

CADTH RAPID RESPONSE REPORT: SUMMARY OF ABSTRACTS

# Thermometer Use for Febrile Pediatric Patients: Clinical Effectiveness, Accuracy, and Guidelines

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## Research Questions

1. What is the comparative clinical effectiveness of temporal artery thermometers with tympanic, rectal, or axillary thermometers in febrile pediatric patients two years of age and older and in patients younger than two years of age?
2. What is the comparative accuracy of temporal artery, tympanic, rectal, or axillary thermometers in febrile pediatric patients two years of age and older and in patients younger than two years of age?
3. What are the evidence-based guidelines associated with the use of temporal artery, tympanic, rectal, or axillary thermometers in febrile pediatric patients two years of age and older and in patients younger than two years of age?

## Key Findings

Five non-randomized studies were identified regarding the comparative clinical effectiveness or the comparative accuracy of temporal artery, tympanic, rectal, or axillary thermometers in febrile pediatric patients two years of age and older and in patients younger than two years of age. Additionally, two evidence-based guidelines were identified.

## Methods

This report makes use of a literature search developed for a previous CADTH report. The original literature search was conducted in February 2016 on key resources including PubMed, The Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. For research question 3, a methodological filter was applied to limit retrieval to guidelines. For all other research questions, no filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The initial search was also limited to English-language documents published between January 1, 2011 and February 16, 2016. For the current report, database searches were rerun on January 11, 2018 to capture any articles published since the initial search date. The search of major health technology agencies was also updated to include documents published since February 2016. Internet links are provided, where available.

## Selection Criteria

One reviewer screened citations and selected studies based on the inclusion criteria presented in Table 1.

**Table 1: Selection Criteria**

<b>Population</b>	Febrile pediatric patients (≥2 and <2 years of age) presenting to the emergency room, operating room, pediatric units or clinics (including hospital and community)
<b>Intervention</b>	Temporal artery thermometer
<b>Comparators</b>	Q1-Q2: Tympanic thermometer; Rectal thermometer; Axillary thermometer; Other thermometers Q3: No comparator
<b>Outcomes</b>	Q1: Comparative clinical effectiveness Q2: Accuracy (in patients ≥2 and <2 years of age) Q3: Guidelines (use of all identified thermometer types in patients ≥2 and <2 years of age)
<b>Study Designs</b>	Health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, non-randomized studies, evidence-based guidelines

## Results

Rapid Response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials, non-randomized studies, and evidence-based guidelines.

Five non-randomized studies were identified regarding the comparative clinical effectiveness or the comparative accuracy of temporal artery, tympanic, rectal, or axillary thermometers in febrile pediatric patients two years of age and older and in patients younger than two years of age. Additionally, two evidence-based guidelines were identified. No relevant health technology assessments, systematic reviews, meta-analyses, or randomized controlled trials were identified.

Additional references of potential interest are provided in the appendix.

## Overall Summary of Findings

Five non-randomized studies (NRS)<sup>1-5</sup> were identified regarding the comparative clinical effectiveness or the comparative accuracy of temporal artery, tympanic, rectal, or axillary thermometers in febrile pediatric patients (≥2 and <2 years of age). Detailed study characteristics are provided in Table 2.

Varied conclusions on the comparative clinical effectiveness or the comparative accuracy of temporal artery, tympanic, rectal, or axillary thermometers in febrile pediatric patients were evident.<sup>1-5</sup> The authors of two NRS<sup>1,4</sup> concluded that rectal thermometry was the most reliable method of temperature assessment in pediatric patients, with one study<sup>1</sup> stating it was superior to axillary and temporal artery thermometry and the other study<sup>4</sup> suggesting it was more reliable than temporal artery thermometry. One NRS<sup>2</sup> reported good correlation between temporal artery and rectal thermometry in febrile neonates. Another study<sup>3</sup> concluded that forehead skin, infrared tympanic, and rectal thermometry were found to be accurate in screening for fever in children; however, lower cut-off points must be used for temperatures obtained with forehead skin and infrared tympanic thermometers. The final

NRS<sup>5</sup> evaluated the differences between temperatures obtained using temporal artery and tympanic thermometers in patients of all ages. The authors concluded that temporal artery thermometry was more reliable than tympanic thermometry in patients aged less than one year (and in patients aged 18 to 64).<sup>5</sup>

