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The Use of Infrared Ear Thermometers in Pediatric and Family Practice Offices

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S Y N O P S I S

Objective. To describe the use of infrared (IR) ear thermometers in pediatric and family practice offices.

Methods. The authors mailed a questionnaire to 350 randomly selected members of the American Academy of Pediatrics and to 355 randomly selected members of the American Academy of Family Physicians.

Results. Of respondents in clinical practice, 78% had used IR ear thermometers at least once in the past; 65% of pediatricians and 64% of family practice physicians were current users. Seventeen percent of pediatric offices and 18% of family practice offices that had used IR ear thermometers had discontinued use, most citing inaccuracy or lack of staff trust in the device. Pediatric offices were less likely than family practice offices to use the device in well neonates and sick neonates and more likely to use it in sick children. Advantages cited included rapid readings, ease of use, and accuracy. Seventy-five percent of current users reported at least one problem, including low readings and lack of staff trust.

Conclusions. IR ear thermometers are widely used in pediatric and family practice offices. Some offices limit use of these devices to older children and adults, and most of the offices surveyed report using other devices as a check on the accuracy of IR thermometers. Statements by professional organizations that provide user guidelines and establish appropriate age cutoffs would be helpful.

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The U.S. Food and Drug Administration's Center for Devices and Radiological Health cleared the first infrared (IR) ear thermometer for marketing in 1985. IR ear thermometers, which are designed to measure body temperature by collecting infrared (IR) radiation from the tympanic membrane, offer several theoretical advantages over more traditional methods of measuring a patient's body temperature in an office setting. IR ear thermometers provide rapid readings, are relatively noninvasive, and require no contact with mucous membranes. Unlike glass mercury thermometers, IR thermometers do not present a risk of breakage with concomitant exposure to a toxic substance. For these reasons, IR ear thermometers have been enthusiastically received by some health care workers, patients, and parents.

Despite the popularity of these devices, questions remain regarding their accuracy. One source of concern is the fact that these devices measure radiant heat from the ear canal as well as from the tympanic membrane, which results in the measured temperature being somewhat lower than the actual tympanic membrane temperature. In addition, poor user technique may reduce temperature readings obtained with these devices due to the effects of skin and ambient air temperatures.¹⁻³ Furthermore, most health care providers are inexperienced in the interpretation of unadjusted auditory canal temperatures, which need to be adjusted to reflect the fact that the auditory canal temperature is generally lower than rectal or core temperatures. Manufacturers have addressed this problem by offering a variety of settings or "modes," each of which converts the auditory canal reading to an estimate of the temperature at another site, such as rectal or oral temperature. The offsets used to perform such conversions and the methods by which they have been derived vary among manufacturers. Therefore, different brands of IR ear thermometer may yield different readings even when set to the same "mode."⁴ As a result of variations in a number of design features, even unadjusted auditory canal readings may differ between thermometers of different brands.⁵

Several studies have suggested that in comparison to more widely accepted standards, such as rectal temperature, IR readings are less sensitive in detecting fever, in both children and adults.⁶⁻¹⁰ Various limitations on the use of IR ear thermometers have been suggested: that they not be used in children under three months of age;^{11,12} that they not be routinely substituted for standard equipment in intensive care units¹³ or emergency departments;^{7,14} or that users take multiple measurements

rather than relying on a single measurement.¹²

We conducted a national survey of family physicians and pediatricians to assess the extent to which IR thermometry has been incorporated into office practice, to determine whether there are standard practices related to the use of these devices, to describe problems related to their use, and to estimate the frequency of occurrence of problems.

METHODS

The survey sample included 350 pediatricians randomly selected from the national membership list of the American Academy of Pediatrics and 355 family physicians randomly selected from the national membership list of the American Academy of Family Physicians. In December 1995, we mailed a structured, multiple choice questionnaire to the sample. In February 1996 we directed a second mailing to those who had not responded to the first mailing.

