td>
</tr>
<tr>
<td>Equal or higher than 38.0°C (100.4°F) axillary temperature*</td>
<td>45 (27.9%)</td>
<td>48 (36.1%)</td>
<td>0.135</td>
</tr>
<tr>
<td>I don’t know</td>
<td>13 (8.1%)</td>
<td>11 (8.3%)</td>
<td>0.951</td>
</tr>
</tbody>
</table>

#### 5) About subfebrile definition (select the right answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=163)</th>
<th>Other physicians (n=135)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precedes fever</td>
<td>9 (5.5%)</td>
<td>4 (3.0%)</td>
<td>0.288</td>
</tr>
<tr>
<td>Temperatures between 37.1−37.5°C (98.8−99.5°F)</td>
<td>20 (12.3%)</td>
<td>28 (20.7%)</td>
<td>0.044*</td>
</tr>
<tr>
<td>Temperatures between 37.5−38.0°C (99.5−100.4°F)</td>
<td>67 (41.1%)</td>
<td>70 (51.9%)</td>
<td>0.055</td>
</tr>
<tr>
<td>Does not exist*</td>
<td>59 (36.2%)</td>
<td>30 (22.2%)</td>
<td>0.010*</td>
</tr>
<tr>
<td>I don’t know</td>
<td>8 (4.9%)</td>
<td>3 (2.2%)</td>
<td>0.356</td>
</tr>
</tbody>
</table>

#### 6) In ambulatory, how can we assess core temperature (select the right answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=162)</th>
<th>Other physicians (n=134)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body temperature</td>
<td>29 (17.9%)</td>
<td>34 (25.4%)</td>
<td>0.118</td>
</tr>
<tr>
<td>Axillary temperature</td>
<td>4 (2.4%)</td>
<td>11 (8.2%)</td>
<td>0.025*</td>
</tr>
<tr>
<td>Rectal temperature*</td>
<td>44 (27.2%)</td>
<td>27 (20.1%)</td>
<td>0.160</td>
</tr>
<tr>
<td>Rectal or tympanic temperature*</td>
<td>44 (27.2%)</td>
<td>23 (17.2%)</td>
<td>0.041*</td>
</tr>
<tr>
<td>I don’t know</td>
<td>41 (25.3%)</td>
<td>39 (29.1%)</td>
<td>0.464</td>
</tr>
</tbody>
</table>

#### 7) What is the most reliable anatomic site for temperature measurement? (select the right answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=163)</th>
<th>Other physicians (n=133)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary</td>
<td>27 (16.6%)</td>
<td>19 (14.3%)</td>
<td>0.594</td>
</tr>
<tr>
<td>Oral</td>
<td>5 (3.1%)</td>
<td>1 (0.8%)</td>
<td>0.229</td>
</tr>
<tr>
<td>Rectal*</td>
<td>119 (73.0%)</td>
<td>88 (66.1%)</td>
<td>0.205</td>
</tr>
<tr>
<td>Temporal</td>
<td>0 (0.0%)</td>
<td>1 (0.8%)</td>
<td>0.449</td>
</tr>
<tr>
<td>Tympanic</td>
<td>12 (7.3%)</td>
<td>24 (18.0%)</td>
<td>0.005*</td>
</tr>
</tbody>
</table>

#### 8) What is the least reliable anatomic site for temperature measurement? (select the right answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=160)</th>
<th>Other physicians (n=132)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary</td>
<td>15 (9.4%)</td>
<td>15 (11.3%)</td>
<td>0.575</td>
</tr>
<tr>
<td>Oral</td>
<td>28 (17.5%)</td>
<td>22 (16.7%)</td>
<td>0.855</td>
</tr>
<tr>
<td>Rectal*</td>
<td>3 (1.9%)</td>
<td>2 (1.5%)</td>
<td>0.815</td>
</tr>
<tr>
<td>Temporal</td>
<td>98 (61.2%)</td>
<td>85 (64.4%)</td>
<td>0.568</td>
</tr>
<tr>
<td>Tympanic</td>
<td>16 (10.0%)</td>
<td>8 (6.1%)</td>
<td>0.224</td>
</tr>
</tbody>
</table>
9) Knowing that temperature differs according to anatomic evaluation site (select the right answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=162)</th>
<th>Other physicians(n=134)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary &lt; tympanic &lt; rectal*</td>
<td>85 (52.5%)</td>
<td>86 (64.2%)</td>
<td>0.042*</td>
</tr>
<tr>
<td>Axillary &lt; tympanic = rectal</td>
<td>56 (34.5%)</td>
<td>34 (25.4%)</td>
<td>0.087</td>
</tr>
<tr>
<td>Axillary = tympanic = rectal</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>-</td>
</tr>
<tr>
<td>Axillary = oral &lt; rectal</td>
<td>16 (9.9%)</td>
<td>8 (5.9%)</td>
<td>0.220</td>
</tr>
<tr>
<td>I don’t know</td>
<td>5 (3.1%)</td>
<td>6 (4.5%)</td>
<td>0.529</td>
</tr>
</tbody>
</table>