Two evidence-based guidelines<sup>6-7</sup> were identified regarding the use of temporal artery, tympanic, rectal, or axillary thermometers in febrile pediatric patients. The guideline by Mahajan et al.<sup>6</sup> suggests that rectal thermometry is the most accurate for assessing core body temperature in young children. This guideline<sup>6</sup> also states that temporal artery or tympanic membrane thermometers can be used for quick temperature assessment provided the clinician is aware of the limitations of these methods. The second guideline<sup>7</sup> was published in 2013 by the National Institute for Health and Care Excellence (NICE). This guideline<sup>7</sup> recommends that axillary thermometry be used for the assessment of fever in infants under the age of four weeks. For children between the ages of four weeks and five years, the guideline recommends temperature assessment with either an electronic thermometer in the axilla, a chemical dot thermometer in the axilla, or an infra-red tympanic thermometer. Finally, the guideline<sup>7</sup> states that forehead chemical thermometers are unreliable and should not be used by clinicians.

**Table 2: Summary of Included Studies on the Comparative Clinical Effectiveness or the Comparative Accuracy of Temporal Artery, Tympanic, Rectal, or Axillary Thermometers in Febrile Pediatric Patients**

First Author, Year	Study Characteristics	Interventions	Comparators	Outcomes	Author's Conclusions
Non-Randomized Studies (Pediatric Population)					
<b>Forrest, 2017<sup>1</sup></b>	<ul style="list-style-type: none"> <li>Prospective study</li> <li>Children (0-36 months) presenting to the ED</li> <li>N=NR</li> </ul>	<ul style="list-style-type: none"> <li>Temporal artery thermometry</li> <li>Axillary thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Rectal thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Sensitivity</li> <li>Specificity</li> <li>NPV</li> <li>PPV</li> </ul>	<ul style="list-style-type: none"> <li>The sensitivities of axillary and temporal artery thermometry in detecting rectal fever were 11.5% and 61.5%, respectively</li> <li>The study findings do not support the use of temporal or axillary thermometry to replace rectal thermometry</li> <li>There may be some instances where temporal thermometry is suitable</li> </ul>
<b>Goswami, 2017<sup>2</sup></b>	<ul style="list-style-type: none"> <li>Cross sectional observational study</li> <li>Febrile and hypothermic neonates</li> <li>N=210</li> </ul>	<ul style="list-style-type: none"> <li>Temporal artery thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Axillary thermometry</li> <li>Rectal thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Temperature</li> <li>Sensitivity</li> </ul>	<ul style="list-style-type: none"> <li>Mean temporal artery temperature showed a good correlation with rectal temperature in febrile neonates</li> <li>Although the results indicated temporal thermometry was effective, the authors suggested that further studies are required before replacing rectal thermometry with temporal artery thermometry in this population</li> </ul>

First Author, Year	Study Characteristics	Interventions	Comparators	Outcomes	Author's Conclusions
<b>Chatproedprai, 2016<sup>3</sup></b>	<ul style="list-style-type: none"> <li>Prospective study</li> <li>Children (<math>\leq 2</math> years) complaining of fever</li> <li>N=312</li> </ul>	<ul style="list-style-type: none"> <li>Forehead skin thermometry</li> <li>Infrared tympanic thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Rectal thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Mean body temperature</li> </ul>	<ul style="list-style-type: none"> <li>Mean body temperatures measured by forehead skin thermometry and infrared tympanic thermometry were lower than those measured with rectal thermometry, with a difference of 1.04°C and 1.03°C, respectively</li> <li>Both forehead skin and infrared tympanic thermometry were effective in assessing children, however, the cut-off points to detect fever should be lowered to 37.0°C</li> </ul>
Non-Randomized Studies (Mixed Population)					
<b>Brosinski, 2018<sup>4</sup></b>	<ul style="list-style-type: none"> <li>Prospective study</li> <li>Febrile and afebrile pediatric (<math>\leq 3</math> years) and geriatric patients (<math>\leq 65</math> years)</li> <li>N=NR</li> </ul>	<ul style="list-style-type: none"> <li>Temporal artery thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Rectal thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Temperature</li> </ul>	<ul style="list-style-type: none"> <li>Unadjusted temporal artery temperature did not provide reliable temperatures measurements</li> <li>Adjusted temporal artery temperature readings were too divergent from rectal temperature readings to be used in pediatric populations</li> </ul>
<b>Yang, 2016<sup>9</sup></b>	<ul style="list-style-type: none"> <li>Prospective study</li> <li>Patients (all ages) presenting to the ED</li> <li>N=710</li> </ul>	<ul style="list-style-type: none"> <li>Temporal artery thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Tympanic thermometry</li> </ul>	<ul style="list-style-type: none"> <li>Temperature</li> </ul>	<ul style="list-style-type: none"> <li>Temperature readings obtained from the temporal artery were more reliable than tympanic temperature in patients aged less than one year (and in patients aged 18 to 64)</li> <li>Several parameters to consider in order to adjust temperature readings (for both temporal artery and tympanic thermometry) were discussed</li> </ul>

