Measuring body temperature using a tympanic thermometer

Body temperature is one of the key physiological observations that should be recorded when a patient is admitted to hospital, and monitored regularly as clinically appropriate. Slight changes in body temperature can be an indication of acute illness and are an important component of the National Early Warning Score 2 (NEWS2) (Royal College of Physicians, 2017).

Nurses need to know how to measure body temperature accurately and reliably, as readings are a vital part of a holistic patient assessment and can inform treatment decisions. This article outlines the rationale for recording body temperature and describes the procedure for measuring temperature using a tympanic thermometer, which is frequently used in clinical practice.

Abstract Nurses need to know how to measure body temperature accurately and reliably, as inaccurate results may influence diagnosis and treatment, lead to a failure to identify patient deterioration and compromise patient safety (McCallum and Higgins, 2012). It is, therefore, important that nurses understand the significance of abnormal temperature readings and, when delegating this task to unregistered staff, ensure they are competent and know when to report concerns.

Regulation of body temperature
The body’s temperature is regulated by the thermoregulatory centre in the hypothalamus through various physiological mechanisms such as sweating, dilation/constriction of peripheral blood vessels and shivering (Waugh and Grant, 2018). Body temperature rises and falls in line with increases and decreases in metabolic rate. Heat is released during periods of increased metabolic activity, such as skeletal muscle, liver and digestive organs activity. Shivering – a repetitive muscular activity – increases heat production when there is a possibility that body temperature could fall below normal.

Heat is lost from the body in four ways:
- Radiation – movement of heat from exposed parts of the body with a higher temperature to the surroundings with a lower temperature. This is the most common mechanism of heat loss;
- Convection – heat transfer from the body by flow or movement of air, such as sitting in front of a fan;
- Conduction – heat transfer due to direct contact with cooler surfaces such as lying on a cold surface;

Normal values
Body temperature represents the balance between heat production and heat loss, and a normal body temperature is generally accepted to be 36.9°C – the optimum temperature needed to maintain enzyme activity required for metabolism. However, in health, it can range from 36.0-37.5°C (Dougherty and Lister, 2015), and slight increases can occur in the evening, during exercise and in women following ovulation (Waugh and Grant, 2018). Box 1 outlines terms used to describe body temperature.

Box 1. Terms for temperature monitoring and reporting
- Normal body temperature: 36.1-37.5°C (Dougherty and Lister, 2015)
- Pyrexia: body temperature above normal daily variation (National Institute for Health and Care Excellence, 2007). Dougherty and Lister (2015) describe low-grade pyrexia as a temperature that is above normal and up to 38°C
- Hyperpyrexia: temperature >40°C (Dougherty and Lister, 2015)
- Fever: abnormal increase in body temperature, usually accompanied by shivering, headache and, if severe, delirium
- Malignant hyperthermia: rapid rise of temperature to a dangerous level (usually 41-45°C). This is a rare condition, usually triggered by anaesthetic drugs and is caused by an increase in metabolic rate, which is driven by an increase in intracellular calcium levels in muscle (Bit.ly/EGMHyperperthermia)
- Hypothermia: temperature <36.1°C

NEWS2
NEWS2 is based on a simple aggregate scoring system in which a score is allocated to measurements of physiological signs, including temperature; the other signs are

<table>
<thead>
<tr>
<th>Table 1. NEWS2 scores</th>
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<tr>
<td>Temperature, °C</td>
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<tr>
<td>35.1-36.1 or 38.1-39</td>
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<tr>
<td>≥39.1</td>
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<td>≤35</td>
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Source: Royal College of Physicians (2017)
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respiration rate, oxygen saturation, sys-
tolic blood pressure, pulse rate and level of
consciousness or new confusion (RCPI,
2017). Abnormal temperature readings out-
side of the range of 36.0–38.0°C (RCPI, 2017)
are a significant finding, prompting
increased frequency of monitoring as well
as a response from a registered nurse
(Table 1).

Causes of pyrexia
There are many causes of pyrexia including:
● Infection;
● High ambient temperature – heat and
humidity in the environment can
reduce the amount of heat lost through
the skin;
● Drugs - amphetamine derivatives, such
as methylenedioxymethamphetamine
(MDMA or ‘Ecstasy’) and anaesthetic
drugs, can cause malignant hyperpyrexia;
● Stroke involving injury to the
hypothenalmus;
● Cardiac arrest – pyrexia is common in
the first 48 hours after cardiac arrest
(Nolan et al, 2015);
● Increased muscular activity following
strenuous exercise or during prolonged
seizures;
● Endocrine disorders, for example,
thyroid storm;
● Myocardial infarction when there is an
inflammatory response to heart-muscle
damage.

Sometimes, patients present with a
pyrexia of unknown origin; this is a con-
sistently elevated body temperature
>37.5°C for over two weeks with no diag-
nosis, despite investigations.

Sepsis and temperature
There is a common misconception that
patients with sepsis will always present
with a pyrexia. For example, in adults, a
temperature of <36.0°C is considered an
amber flag warning in a patient who is sus-
pected of having sepsis and this requires
prompt review (Bit.ly/USTScreening12plus).

In children <5 years who have a sus-
ppected diagnosis of sepsis, a temperature
<36.0°C is considered a red flag warning
sign (Bit.ly/USTScreeningUnder5).

