Body temperature measurement methods and targets in Australian and New Zealand intensive care units

Salvatore L Cutuli, Eduardo A Osawa, Neil J Glassford, David Marshall, Christopher T Eyeington, Glenn M Eastwood, Paul J Young and Rinaldo Bellomo

ABSTRACT

Objective: In Australian and New Zealand (ANZ) intensive care units (ICUs), the preferred measurement methods and targets for temperature remain uncertain, but are crucial for future interventional studies. We aimed to investigate the reported use of temperature measurement methods and targets in ANZ ICUs.

Design, settings and participants: Structured online questionnaire delivered via the email list of the Australian and New Zealand Intensive Care Society Clinical Trials Group.

Main outcomes measures: Measurements methods and targets for temperature in ANZ ICUs.

Results: Of 209 respondents, 130 were nurses (62.2%) and 79 were doctors (37.8%). Only 21.5% of the respondents reported having a unit protocol for measuring body temperature. However, invasive temperature measurement methods were preferred by doctors (69.8% *v* 55.3%) and non-invasive methods by nurses (29.9% *v* 44.2%). Moreover, among non-invasive methods, tympanic measurement was preferred by doctors (66.0% *v* 26.9%) and axillary by nurses (11.7% *v* 51.9%). Both professions reported a wide range of temperature thresholds that they believed required cooling interventions, but 16.7% of doctors and 42.4% of nurses reported that, in patients with cardiac arrest, they would actively cool patients only if the temperature was ≥ 38°C.

Conclusion: In ANZ ICUs, preferred temperature measurement methods and targets are typically not governed by protocol, vary greatly and differ between doctors and nurses. Targeted temperature management after cardiac arrest is not fully established. Future studies of the comparative accuracy of non-invasive temperature measurements methods and practice in patients with cardiac arrest appear important.

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Perturbations of body temperature are common in critically ill patients and predict adverse outcomes.[1-5] However, in some studies, temperature measurement methods are typically not considered, creating uncertainty about accuracy and reliability.[6-16] In the past decade, three observational studies conducted in Australian and New Zealand (ANZ) intensive care units (ICUs)[17-19] confirmed a wide use of different non-invasive methods, and a recent survey revealed variable attitudes of doctors and nurses to temperature management in the ICU.[20] Therefore, to inform the design of future interventional studies, we sought to investigate the current reported body temperature measurement methods and targets among doctors and nurses in ANZ ICUs.

Methods

We conducted a structured online questionnaire (www.SurveyMonkey.net) of intensive care doctors and nurses via the email list of the Australian and New Zealand Intensive Care Society Clinical Trials Group (December 2017 and February 2018). Ethical approval was obtained by the Austin Health Human Research Ethics Committee as Quality Improvement and Innovation project on 11 September 2017. Participation in the survey questionnaire was voluntary and implied that consent was granted. Participants were asked to provide anonymous information on their demographic and professional characteristics and on the methods used for measuring body temperature, timing and measured values (with options presented in 1°C bands) that they believed required intervention in five clinical scenarios of:

- suspected hypoxic ischaemic encephalopathy post-cardiac arrest (CA);
- traumatic brain injury;
- multi-organ failure;
- extracorporeal organ support; and
- post-operative monitoring.

Differences in the proportion of responses between doctors and nurses were analysed using the χ^2 or the Fisher exact test as appropriate. Statistical analyses were performed using Stata 13 (StataCorp) and graphs were drawn using Excel version 16.3 (Microsoft).

