Expert Review Measurement of Body Temperature

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Abstract

This article describes an evidence-based method for measurement of body temperature consistent with The Principles of Clinical Examination[1]. Temperature measurement at oral, aural, rectal and axillary sites is addressed, and measurement technique, accuracy and precision, and the normal ranges are discussed. We recommend a method for the measurement of body temperature based on the best evidence available at the time of publication. We welcome responses to this article which provide evidence for improvements to the method described here. Word count: 1,789 (excluding abstract, figures, tables and references).

Key words: temperature, thermometers, examination, fever, hypothermia

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Introduction

Core body temperature is the average temperature of the core thermal compartment, most accurately approximated using a pulmonary artery catheter. In hospital and general practice settings, the core temperature is often approximated by measurement of temperature at peripheral sites. Abnormalities in body temperature are an important clinical sign and frequently influence decision making in clinical practice.

Defining normal body temperature

The normal range for core temperature is generally considered to be between 36.5 °C and 37.5 °C. However, a number of studies comparing core temperature (measured via a pulmonary artery catheter) with simultaneous measurement of peripheral temperatures suggest that there may be discrepancies between the two. In general terms, measurements obtained at oral, aural and axillary sites tend to underestimate the true core temperature. In contrast, measurements obtained by rectal thermometry may overestimate the true core temperature.

There is significant uncertainty in the available data. The precision of peripheral temperature measurement for estimating pulmonary artery temperature is poor (evidence boxes 1-4). The authors recommend that temperatures measured at peripheral sites are compared with the (relatively well established) normal ranges for temperature at that site (table 1), rather than extrapolating to an estimated “true” core temperature.

Elevated body temperature is most commonly caused by infection but the differential diagnosis is broad and includes systemic inflammatory response syndrome (SIRS) (of which infection is the most common cause), malignant disease, hyperthyroidism, environmental and exertional hyperthermia, drug effects and drug reactions (importantly including neuroleptic malignant syndrome and malignant hyperthermia). The differential diagnosis for hypothermia includes sepsis, SIRS, environmental exposure, hypothyroidism, adrenal insufficiency, hypoglycaemia, and drug or alcohol intoxication. The most important use of measurements of body temperature is in diagnosis but extreme derangements in body temperature require urgent treatment to bring the core temperature into a safe range.
### Table 1 The limits of normal body temperature measured at different sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Age group studied</th>
<th>Lower limit (°C)</th>
<th>Upper limit (°C)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>18-40</td>
<td>36.0</td>
<td>37.7</td>
<td>[26]</td>
</tr>
<tr>
<td></td>
<td>&gt;70</td>
<td>36.2</td>
<td>37.0</td>
<td>[28]</td>
</tr>
<tr>
<td>Aural</td>
<td>11 - 85</td>
<td>37.6</td>
<td></td>
<td>[21]</td>
</tr>
<tr>
<td></td>
<td>&gt;85</td>
<td>37.5</td>
<td></td>
<td>[21]</td>
</tr>
<tr>
<td>Axillary</td>
<td>&gt;70</td>
<td>35.5</td>
<td>37.0</td>
<td>[28]</td>
</tr>
<tr>
<td>Rectal</td>
<td>&gt;70</td>
<td>36.7</td>
<td>37.5</td>
<td>[28]</td>
</tr>
</tbody>
</table>

**Abnormalities of temperature**

**Anatomy and physiology of temperature regulation**

Central temperature-sensitive neurons are found in the preoptic and anterior hypothalamic nuclei of the hypothalamus, and peripheral temperature receptors are found in the skin, abdominal viscera, spinal cord and great veins of the thorax. Afferent signals from these receptors are integrated in the posterior hypothalamus, which tightly regulates body temperature under normal conditions. When body temperature increases, heat loss is achieved by peripheral vasodilation and by sweating. When body temperature falls, heat production is increased by shivering and by sympathetic stimulation of metabolic thermogenesis, and heat is also conserved by peripheral vasoconstriction. In the longer term, the production of thyrotropin-releasing hormone is upregulated by the hypothalamus in response to cold exposure, increasing metabolic heat production via release of thyroid-stimulating hormone and ultimately through the action of thyroxine. The temperature set-point of the hypothalamus is increased by exposure to pyrogens, which include components of the inflammatory cascade as well as products of bacterial cell lysis and tissue breakdown. Animal, in vitro, and some limited human data suggest that the resulting fever may have adaptive value in the setting of infection [2], and the widespread use of antipyretics in this context is increasingly being questioned. Results of the HEAT trial, a randomised double-blinded placebo controlled trial of paracetamol for febrile intensive care patients with known or suspected infection, are eagerly awaited [3].

