

# WHEN BODY TEMPERATURE CHANGES, DOES RECTAL TEMPERATURE LAG?

DAVID S. GREENES, MD, AND GARY R. FLEISHER, MD

By using temporal artery and rectal thermometers, we followed temperatures in 45 febrile ( $>38.5^{\circ}\text{C}$ ) infants given an antipyretic drug. Sixty and 90 minutes after drug administration, temporal artery temperatures had decreased significantly more than rectal temperatures. When body arterial temperature changes rapidly, changes in rectal temperature may lag. (*J Pediatr* 2004;144:824-6)

**M**ost research studies evaluating noninvasive clinical thermometers<sup>1-5</sup> use rectal thermometry as the criterion standard. Although rectal temperature usually correlates closely with core body temperature, some data indicate that when core body temperature is changing rapidly, changes in rectal temperature may lag.<sup>6-9</sup> To explore this possibility, we measured the rate of temperature change by using temporal artery (TA) and rectal thermometers for febrile infants given an antipyretic drug. We hypothesized that TA temperatures would decrease more than rectal temperatures measured simultaneously.

## METHODS

All infants  $<12$  months of age brought to the triage area of our pediatric emergency department were approached consecutively for enrollment whenever research personnel were available. Infants were excluded if they were too unstable to participate or if rectal thermometry was contraindicated. As per triage protocol, rectal temperature was measured by using a Diatek digital thermometer (Welch Allyn, Skaneateles Falls, NY). After obtaining verbal consent from the guardian, we measured TA temperature by using the Exergen TemporalScanner Thermometer (model LXTA; Exergen Corp, Watertown, MA).<sup>10</sup>

Patients were eligible for continued participation if their rectal and TA temperatures both were  $\geq 38.5^{\circ}\text{C}$  and if they had had no antipyretic drug within the preceding 2 hours. Written informed consent was obtained. The study was approved by the hospital's Committee for Clinical Investigation.

Subjects were given oral acetaminophen (15 mg/kg) or ibuprofen (10 mg/kg) as per triage protocol. Acetaminophen is the first-choice drug, with ibuprofen given when acetaminophen is contraindicated. Follow-up TA and rectal temperatures were measured 30, 60, and 90 minutes after antipyretic drug administration. In some cases, follow-up temperatures could not be measured when scheduled because the patient was undergoing a procedure or because parents refused ongoing participation. Cases were included in the analysis only if all three follow-up temperatures were measured no earlier than 5 minutes before and no later than 15 minutes after the scheduled time.

The primary outcomes were changes from baseline temperature 30, 60, and 90 minutes after antipyretic drug administration. A secondary outcome was area under the curve of temperature decrease for the 90-minute observation period. We used the paired  $t$  test for all statistical comparisons. Data are presented as mean values with 95% confidence intervals. Data were analyzed with SPSS version 9.0 (SPSS, Chicago, IL).

We determined *a priori* that a difference in measured temperature decrease of  $0.3^{\circ}\text{C}$  could have clinical significance. We expected the mean temperature decrease 60 minutes after antipyretic drug administration to have a SD of  $0.5^{\circ}\text{C}$ .<sup>11,12</sup> Assuming  $\alpha = 0.05$  and  $\beta = 0.90$ , we calculated the need for 44 subjects to detect a difference in temperature decrease of  $0.3^{\circ}\text{C}$ .

From the Division of Emergency Medicine, Children's Hospital Boston, Harvard Medical School, Boston, Massachusetts.

This research was funded by a grant from the Exergen Corp, Watertown, Massachusetts. The authors have no other financial relationship with Exergen or financial interest in the products used in this study.

The authors have no conflicts of interest to declare.

Submitted for publication July 22, 2003; last revision received Jan 15, 2004; accepted Feb 18, 2004.

Reprint requests: David S. Greenes, MD, Division of Emergency Medicine, Children's Hospital Boston, 300 Longwood Ave, Boston, MA 02115. E-mail: david.greenes@childrens.harvard.edu.

