Accuracy of noninvasive core temperature measurement in acutely ill adults: the state of the science

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CRD summary
The authors concluded that oral temperature measurements accurately reflect invasive core temperature, but there was no high-quality evidence supporting tympanic temperature measurement and there was insufficient evidence about temporal artery measurement. The limited search, poor reporting of review methods and insufficient information about the included studies mean that the reliability of the authors' conclusions is unclear.

Authors' objectives
To assess the accuracy of noninvasive methods of temperature measurement in acutely ill adults compared with invasive methods, and to compare different noninvasive methods.

Searching
MEDLINE and CINAHL were searched from 1982 to March 2005 for published studies; the search terms were reported.

Study selection
Study designs of evaluations included in the review
Studies had to be comparative and ‘data based’; other than that no inclusion criteria for the study design were specified.

Specific interventions included in the review
Studies that compared noninvasive temporal artery, tympanic and oral temperature measurements with invasive pulmonary artery and/or oesophageal measurements were eligible for inclusion. Studies evaluating measurements of only rectal, axillary, bladder or skin temperatures were excluded. None of the included studies appeared to use oesophageal measurements. The included studies measured oral temperature with an electronic digital thermometer in the right or left sublingual (buccal) pocket. The instruments used to measure temperature were described. The review also compared oral and tympanic temperature measurements.

Participants included in the review
Studies in acutely ill hospitalised adults (aged older than 18 years) were eligible for inclusion. The included studies were conducted in convenience samples of patients in various hospital settings, including operating rooms, intensive care units and postanaesthesia care units. The participants appeared to include hypothermic patients and intubated patients.

Outcomes assessed in the review
Inclusion criteria for the outcomes were not explicitly specified, but it was clear that the review focused on the accuracy of temperature measures. The review also assessed linearity (the performance of the measuring device over expected temperature ranges).

How were decisions on the relevance of primary studies made?
The authors did not state how the papers were selected for the review, or how many reviewers performed the selection.

Assessment of study quality
Validity was assessed using a modified version of the American Society for PeriAnesthesia Nurses' Appraising the Evidence: Evaluation Tool (see Other Publications of Related Interest no.1). This considered the study design, sample size, number of and methods used for measuring temperature, number and training of data collectors, inter-rater reliability, accuracy standard established, instrument calibration, statistical analysis and methodological limitations. The
authors did not state how the validity assessment was performed.

**Data extraction**
The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction.

**Methods of synthesis**
*How were the studies combined?*
The studies were grouped by type of noninvasive test and combined in a narrative.

*How were differences between studies investigated?*
Differences between studies evaluating oral temperature measurements were discussed with respect to whether they confirmed clinical accuracy, negated clinical accuracy, or reported inconclusive findings.

**Results of the review**
Twenty-three prospective descriptive studies were included. The number of participants was not reported.

All of the included studies were rated level IV studies.

**Oral temperature measurement.**
Ten studies compared oral temperature measurement with invasive pulmonary artery core temperature. Six of these studies established accuracy standards ranging from 0.2 to 0.5 degrees centigrade (C); the most common value was 0.3 degrees C. Three studies reported linearity of measurements across temperature extremes. Of the 8 studies that estimated 'clinical bias', three reported standard deviation (SD) values of less than 0.3 degrees C from the mean difference, two reported SDs of 0.36 and 0.34 degrees C, two reported SDs of less than or equal to 0.5 degrees C, and one reported an SD greater than 0.5 degrees C. Tympatic measurement.

Twenty studies compared tympanic measurement with invasive pulmonary artery core temperature. Six studies established accuracy standards ranging from 0.2 to 0.5 degrees C; the most common value was 0.3 degrees C. Ten studies concluded that tympanic measurement was a clinically acceptable alternative to invasive core measurement; four of these were rated B or higher for quality. Eight studies reported that tympanic measurement was not a clinically acceptable alternative to invasive core measurement; four of these were rated B or higher for quality. Two studies reported inconclusive results. Six studies reported linearity of measurements.

**Oral and tympanic measurement.**
Eight studies compared oral and temperature measurements. One study reported that only pulmonary artery measures were valid for hypothermic patients. Two studies reported that oral and tympanic measurements were equally effective. One study reported oral measurements were as close or closer to pulmonary artery readings than three of the tympanic instruments evaluated. Three studies reported that oral readings were more accurate than tympanic readings.

**Temporal artery measurement.**
One study compared temporal artery measurement with invasive pulmonary artery core temperature. Eighty-nine percent of measurements were out with the established accuracy standard of 0.5 degrees C. Sensitivity to hypothermic ranges was 0%.

**Authors' conclusions**
Oral temperature measurements taken at the left or right posterior sublingual (buccal) are an accurate measure of invasive core temperature measurement. There was no high-quality evidence supporting the accuracy of tympanic temperature measurement and there was insufficient evidence about temporal artery measurement.
CRD commentary
The review addressed a clear question that was defined in terms of the participants and intervention; inclusion criteria for the study design or outcomes were not explicitly specified. Limiting the search to publications listed in two databases might have resulted in the omission of other relevant studies and increases the potential for publication bias. It was not clear whether any language limitations were applied, thus the potential for language bias could not be assessed. The methods used to select studies, assess validity and extract the data were not described, so it is not known whether any efforts were made to reduce reviewer errors and bias. Validity was assessed using a hierarchy of study design and differences between the studies were discussed with respect to some of the review's quality criteria. A narrative synthesis was appropriate given the diversity of the studies. However, the synthesis was not easy to interpret and there was very little information about individual studies; in particular, results data were not presented which means it is not possible to confirm the findings reported in the review. The limited search, lack of reporting of review methods and insufficient information about the included studies mean that the reliability of the authors' conclusions is unclear.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice. Research: The authors stated that further studies evaluating the accuracy of temporal artery temperature measurement across different adult populations may be needed.

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Other publications of related interest

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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.