The questionnaire, designed to be completed by any staff member in the physician's office who was familiar with patient care practices, asked whether the office had ever used IR ear thermometers, the length of time that various brands of the device were in use, and specific practices related to use of the device.

To test for the possibility that survey responders were more likely to use IR ear thermometers than nonresponders, we selected a random sample of non-responding pediatricians and family physicians for telephone follow-up. We used a nationwide telephone directory available on the World Wide Web to identify a telephone listing for each of these physicians. Telephone interviews were conducted by two of the authors, BGS and WRD. The interviewers asked each of the nonresponders contacted whether he or she was in outpatient clinical practice and, if so, whether he or she had ever used or was currently using an IR ear thermometer.

We entered all questionnaire responses into an Epi-Info 6.02 database and analyzed the data using SAS PC 6.08. Associations between selected demographic factors and both overall use of the IR ear thermometer and various practices related to the use of the device were examined using chi-square tests.

RESULTS

A total of 755 physicians received questionnaires. We received mailed responses from 350 of these physicians or their office staff, which represented a 50% response

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rate. More than half of the surveys (59%) were at least partially completed by a physician rather than by another member of the office staff. Pediatric and family practice offices were equally likely to respond; however, pediatricians were more likely than family physicians to complete the surveys themselves (68% versus 51%, $P < 0.002$).

Of the physicians responding to the mailed survey, 96% (337/350) were in active clinical practice in outpatient settings; this included 164 pediatricians and 173 family physicians. Most outpatient practitioners (75%) were in private practice (ranging from solo practice to offices with over 50 physicians, with a median of three physicians); others worked in health maintenance organizations, health centers, emergency departments, and other settings.

We analyzed the responses given by the 337 physicians or members of their office staff. More than three-quarters of practices (127/164 pediatric offices; 135/173 family practices; 262/337, or 78%, overall) reported having used an IR ear thermometer at least once. Seventeen percent (21/127) of pediatric offices and 18% (24/135) of family practices; 45/262 overall) reported having discontinued use. The most common reasons given for discontinuing use were that the device gave low or high readings or that office staff did not trust the device.

The remaining 83% (106/127) of pediatric offices and 82% (111/135) of family practices reported current use of the device. Approximately 90% of current users had been using the device for five years or less. Pediatric offices reported using IR ear thermometers for a significantly longer period than family practice offices (a mean of 3.16 years versus a mean of 2.16 years, $P = 0.0003$).

Of 60 nonresponders randomly selected for additional follow-up, 24 (40%) could be reached and were in outpatient practice. Of these, 16 (67%) said they were current users of the device, three reported having used it in the past, and five said they had never used it. Thus the proportion of current or ever users was 79%, while the pro-

portion of current or ever users among mail responders in clinical practice was 78%.

Age groups. Current users (106 pediatric offices and 111 family practices) were asked to identify the patient groups for which they were likely to use the device. (See Figure.) Both pediatric and family practice offices mentioned use in children (ages 1-12) and adolescents or adults more often than use in neonates (≤ 8 weeks of age) or infants (9 weeks to 1 year). More than half of both pediatric and family practice offices reported routine use in infants, children, adolescents, and adults. Pediatric offices were significantly less likely than family practice offices to use the device routinely in neonates ($P = 0.024$ for routine use in neonates, and $P = 0.013$ for use with ill neonates) and more likely to use the device in ill children ($P = 0.003$).

Use of settings. Fifty-six percent of the 217 current users reported the use of one or more special settings of the thermometer: 27% reported having used the “oral” setting, 21% the “rectal” setting, 21% the “tympanic” setting, and only 2% the “core” setting.

Pediatric offices were significantly more likely to report having used the “rectal” setting than family practice offices (27% versus 14%, $P = 0.019$).

Advantages. Pediatric and family practice offices did not differ significantly in their responses regarding the advantages of the device. The most commonly reported advantages were rapid readings (96%), ease of use (89%), and patient comfort (77%). Accuracy was mentioned by only 30%; in fact, 25% of offices reported taking multiple readings as a way of improving the accuracy of results.