Results

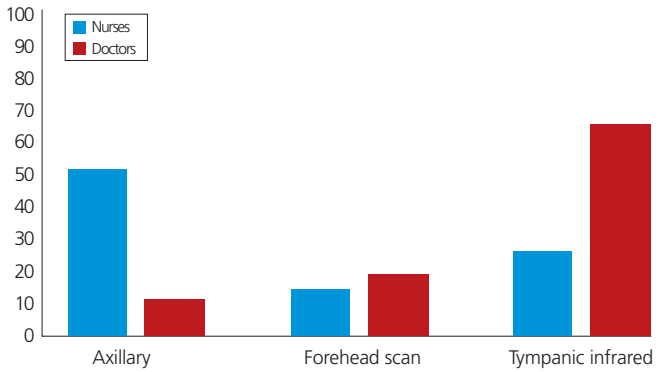
We collected 209 fully completed responses, 130 (62.2%) from nurses and 79 (37.8%) from doctors. Most nurses held a graduate certificate (53/130; 40.8%), a post-graduate diploma (39/130; 30.0%) or other higher degrees (41/130; 31.5%), while 67 doctors (84.8%) were ICU specialists. Respondents typically worked in mixed (192/209; 91.9%), public (193/209; 92.3%) and teaching (148/209; 70.8%) ICUs with more than 20 beds (166/209; 79.4%), and many had worked in such ICUs for ≤ 15 years (125/209; 59.8%). However, a protocol for measuring body temperature was reported by only 45 respondents (45/209, 21.5%).

There was great variability of temperature measurement methods. Non-invasive methods were preferred by nurses and invasive methods by doctors ($P < 0.001$) (online Appendix, eFigure 1; available at cicm.org.au/Resources/Publications/Journal).

Among non-invasive methods, axillary measurements were preferred by nurses and tympanic measurements by doctors ($P < 0.001$) (Figure 1). Doctors and nurses reported a wide range of temperature values they believed should receive cooling interventions, with significantly lower values for nurses ($P < 0.001$) (Figure 2).

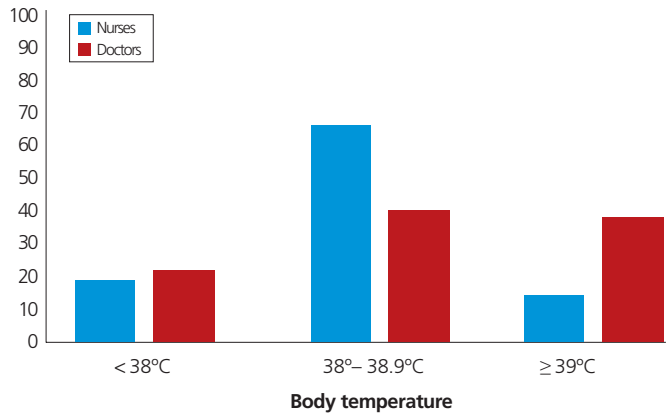
Invasive methods and hourly measurements (online Appendix, eFigure 2) were preferred in patients with suspected hypoxic ischaemic encephalopathy post-CA and in patients with traumatic brain injury (Figure 3). However, in patients with suspected hypoxic ischaemic encephalopathy post-CA, 16.7% (11/66) of doctors and 42.4% (50/118) of nurses reported that they would actively cool patients only if the temperature was ≥ 38°C. Similarly, 80.8% of respondents reported they would require this trigger to cool patients with traumatic brain injury (online Appendix, eFigure 3).

Figure 1. Preferred non-invasive body temperature measurement methods used by nurses and doctors in different intensive care unit situations*



* Fifteen nurses (15/264; 6%) and two doctors (2/103; 2%) preferred the oral site; one doctor (1/103; 1%) and three nurses (3/264; 1%) were unsure.

Figure 2. Highest measured limit of body temperature that respondents believed required lowering in different intensive care unit situations*



* Six nurses (6/591; 1%) were unsure.