0022-3476/\$ - see front matter

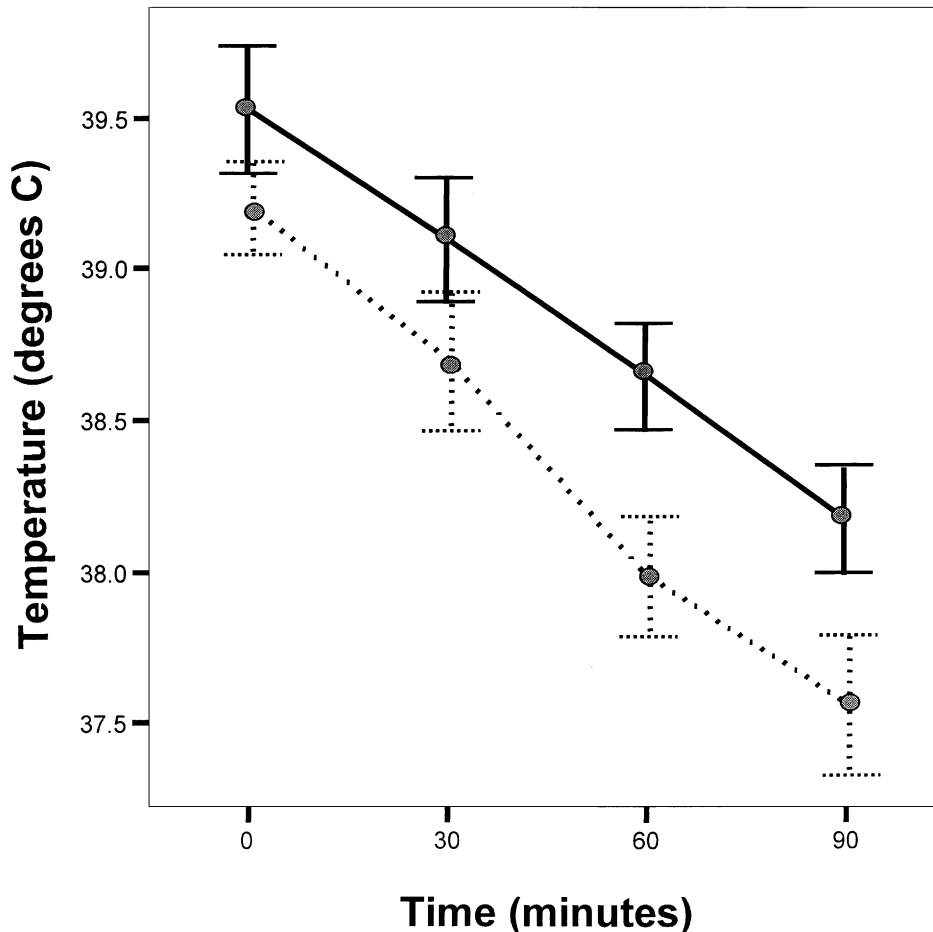
Copyright © 2004 Elsevier Inc. All rights reserved.

10.1016/j.jpeds.2004.02.037

---

TA Temporal artery

---



**Figure.** Mean rectal and TA temperatures by measurement time. Error bars show 95% CI of mean; solid line, rectal; dashed line, TA.

**Table. Mean defervescence from time 0 with rectal and TA thermometers and mean difference in defervescence (TA minus rectal)**

Time (min)	Defervescence since time 0 in rectal temperature, °C (95% CI)	Defervescence since time 0 in TA temperature, °C (95% CI)	TA defervescence minus rectal defervescence, °C (95% CI)
30	0.40 (0.21, 0.60)	0.47 (0.23, 0.71)	0.07 (-0.17, 0.31)
60	0.85 (0.67, 1.03)	1.17 (0.93, 1.40)	0.32 (0.09, 0.55)
90	1.31 (1.08, 1.53)	1.58 (1.34, 1.83)	0.27 (0.07, 0.48)

## RESULTS

Of 1273 patients initially enrolled, 78 had temperature  $\geq 38.5^{\circ}\text{C}$  by both rectal and TA thermometers and had not been given antipyretic drugs within the preceding 2 hours. Guardians of 51 of these 78 eligible patients consented to participate. Forty-five of 51 (82%) subjects completed all scheduled follow-up temperature measurements.

The subjects' mean age was 210 days (range, 11–335). Thirty-six (80%) subjects were treated with acetaminophen and nine (20%) with ibuprofen. Mean temperatures at times 0, 30, 60, and 90 minutes are shown in the Figure. For both rectal and TA temperatures, temperature decreased signifi-

cantly from the preceding value at each follow-up measurement ( $P < .001$ ). At all time points, TA temperature was lower than rectal temperature ( $P < .001$ ).

Decreases from baseline temperature at 30, 60, and 90 minutes are shown in the Table, along with the mean difference in temperature decrease between TA and rectal temperatures. The decrease from baseline temperature was significantly greater for TA than for rectal thermometry at times 60 minutes ( $P = .005$ ) and 90 minutes ( $P = .013$ ). The calculated area under the curve for temperature decrease over time was greater for TA than for rectal thermometry ( $P = .025$ ).