**Literature search**

Pubmed was searched for (Thermometers[MeSH Terms] OR thermography[MeSH Terms]) plus any of the search terms oral, tympanic, ear, rectal, oesophageal, esophageal, axilla, chemical dot, forehead, liquid crystal, bladder, temporal artery or pulmonary artery, with filters humans and english. The Cochrane Database of Systematic Reviews was searched using the terms thermometers and body temperature.

The following textbooks were also used in the preparation of this article:

- McGee’s Evidence-Based Physical Diagnosis [4]
- Sapira’s Art and Science of Clinical Diagnosis [5]

**Preparation**

Clinical examination should ideally take place in a warm, private environment with good illumination. The examiner should be appropriately dressed [6]. It may be appropriate to offer a chaperone to the patient especially for rectal temperature measurement. Wash your hands and take appropriate infection control measures [7]. Introduce yourself to the patient and confirm their identity. Obtain informed consent. Check that the patient is comfortable, then position the patient appropriately and ensure adequate exposure depending on the method of measurement you intend to use. Ensure you have the appropriate equipment to hand, including a thermometer and any necessary probe covers.
The use of an infrared emission detection aural thermometer is the most common method for measuring temperature in the NHS and is usually a suitable method. See Figures 1-3 for an example of a typical device. However other methods may be equally suitable and in some situations infrared emission detection aural thermometry may not be suitable. So, the most appropriate thermometer, site and method should be chosen for each case and the results interpreted accordingly.

Figure 1  Electronic oral and axillary thermometer

Figure 2 Infrared emission detection aural thermometer

Figure 3 Aural thermometer probe covers

Thermometer Selection

Infrared emission detection ‘tympanic’ thermometers are the most commonly used device in routine clinical practice in the NHS. They measure the temperature of the aural canal rather than specifically that of the tympanic membrane, and some devices apply correction factors to estimate “core”, “oral” or “rectal” temperature when these modes are selected. The estimate of aural temperature and the effect of these correction factors depend on the manufacturer’s calibration of the particular model of thermometer. As a very general rule, these devices are more likely to overestimate core temperature in “core” or “rectal” equivalence modes, and more likely to underestimate core temperature in “ear/equal” or “oral” equivalence modes (evidence box 2).

Electronic contact thermometers measure temperature using a thermistor (a resistor designed so that resistance varies with temperature to a far greater extent than it usually would), and may operate in predictive or monitoring modes. Monitoring modes continuously display temperature and may provide an audible tone when the rate of increase falls below a preset level. In contrast, predictive modes use the rate of temperature increase to extrapolate a final temperature, resulting in a faster but potentially less accurate reading. Chemical dot thermometers use an array of coloured dots formulated to change colour at specific temperature increments. Either an electronic contact thermometer in a monitoring mode (properly calibrated) or chemical dot thermometer is a reasonable choice for routine clinical practice.
Traditional mercury-in-glass thermometers require at least 3 minutes (and preferably 8-10 minutes) for an accurate reading, and carry a small but significant risk of harm both from broken glass and from the toxicity of mercury \[8\]. The use of mercury thermometers for oral, rectal and axillary temperature measurement has largely been replaced by electronic contact thermometers and chemical dot thermometers.

**Choice of measurement site**

No peripheral temperature measurement site has been shown to reflect pulmonary artery temperature with good precision. Aural temperature measurement is a reasonable choice for the majority of situations. Aural measurement appears a little less precise than measurement at the oral site, but with relatively good repeatability within the same patient, fewer confounding factors, and a significant advantage in terms of patient comfort and speed of measurement, all of which facilitate serial measurement. For a single temperature measurement in a fully cooperative patient with no confounding factors (see evidence box 6), the oral site may be more reliable. Axillary temperature measurement is probably less reliable in unselected patients compared to oral and aural sites and carries theoretical concerns about underestimation of core temperature. Rectal thermometry has greater sensitivity for detection of fever and of severe hyperthermia than oral or aural thermometry. These issues are discussed in evidence boxes 1-4, 6 and 7.

