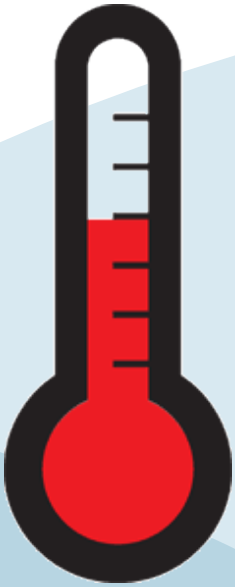
ACI NSW Agency for Clinical Innovation

ICCMU Intensive Care Coordination & Monitoring Unit

IC Manual
best practice guidelines for intensive care

Temperature Measurement for Critically Ill Adults

A Clinical Practice Guideline



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Disclaimer

- This clinical practice guideline (CPG) is aimed at providing clinicians working in NSW hospital intensive care units (ICU) with recommendations to frame the development of policies and procedures related to the measurement of temperature of critically ill adult patients in acute care facilities.
- This CPG includes: 1) an update of the evidence base; 2) an evaluation of how this literature applies to the NSW intensive care context; 3) the extensive clinical knowledge of the guideline development network members (GDN); 4) and a consensus development process.
- The CPG is not intended to replace the critical evaluation processes that underpin the development of local policy and procedure nor does it replace a clinician's judgement in an individual case.
- Users of this CPG must critically evaluate this CPG as it relates to local circumstances and any changes in the literature that may have occurred since the dates of the literature review conducted. In addition, NSW Health clinicians must review NSW State Government policy documents to identify any directives that may relate to this clinical practice.
- These guidelines are intended for use in NSW acute care facilities.
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Suggested citation

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FOREWORD

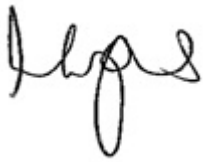
Temperature measurement has come a long way since Carl Reinhold August Wunderlich first described the serious consequences of abnormal temperatures and introduced temperature charts into hospitals in Germany.

Accurate measurement of a critically ill patient's temperature is important to ensure they receive appropriate and timely interventions.

The purpose of this guideline is to provide intensive care clinicians with guidance to ensure that patients' temperatures are measured accurately.

Developed under the auspices of the Intensive Care Best Practice Manual Project, this guideline highlights the ability of the Agency for Clinical Innovation (ACI) to facilitate strong working relationships with clinicians as well other executive branches of the Ministry.

On behalf of the ACI, I would like to thank Susan Pearce, Chief Nursing and Midwifery Officer for providing state executive sponsorship for the project and funds for the Project Officer. I would also like to extend my appreciation to the LHD executives for facilitating the participation of LHD staff in developing these guidelines, which I commend to you the clinicians of NSW.



Dr Nigel Lyons
Chief Executive, Agency for Clinical Innovation

ABOUT THE ACI

The Agency for Clinical Innovation (ACI) works with clinicians, consumers and managers to design and promote better healthcare for NSW. It does this by:

- Service redesign and evaluation – applying redesign methodology to assist healthcare providers and consumers to review and improve the quality, effectiveness and efficiency of services.
- Specialist advice on healthcare innovation – advising on the development, evaluation and adoption of healthcare innovations from optimal use through to disinvestment.
- Initiatives including Guidelines and Models of Care – developing a range of evidence-based healthcare improvement initiatives to benefit the NSW health system.
- Implementation support – working with ACI Networks, consumers and healthcare providers to assist delivery of healthcare innovations into practice across metropolitan and rural NSW.
- Knowledge sharing – partnering with healthcare providers to support collaboration, learning capability and knowledge sharing on healthcare innovation and improvement.
- Continuous capability building – working with healthcare providers to build capability in redesign, project management and change management through the Centre for Healthcare Redesign.

ACI Clinical Networks, Taskforces and Institutes provide a unique forum for people to collaborate across clinical specialties and regional and service boundaries to develop successful healthcare innovations.

A priority for the ACI is identifying unwarranted variation in clinical practice and working in partnership with healthcare providers to develop mechanisms to improve clinical practice and patient care.

Guideline development network members

GUIDELINE GROUP	ROLE	ORGANISATION	HOSPITAL
Kaye Rolls	Chair, critical care specialist nurse guideline development expert	ACI ICCMU	
Deirdre Wrightson	Critical Care Specialist Nurse	SES LHD	Wollongong ICU
Karyn Armstrong	Critical Care Specialist Nurse	SSW LHD	Bankstown
Lawrence Keating	Critical Care Specialist Nurse	SES LHD	St George ICU
Suzanne Schacht	Critical Care Specialist Nurse	SES LHD	
Sally Irwin	Critical Care Specialist Nurse	NC LHD	Port Macquarie
Dr Sandra Walker	Nurse academic	Central Queensland University	

All GDN members completed a 'declaration of interest' form based on NHMRC guidelines.
The guideline development network members declared no conflicts of interest..

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1. EXECUTIVE SUMMARY

Abnormal temperature can pose risks for or herald the onset of serious complications for critically ill adults. For this reason, accurate measurement of temperature is important to ensure patients receive appropriate and timely interventions to prevent significant morbidity and mortality. The clinical question underpinning this guideline is "What method(s) of measuring body temperature ensure(s) the timely identification of abnormal temperatures in critically ill adults?" This guideline is provided to guide the development of local practices to support the accurate and timely measurement of temperature in critically ill adults.

Specific guidance is required because surface temperature methods [1, 2] are still used despite long-standing evidence regarding their inaccuracy [3-6].