Subjects treated with acetaminophen did not differ from those treated with ibuprofen in the amount of decrease from baseline temperature at 30, 60, or 90 minutes measured with either TA or rectal thermometers ( $P > .05$  for all comparisons; data not shown).

## DISCUSSION

Temporal artery temperature decreases faster than rectal temperature in febrile infants given an antipyretic drug, with significant differences evident 60 and 90 minutes after antipyretic drug administration. Previous observations of patients undergoing artificial changes in body temperature—by immersion in hot baths or rapid cooling during cardiac bypass—have shown that changes in rectal temperature are slow and blunted compared with changes measured at other body sites.<sup>6-8</sup> Similarly, one study of seven healthy adults who exercised in hot, humid conditions found that tympanic temperature peaked earlier than rectal temperature.<sup>9</sup> We found no previous studies comparing the rate of temperature change in different body sites in the setting of naturally occurring fever.

Our study is limited by the absence of a clear criterion standard. We found that TA and rectal temperatures respond differently to antipyretic drug administration, but we do not know which thermometer more accurately reflects core body temperature. Only a simultaneous measurement of core body temperature, using a pulmonary artery or esophageal probe, would fully answer this question. However, studies using invasive thermometers typically involve critically ill and heavily sedated patients. It is unclear whether data from these patients, with substantially altered blood flow and temperature regulation mechanisms, can be extrapolated to healthy, ambulatory patients.

In some cases, a thermometer measuring arterial temperature may better reflect current core body temperature than a rectal thermometer. This does not mean, however, that rectal thermometry should be abandoned in clinical practice. Perhaps the time-averaged information gained from rectal temperature, less sensitive to instantaneous perturbations of body temperature than arterial measures, is particularly useful

in the evaluation of febrile children. It is unknown whether the substitution of other modes of thermometry would lead to differences in patient management or outcome.

In conclusion, when febrile infants are given an antipyretic drug, temporal artery temperature drops more quickly than rectal temperature. These data raise questions about whether rectal thermometry should be considered the criterion standard for clinical thermometry.

## REFERENCES

1. Brennan DF, Falk JL, Rothrock SG, Kerr RB. Reliability of infrared tympanic thermometry in the detection of rectal fever in children. *Ann Emerg Med* 1995;25:21-30.
2. Chamberlain JM, Grandner J, Rubinoff JL, Klein BL, Waisman Y, Huey M. Comparison of a tympanic thermometer to rectal and oral thermometers in a pediatric emergency department. *Clin Pediatr* 1991;30:24-9; discussion 34-5.
3. Shann F, Mackenzie A. Comparison of rectal, axillary, and forehead temperatures. *Arch Pediatr Adolesc Med* 1996;150:74-8.
4. Weisse ME, Reagen MS, Boule L, France N. Axillary vs. rectal temperatures in ambulatory and hospitalized children. *Pediatr Infect Dis J* 1991;10:541-2.
5. Yetman RJ, Coody DK, West MS, Montgomery D, Brown M. Comparison of temperature measurements by an aural infrared thermometer with measurements by traditional rectal and axillary techniques. *J Pediatr* 1993;122:769-73.
6. Gerbrandy J, Snell E, Cranston W. Oral, rectal, and oesophageal temperatures in relation to central temperature control in man. *Clin Sci* 1954;13:615-24.
7. Molnar G, Read R. Studies during open-heart surgery on the special characteristics of rectal temperature. *J Appl Physiol* 1974;36:333-6.
8. Stone JG, Young WL, Smith CR, Solomon RA, Wald A, Ostapkovich N, et al. Do standard monitoring sites reflect true brain temperature when profound hypothermia is rapidly induced and reversed? *Anesthesiology* 1995;82:344-51.
9. Newsham KR, Saunders JE, Nordin ES. Comparison of rectal and tympanic thermometry during exercise. *South Med J* 2002;95:804-10.
10. Greenes DS, Fleisher GR. Accuracy of a noninvasive temporal artery thermometer for use in infants. *Arch Pediatr Adolesc Med* 2001;155:376-81.
11. Vauzelle-Kervroedan F, d'Athis P, Pariente-Khayat A, Debregeas S, Olive G, Pons G. Equivalent antipyretic activity of ibuprofen and paracetamol in febrile children. *J Pediatr* 1997;131:683-7.
12. Kauffman R, Sawyer L, Scheinbaum M. Antipyretic efficacy of ibuprofen vs. acetaminophen. *Am J Dis Child* 1992;146:622-5.