Disadvantages. Seventy-five percent of current users reported that office staff had had at least one problem with the device. Commonly reported problems included

temperature readings that seemed too low (71%) and lack of staff trust in the device (36%). High readings were cited as a disadvantage by about a third of pediatric practices but by fewer than 20% of family practices.

In cases in which users of IR ear thermometers obtained what they believed to be inaccurate temperature readings, most (84%) reported that they would repeat the measurement with another device; 86% of users had another type of thermometer available in the office (34% glass mercury only, 36% electronic only, and 16% both).

DISCUSSION

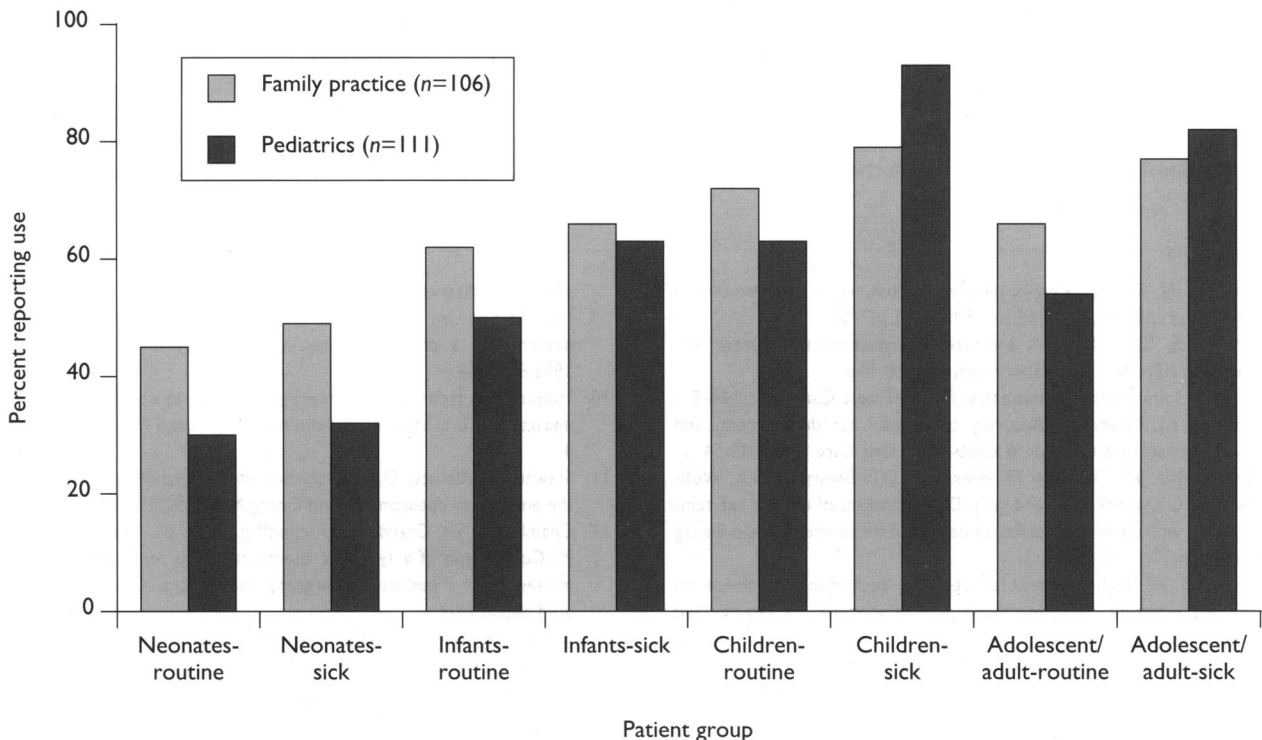
This survey of pediatric and family practice offices suggests that, 10 years after the introduction of IR ear thermometers, most pediatricians and family physicians in the United States have used these devices in their practices. Yet IR ear thermometers have not supplanted traditional devices. Many offices limit their use in very young children, particularly neonates, and most reportedly use more traditional devices in addition to IR ear thermometers, often as a check on the accuracy of the newer devices. Although the design of the survey precluded a

calculation of the incidence of adverse events, reports of problems associated with the device were frequent, even in those offices continuing to use the device.