Decisions regarding temperature measurement and interventions should be guided by how important a patient's temperature is within the full scope of diagnosis, treatment and potential complications. More invasive and continuous methods should be utilised where identification of an accurate temperature is time-critical and significant to patient outcomes.

SECTION	RECOMMENDATION	GOR
1.	Critically ill unstable patients (see Table 2) require continuous invasive temperature (using brain, intra-vascular or urinary bladder) monitoring that is recorded at least hourly.	B (7-12)
2.	Complex patients (see Table 2) require invasive temperature (using brain, intra-vascular or urinary bladder) measurement that is recorded at least second hourly.	B (7-12)
3.	For routine monitoring of stable patients (see Table 2) measurement of temperature, using either oral or axillary methods, is required at least four-hourly.	C (3, 13, 14)
4.	Tympanic or temporal artery temperature measurement methods should not be used, as these methods do not accurately reflect core body temperature.	B (4-6, 10, 15, 16)
5.	Clinicians should undertake a risk assessment to identity the risk of contamination and mucosal or conjunctival splash injuries when taking a patient's temperature; and PPE (including goggles/face shield/gloves and gown/apron) as per NSW 2007 infection prevention control policy should be worn accordingly.	National and NSW Policy
6.	Clinicians must adhere to the five moments of hand hygiene.	Hand hygiene policy
7.	To reduce the risk of microbial transmission, ICUs should consider having either an electronic thermometer at each bed area, or disposable single-use thermometers.	Consensus
8.	To reduce the risk of microbial transmission where patients are considered stable but are isolated, ICUs might consider the use of disposable single-use thermometers.	Consensus
9.	Electronic thermometers must be cleaned between patients. This includes where equipment is shared between bed areas and when a patient is discharged.	Consensus
10.	Clinicians should refer to state or local IDUC management guidelines to minimise CAUTI.	Consensus

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SECTION	RECOMMENDATION	GOR
11.	To facilitate rapid detection and treatment of abnormal temperatures, ICUs should consider developing standard definitions and interventions for hyperthermia and hypothermia.	Consensus
12.	Fever control including administration of anti-pyretics should not be commenced without consultation with senior Medical Officers.	Consensus (17, 18)
13.	Staff should receive education on: • correct use and calibration of equipment • local definitions and standard treatments for abnormal temperatures.	Consensus
14.	Education related to temperature measurement should be included in patient assessment practices.	Consensus
15.	Evaluation of adherence to this guideline should be incorporated into the audit of clinical practices related to patient assessment.	Consensus

2. INTRODUCTION

Health question/s at focus of clinical practice

Temperatures outside normal homeostatic ranges may pose risks for or herald the onset of significant complications in critically ill patients. Accurate measurement of temperature is important to ensure patients receive appropriate and timely interventions. The clinical question underpinning this guideline is "What method(s) of measuring body temperature ensure(s) the timely identification of abnormal temperatures in critically ill adults?"

Scope

This guideline is provided so that acute care facilities can develop local practices to support the accurate measurement of temperature in critically ill adults (individuals aged older than 14). It does not include recommendations regarding when to undertake a blood cultures or a septic work up. It does not include practices concerning therapeutic thermoregulation, except advice regarding temperature measurement.

Target clinicians

This guideline is aimed at clinicians who care for critically ill adults across acute care hospitals in NSW. Specifically it refers to nursing staff as this clinical practice falls within their scope of practice. Medical Officers were consulted and included during consensus development.

How the guideline was developed

Guideline development methods were based on Rolls and Elliott [19] which was revised to reflect updates from NHMRC [20] and the AGREE tool (21). A guideline development network (GDN) was formed. This network developed the guideline template that outlined the clinical question and specific areas to be addressed within the guideline. Following this, a systematic review was undertaken (for more details see below). The practice review was restricted to a review of local practices from the experience of GDN members. No ICUs had specific practices related to temperature measurement. A technical report was developed from the systematic review and this document was used to inform discussions and recommendation development at the consensus meeting (November 27, 2012). NHMRC evidence statement forms were created and formed our evidence audit trail. Following the meeting, the guideline document was written and circulated among group members. Consensus development and organisational consultation was undertaken over three stages:

1. Guideline group consensus – two intensive care doctors were recruited. This larger guideline group received the guideline and technical report. Agreement on recommendations was undertaken using an online survey (Survey Monkey) and a 1-9 Likert scale. Consensus was set as a median of ≥ 7 (see Table 4).
2. External validation consensus – another clinician group was recruited from NSW and their agreement with the recommendation statements was sought using the processes outlined above (see Table 4).
3. Organisational consultation was undertaken by distribution via ACI critical care networks. No additional feedback was forwarded The guideline was revised to reflect feedback received at each stage of the process.

Guideline group

The guideline development network (GDN) was comprised of senior nurses working in NSW intensive care units (ICU) as well as a nursing academic (see author list). This group undertook the bulk of work for the guideline.

Evidence review

A systematic literature review was undertaken using the following clinical question: "What method(s) of temperature measurement accurately identifies body

temperature in critically ill adults?" An electronic search of the main health databases was undertaken using the MeSH terms or keywords that mapped to temperature and critical illness. Limits included: 1) 2000-May 2012; 2) English language; 3) older than 14; 4) human studies; 5) peer-reviewed; and 6) abstract available. Thirty-one papers were reviewed by two guideline group members using a standardised data extraction tool with quality assessment.