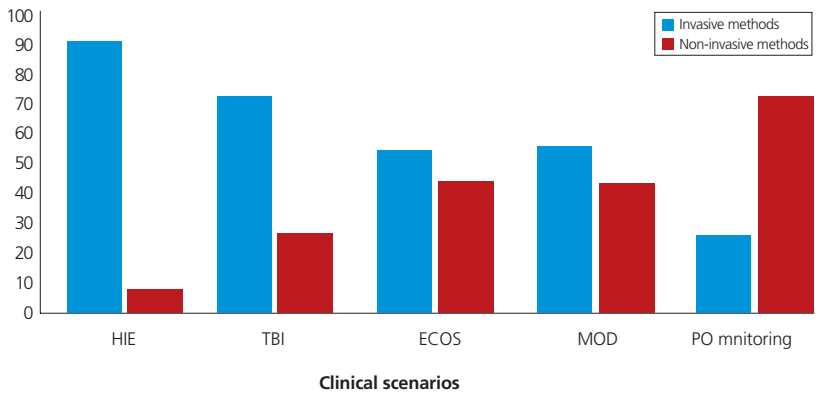
Discussion

Among more than 200 ANZ ICU doctors and nurses, only a minority reported having an ICU protocol for the measurement of body temperature. Moreover, preferred methods and targets varied significantly when comparing nurses with doctors. Finally, a significant proportion of respondents would allow a temperature ≥ 38°C before reacting in patients post-CA and the majority would allow such fever before cooling patients with traumatic brain injury.

Relationship to previous studies

Previous observational studies described the approach to temperature management among ANZ ICUs[17-19] with findings similar to ours. In 2008, Saxena and colleagues[17] conducted a multicentre observational study of 217 ICU patients and found that non-invasive body temperature methods were used in 83% of patient-days, with 21% of measurements between 38°C and 39°C. In 2009, Saxena et al[18] studied temperature management in 106 patients with neurological injury admitted to 33 ANZ ICUs and observed variable use of non-invasive measurement methods (68%), with the axillary route used in 40% of cases and a body temperature ≥ 38°C in 22%. In a study conducted in 2010 and published in 2013, Hammond and colleagues[19] described body temperature management in 311 adult patients admitted to 38 ANZ ICUs with sepsis or other inflammatory conditions and found that non-invasive methods were used in 82.6% of

Figure 3. Body temperature measurements in five clinical scenarios and percentage of respondents who would use invasive or non-invasive methods*



ECOS = extracorporeal organ support. HIE = hypoxic ischaemic encephalopathy. MOD = multi-organ dysfunction. PO = post-operative. TBI = traumatic brain injury. * Four respondents were unsure about the body temperature measurement methods they would use in patients with TBI (1/193; 0.5%), ECOS (2/188; 1%) and MOD (1/177; 0.6%).

observations, with axillary (38.2%) and tympanic (36.2%) routes frequently reported and 20.3% of patients with a peak temperature ≥ 38°C. In 2011, Saxena et al[20] described a highly variable attitude to fever management among doctors and nurses similar to that reported in our survey. In 2013, a multinational questionnaire surveyed 139 ICU site leads participating in the EUROBACT study.[21] The use of thermometers followed a protocol in 65% of centres, and axillary (58/139; 41.7%) and tympanic (30/139; 21.6%) methods were frequently indicated as primary routes of temperature measurement.

For the first time, however, we found that, in patients post-CA and in contradiction to trial findings[22] and guidelines,[23] almost a third of respondents would not respond to fever unless it was ≥ 38°C. In 2013, the Target Temperature Management (TTM) trial[22] showed no differences in mortality and neurological outcomes of mild therapeutic hypothermia at 33°C compared with strict therapeutic normothermia (STN) at 36°C in unconscious patients admitted to the ICU post-CA. Accordingly, STN has been implemented in the care of post CA, and preliminary reports from ANZ ICUs[24,25] observed greater rates of fever above 38°C in STN compared with therapeutic hypothermia period. Difficulties in maintaining STN outside a clinical trial[24,25] and low adherence to or abandonment of TTM[25] protocol to prevent fever in favour of treating fever are possible explanations of such results.

Acceptance of fever up to 38°C was also seen for patients with traumatic brain injury, despite concerns about the adverse effects of fever in such patients.[26-27]

Study implications

A key implication of our study is that dedicated temperature management protocols even among selected Australian and New Zealand Intensive Care Society Clinical Trials Group ICUs are uncommon, which, in turn, implies a degree of neglect of this vital sign. Moreover, our study shows that, 7 years after the previous survey, nurses and doctors continue to prefer different methods and targets, implying a disconnect between what may be expected and what might be actually done at the bedside. Due to the unclear accuracy and precision of different non-invasive methods,[6-16] these observations imply a high risk of misleading temperature measurements. Finally, our findings suggest a disconnect between reported responses to fever in patients post-CA and in patients with traumatic brain injury and evidence-based recommendations.