ED = emergency department; NPV = negative predictive value; NR = not reported; PPV = positive predictive value.

## References Summarized

### Health Technology Assessments

No literature identified.

### Systematic Reviews and Meta-Analyses

No literature identified.

## Randomized Controlled Trials

No literature identified.

## Non-Randomized Studies

### *Pediatric Population*

1. Forrest AJ, Juliano ML, Conley SP, Cronyn PD, McGlynn A, Auten JD. Temporal artery and axillary thermometry comparison with rectal thermometry in children presenting to the ED. *Am J Emerg Med*. 2017 Dec;35(12):1855-8.  
[PubMed: PM28641982](#)
2. Goswami E, Batra P, Khurana R, Dewan P. Comparison of temporal artery thermometry with axillary and rectal thermometry in full term neonates. *Indian J Pediatr*. 2017 Mar;84(3):195-9.  
[PubMed: PM27981430](#)
3. Chatproedprai S, Heamawatanachai K, Tempark T, Wananukul S. A Comparative study of 3 different methods of temperature measurement in children. *J Med Assoc Thai*. 2016 Feb;99(2):142-9.  
[PubMed: PM27249893](#)

### *Mixed Population*

4. Brosinski C, Valdez S, Riddell A, Riffenburgh RH. Comparison of temporal artery versus rectal temperature in emergency department patients who are unable to participate in oral temperature assessment. *J Emerg Nurs*. 2018 Jan;44(1):57-63.  
[PubMed: PM28595947](#)
5. Yang WC, Kuo HT, Lin CH, Wu KH, Chang YJ, Chen CY, et al. Tympanic temperature versus temporal temperature in patients with pyrexia and chills. *Medicine (Baltimore)*. 2016 Nov;95(44):e5267. Available from:  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5591141>  
[PubMed: PM27858893](#)

## Guidelines and Recommendations

6. For Academic College of Emergency Experts in India (ACEE-INDIA) - INDO US Emergency and Trauma Collaborative, Mahajan P, Batra P, Thakur N, Patel R, Rai N, et al. Consensus guidelines on evaluation and management of the febrile child presenting to the emergency department in India. *Indian Pediatr*. 2017 Aug 15;54(8):652-60.  
[PubMed: PM28607213](#)
7. NICE. Fever in under 5s: assessment and initial management [Internet]. London, England: National Institute for Health and Care Excellence (NICE); 2013 (updated Aug 2017) [cited 2018 Jan 16]. Available from: <https://www.nice.org.uk/guidance/cg160/resources/fever-in-under-5s-assessment-and-initial-management-pdf-35109685049029>  
*See: 1.1 Thermometers and the detection of fever, page 12*