The systematic review revealed that the evidence base for temperature measurement in critically ill adults is limited by the research methods used and comparison between thermometry methods. Twenty four papers, including 17 Level III-2 studies (observational with repeated measures), four systematic reviews and three guidelines, were used in the final review. Only nine studies had a low risk of bias (see Appendix 1 and Appendix 2). The most common problems with the quality of the studies were failure to ensure high inter-rater reliability, adequate sample size, appropriate procedures and application of Bland-Altman analysis.

Level of evidence taxonomy

NHMRC procedures and taxonomy were used. Where research evidence could not be identified, participant expert opinion was used with agreement methods applied.

Table 1. NHMRC grading of recommendations

GRADE OF RECOMMENDATION	DESCRIPTION
A	Body of evidence can be trusted to guide evidence
B	Body of evidence can be trusted to guide practice in most situations
C	Body of evidence provides some support for recommendation/s but care should be taken in its application
D	Body of evidence is weak and recommendation must be applied with caution
Consensus	Consensus was set as a median of ≥ 7

Glossary

BMI ..... Body mass index

BSA ..... Body surface area

CAUTI..... Catheter associated urinary tract infection

DC..... Data collector

Dx..... Diagnosis

GDN ..... Guideline development network

ICU ..... Intensive care units

IDUC ..... Indwelling urinary catheter

IRR..... Inter-rater reliability

NICCT..... Non-invasive continuous cerebral temperature

NiPPV ..... Non-invasive positive pressure ventilation

PAC ..... Pulmonary artery catheter

PiCCO ..... Pulse contour cardiac output

Sx ..... Surgery

T^0-A..... Axillary temperature

T^0-Br ..... Direct bBrain temperature

T^0-F..... Forehead temperature

T^0-I ..... Inguinal temperature

T^0-O..... Oral temperature

T^0-Oesp ..... Oesophageal temperature

T^0-PA ..... Pulmonary artery temperature

T^0-R ..... Rectal temperature

T^0-T..... Tympanic Temperature

T^0-TA ..... Temporal artery temperature

T^0-UB..... Urinary bladder temperature

TED..... Thromboembolic device

Thermometry..... The branch of physics concerned with the measurement of temperature and the design and use of thermometers.

3. WHY IS ACCURATE TEMPERATURE MEASUREMENT IMPORTANT IN CRITICALLY ILL ADULTS?

Temperature measurement is a vital sign with a long history, and altered thermoregulation is common in critically ill patients[22]. Historically much of the focus has been on fever and treatment of infection however recent research has turned to hypothermia, both as a negative consequence of disease or as a treatment modality.

Thermoregulation

Core body temperature is defined as the temperature of blood at the hypothalamus or within the core structures of the body. The hypothalamus regulates body temperature by negative feedback mechanisms to: 1) vasodilate skin vessels in response to temperatures greater than 37°C; or 2) stimulate shivering in response to hypothermia. Other factors which may affect thermoregulation include diurnal variation, cellular metabolism, exercise, ambient temperature and age[23]. Maintenance of temperature within physiological boundaries ensures optimal conditions for enzyme activity and chemical reactions [24].

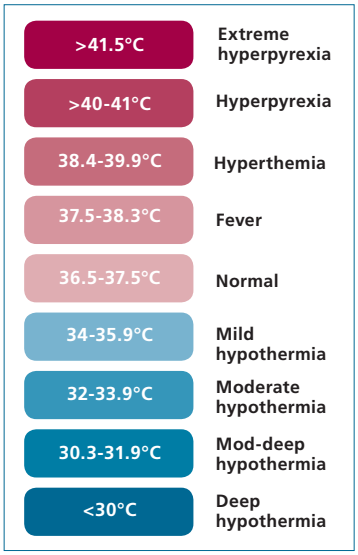
Fever

Current epidemiological evidence suggests that fever holds different risks depending on a patient's diagnosis. Where patients have an infection the in-hospital risk of death progressively decreases as temperature rises even when temperatures exceed 39°C[17]. However hyperthermia has been associated with poorer outcomes in patients with traumatic brain injury [25] and intensive care patients who do not have infections[17] or neurological issues[26]. Extreme hyperpyrexia (T ≥ 41.5°C) represents an emergency that should be treated quickly to avoid organ failure[22]. A key problem in understanding the relationship is that studies do not use a universal definition of fever[26].

Hypothermia

Negative effects of hypothermia include immunosuppression, electrolyte disorders, insulin resistance, arrhythmias, cold diuresis, hypovolaemia and coagulation [22, 27]. Hypothermia has been associated with poorer outcomes in all intensive care patients [17], those with traumatic brain injury [25], post-operative intensive care patients [28] and elderly patients with sepsis [29]. Clinicians should endeavour to prevent hypothermia developing as a consequence of exposure or massive blood or fluid resuscitation. Patients should not be warmed faster than 0.5°C per hour to avoid localised temperature differences (cerebral thermopooling), cerebral hypoxia and impaired cerebrovascular reactivity [22].

Figure 1 Defining temperature ranges[22]



Therapeutic hypothermia (maintaining core temperature between 32-34°C) treatment in intensive care has been shown to improve outcomes for patients following cardiac arrest due to ventricular tachycardia or ventricular fibrillation [30] but not for traumatic brain injury [31].

Temperature measurement practices

Accurate identification of body temperature is essential if clinicians are to intervene quickly to prevent the potential negative consequences of abnormal temperatures. However despite long-standing evidence regarding the inaccuracy of surface temperature methods 3-6 they continue to be used in intensive care [1, 2]. Additionally, body temperature is an integral component of risk predictor scores for intensive care patients[32] and is used as a diagnostic component for sepsis, systemic inflammatory response syndrome and ventilated associated pneumonia[33]. For these reasons guidance regarding temperature measurement is required to ensure the timely and accurate identification of body temperature in critically ill adults.

