Infrared ear thermometry compared with rectal thermometry in children: a systematic review

Authors' objectives
To investigate the agreement between temperature measured at the ear and at the rectum in children.

Searching
MEDLINE (from 1966 to January 2000), CINAHL (from 1982 to December 1999), British Nursing Index (to June 1999), the Cochrane Library (Issue 1, 2000), the ASLIB Index to Theses (from 1970 to 1999), and the Index to Scientific and Technological Proceedings (via BIDS; from 1982 to 2000) were searched. The full search strategy was given in the published article. Additional information was requested from authors and suppliers of clinical thermometers, and the reference lists of retrieved studies were checked.

Study selection

Study designs of evaluations included in the review
Comparative studies in which the two types of measurement were performed in the same participant (method comparison studies) were included in the review.

Specific interventions included in the review
The inclusion criteria for the review specified studies in which temperature measured at the ear was compared with temperature measured at the rectum. Temperature measurements at the two sites had to have been recorded in the same child using electronic, mercury or in-dwelling thermocouple devices at the rectum and infrared devices at the ear. Temperature measurement at the rectum was taken to be the reference.

Participants included in the review
Studies whose participants were children aged up to 18 years were eligible for inclusion in the review. Most studies reviewed were of children aged less than 6 years and only one study was exclusively of children aged over 6 years (age range: 14 to 18). Children with a rectal temperature of less than 35 degrees C and pre-term infants were excluded.

Outcomes assessed in the review
Studies that reported the mean difference and standard deviation (SD) of the temperatures at the rectum and ear, or studies from which they could be calculated, were eligible for inclusion in the review.

How were decisions on the relevance of primary studies made?
Two reviewers selected the studies for the review.

Assessment of study quality
The quality of the studies was assessed using a checklist (see Other Publications of Related Interest no.1.), which had been modified from a diagnostic study checklist. Two reviewers independently performed the quality assessment.

Data extraction
Two reviewers independently extracted data from the primary studies, and any disagreements were resolved through discussion with other reviewers. The categories of data extracted were: study details, sample size, details of population, ear device and method used, mode of using ear device, rectal device and method used, results (mean difference between ear and rectal measurement and SD). The 95% confidence interval (CI) for each mean difference was calculated.
Methods of synthesis
How were the studies combined?
Individual patient data were used to check that the differences between the rectal and ear temperature measurements were normally distributed and were unrelated to the true underlying temperature. The individual study estimates of the mean difference between ear and rectal temperature measurements were combined using the inverse variance weighted approach, as was the pooled SD. The methods used were described in another publication (see Other Publications of Related Interest no.2.).

How were differences between studies investigated?
Homogeneity of the mean differences and SDs was assessed with the standard large sample test (see Other Publications of Related Interest no.3.). In the presence of significant heterogeneity, random-effects pooled estimates of the mean difference and the SD of the individual differences were calculated. A priori assumptions about sources of heterogeneity were made. These were ear thermometer mode, use of ear tugs, age and presence of otitis media. Only the impact of ear thermometer mode was investigated in this review, as there were insufficient data for the other factors.

Results of the review
Forty-four (or 45 - it was unclear from the review) studies describing 55 (or 56) comparisons were included in the review (n=5,935). Of these, 31 comparisons (n=4,441) could be included in the meta-analysis. It is not clear from the article how these comparisons were arrived at. The details of the comparisons were included in the article. In addition, the authors gave a web address where details of the studies reviewed but not included in the meta-analysis can be found.

The individual patient data available from 22 comparisons (n=2,679) indicated that the difference between rectal and ear temperature measurements were indeed normally distributed, with no systematic relationship with the ambient temperature.

Overall, there was statistically-significant heterogeneity between the mean differences and between SDs so a random-effects model was used to calculate the pooled and 95% CI. The overall pooled mean difference was 0.29 degrees C (95% CI: -0.74, 1.32). When subgrouped by device mode, the random-effects pooled mean temperature differences were similar to the overall result and there was significant residual heterogeneity within the mode groups. The results also remained similar where weights were adjusted to take into account the same children being used in different comparisons.

Authors' conclusions
The authors concluded that although the mean differences between rectal temperature measurements and ear temperature measurements were small, the wide CIs mean that ear temperature is not a good approximation of rectal temperature. They suggest that when body temperature needs to be measured with precision, infrared ear thermometry should not be used in preference to rectal measurement, which is the established method.

CRD commentary
This review addressed an appropriate question using clearly defined inclusion criteria. The literature search covered a number of suitable electronic databases and this was backed up by some handsearches. It is unclear whether any language restrictions were applied. Publication bias was not assessed. A quality assessment of the studies was performed using a published checklist, but it is not clear if, or how, the results of this assessment were used in the review. It is unclear on what basis the studies were included in the review, but then excluded from the analysis. The studies were pooled in a meta-analysis despite significant statistical heterogeneity, which persisted even when grouped by the mode in which the device was used. Although the potential effect of ambient temperature was investigated, the results would suggest that the source of heterogeneity in these studies was not explored sufficiently. The wide CIs of the pooled estimates may reflect some undefined clinical diversity between studies, rather than a true difference in the accuracy of ear versus rectal temperature measurement.
Implications of the review for practice and research

Practice: The authors state that measurements taken with infrared ear thermometry cannot be used as an approximation of rectal temperature, even when the device is used in rectal mode.

Research: The authors did not state any implications for further research.

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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.