Strengths and limitations

We tested the questionnaire in a pilot sample of experienced clinicians before distribution. We delivered the questionnaire via a widely used online tool and surveyed a large sample of doctors and nurses. Moreover, our findings have revealed several areas of concern with temperature management in ANZ ICUs, such as lack of protocols, a doctor–nurse disconnect in preferences and priorities and acceptance of fever in patients for whom it should be prevented. However, we acknowledge we received only a few responses from private and rural hospitals, making extension of our findings to such settings uncertain. Furthermore, we acknowledge that reported behaviour may significantly differ from actual practice.

Conclusion

Most ANZ ICU doctors and nurses who responded to our questionnaire report having no unit temperature measurement protocol; using a wide range of non-accuracy tested, non-invasive measurement methods; showing a disconnect between doctors and nurses regarding their selection, routes and thresholds of intervention; and accepting fever in patients for whom its avoidance is strongly recommended. These findings imply a degree of neglect in relation to the measurement of a key vital sign and suggest the need for education, training and systematic assessment of measurement methods before interventional studies.

Competing interests

None declared.

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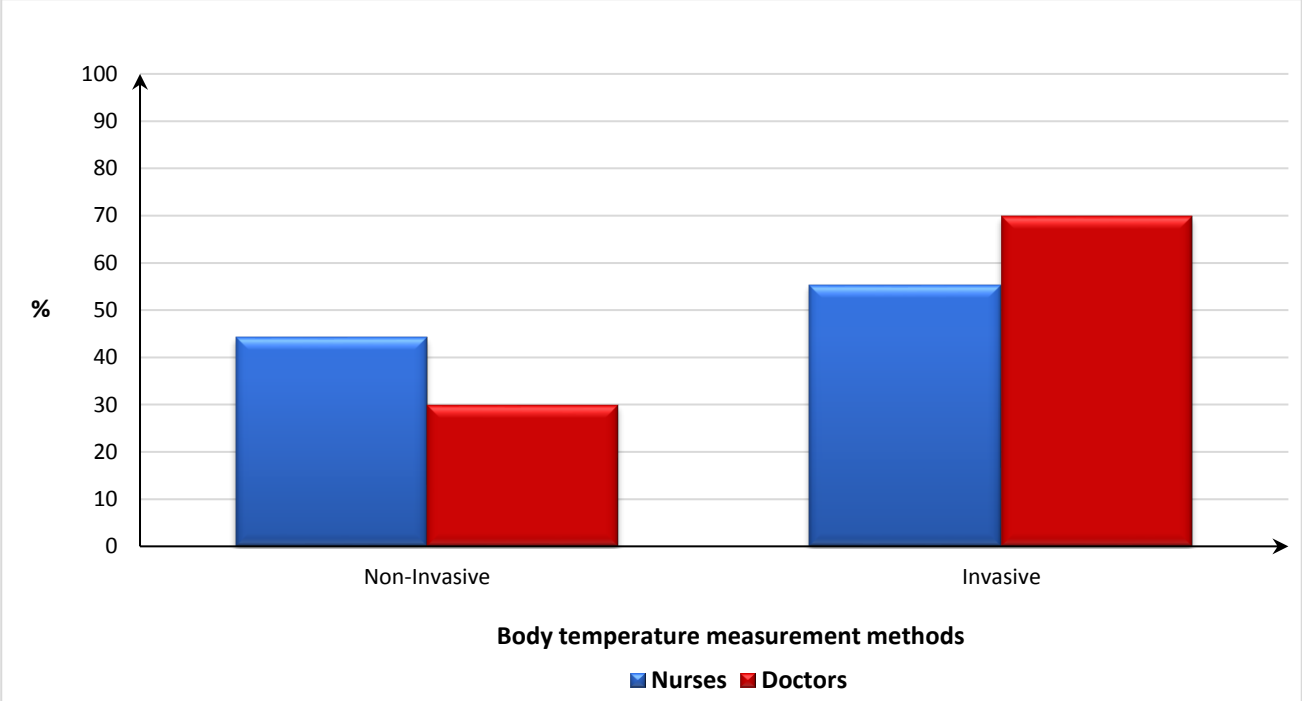
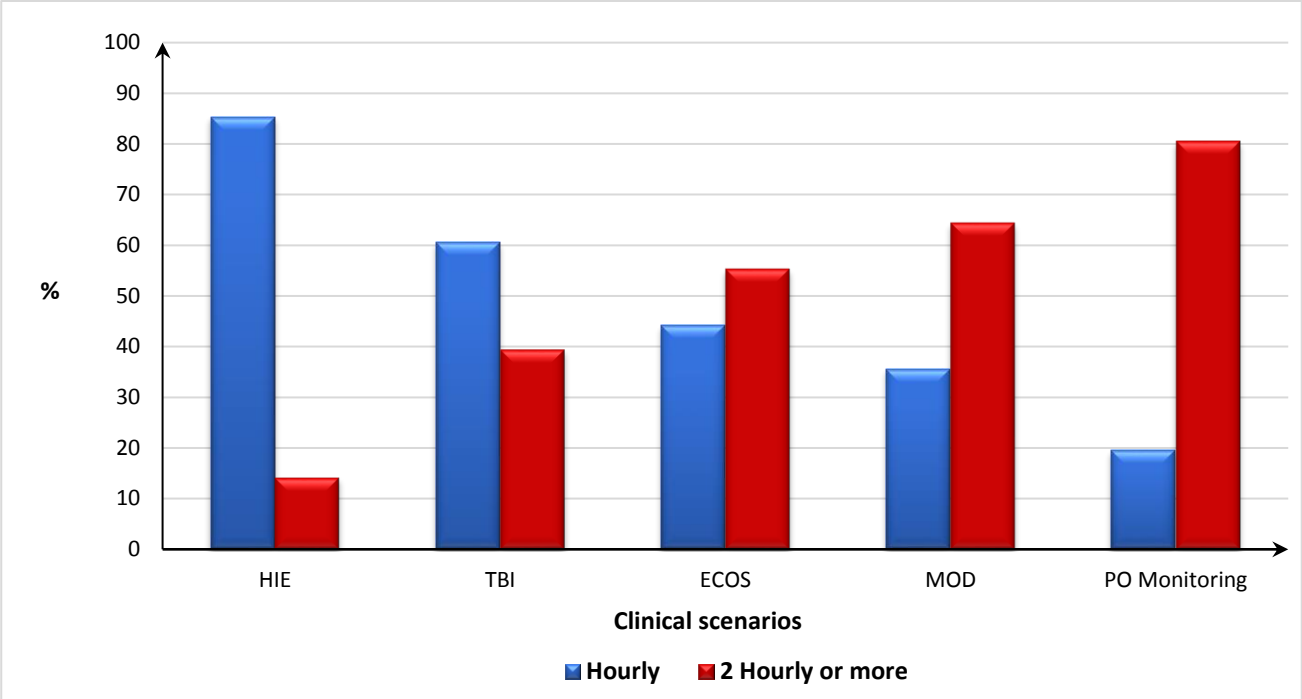
Appendix 1. This appendix was part of the submitted manuscript and has been peer reviewed. It is posted as supplied by the authors



* 4 respondents were unsure: 3 (*n* = 3/591, 0.51%) nurses and 1 (*n*= 1/341, 0.3%) doctor.