4. RECOMMENDATIONS FOR PRACTICE

SECTION	RECOMMENDATION	GOR
1.	Critically ill unstable patients (see Table2) require continuous invasive temperature (using brain, intra-vascular or urinary bladder) monitoring that is recorded at least hourly.	B [7-12]
2.	Complex patients (see Table 2) require invasive temperature (using brain, intra-vascular or urinary bladder) measurement that is recorded at least second hourly.	B [7-12]
3.	For routine monitoring of stable patients (see Table 2) measurement of temperature, using either oral or axillary methods, is required at least four-hourly.	C [3, 13, 14]
4.	Tympanic or temporal artery temperature measurement methods should not be used, as these methods do not accurately reflect core body temperature.	B [4-6, 10, 15, 16]

The systematic review revealed that the evidence base for temperature measurement in critically ill adults is limited by the quality of studies. When examining the accuracy of different methods of temperature measurement, researchers have generally sought to identify which methods were equivalent; that is within a clinically acceptable range of ±0.3C°, to core temperature or a surrogate, such as pulmonary artery or urinary bladder. The evidence base shows that (in order of volume and quality) urinary bladder and oesophageal thermometry are equivalent to intra-vascular or direct brain thermometry. All available studies were level III.2 and had a range of bias; the weight of evidence supports urinary bladder temperature over oesophageal temperature. Rectal thermometry was found to not be equivalent to core temperature [7, 34].

Non-invasive or surface thermometries (including axilla, oral, tympanic and temporal artery methods) have been evaluated across a variety of critical care settings. All available studies were level III.3 and outcomes were variable according to temperature measurement method. Axillary and oral methods had mixed results however a recent systematic review [13] found them to be within clinically acceptable ranges. By contrast, researchers consistently found that tympanic and temporal artery methods were not equivalent to core body temperature (including direct brain, intravascular or urinary bladder).

This means these methods are probably unreliable, unsafe and should not be used, even for stable patients. Operator error is a significant problem impacting on accuracy of tympanic temperature method. It should be noted:

- that the more a patient's temperature deviates from normal the greater the discrepancy across all surface methods
- there is no reliable method of adjusting one body temperature measurement for another [23]
- there were few studies where the sample included adequate numbers of patients with abnormal temperatures.

Table 2: Definitions for patient groups

	CRITICALLY ILL AND UNSTABLE	COMPLEX	STABLE
Descriptor	Patients with significant haemodynamic, respiratory, thermoregulatory or neurological instability.	Patients whose condition is stable, however have potential for complication or deterioration.	Patients who do not require intense or invasive physiological monitoring.
Patient groups – examples only	• Multiple organ dysfunction • Multi trauma • Traumatic brain injury [35] • Severe sepsis • Burns	• Post-op cardiothoracic surgery • Major surgery[28] • Ventilated patients • Acute stroke[36] • Sepsis	• Routine post op • DKA • Cleared for discharge
Treatment – examples only	• Therapeutic thermoregulation[12] • Massive blood transfusion [37] • Rapid fluid resuscitation	• Blood product transfusion • Invasively ventilated	• NiPPV
PLEASE NOTE THIS TABLE IS PROVIDED AS A GUIDE ONLY. UNITS SHOULD DECIDE HOW THESE DEFINITIONS RELATE TO THEIR PATIENT POPULATION			

What clinicians should consider before choosing a method of temperature measurement

When selecting the most appropriate method of temperature measurement clinicians need to decide how important a patient's temperature is within the full scope of diagnosis, treatment and potential complications. More invasive and continuous methods should be utilised where identification of accurate temperature is time-critical and significantly important to patient outcomes. This was the guiding principle when developing the categories in Table 2 that outlines patients and interventions. However, this table should not be seen as exhaustive. Clinicians should consider using monitoring devices already in situ when choosing an invasive method. For most patients the default method would be urinary bladder temperature measurement because:

- urine measurement is required by most, if not all adults in critical care units, even routine post-operative or simple cardiac patients
- IDUC remain in situ after many other monitoring devices have been removed
- there are a number of potential problems impacting on the correct placement of rectal and oesophageal probes
- the use of pulmonary artery catheters is becoming less common in intensive care.

Refer to Table 3 Clinical considerations when choosing temperature measurement method.