**Method for measurement of temperature**

*Aural/tympanic temperature measurement*

Use an infrared emission detection aural thermometer in “ear/equal” or “core” mode depending on the model of thermometer. You need to be familiar with the model of thermometer used locally. Ensure that the thermometer has been calibrated according to manufacturer’s instructions and that the lens is clean. Use a disposable probe cover, applied by pressing the probe tip into the probe cover until it engages. Apply gentle upward and backward traction to the pinna as for routine otoscopy (see figure 1). Align the probe tip with the ear canal, which runs forwards at about a 20° angle (the direction of the earpieces on a stethoscope), and insert the probe tip gently but firmly enough to form a seal. Depending on the model of thermometer, press or hold the measurement button. The end of the measurement period is usually signalled by an audible tone.

**Oral temperature measurement**

Use a properly calibrated electronic contact thermometer in a monitoring mode, or chemical dot thermometer. You need to be familiar with the model of thermometer used locally. Use a disposable probe cover. If you feel it is appropriate, pass the thermometer to the patient rather than putting it in the mouth yourself. Ask them to put the tip of the thermometer under the tongue, close the mouth and breathe normally through the nose. Remove the thermometer once it has equilibrated with oral temperature.

**Axillary temperature measurement**

Axillary temperature measurement is an option when other measurement sites are inappropriate, although the potential to underestimate core temperature should be borne in mind. Use an electronic contact thermometer in a monitoring mode, with disposable probe cover, or a chemical dot thermometer. Position the thermometer high in the axilla, with the arm tight against the chest wall, until the temperature equilibrates.
Rectal temperature measurement

Rectal temperature measurement is relatively contraindicated by local pathology (haemorrhoids, colitis, recent surgery etc.), and may cause an increase in vagal outflow to the heart, potentially resulting in bradycardia. Explanation and informed consent is especially important if rectal temperature measurement is considered.

A chaperone should be offered and disposable gloves should be worn. Ask the patient to lie in the left lateral position with hips and knees flexed. Underwear should be removed and a towel or sheet used to preserve patient dignity. Use an electronic rectal thermometer and apply the probe cover. Lubricate the tip of the thermometer using water-based lubricant at room temperature. Holding the thermometer in your right hand and, if necessary, using your left hand to part the patient’s buttocks, gently insert the tip of the probe 2-3 inches into the rectum. Leave the probe in position until the temperature equilibrates. Once the temperature reading is obtained, a tissue should be used to remove excess lubricant.

Concluding the examination

Most electronic thermometers signal that equilibration has been achieved with an audible tone; manufacturer’s instructions should be followed in the case of chemical dot thermometers. Equilibration typically takes about one minute but may be quicker. Read off the temperature and dispose of the probe cover in an appropriate clinical waste bin. Most thermometers have a release button for the probe cover, which should be used if available, rather than removing the probe cover manually. Finally, wash your hands, thank the patient, allow him or her to redress in privacy, and make a record of the temperature measured.

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Conflicts of interest
None declared
References


[16] Stavem, K et al. Accuracy of infrared ear thermometry in adult patients Intensive Care Med 1997; 23:100-105


[26] Mackowiak, PA et al. A critical appraisal of 98.6°F, the upper limit of the normal body temperature, and other legacies of Carl Reinhold August Wunderlich. JAMA 1992; 268:1578-1580


[34] Rampen, AJ et al. Tympanic measurement of body temperature in stroke patients “turned on its ear”. J Neurol Neurosurg Psychiatry 2005; 76:1041-1042


[38] Rajee, M & Sultana, RV. NexTemp thermometer can be used interchangeably with tympanic or mercury thermometers for emergency department use. Emerg Med Aus 2006 18:245-251


[43] Zengeya, ST & Blumenthal, I. Modern electronic and chemical thermometers used in the axilla are inaccurate. Eur J Pediatrics : 2006; 1551005-8


Evidence box 1

**Question:** What is the accuracy and precision of oral temperature measurement for estimation of pulmonary artery temperature in adults?