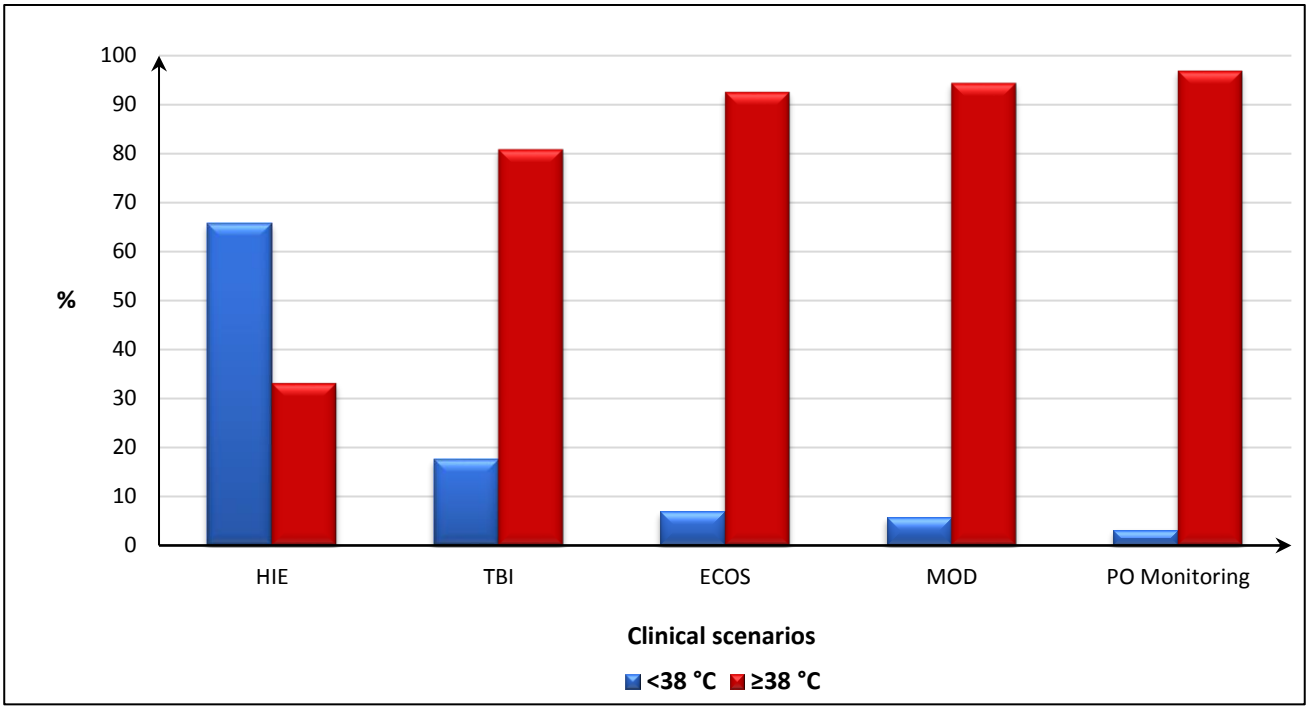
eFigure1. Preferred body temperature measurement methods by nurses and doctors in a mixed population of ICU patients*.



* 2 respondents were unsure about the timing of body temperature measurement in patients with: HIE (n = 1/184, 0.54%,) and ECOS (*n* = 1/188, 0.53%)

HIE= suspected Hypoxic Ischaemic Encephalopathy after cardiac arrest; TBI= Traumatic Brain Injury; MOD= Multi-Organ Dysfunction; ECOS= Extra-Corporeal Organ Support; PO Monitoring= Post-Operative monitoring.

eFigure 2. Preferred timing of body temperature measurement in 5 clinical scenarios*.



* 6 respondents were unsure about the highest measured limit of body temperature that they believed requires cooling in patients with HIE (*n* = 2/184, 1.1%), TBI (*n* = 3/193, 1.5%) and ECOS (*n* = 1/188, 0.53%).

HIE= suspected Hypoxic Ischaemic Encephalopathy after cardiac arrest; TBI= Traumatic Brain Injury; MOD= Multi-Organ Dysfunction; ECOS= Extra-Corporeal Organ Support; PO Monitoring= Post-Operative monitoring.

eFigure3. Preferred highest measured limit of body temperature that respondents believed requires cooling the patient in 5 clinical scenarios*.