10) About the difference between rectal and axillary temperature: (select the wrong answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=162)</th>
<th>Other physicians(n=134)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies between 0.5−1.0ºC (0.9−1.8ºF)*</td>
<td>64 (39.5%)</td>
<td>70 (52.2%)</td>
<td>0.028*</td>
</tr>
<tr>
<td>Varies on average ±1.0ºC (1.8ºF)</td>
<td>27 (16.7%)</td>
<td>24 (17.9%)</td>
<td>0.778</td>
</tr>
<tr>
<td>Varies between 0−2.0ºC (0−3.6ºF) in apyrexia</td>
<td>24 (14.8%)</td>
<td>12 (9.0%)</td>
<td>0.125</td>
</tr>
<tr>
<td>Varies between 0−3.0ºC (0−5.4ºF) in fever</td>
<td>33 (20.4%)</td>
<td>17 (12.7%)</td>
<td>0.079</td>
</tr>
<tr>
<td>I don’t know</td>
<td>14 (8.6%)</td>
<td>11 (8.2%)</td>
<td>0.894</td>
</tr>
</tbody>
</table>

11) Regarding fever, hyperthermia and hyperpyrexia concepts (select the right answer)

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=163)</th>
<th>Other physicians(n=135)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperthermia = fever</td>
<td>11 (6.7%)</td>
<td>18 (13.3%)</td>
<td>0.053</td>
</tr>
<tr>
<td>Hyperpyrexia = hyperthermia</td>
<td>12 (7.4%)</td>
<td>7 (5.2%)</td>
<td>0.454</td>
</tr>
<tr>
<td>Hyperthermia = endogenous warming</td>
<td>45 (27.6%)</td>
<td>41 (30.4%)</td>
<td>0.572</td>
</tr>
<tr>
<td>Hyperthermia = exogenous warming*</td>
<td>77 (47.2%)</td>
<td>52 (38.5%)</td>
<td>0.145</td>
</tr>
<tr>
<td>I don’t know</td>
<td>18 (11.1%)</td>
<td>17 (12.6%)</td>
<td>0.662</td>
</tr>
</tbody>
</table>

Legend: #correct answer; *p<0.05

Table 4 - Comparison between answers of pediatricians and pediatric residents

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=110)</th>
<th>Pediatric residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cross-sectional studies*</td>
<td>18 (16.4%)</td>
<td>8 (15.1%)</td>
<td>0.836</td>
</tr>
<tr>
<td>Cross-sectional and longitudinal studies</td>
<td>12 (10.9%)</td>
<td>8 (15.1%)</td>
<td>0.446</td>
</tr>
<tr>
<td>All longitudinal studies</td>
<td>3 (2.7%)</td>
<td>2 (3.8%)</td>
<td>0.661</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>10 (9.1%)</td>
<td>2 (3.8%)</td>
<td>0.340</td>
</tr>
<tr>
<td>I don’t know</td>
<td>67 (60.9%)</td>
<td>33 (62.2%)</td>
<td>0.868</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=109)</th>
<th>Residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average individual normal temperature</td>
<td>19 (17.4%)</td>
<td>7 (13.2%)</td>
<td>0.492</td>
</tr>
<tr>
<td>Maximum individual normal temperature</td>
<td>1 (0.9%)</td>
<td>0 (0.0%)</td>
<td>0.673</td>
</tr>
<tr>
<td>Average population normal temperature</td>
<td>54 (49.6%)</td>
<td>32 (60.4%)</td>
<td>0.195</td>
</tr>
<tr>
<td>Maximum population normal temperature*</td>
<td>12 (11.0%)</td>
<td>17 (13.2%)</td>
<td>0.683</td>
</tr>
<tr>
<td>I don’t know</td>
<td>23 (21.1%)</td>
<td>17 (13.2%)</td>
<td>0.225</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Pediatrics (n=109)</th>
<th>Residents (n=51)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>16 (14.7%)</td>
<td>13 (25.5%)</td>
<td>0.098</td>
</tr>
<tr>
<td>Two</td>
<td>23 (21.1%)</td>
<td>11 (21.6%)</td>
<td>0.946</td>
</tr>
<tr>
<td>Three*</td>
<td>16 (14.7%)</td>
<td>5 (9.8%)</td>
<td>0.395</td>
</tr>
<tr>
<td>It is not relevant</td>
<td>25 (22.9%)</td>
<td>4 (7.8%)</td>
<td>0.021*</td>
</tr>
<tr>
<td>I don’t know</td>
<td>29 (26.6%)</td>
<td>18 (35.3%)</td>
<td>0.261</td>
</tr>
</tbody>
</table>
### 4) About fever definitions (select the wrong answer)