**References:** Lawson et al. 2007 [9], Erickson & Kirklin 1993 [10], Giuliano et al. 2000 [11], Mangat et al. 2010 [12]

**Discussion:** Studies comparing electronic contact oral thermometry with simultaneous pulmonary artery temperature measurement in adults have found mean offsets of oral temperature measurements from pulmonary artery temperature (reflecting accuracy)* of -0.09 °C, 0.05 °C, and 0.04 °C, and standard deviations for these offsets (reflecting precision) of 0.43 °C, 0.26 °C, and 0.5 °C respectively [9-11]. The factors contributing to this low precision are unclear. The study populations included both intubated patients and non-intubated patients requiring intensive care. Erickson & Kirklin [10] note a mean offset from pulmonary artery temperature of 0.12 °C in intubated patients and -0.29 °C in non-intubated patients.

Mangat et al. [12] report a repeatability coefficient (defined as the value below which 95% of the differences between two readings by the same operator are expected to lie) of 0.60°C for an electronic contact oral thermometer in a predictive mode. Their study population included 30 febrile patients and 70 normal volunteers. Repeatability coefficients were 0.33°C in normal volunteers and 0.98°C in the subgroup of patients with fever.

**Key points:** On average, oral temperature most likely underestimates pulmonary artery temperature in non-intubated patients. There is significant variability of oral temperature readings relative to pulmonary artery temperature in these studies, the contributing factors to which are unclear.

*In this review, mean offsets are reported as negative if the test thermometer underestimated pulmonary artery temperature, positive if the test thermometer overestimated.*
Evidence box 2

**Question:** What is the accuracy and precision of infrared emission detection aural temperature measurement for estimation of pulmonary artery temperature in adults?


**Discussion:** Rotello et al. [13] found mean offsets of measured aural temperature from pulmonary artery temperature of 0.06 °C, 0.07 °C, and -0.22 °C for three models of aural thermometer in 21 intensive care patients. One of these (mean offset 0.07 °C) was the model used in Chamberlain et al.’s study on the normal range for aural temperature [21], set in “ear/equal” mode in both studies. Giuliano et al. [11] reported mean offsets of -0.17 °C and -0.05 °C for two thermometer models using a “core” equivalence mode in a population of 72 patients. Erickson et al. [10] found a mean offset of 0.07 °C in 38 patients using a “core” equivalence mode. Fisk et al. [14] found mean offsets between -0.18°C and 0.00°C in 56 patients. Milewski et al. [15] found mean offsets between -0.01 and 0.35°C in a study with nine participants. Several studies have reported aural thermometers systematically overestimating pulmonary artery temperature: Lawson et al. [9] reported a mean offset of 0.36°C using a “core” equivalence mode in 60 patients, Stavem et al. [16] 0.45°C in 16 patients using a “rectal” equivalence mode, and White et al. [17] 0.17-0.36°C in 19 patients. Moran et al. [18] reported a systematic underestimate of 0.36°C in 110 patients using a “core” mode. Hasper et al. [19] have found good accuracy relative to oesophageal temperature in patients undergoing mild therapeutic hypothermia (mean offset +0.02°C).

A number of studies report the standard deviation for the mean offset from pulmonary artery or oesophageal temperature at around 0.4-0.5 °C [10, 13, 16, 17, 19]. Giuliano et al. [11] found standard deviations as high as 0.65 °C, Lawson et al. 0.56 °C [9], Fisk et al. [14] 0.51-0.68°C, Farnell et al. [20] 0.6°C, and White et al. [17] 0.32-0.61°C. Mangat et al. [12] report tighter limits of agreement relative to nasopharyngeal temperature, corresponding to standard deviations of 0.26-0.28 °C, while Milewski et al. [15] found standard deviations as low as 0.1-0.23 °C. Repeatability of aural temperature measurements is relatively good, with the standard deviation for triplicate readings reported in the range of 0.13-0.2 °C [10, 18], and repeatability coefficients in the range of 0.29-0.44 °C (0.26-0.49°C in the subgroup of patients with fever) [12].

**Key points:** As with oral temperature measurement, there is significant variability in aural temperature measurements relative to pulmonary artery temperature, the contributing factors to which are unclear. Repeatability of aural measurements within the same patient appears relatively good.
**Evidence box 3**

**Question:** What is the accuracy and precision of rectal temperature measurement for estimation of pulmonary artery temperature in adults?


**Discussion:** The mean offset of rectal temperature from pulmonary artery temperature is reported in the range of -0.16 - 0.3°C [13, 16, 22, 23]. Milewski et al. report much greater mean offsets of 0.46-1.10°C in their nine participants [24]. Standard deviation for the offset from pulmonary artery temperature is reported in the range of 0.05-0.5 °C. An important aspect of rectal temperature measurement is that the rectal temperature may lag significantly as core temperature changes. This phenomenon of “probe lag” has been elegantly demonstrated by Weingart et al. [24] in the setting of rapid saline induction of therapeutic hypothermia (the authors recommend oesophageal temperature monitoring in this setting).

