



**HYPOTHERMIA, DETECTION,
PRESCRIPTION &
PATHOPHYSIOLOGY
PART 2**


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Inadvertent Perioperative Hypothermia (IPH) is an uncomfortable, dangerous, and costly preventable complication of surgery (Conway et al. 2019)



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BARRIERS TO COMPLIANCE

Compliance to international perioperative temperature management guidelines in Asia-Pacific remains poor, especially in small hospitals

- Barriers to compliance were limited temperature management equipment,
- lack of locally-relevant standard operating procedures and training (Koh et al. 2021)



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INADVERTENT PERIOPERATIVE HYPOTHERMIA

- For perioperative nurses to treat this condition, they must first have an accurate means of detecting it
- To make accurate assessments and clinical decisions based on patients' temperature, which is an important part of patient vital signs, nurses must first have an understanding how different thermometers work and be competent in their use
- It is vital that patients have accurate core body temperature recorded during their perioperative journey and on arrival to the post anaesthetic care unit (PACU)

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INADVERTENT PERIOPERATIVE HYPOTHERMIA

- Infrared tympanic thermometers are a regular tool for PACU nurses' and provide a quick and easily obtained measurement that is non-invasive and a reflection of core body temperature
- Despite this, uncertainty remains on their accuracy of thermometry questions raised on their acceptable clinical use

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BACKGROUND

The ACORN standard for hypothermia states that patients' temperature should be taken, within the hour prior to transfer to the perioperative suite, on arrival to the holding bay, immediately preceding induction of anaesthesia, every 15 minutes when forced air warming is being instigated and every 30 minutes for other patients during the operative phase (Australian College of Perioperative Nurses 2020)

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INADVERTENT PERIOPERATIVE HYPOTHERMIA

ACORN also suggests that all other patients should have their temperature taken on arrival to PACU, at least every 15 minutes during their stay and prior to discharge to either stage 2 recovery or a surgical ward area (Australian College of Perioperative Nurses 2020)

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INADVERTENT PERIOPERATIVE HYPOTHERMIA

It is generally accepted that temperature be recorded with the other observations every 10 minutes in PACU

- ACORN further suggests perioperative nurses follow the National Institute for Health and Care Excellence (NICE) recommendations.(Australian College of Perioperative Nurses 2020)

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INADVERTENT PERIOPERATIVE HYPOTHERMIA

- NICE highly recommend prevention of IPH and state that a patient's temperature should be taken using a device or product that either directly measures core temperature or records a direct estimate of core temperature (National Institute for Health and Clinical Excellence 2016)
- NICE also reports that an accuracy to within $\pm 0.5^{\circ}\text{C}$ is acceptable in clinical use (National Institute for Health and Clinical Excellence 2016)

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INADVERTENT PERIOPERATIVE HYPOTHERMIA

The most common thermometer used to estimate core body temperature in the PACU is an infrared tympanic thermometer (Aykanat V, Broadbent E, & Peyton P. 2021)

- Although tympanic thermometry use is widespread, the use is subject to discussion and debate on the accuracy and reliability in the acute clinical and critical setting
- Machin et al. highlight the importance of the accurate measurement of core body temperature and acknowledges thermometry as a focal point in research in which many clinicians have distrust in the performance of some commonly used peripheral thermometers

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TEMPERATURE MONITORING

- The first important thing to understand is that there are two types of temperature readings, core and shell (Stanhope 2006)
- It is vital that patients have accurate **core body temperature** recorded when admitted to the PACU as this temperature reading provides important information to guide clinical judgement (Stanhope 2006)

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INADVERTENT PERIOPERATIVE HYPOTHERMIA

- Core temperature refers to the temperature within the contents of the skull, the thorax, and the abdomen and most notably the hypothalamus (Stanhope 2006)
- Shell temperature refers to the skin, subcutaneous tissue and the limbs and is completely expendable to ensure the core temperature is maintained (Stanhope 2006)

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**INADVERTENT PERIOPERATIVE
HYPOTHERMIA**

In a haemodynamically unstable patient or one that has experienced rapid thermal changes such as hypothermia, blood supply may be shunted away from vital organs and as a result of shunting skin, gut and rectal temperatures can be poor indicators of a patients core temperature (Stanhope 2006)

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**INADVERTENT PERIOPERATIVE
HYPOTHERMIA**

It is also important to understand that these alterations to the vascular system cause alteration to blood pressure, thus a hypothermic patient may be vasoconstricted which can elevate the BP, even in the presence of hypovolaemia (Foran & Johns 2022)

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**INADVERTENT PERIOPERATIVE
HYPOTHERMIA**

Similarly, a hyperthermic patient may be vasodilated; this can cause the BP to fall (Foran & Johns 2022)
Due to the connection between temperature and blood pressure, it is vital that normothermia be achieved prior to discharge to ensure accurate blood pressure readings (Foran & Johns 2022)

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HOW DO WE TAKE PATIENT TEMPERATURE????????????????????