<table>
<thead>
<tr>
<th>Temperature Definition</th>
<th>Pediatricians (n=108)</th>
<th>Residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher than normal for the individual, depending on the anatomic site of evaluation</td>
<td>12 (11.1%)</td>
<td>8 (15.1%)</td>
<td>0.471</td>
</tr>
<tr>
<td>More than 1°C above the average individual temperature, depending on the anatomic site of evaluation</td>
<td>15 (13.9%)</td>
<td>12 (22.6%)</td>
<td>0.162</td>
</tr>
<tr>
<td>Equal or higher than 37.4°C (99.3°F) axillary temperature</td>
<td>40 (37.0%)</td>
<td>16 (30.2%)</td>
<td>0.391</td>
</tr>
<tr>
<td>Equal or higher than 38.0°C (104.4°F) axillary temperature*</td>
<td>33 (30.6%)</td>
<td>12 (22.6%)</td>
<td>0.293</td>
</tr>
<tr>
<td>I don’t know</td>
<td>8 (7.4%)</td>
<td>5 (9.4%)</td>
<td>0.760</td>
</tr>
</tbody>
</table>

### 5) About subfebrile definition (select the right answer)

<table>
<thead>
<tr>
<th>Temperature Definition</th>
<th>Pediatricians (n=110)</th>
<th>Residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precedes fever</td>
<td>7 (6.4%)</td>
<td>2 (3.8%)</td>
<td>0.719</td>
</tr>
<tr>
<td>Temperatures between 37.1−37.5°C (98.8−99.5°F)</td>
<td>16 (14.5%)</td>
<td>5 (9.4%)</td>
<td>0.362</td>
</tr>
<tr>
<td>Temperatures between 37.5−38.0°C (99.5−100.4°F)</td>
<td>41 (37.3%)</td>
<td>25 (47.2%)</td>
<td>0.228</td>
</tr>
<tr>
<td>Does not exist*</td>
<td>40 (36.4%)</td>
<td>19 (35.8%)</td>
<td>0.949</td>
</tr>
<tr>
<td>I don’t know</td>
<td>6 (5.4%)</td>
<td>2 (3.8%)</td>
<td>0.486</td>
</tr>
</tbody>
</table>

### 6) In ambulatory, how can we assess core temperature (select the right answer)

<table>
<thead>
<tr>
<th>Temperature Measurement</th>
<th>Pediatricians (n=109)</th>
<th>Residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body temperature</td>
<td>18 (16.5%)</td>
<td>11 (20.8%)</td>
<td>0.509</td>
</tr>
<tr>
<td>Axillary temperature</td>
<td>4 (3.7%)</td>
<td>0 (0.0%)</td>
<td>0.304</td>
</tr>
<tr>
<td>Rectal temperature*</td>
<td>35 (32.1%)</td>
<td>10 (18.9%)</td>
<td>0.077</td>
</tr>
<tr>
<td>Rectal or tympanic temperature*</td>
<td>33 (30.3%)</td>
<td>11 (20.7%)</td>
<td>0.201</td>
</tr>
<tr>
<td>I don’t know</td>
<td>19 (17.4%)</td>
<td>21 (39.6%)</td>
<td>0.002*</td>
</tr>
</tbody>
</table>