Causes of hypothermia
There are many causes of hypothermia
including:
● Exposure to a cold environment, for
example immersion in cold water;
● Underlying illness such as
hypothyroidism, hepatic encephalopathy
and cerebrovascular accident;
● Social factors including poor
accommodation/inadequate heating,
malnourishment or alcohol misuse;
● Burns, which can lead to excessive
heat loss.

Children (due to their immature regu-
latory systems) and older people (due to their
altered thermoregulatory mechanisms) are
at risk of developing hypothermia.

Sometimes hypothermia may be
induced during certain types of cardiac
surgery when it is used to protect the brain
from periods of low blood flow. Targeted
temperature management (formerly called
therapeutic hypothermia) used post cardi-
opulmonary arrest, when the patient
remains in a coma to protect the brain
from low blood flow, is becoming increas-
ingly common (Nolan et al, 2015).

Measuring temperature
Indications for measuring body tempera-
ture include:
● Baseline observation on admission/first
consultation and as part of NEWS2
assessment;
● Routine bedside observations, and other
vital signs, to help the early detection
of acute illness and deterioration;
● Observations associated with a
transfusion of blood products to detect
signs of transfusion reaction;
● Assessment in acute illness as part
of ABCDE approach. Nurses should
manually check skin temperature as
part of the assessment of circulation (C)
- cool peripheries could indicate
circulatory shock – and measure body
temperature as part of exposure (E);
● As part of the NEWS2 assessment.

Frequency of measurements
The National Institute for Health and Care
Excellence (2007) recommends that adult
patients in acute hospitals should have
physiological observations, including
body temperature, recorded at initial
assessment or admission and then subse-
quentley monitored at least every 12 hours,
unless a decision has been made at a senior
level to increase or decrease the frequency
of monitoring.

Methods for measuring body
temperature
Methods for measuring body temperature
include:
● Tympanic thermometer – commonly
used in clinical practice (Fig 1);
● Single-use chemical dot thermometer –
commonly used with infants and
small children;
● Rectal thermometer – frequently used
when hypothermia is suspected;
● Oesophageal/nasopharyngeal probes,
bladder probe or pulmonary artery
catheter: reliable methods, but generally
only used on critical care units.

Forehead chemical thermometers are
unreliable and should not be used by
health professionals (NICE, 2019).

The same site should be used for con-
secutive temperature measurements and
documented, as switching between sites
can produce readings that are difficult to
interpret (Jevon and Joshi, 2020).

Tympanic temperature measurement
The tympanic membrane shares the same
carotid blood supply as the hypothalamus: measure-
tment of tympanic membrane
temperature and, therefore, reflects core
temperature (Jevon and Joshi, 2020).

Care should be taken when using the
tympanic thermometer as poor technique
can render the measurement inaccurate.

Temperature differences between the
opening of the ear canal and the tympanic
membrane can be as much as 2.8°C (Jevon
and Joshi, 2020).

To ensure accurate temperature mea-
surements, the tympanic thermometer
probe should be positioned to fit snugly in
the ear canal. This will prevent ambient
air at the opening of the ear canal from
entering it, resulting in a false low tempera-
ture measurement. Size of the external
acoustic meatus (ear canal), presence of
cerumen (ear wax), operator technique and
the patient’s position can affect the accu-
racy of the measurement.

Arslan et al (2011) found that readings
using a tympanic thermometer in patients
who had been lying on one ear were
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significantly higher in that ear than in the exposed ear. The study involved 68 healthy young people who had no signs of discharge or infection of the ear or upper respiratory tract infection. Dougherty and Lister (2015) suggest that patients should not lie on their side for 20 minutes before their temperature is measured using a tympanic thermometer.

Infection prevention

The thermometer is an important tool for clinical assessment but can become contaminated by micro-organisms. Adherence to local infection prevention and control policies, including the cleaning of equipment, is essential. Non-sterile gloves are not required routinely for this procedure. Nurses need to assess individual patients for the risk of exposure to blood and body fluids (Royal College of Nursing, 2020) and to be aware of local policies for glove use.

Procedure using an electronic tympanic thermometer

Equipment:
- Electronic tympanic thermometer that has been cleaned and maintained according to local policy;
- Clean disposable probe tip;
- Waste bag.

1. Decontaminate hands and assemble equipment.
2. Introduce yourself to the patient, explain the procedure and gain consent.
3. Ascertain which ear was used for previous readings and use the same ear for subsequent readings.
4. Ensure the patient is in a comfortable position.
5. Decontaminate hands.
6. Inspect the ear canal for any problem that may affect the accuracy of the reading including the presence of cerumen, ear discharge and foreign bodies. If you identify a problem select a different site and document and report your concerns.

Professional responsibilities

This procedure should be undertaken only after approved training, supervised practice and competency assessment, and carried out in accordance with local policies and protocols.

References

National Institute for Health and Care Excellence (2007) Acutely Ill Adults in Hospital: Recognising and Responding to Deterioration. NICE.

Fig 2. Using an electronic tympanic thermometer

2a. Attach the probe tip to the thermometer
2b. Gently pull the pinna of the ear upwards and backwards
2c. Insert the thermometer probe into the external acoustic meatus and ensure there is a snug fit