Table 3: Clinical considerations when choosing temperature measurement method

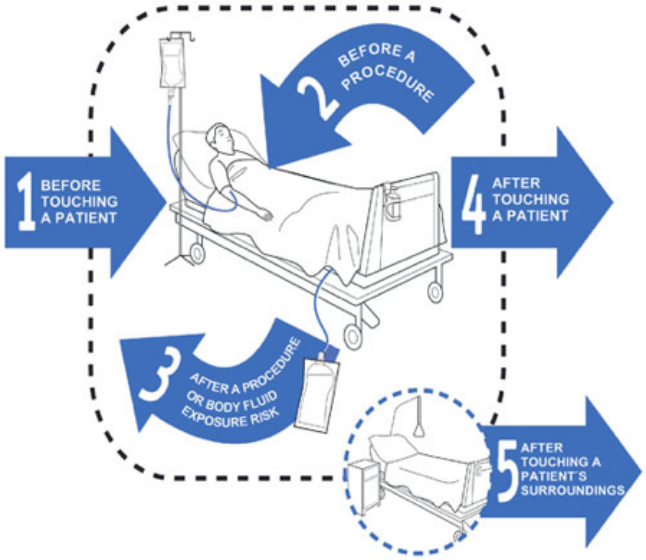
	METHOD	CLINICAL CONSIDERATIONS	CLINICAL CONSIDERATIONS POTENTIAL PROBLEMS
NON-INVASIVE > HIGHLY INVASIVE	Brain	Probe should be in non-injured tissue	• Highly invasive, reading may be influenced by injury/ischaemia
	Direct blood PAC; PiCCO	Requires aseptic insertion and should be removed when there is no longer an indication	• Blood stream infection
	Urinary catheter	Requires aseptic insertion and should be removed when there is no longer an indication for urine measurement	• May be effected by urine output (the effects of oliguria on accuracy are unknown [9]) • Inaccurate with severe hypothermia
	Oesophageal	Probe needs to be located within distal third of oesophagus (confirmed by CXRay to be within cardiac shadow) [38]	• Can take significant time to insert [38] • Training to ensure accurate / placement [38, 39] • Fluids passing through enteral tubes may alter the temperature (no research evidence was located)
	Rectal	Tip should be 4cm inside rectum [23]	• Presence of hard faeces impairing placement, inflammation around rectum and heat producing microorganisms in faeces • Inappropriate for patients with rapid temperature flux [40]
	Oral	Must be placed in posterior sublingual pocket (perfused by branch of external carotid) [23]	• Oral or mouth breathing, administration of oxygen or warmed gases via an ETT do not effect accuracy [16]
	Axillary	Placement in central position with arm adducted to the chest wall [16]	• May be significantly affected by ambient temperature, local blood flow, sweat, inappropriate placement of probe, correct timing [23]

Infection prevention

SECTION	RECOMMENDATION	GOR
5.	Electronic thermometers must be cleaned between patients. This includes where equipment is shared between bed areas and when a patient is discharged.	Consensus
6.	Clinicians should refer to state or local IDUC management guidelines to minimise CAUTI.	Consensus
7.	To facilitate rapid detection and treatment of abnormal temperatures ICUs should consider developing standard definitions and interventions for hyperthermia and hypothermia.	Consensus
8.	Fever control including administration of anti-pyretics should not be commenced without consultation with senior Medical Officers.	Consensus [17, 18]
9.	Staff should receive education on: • correct use and calibration of equipment • local definitions and standard treatments for abnormal temperatures.	Consensus
10.	Education related to temperature measurement should be included in patient assessment practices.	Consensus

Hand hygiene

The NSW Health Hand Hygiene Policy (PD2010_058) states that all staff must perform hand hygiene as per the Five Moments for Hand Hygiene (http://www.hha.org.au/); Hand hygiene must occur before touching the patient; prior to a procedure; after a procedure or body fluid exposure risk; after touching a patient; after touching a patient's surroundings. Hand hygiene can be performed using appropriate soap solutions and water or alcohol-based hand rub (ABHR). Soap and water must be used when hands are visibly soiled.



NSW Ministry of Health policies

Prevention of infection is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering infection control. Local policy must also be consulted.

1. Infection Control Policy - http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_036.html
2. Infection Control Policy: prevention & management of multi-resistant organisms (MRO) http://www0.health.nsw.gov.au/policies/pd/2007/PD2007_084.html
3. Hand Hygiene Policy http://www0.health.nsw.gov.au/policies/pd/2010/pdf/PD2010_058.pdf
4. Australian Guidelines for the Prevention and Control of Infection in Health Care http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/cd33_complete.pdf

Personal protective equipment

The Australian Guidelines for the Prevention and Control of Infection in Health Care and the NSW Infection Control Policy (PD2007_036) state that all procedures that generate or have the potential to generate secretions or excretions require that either a face shield or a mask with protective goggles be worn.

Workplace health and safety

Prevention of work injury is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering work health and safety. Local policy must also be consulted.

- NSW Work Health and Safety Act 2011 http://www.legislation.nsw.gov.au/maintop/view/inforce/act+10+2011+cd+0+N

The NSW Work Health and Safety Act 2011 states that organisations must eliminate the health and safety risks to workers where at all possible. When it is not possible to eliminate risks, the risk must be minimised as far as reasonably practicable. Organisations must provide appropriate PPE for use by staff. Staff have a responsibility to use that PPE according to policy.

The worker has an obligation under the NSW Work Health and Safety Act 2011 to;

i) take all reasonable care for their own safety

ii) take care that their acts or omissions do not adversely affect the health and safety of other persons

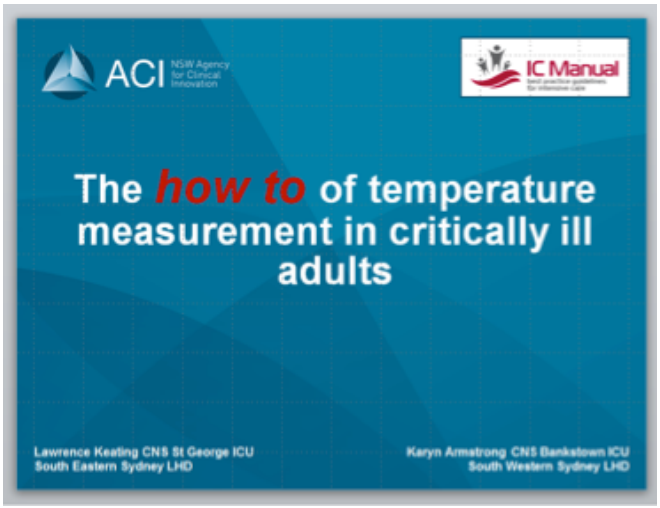
iii) comply with any reasonable instruction they are given.