### 7) What is the most reliable anatomic site for temperature measurement? (select the right answer)

<table>
<thead>
<tr>
<th>Temperature Measurement</th>
<th>Pediatricians (n=110)</th>
<th>Residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary</td>
<td>15 (13.6%)</td>
<td>12 (22.6%)</td>
<td>0.155</td>
</tr>
<tr>
<td>Oral</td>
<td>5 (4.6%)</td>
<td>0 (0.0%)</td>
<td>0.174</td>
</tr>
<tr>
<td>Rectal*</td>
<td>81 (73.6%)</td>
<td>38 (71.7%)</td>
<td>0.724</td>
</tr>
<tr>
<td>Temporal</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>-</td>
</tr>
<tr>
<td>Tympanic</td>
<td>9 (8.2%)</td>
<td>3 (5.7%)</td>
<td>0.752</td>
</tr>
</tbody>
</table>

### 8) What is the least reliable anatomic site for temperature measurement? (select the right answer)

<table>
<thead>
<tr>
<th>Temperature Measurement</th>
<th>Pediatricians (n=108)</th>
<th>Residents (n=52)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary</td>
<td>14 (13.0%)</td>
<td>2 (3.9%)</td>
<td>0.069</td>
</tr>
<tr>
<td>Oral</td>
<td>15 (13.9%)</td>
<td>13 (25.0%)</td>
<td>0.088</td>
</tr>
<tr>
<td>Rectal</td>
<td>2 (1.8%)</td>
<td>1 (1.9%)</td>
<td>0.698</td>
</tr>
<tr>
<td>Temporal*</td>
<td>70 (64.8%)</td>
<td>27 (51.9%)</td>
<td>0.102</td>
</tr>
<tr>
<td>Tympanic</td>
<td>7 (6.5%)</td>
<td>9 (17.3%)</td>
<td>0.034*</td>
</tr>
</tbody>
</table>

### 9) Knowing that temperature differs according to anatomic evaluation site (select the right answer)

<table>
<thead>
<tr>
<th>Temperature Comparison</th>
<th>Pediatricians (n=109)</th>
<th>Residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary &lt; tympanic &lt; rectal*</td>
<td>54 (49.5%)</td>
<td>31 (58.5%)</td>
<td>0.285</td>
</tr>
<tr>
<td>Axillary &lt; tympanic = rectal</td>
<td>39 (35.8%)</td>
<td>17 (32.1%)</td>
<td>0.642</td>
</tr>
<tr>
<td>Axillary = tympanic = rectal</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>-</td>
</tr>
<tr>
<td>Axillary = oral &lt; rectal</td>
<td>11 (10.1%)</td>
<td>5 (9.4%)</td>
<td>0.895</td>
</tr>
<tr>
<td>I don’t know</td>
<td>5 (4.6%)</td>
<td>0 (0.0%)</td>
<td>0.134</td>
</tr>
</tbody>
</table>

### 10) About the difference between rectal and axillary temperature: (select the wrong answer)

<table>
<thead>
<tr>
<th>Temperature Difference</th>
<th>Pediatricians (n=109)</th>
<th>Residents (n=53)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies between 0.5−1.0°C (0.9−1.8°F)*</td>
<td>41 (37.6%)</td>
<td>22 (41.5%)</td>
<td>0.633</td>
</tr>
<tr>
<td>Varies on average ±1.0°C (1.8°F)</td>
<td>18 (16.5%)</td>
<td>9 (17.0%)</td>
<td>0.940</td>
</tr>
<tr>
<td>Question</td>
<td>Pediatrics (n=110)</td>
<td>Residents (n=53)</td>
<td>P</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>------------------</td>
<td>-------</td>
</tr>
<tr>
<td>11) Regarding fever, hyperthermia and hyperpyrexia concepts (select the right answer)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperthermia = fever</td>
<td>11 (10.0%)</td>
<td>1 (1.9%)</td>
<td>0.106</td>
</tr>
<tr>
<td>Hyperpyrexia = hyperthermia</td>
<td>11 (10.0%)</td>
<td>1 (1.9%)</td>
<td>0.106</td>
</tr>
<tr>
<td>Hyperthermia = endogenous warming</td>
<td>28 (25.4%)</td>
<td>17 (32.1%)</td>
<td>0.376</td>
</tr>
<tr>
<td>Hyperthermia = exogenous warming*</td>
<td>51 (46.4%)</td>
<td>26 (49.0%)</td>
<td>0.747</td>
</tr>
<tr>
<td>I don’t know</td>
<td>9 (8.2%)</td>
<td>8 (15.1%)</td>
<td>0.176</td>
</tr>
</tbody>
</table>