Types of thermometry
Central sites for monitoring include:

- Pulmonary artery is the gold standard for core temperature monitoring

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CENTRAL SITES FOR ESTIMATION OF CORE TEMPERATURE ARE

- Oesophagus
- Nasopharynx
- Tympanic membrane
- Temporal artery

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INTERMEDIATE SITES

- Bladder
- Rectum

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PERIPHERAL

- Skin
- Oral

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DIFFICULTIES SEEN WITH ORAL

- Unconscious patients
- O2 therapy
- Mouth breathing
- NG tube

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DIFFICULTIES SEEN WITH AXILLA

Axillary temperatures correlate well to core in normothermia and febrile states however, in hypothermia vasoconstriction causes unreliable correlation to core temp readings (Stanhope 2006)

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DIFFICULTIES WITH TEMPORAL ARTERY THERMOMETRY (TAT)

- Measures the temporal artery via the skin on the forehead
- Conflicting Research
- Marathon runners were tested with both rectal & TAT measurements
- 60 collapsed runners with potential for Exertion Heat Stroke were tested
- 17 runners were hyperthermic >39.4
- When 9 of these runners had a rectal temp of >40.6 the TAT did not trend upwards accurately suggesting very poor temperature discrimination in the highest risk runners (Ronneberg, Roberts, McBean & Center 2008)

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DIFFICULTIES WITH TEMPORAL ARTERY THERMOMETRY (TAT)

Infrared thermometry of the skin over the superficial temporal artery is unreliable for measuring core body temperature, particularly in febrile subjects and patients in theatre (Mangat, Standley, Prevost, Vasconcelos & White 2010)

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DIFFICULTIES WITH TEMPORAL ARTERY THERMOMETRY (TAT)

- Very successfully used in the paediatric group
- ? issues in adults re thickness of skin & temporal artery atherosclerotic disease (Hooper & Andrews 2011)

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OLDER RESEARCH

Winslow et al. (2012) compared oral, bladder and temporal artery thermometer (TAT)
They compared TAT pre-op, bladder intra-op & bladder & TAT post-op
Bladder showed detection of 52% hypothermia intra-op, 42% post-op
TAT showed no hypothermia
Their finds suggested:
Discrepancy between oral/bladder and temporal artery
'Based on our findings and findings in previous studies, we do not recommend using temporal artery in the perioperative area' (Winslow et al. 2012, p. 165)

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RESEARCH (KIEKKAS, STEFANOPOULOS, BAKALIS, KEFALIAKOS & KARANIKOLAS 2016)

- Data were extracted from twenty method-comparison studies published between 2002-2015
- Methodological quality of selected studies was evaluated
- temperature measurements of temporal artery were compared with pulmonary artery, urinary bladder, oesophageal or nasopharyngeal ones in eight studies for the whole temperature range

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RESEARCH (KIEKKAS, STEFANOPOULOS, BAKALIS, KEFALIAKOS & KARANIKOLAS 2016)

With regard to fever and hypothermia, although specificity of temporal artery thermometers for detecting these disorders was satisfactory, their sensitivity was low
Conclusions: Existing evidence does not support that temporal artery thermometry can replace common invasive and noninvasive thermometry methods in adult patients
What temperature probe to choose?????

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NORWEGIAN RESEARCH (HAUGAN, LANGERUD, KALVØY, FRØSLIE, RIISE & KAPSTAD 2013)

New generation infra red tympanic membrane thermometry

- BraunThermoscan Pro 4000 & Genius 2 were chosen as they had the latest developed geometry and algorithms at the time of data collection (2007) to ensure tympanic not ear temperature

Findings

- Good reliability using new generation infra red tympanic thermometry (IRT)
 - Good agreement between core & IRT in ICU patients
- Tympanic membrane and its close proximity to the hypothalamus and its blood supply (the internal carotids), serves as its main advantage
- Tympanic thermometry more accurately reflects the core temperature than other noninvasive sites (Stanhope 2006)

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RECENT RESEARCH

Recent research comparing seven different commercially available thermometers (four digital infrared thermometers, one digital sublingual thermometer, one zero heat flux thermometer, and one infrared thermal imaging camera (May et al. 2021)

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RECENT RESEARCH

Their study showed that not all temperature monitoring techniques are equal, and suggested that tympanic thermometers are the most accurate commercially available system for the regular measurement of body temperature (May et al. 2021)

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RECENT RESEARCH

- Maintenance of equipment
- Ensure all staff can use the probes
 - Competencies in temperature taking
 - A good cleaning routine of the probe is essential