**Key points:** Rectal temperature may overestimate pulmonary artery temperature. Rectal temperature exhibits substantial “probe lag” and is unsuitable for monitoring active patient warming or cooling.

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**Evidence box 4**

**Question:** What is the accuracy and precision of axillary temperature measurement for estimation of pulmonary artery temperature in adults?

**References:** Lawson et al. 2007 [9], Erickson & Kirklin 1993 [10], Mangat et al. 2010 [12], Lefrant et al. 2003 [22], Fulbrook 1993 [23], Giuffre et al. 1990 [25]

**Discussion:** Studies in the intensive care population comparing axillary temperature to simultaneous pulmonary artery temperature measurement have found mean offsets of axillary from pulmonary artery temperature of -0.23 °C, -0.27 °C, -0.33°C, -0.19°C, and -0.68°C [9, 10, 22, 23, 25]. Reported standard deviations were 0.44°C, 0.45°C, 0.16°C, and 0.57°C [9, 10, 22, 23, 25]; the precision in this setting is similar to other measurement sites.

Mangat et al. report a repeatability coefficient of 0.92°C for axillary temperature measurement using an electronic axillary thermometer in a predictive mode. Repeatability coefficients were 0.5°C in normal volunteers, and 1.49°C in the subgroup of patients with fever [12].

**Key points:** Axillary temperature underestimates pulmonary artery temperature. Some of the variability in axillary temperature measurements observed in the general population is not reproduced in the intensive care environment.
Evidence box 5

**Question:** What is the normal range for body temperature measured at oral, aural, rectal and axillary sites?


**Discussion:** Mackowiack *et al.* [26] analysed 700 oral temperature measurements obtained from 148 healthy volunteers aged 18-40 over a 2½ day period. Diurnal variation in temperature was observed. The upper limit of normal (99th centile) was 37.2 °C at its 6am nadir and 37.7 °C at its 4pm zenith, with lower limits of 36.0°C and 36.3°C respectively.

Chamberlain *et al.* [21] measured aural temperatures using an infrared emission detection thermometer (Thermoscan Pro-1® set in “equal” mode, to display the measured temperature in the ear canal) in 2447 subjects across eight age brackets from 0-2days to >85 years, without potentially febrile illness or use of medication known to affect body temperature. The upper limit of normal (99th centile) was 37.9 °C for children under 11 years, 37.6 °C for all subjects over 11 years, and 37.5 °C for adults over 85 years. In a longitudinal study of 5 patients, a pattern of diurnal temperature variation was observed similar to that reported by Mackowiack *et al*.

Purssell *et al.* [27] recorded aural temperatures using and infrared emission detection thermometer (no “core” or other correction factor specified) in 244 children between one and six years old and without suspicion for febrile illness, in an outpatient setting. Mean temperature was 36.65°C with 95% confidence intervals of 35.8°C -37.5°C.

Darowski *et al.* [28] measured oral, rectal, ear canal and axillary temperatures in 50 hospital inpatients aged 70 years or over and with no suspicion for febrile illness. Aural temperatures were measured with an electronic thermocouple probe and with a zero gradient device, rather than with an infrared emission detection thermometer. Measurements were made between 10am and 6pm. Temperature ranges were lower than those from studies with a younger sample: 36.2-37.0 °C for oral, 36.4-37.2 °C for ear canal, 36.7-37.5 °C for rectal and 35.5-37.0 °C for axillary temperatures.

**Key points:** In the general population, oral or infrared emission detection aural temperature outside the range 36.0-37.7 is abnormal. In the elderly population, oral temperature greater than 37.0 or aural temperature greater than 37.5 should be suspicious for fever. The upper limit of normal body temperature is lower in the early morning.
**Evidence box 6**

**Question:** What factors are known to affect the accuracy of temperature measurement at peripheral sites?


**Discussion:** Oral temperatures are a little higher in orally intubated patients and may be misleadingly low in tachypnoeic patients [9, 10, 29], including in the setting of exertional hyperthermia. Chewing gum for 5 minutes appears to increase oral temperature by 0.3-0.5°C, an effect which can persist for as long as 30 minutes [30,31]. The effect of hot and cold drinks on oral temperature is maximal in the first few minutes but may persist for 10-30 minutes [29-32]. Smoking has been found to cause a small delayed increase in oral temperature (mean 0.2°C), starting at around 10 minutes and persisting until about 30 minutes [30]. The repeatability of oral temperature measurements worsens significantly in febrile patients [12], although this may in part be due to difficulties in maintaining nasal breathing during temperature measurement.