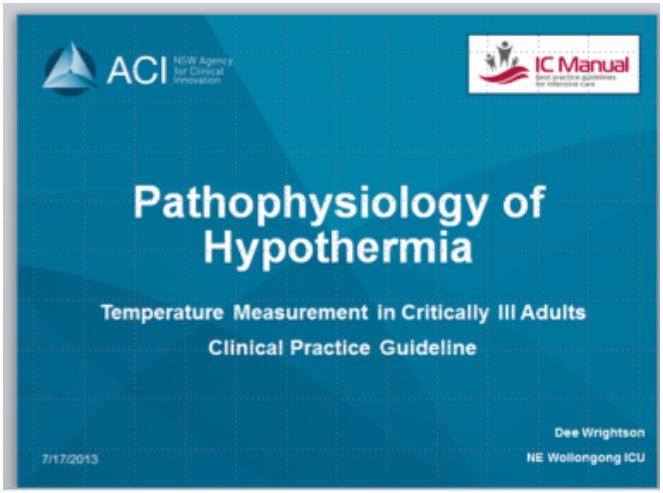
Governance and education

The effect of abnormal body temperatures on patient outcomes differs depending on patient diagnosis. A recent meta-analysis [18] found that the administration of anti-pyretics did not reduce mortality in febrile critically ill patients. Moreover there is epidemiological evidence to suggest that fever may be protective in critically ill patients with infections [17]. Current studies, however, have not used consistent definitions for fever and were not powered to show other clinically significant outcomes [26].

SECTION	RECOMMENDATION	GOR
11.	Evaluation of adherence to this guideline should be incorporated into the audit of clinical practices related to patient assessment.	Consensus
12.	Fever control including administration of anti-pyretics should not be commenced without consultation with senior Medical Officers.	Consensus [17, 18]
13.	Staff should receive education on: • correct use and calibration of equipment • local definitions and standard treatments for abnormal temperatures.	Consensus
14.	Education related to temperature measurement should be included in patient assessment practices.	Consensus
15.	Evaluation of adherence to this guideline should be incorporated into the audit of clinical practices related to patient assessment.	Consensus

5. IMPLEMENTATION TOOLS





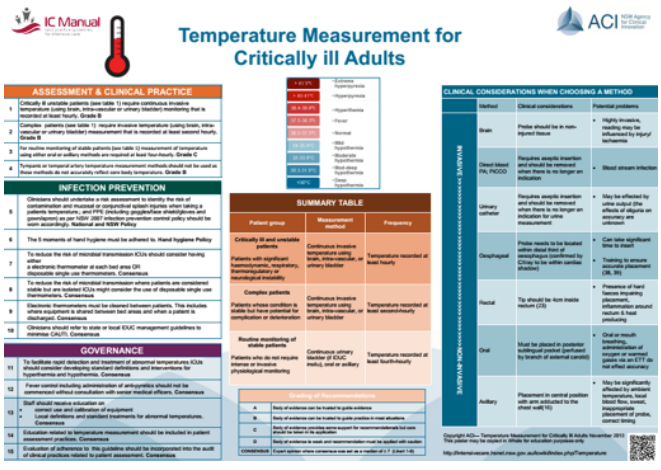
Temperature assessment is an integral component of patient assessment, and compliance with this guideline should be incorporated into evaluation of patient assessment practices.

Education tools

Three vodcasts are available via the ACI Vimeo channel. These are:

1. The how to of temperature measurement in critically ill adults
2. Pathophysiology of Hypothermia
3. Pathophysiology of Fever

The full guideline and links to the implementation tools can be found at the ICCMU website under: Intensive Care Best Practice Manual.



This A3 poster has been formatted to print as an A4 handout.

www.aci.health.nsw.gov.au/networks/intensive-care

6. GUIDELINE DEVELOPMENT HISTORY

1. April 2012 – CPG topic identified; GDN executive formed; guideline scope and systematic review formulated
2. May 2012 – Team building; finalisation of guideline scope and CPG workplan; evidence-based practice education; team plan
3. May-September 2012 – Systematic review work undertaken culminating in development of technical report
4. November 27, 2012 – Consensus development meeting – recommendation development
5. December 2012-February 2012 – Guideline writing
6. March-April 2013 – Internal consensus – all recommendations achieve consensus (see Table 5)
   - Changes – recommendation 12 – change to senior Medical Officer
7. May 2013 – External validation (see Table 5)
8. August 2013 – Organisation consultation via ACI networks

Table 4: External validation participants

EXTERNAL CONSENSUS	ROLE	ORGANISATION	HOSPITAL
Carolyn Zimbiti	CNC	ICU	Western NSW LHD
Sherri-leigh Bayliss	CNC	ICU	Southern NSW LHD
Kay Johnson SVH	CNS	ICU	SVH
Chiho Otani	CNS	ICU	SVH
Karina Griffiths	CNS	ICU	RPA
Ramanathan Lakshmanan	Director (Acting)	ICU	Blacktown
Kathy Dempsey	Infection Prevention	CNC	Westmead

Table 5: Consensus results

	RECOMMENDATION NUMBER							
Median (IQR)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Internal consensus	9 (8.5-9)	9 (6.5-9)	9 (7-9)	9 (9)	9 (9)	9 (9)	9 (9)	9 (7.5-9)
External consensus	8 (7-9)	8 (8-9)	8 (7-8)	8 (8-9)	8 (8-9)	8 (7-9)	7 (7-9)	9 (8-9)