Legend: #correct answer; *p<0.05

**DISCUSSION**

Studies published about the knowledge of health professionals regarding fever have mainly focused the concept of fever phobia and fever treatment, providing a picture of caregivers’ fever phobia.\(^1,5,7,9,12,14,16,18,20,28\) However, the present study had a different scope, similar to the one conducted by Mackowiak et al., and focused on the basic concepts of evaluating and quantifying fever.\(^16\)

“Normal temperature” varies from person to person according to age, sex, race, activity level, time of day, and anatomical site of measurement and is regulated through the thermoregulatory process within a specific range of values.\(^2,7,16,17,20,28\) In this study, only 10.6% of respondents knew how studies leading to the definition of “normal temperature” were conducted and almost 70% did not question the traditional fever definition, suggesting that health professionals frequently forget that individual body temperature is not an exception to other biological phenomena in which variability is the rule. The idea of a standard “normal body temperature” based on the highest population value, irrespective of intrinsic individual variability, has no physiological basis.\(^2,23,25\)

The best individual fever definition is a “rise in temperature above the normal daily range of each individual”.\(^5,18,23,25\) As most people do not know their temperature range, a fever definition of “temperature 1.0ºC (1.8ºF) above the individual average at a specific anatomic site” is significantly more precise than population-level definitions.\(^1,28\)

Overall, 73.5% of health professionals acknowledged the existence of “subfebrile” temperatures. Individual-centred fever definitions eliminate the need of a “subfebrile” concept, which represents a misconception that persists to compensate the erroneous use of a population-based “normal temperature” concept that implies that a range of temperatures can simultaneously indicate normality or illness.\(^1,28\)

Peripheral body temperature is significantly different from core temperature.\(^2,15,17,20,30\) Although the non-invasive temperatures that theoretically better correlate with core temperatures are rectal and tympanic, the last is greatly influenced by age and measurement technique.\(^2,12,17,20,28,34\) It requires a correct sensor adjustment to the tympanic membrane, in order to guide infrared rays while avoiding cold air flow interference in the ear canal. This can be hindered by curvature of the ear canal and/or by interposition of earwax, justifying the lower accuracy of this method compared to rectal measurement.\(^2,17,20,30,32,37\)

Acceptance of current fever definitions without considering the anatomical site of evaluation was an issue also pointed out by Mackowiak et al.\(^5,14,16,18\) This suggests that health professionals in Portugal almost exclusively use the axillary and/or tympanic temperatures, without questioning the accuracy of these methods and considering them identical. However, compared to rectal temperature and regardless of age, measurement of axillary temperature does not exceed 75% sensitivity.\(^2,17,24\) The peripheral vasoconstriction which occurs in thermal rise justifies a dynamic difference between rectal and axillary temperature up to 3.0ºC.\(^2,17,20,28,30,32,34,39\)

Oral temperature was considered the least reliable by 19.5% of respondents. Traditional issues can justify the little use of this method in Portugal and its consequent devaluation. Oral is more accurate than axillary temperature, but less accurate than rectal temperature.\(^2,23,32,34\)

Temperature evaluation in the temporal area is the least accurate, with the lowest sensitivity in fever diagnosis and a high false-positive rate, due to being strongly influenced by environmental conditions.\(^2,17,20,30,35\)

This study suggests that 41% of health professionals confuse hyperthermia with fever. This confusion is perpetuated in medical literature, highlighting the lack of knowledge regarding fever pathophysiology.\(^5,40\)

The present study aims to suppress two gaps in the literature by providing two individual-centred fever definitions, on the one hand, and assessing health professionals’ knowledge regarding basic concepts of fever and clinical thermometry, on the other. However, it has some limitations: a convenience sample was used, which was validated in a small group of professionals, and it did not analyse the circadian rhythm of normal temperature or thermometer contact time, required for an accurate temperature assessment. These are two particularly relevant issues that should be addressed in future studies.
CONCLUSION

Many health professionals do not have a consolidated knowledge regarding clinical thermometry and how to correctly define “normal temperature” and fever. It is questionable to further investigate caregivers’ knowledge about fever before they self-assess their own knowledge.

Fever research studies, in which a numerical definition of fever is required, should not be confused with the clinical evaluation of patients, who have their own physiologic temperature.

REFERENCES


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Received for publication: 26.04.2019
Accepted in revised form: 02.10.2019