While oral temperatures increase for up to 30 minutes following 5 minutes of chewing gum, mean aural temperatures appear to fall by around 0.3°C on average over this period [30]. Mean aural temperature can be up to 0.4 °C higher in the downward ear when a patient has been lying on one side, but resolves within ten minutes of upright positioning [34]. Mean aural temperatures may fall by several degrees Celsius following immersion in water [29], and infrared aural thermometry should not be used in this setting.

The mean aural temperature reading by infrared thermometry is increased by traction on the pinna to straighten the ear canal [36], and varies with ear canal morphology, in particular the circumference of the ear canal at its distal bend [37]. Repeat measurements in the same ear appear to have a small bias of 0.1°C towards a lower second reading [38]. A randomised single-blind trial found occlusion of the ear canal by cerumen to lower the mean temperature reading by 0.3 °C [39].

Axillary measurements will theoretically underestimate core temperature when the core-peripheral temperature gradient is high (e.g. vasoconstriction, hypoperfusion). Darowski et al.’s study on the normal range of temperature at different sites in elderly patients found the lower limit for axillary temperature to be substantially lower than for other measurement sites, at 35.5 °C vs. 36.2 °C, 36.4 °C and 36.7 °C for oral, aural and rectal temperatures respectively [28].

**Key points:** Aural temperature measurement should be preferred over the oral site in patients with tachypnoea, those who cannot maintain nasal breathing, and following eating, drinking or smoking (although chewing appears to have some effect on aural temperature). Aural temperature measurement should not be used following immersion in water, and should not be used in the downward ear when a patient has been lying on one side. Axillary temperature measurement is unreliable in unselected patients.
Evidence box 7

Question: What is the sensitivity of oral, aural and axillary thermometry for fever compared with rectal thermometry?


Discussion: Varney et al. [40] measured the temperature of 95 patients over the age of 60 and presenting with symptoms suggestive of infection using oral, aural and rectal thermometry. Allowing for rectal temperature to be on average 0.5 °C higher than oral temperature, they identified fever >38 °C by rectal but not oral thermometry in 14.7% of patients overall, and by rectal but not aural thermometry in 12.2%. Of those patients tested, 5.6% were febrile by rectal thermometry but afebrile by both oral and aural thermometry. Of note, no patients were febrile on oral or aural measurement but afebrile on rectal measurement. Barnett et al. [41] measured oral, aural and rectal temperatures in 457 adults presenting to the emergency department with a mean age of 65 years old. In this population, a binary cut-off value of 37.2 °C for oral temperature had a sensitivity of 84.7% and specificity of 83.5% for rectal temperatures >38 °C. Using an aural thermometer with a “rectal” mode manufacturer’s correction factor, a cut-off value of 37.9 °C had a sensitivity of 80.0% and specificity of 80.8% for rectal temperature >38 °C.

Two recent studies in the paediatric population have reported very poor sensitivity of axillary temperature measurement for identifying fever on rectal temperature measurement [42, 43]. A 1996 Cochrane review [44] concluded that in the paediatric population, rectal temperature measurement should be used until the child is old enough to cooperate with oral temperature measurement. Aural temperature measurement may be a reasonable alternative provided imperfect sensitivity is acknowledged and the results taken in their clinical context, with one study demonstrating that temperatures >37.6 °C on infrared aural thermometry has a 76% sensitivity for rectal temperatures >38 °C [42]. A systematic review in 2006 based on heterogeneous sensitivity estimates found a pooled sensitivity of 63.7% (with a specificity of 95.2%) [45].

In the specific setting of suspected severe hyperthermia (>41°C), where reliable detection of elevated temperature is important for prompt therapeutic cooling, rectal temperature measurement should be strongly considered [46].

Key points: In the general population, aural and oral thermometry have a sensitivity in the region of 80-85% for fever at the rectal site. In the paediatric population, aural thermometry has a sensitivity in the region of 60-75% for fever at the rectal site.