## Appendix — Further Information

### Previous CADTH Reports

8. Thermometer use for febrile pediatric patients: a review of clinical effectiveness, accuracy, and guidelines [Internet]. Ottawa (ON): CADTH; 2016 Mar [cited 2018 Jan 16]. Available from: <https://www.cadth.ca/sites/default/files/pdf/htis/mar-2016/RC0761%20Pediatric%20Thermometers%20Final.pdf>
9. Non-contact thermometers for detecting fever: a review of clinical effectiveness [Internet]. Ottawa (ON): CADTH; 2014 Nov [cited 2018 Jan 16]. Available from: <https://www.cadth.ca/sites/default/files/pdf/htis/nov-2014/RC0610%20Non-contact%20Thermometers%20Final.pdf>
10. Non-contact infrared thermometers for pediatric patients: clinical evidence and guidelines [Internet]. Ottawa (ON): CADTH; 2014 Oct [cited 2018 Jan 16]. Available from: <https://www.cadth.ca/sites/default/files/pdf/htis/nov-2014/RA0703%20Non-Contact%20Thermometers%20Final.pdf>
11. Temporal versus tympanic thermometers: ease of use and cost-effectiveness [Internet]. Ottawa (ON): CADTH; 2011 Mar [cited 2018 Jan 16]. Available from: [https://www.cadth.ca/sites/default/files/pdf/htis/march-2011/K0325\\_Thermometers\\_final.pdf](https://www.cadth.ca/sites/default/files/pdf/htis/march-2011/K0325_Thermometers_final.pdf)
12. Measuring temperature with infrared tympanic thermometers versus oral, axillary and rectal thermometers for proper patient management [Internet]. Ottawa (ON): CADTH; 2007 Aug [cited 2018 Jan 16]. Available from: <https://www.cadth.ca/sites/default/files/pdf/htis/Measuring%20Temperature%20with%20Infrared%20Tympanic%20Thermometers%20versus%20Oral%2C%20Axillary%20and%20Rectal%20Thermomet.pdf>

### Randomized Controlled Trials

#### *Alternative Population – Febrile Patients Unspecified*

13. Opersteny E, Anderson H, Bates J, Davenport K, Husby J, Myking K, et al. Precision, sensitivity and patient preference of non-invasive thermometers in a pediatric surgical acute care setting. *J Pediatr Nurs*. 2017 Jul;35:36-41. [PubMed: PM28728767](#)

### Non-Randomized Studies

#### *Alternative Intervention – Digital Axillary vs. Non-Contact Infrared Thermometers*

14. Franconi I, La Cerra C, Marucci AR, Petrucci C, Lancia L. Digital axillary and non-contact infrared thermometers for children. *Clin Nurs Res*. 2016 Nov 1;1054773816676538. [PubMed: PM28699399](#)

## *Alternative Population – Febrile Patients Unspecified*

15. Evron S, Weissman A, Toivis V, Shahaf DB, You J, Sessler DI, et al. Evaluation of the Temple Touch Pro, a novel noninvasive core-temperature monitoring system. *Anesth Analg*. 2017 Jul;125(1):103-9.  
[PubMed: PM28617697](#)
16. Syrkin-Nikolau ME, Johnson KJ, Colaizy TT, Schrock R, Bell EF. Temporal artery temperature measurement in the neonate. *Am J Perinatol*. 2017 Aug;34(10):1026-31.  
Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5532079>  
[PubMed: PM28395367](#)
17. Sim MA, Leow SY, Hao Y, Yeo CL. A practical comparison of temporal artery thermometry and axillary thermometry in neonates under different environments. *J Paediatr Child Health*. 2016 Apr;52(4):391-6.  
[PubMed: PM27145501](#)
18. Sollai S, Dani C, Berti E, Fancelli C, Galli L, de Martino M, et al. Performance of a non-contact infrared thermometer in healthy newborns. *BMJ Open*. 2016 Mar 16;6(3):e008695. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4800130>  
[PubMed: PM26983944](#)

## Clinical Practice Guidelines – Unspecified Methodology

19. LeDuc D, Woods S. Temperature measurement in paediatrics [Internet]. Ottawa (ON): Canadian Paediatric Society; 2017 (reaffirmed 2017 Jan) [cited 2018 Jan 16].  
Available from: <https://www.cps.ca/en/documents/position/temperature-measurement>

## Review Articles

20. Barbi E, Marzuillo P, Neri E, Naviglio S, Krauss BS. Fever in children: pearls and pitfalls. *Children*; 2017 Sep 1;4(9). [PubMed: PM 28862659](#)
21. Joseph RA, Derstine S, Killian M. Ideal site for skin temperature probe placement on infants in the NICU: a review of literature. *Adv Neonatal Care*. 2017 Apr;17(2):114-22.  
[PubMed: PM28092317](#)

## Additional References

22. Summary safety review - ear and forehead (contact) infrared thermometers (various brands): assessing the potential risk of inaccuracy in children under 2 years old [Internet]. Ottawa (ON): Health Canada; 2017 May [cited 2018 Jan 16].  
Available from: <https://www.canada.ca/en/health-canada/services/drugs-health-products/medeffect-canada/safety-reviews/summary-safety-review-forehead-contact-infrared-thermometers-various-brands-assessing-potential-risk-inaccuracy-children-under-2-years-old.html>