Median (IQR)	**9**	**10**	**11**	**12**	**13**	**14**	**15**	
Internal consensus	9 (9-9)	9 (8.75-9)	9 (8.75-9)	9 (7.75-9)	9 (9)	9 (9)	9 (8.5-9)	
External consensus	8 (8-9)	8 (8-9)	8 (7-9)	8 (8-9)	8 (7-9)	8 (7-9)	8 (7-8)	

7. APPENDICES

Appendix 1: Evidence table – studies sorted by invasive comparison

STUDY	CORE	COMPARISON	OUTCOME	FINDINGS	LOE	RISK OF BIAS
Hooper [3] SR		T° O T° T T° TA		• Oral temperature = core • Tympanic ≠ core • Temporal artery ≠ core	III.2	Moderate
Fallis [8] SR		T° - UB	T° UB =core	• In normothermic and hyperthermic patients –T° UB and T° PA correlate (0.78-0.99) • Question regarding the effect of urine flow on T° UB	III.2	Moderate
Zeiner [41]	NICCT	Multiple	NICCT = T° Oesp ; T° PA & T° UB NICCT ≠ T°T	Data shows a high correlation between T° Oesp and NICCT, T° PA and T° UB but not T° T	III.2	Low
Kirk [42] General ICU all intubated	T° Br	T° A	T° A ≠ T° Br	0.58 °C (95% CI 0.31 °C to 0.85 °C, P < 0.0001)	III.2	Moderate
Childs [34] Head injuries	T° Br	T° R	T° R ≠ T° Br	The brain-rectal temperature difference is inconsistent and unpredictable.	III.2	Low
Kirk [42] General ICU all intubated	T° Br	T° T	T° T ≠ T° Br	-0.8 to 2.5 (mean 0.9)	III.2	Moderate
Kirk [42] General ICU all intubated	T° Br	T° TA	T° TA ≠ T° Br	-0.7 °C to 1.5 °C (mean 0.3 °C)	III.2	Moderate
Haugk [43]	T°Oesp	T° cuff	T° cuff = T°Oesp	Mean bias -0.22 (-0.17 to -0.27)	III.2	Low
Kimberger [43] Perioperative/ ICU	T°Oesp	T° F	T° F = T°Oesp	• Bias -0.08 (-0.66 – 0.5C) • T° F Fever • Sensitivity – 0.86 (95%CI 0.69-1.00) • Specificity – 0.97 (95%CI 0.92-1.00 • T° F Hypothermia • Sensitivity 0.77 (95%CI 0.54-.99) • Specificity – 0.93 (95%CI 0.7-0.99) • Novel hem. lized sensor • Only small number of patients T≠normal	III.2	Moderate

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STUDY	CORE	COMPARISON	OUTCOME	FINDINGS	LOE	RISK OF BIAS
Lefrant [7] General ICU – 93% ventilated	T° PA	T° I	T° I ≠ T°- PA	0.17 ± 0.4	III.2	High
Lefrant [7] General ICU – 93% ventilated	T° PA	T° A	T° A ≠ T°- PA	0.27 ±0.45	III.2	High
Farnell [6] General ICU	T° PA	T° A	T° A ≠ T°- PA	• T°- PA – T° A • Mean 0.2 (p<0.0001, SD 0.34) • 95%CI -1.3 to +0.9 • BA -0.5 to +0.9 • Delay in treatment – 15.3% T° A • Unnecessary interventions – 28.8% T° A	III.2	Moderate
Lawson [16] General ICU	T° PA	T° A	T° A ≠ T°- PA	Mean diff (SD) 0.2 (0.4) (95% CI-0.64-1.12)	III.2	Moderate
				% outside ±0.5°C – 27% [49]		
Smith [45] Day 1 post op cardiac Sx	T° PA	T° A DataTherm	T° A ≠ T°- PA	0.72 (0.30); –0.82, –0.62 R2 0.882-0.857 p<0.001	III.2	Moderate
Smith [45] Day 1 post op cardiac Sx	T° PA	T° A SolarTherm	T° A ≠ T°- PA	0.46 (0.16); –0.51, –0.40 R2 0.815 p<0.001		Moderate
Moran [10] General ICU – 78% ventilated	T° PA	T° A	T° A ≠ T°- PA	0.295 (0.367); -0.424, 1.014	III.2	Moderate
Jeffries [13] Only studies with febrile patients	T° PA	T° A T° O	T° A & T° O = core	Studies suggest tympanic and oral thermometers provide on average accurate core temperature measurements.	III.2	Moderate
Haugk [43]	T° PA	T° cuff	T° cuff = T° PA	Mean bias -0.16 (-0.13 to -0.20)	III.2	Low
Smith [45] Day 1 post op cardiac Sx	T° PA	T° O SolarTherm	T° O ≠T° PA	0.62 (0.34); –0.73, –0.50 R2 0.813 p<0.001	III.2	Moderate
Lawson [16] General ICU	T° PA	T° O	T° O ≠ T° PA	Mean diff (SD) 0.1(0.3) (95% CI -0.75-0.93) % outside ±0.5°C – 19% (n=34)	III.2	Moderate
Guilano [5] General ICU	T° PA	T° O (SureTemp)	T° O ≠ T° PA	• Mean 0.04±0.50 (range -1.56 – 1.17) • 23% (47) data points outside tolerance. Mean diff 0.18C • Febrile 0.47; afebrile 0.50	III.2	Moderate