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COMPETENCY

It is vital that nurses are assessed as competent in the use of tympanic thermometers and ensure they are familiar with the individual manufacture guidelines when undertaking temperature assessment (Hill & Mitchell 2021; Jevon 2020)

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COMPETENCY

- Modern tympanic thermometers measure the temperature at the tympanic membrane by sensing the infrared radiation emitted by the tympanic membrane and through algorithms that convert the measurement into a temperature reading
- Infrared tympanic thermometers used in a clinical environment must comply with the International Organization for Standardisation ISO 80601-2-56:2017 14 and comply with the Therapeutic Goods (Medical Devices) Regulations 2002

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COMPETENCY

A common theme noted in the literature is the need for nurses to have completed competency in the use of different tympanic thermometers, and the need for regular calibration of these devices

Despite passing approval for clinical use and having acceptable ranges in test settings, the accuracy in measuring the tympanic temperature is dependent on the skill and technique of the clinician

Whilst there are several factors that may affect the reliability of tympanic thermometers, problems may be a result of user error

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COMPETENCY

It is vital that nurses are assessed as competent in the use of tympanic thermometers and ensure they are familiar with the individual manufacture guidelines when undertaking temperature assessment

Used incorrectly Jevon explains that the temperature difference between the tympanic membrane and the opening of the ear canal can be as much as 2.8°C

Yeoh et al. explains the importance in understanding how tympanic thermometry works and emphasizes that knowledge is required on the correct positioning and the anatomy of tympanic membrane Yeoh et al. highlight that consistently obtaining the temperature at a specific focal spot-on tympanic membrane increased accuracy and gave a reliable measurement

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COMPETENCY

Nurses should ensure that the ear canal is free from any visible debris and use a technique that involve inserting the tympanic probe at the correct angle in the ear canal to achieve accurate results

Consideration should also be given to patients who arrive in PACU in the lateral position, and the tympanic temperature should be taken from the ear that is facing up as this will reflect core temperature

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COMPETENCY

Niven et al. conducted a meta-analysis and systematic review on the accuracy of thermometers for estimating temperature
In their study they explored 75 studies (n=8682) in which 52 studies were relevant to tympanic thermometers and concluded that peripheral thermometers including tympanic thermometers, temporal artery thermometers and oral thermometers did not have a clinically acceptable limit of agreement (LOA) when compared to pulmonary artery catheter temperature measurement

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COMPETENCY

- However, Niven et al. did acknowledge an improvement on limit of agreement between pulmonary artery temperature and tympanic measurement when the tympanic thermometers had been **calibrated before use** with a pooled mean difference of -0.01 (-0.49°C to 0.47°C at 95% LOA) compared to -0.24 (-1.61°C to 1.13°C at 95% LOA) in the non-calibrated group
- As a result of this information, Niven et al. recommend that when a central invasive thermometer is impractical then a tympanic thermometer that has been calibrated was the best alternative in both adult and paediatric patients for accurate temperature readings
- Niven et al. also reported a +0.5 degree correlation at 95% for calibrated tympanic thermometers, placing them within the NICE guidelines of accuracy to within +0.5°C as being acceptable in clinical use

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RECOMMENDATIONS FOR PERIOPERATIVE NURSES

Literature presented does not make a definitive recommendation on peripheral thermometers in providing core temperature, however, fail in suggesting alternative body temperature measurement strategies that are non-invasive for the PACU patient (Halford & Foran 2022)

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RECOMMENDATIONS FOR PERIOPERATIVE NURSES

It does appear that when calibrated and used correctly by competent users' tympanic thermometers are more reliable than temporal artery thermometers, axillary thermometers, and oral thermometers in providing a best core temperature estimate (Halford & Foran 2022)

It is therefore vital all tympanic membrane thermometers are regularly calibrated and that PACU nurses are trained and have had their competency assessed in the use of the type of tympanic membrane thermometer used in their PACU (Halford & Foran 2022)

Several studies do suggest that the newer generation of tympanic thermometers have a place in clinical practice due to their ease of use and ability to provide core estimate and are recommended when invasive measurement is contraindicated (Halford & Foran 2022)

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RECOMMENDATIONS FOR PERIOPERATIVE NURSES

• Tympanic temperature measurement will continue to aid the PACU nurse in obtaining a noninvasive core temperature measurement that is practical, cost effective and minimally disruptive to patients' dignity (Halford & Foran 2022)

• The accuracy of tympanic thermometers is still a focal point of research and there are minimal studies that measure the effectiveness of tympanic and other peripheral thermometers specific to the PACU environment highlighting a need for more research in perioperative practice (Halford & Foran 2022)

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Discussion

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