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STUDY	CORE	COMPARISON	OUTCOME	FINDINGS	LOE	RISK OF BIAS
Lefrant [7] General ICU – 93% ventilated	T° PA	T°Oesp	T°Oesp = T° PA	0.11±0.30	III.2	High
Lefrant [7] General ICU – 93% ventilated	T° PA	T° R	T° PA ≠ T°-R	-0.07 ±0.40	III.2	High
Guilano [5] General ICU	T° PA	T° T First Temp Genius II	T° - T ≠T° PA	• (First Temp) error • 0.00±0.67 • 37% (75) data points outside tolerance • underestimated • NB failed calibration 7/12	III.2	Moderate
Farnell [6] General ICU	T° PA	T° T	T° - T ≠T° PA	• T°- PA – T° - T • Mean 0.0 (p=0.39; SD 0.59) • 95%CI -2.3 to +1 • BA -1.2 to +1.2 • Delay in treatment – 21.1% T° T • Unnecessary interventions – 37.8% T° T	III.2	Moderate
Lawson [16] General ICU	T° PA	T° T	T° T ≠T° PA	• Mean diff (SD) -0.3(0.7) (95% CI -1.46-0.88) • % outside ±0.5°C – 49% (n=88)	III.2	Moderate
Moran [10] General ICU – 78% ventilated	T° PA	T° T	T° T ≠T° PA	0.358(0.469); -.0560, 1.276	III.2	Moderate
Guiliano [5] General ICU	T° PA	T° T Thermoscan	T° - T ≠T° PA	-0.14 ±0.64 -0.14 ±0.64 (range -2.33 – 1.72	III.2	Moderate
Lawson [16] General ICU	T° PA	T° TA	T° TA ≠T° PA	Mean diff (SD) 0.03 (0.5) (95% CI -0.92-0.88) % outside ±0.5°C – 20% (n=36)	III.2	Moderate
Lefrant [7] General ICU – 93% ventilated	T° PA	T° UB	T° UB = T° PA	-0.21±0.20	III.2	High
Fallis [9] Post op cardiac sX	T° PA	T° UB		All patients – As urine flow↟ temp gradient ↓ (rs2= -.07; P=0.034) Intervention patients only - As urine output↟ - temp gradient ↓(rs2= -.-.12; P=0.041)	III.2	Low

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STUDY	CORE	COMPARISON	OUTCOME	FINDINGS	LOE	RISK OF BIAS
Moran [10] General ICU – 78% ventilated	T° PA	T° UB	T UB = T PA	-0.052 (0.327); -0.694, 0.589	III.2	Moderate
Khan [4]	T° UB	T° A	T° A ≠ T° UB	Mean error 0.55 CI -0.27 – 1.36		High
Moran [10] General ICU – 78% ventilated	T° UB	T° A	T° A ≠ T° UB	0.322 (0.555); -0.765, 1.409	III-2	Moderate
Khan [4]	T° UB	T° T	T° T ≠ T° UB	Left – 0.39±0.52 to 0.93 ± 0.70 Right – 0.41±0.58 to 0.79±0.68	III.2	High
Moran [10] General ICU – 78% ventilated	T° UB	T° T	T° T ≠T° UB	0.447 (0.659); -0.845, 1.739	III.2	Moderate
Stelfox [46] Mixed ICU – Multiple Dx	T° UB	T° TA	T° TA = T° UB (Normal) T° TA ≠ T° UB (abnormal	• T° UB – T° TA • -0.44°C (95% [CI], -0.47°C to -0.41°C), • T° TA > T° UB - <36° • mean difference 0.66°C [95% CI, 0.53°C to 0.79°C]) • T° UB < T° TA -≥38.3°C • mean difference -0.90°C [95% CI, -0.99°C to -0.81°C • T° TA unable to detect fever	III.2	High
Kimberger [15] Neurosurgical	T° UB	T° TA	T°TA ≠ T°UB	• T°-UBT° TA (all) • (0.8; -1.5-1.6) • T°-UBT° TA (normothermia; n= 205) • III.30 (0.7; -1.3-1.5) • T°-UBT° TA (>37.8; n=55) • 0.4 (0.7; -1.1-1.8) • T°-UBT°T-A (<35.5; n=20) • -0.7 (1.1; -2.9-1.5)	III.2	Low

Appendix 2: Evidence table – studies sorted by non-invasive comparison

STUDY	CORE	COMPARISON	OUTCOME	FINDINGS	LOE	RISK OF BIAS
Smith [45] Day 1 post op cardiac Sx	T° A	T° O	T° O = T° A	0.30 (0.39); 0.17, 0.44 R2 0.768 p<0.001	III.2	Moderate
Moran [10] General ICU – 78% ventilated	T° A	T° T	T° T ≠ T° A	-0.097(0.552); -1.178, 0.984	III.2	Moderate
Leon [47] Med-surgical ICU	T° A	T° T	T° T = T° A (normal) T° T ≠ T° A (febrile)	• Bland Altman – mean diff 0.006 (limits -1.09-1.102) • T T – T A – r=0.813; P,0.0005) • T= 37 sens 74%; spec 85% • T = 38 sens 70%; spec 80% • T=39; - sensitivity 25%; specificity 99.8%; neg predictive value of 99%	III.2	moderate
Potter [48] Surgical/ neurosurgical ICU	T° O Electronic	T° O Chemical dot	T° O [Chemdot] = T° O [elect]	• T° O electronic v schem dot • mean diff 0.001°C • (SD=0.318C; t84=.034, P=.97; 95% CI, -0.061°C to +0.070°C).; p=0.01 • hem. dot vs. electronic difference ±0.4°C • 11.8% overestimates • 10.8% underestimates	III.2	Moderate
Spitzer [49] Critical care units	T° O	T° T	T° T ≠ T° O	The lower the average T° the greater the disagreement between O-T° and T° T	III.2	moderate

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