Pediatricians had, in general, been using IR ear thermometers longer than family physicians; this finding may reflect heavier marketing of these devices to pediatricians or may be indicative of a greater perceived need among pediatricians than among family physicians for a rapid, convenient alternative to rectal temperatures.

At the same time, however, our study suggests that pediatricians and their office staffs are more skeptical than family practitioners about the accuracy of these devices, particularly in neonates and infants. This skepticism may result from longer experience with these products, greater familiarity with the literature devoted to this subject (much of which has been published in pediatric journals), or the higher proportion in pediatric practices of infants, in whom accurate temperature measurement is critical. On the other hand, the finding that pediatric offices were more likely than family practice offices to use these devices in sick children ages 1-12 suggests that pediatricians consider precise temperature measurement to be less important in this age group

Figure. Use of infrared ear thermometers, by patient group and type of practice, survey of family practice and pediatric offices, 1996



“More than half of both pediatric and family practice offices reported routine use in infants, children, adolescents, and adults.”

than in infants and recognize the value of a rapid estimate of body temperature in uncooperative children.

Many pediatricians and family physicians expressed concern that IR ear thermometers sometimes yielded low readings, an expected finding given the potential contribution of ambient air and skin temperatures to these measurements.

The follow-up contact with a sample of initial nonresponders showed that current use of the device was not a major factor in the decision to respond, suggesting that the survey's prevalence estimates are probably reliable. As members of professional societies, the physicians we surveyed may be more likely than others in their specialties to read journals and be aware of new technologies, through both advertisements and articles.

The case of IR ear thermometers demonstrates the problems that may result when widespread acceptance of a new technology outpaces the establishment of accepted standards for its proper use. Given the concerns raised by several recent clinical trials,^{4,7,9,10} more data are needed to determine the settings and circum-

stances in which IR ear thermometers are most appropriately used. Because the weight given to a body temperature measurement in the medical decision-making process depends on many factors, including patient age and history, setting of care, physical examination, and laboratory data, future research into IR ear thermometers should focus not only on sensitivity and specificity but also on the effect of these devices on clinical outcomes in a variety of health care settings.

As new devices become available and achieve rapid acceptance among practitioners, it is crucial that professional organizations help their members make the best use of these products. Further research will contribute to the development of guidelines for health care providers that establish appropriate age cutoffs and standard practices for interpreting and recording readings obtained with IR ear thermometers.

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References

- Schuman AJ. The accuracy of infrared auditory canal thermometry in infants and children. *Clin Pediatr* 1993;32(6):347-54.
- Emergency Care Research Institute. Thermometers, infrared, ear. Healthcare Product Comparison System 1995 Mar.
- Nobel JJ. Infrared ear thermometry. *Pediatr Emerg Care* 1992;8:54-8.
- Erickson RS, Meyer LT. Accuracy of infrared ear thermometry and other temperature methods in adults. *Am J Crit Care* 1994;3:40-54.
- Chamberlain JM, Terndrup TE, Alexander DT, Silverstone FA, Wolf-Klein G, O'Donnell R, Grandner J. Determination of normal ear temperature with an infrared emission detection thermometer. *Ann Emerg Med* 1995;25:15-20.
- Terndrup TE, Rajk J. Impact of operator technique and device on infrared emission detection tympanic thermometry. *J Emerg Med* 1992;10:683-7.
- 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.
- Kenney RD, Fortenberry JD, Surratt SS, Ribbeck BM, Thomas WJ. Evaluation of an infrared tympanic membrane thermometer in pediatric patients. *Pediatrics* 1990;85:854-8.
- Hooker EA. Use of tympanic thermometers to screen for fever in patients in a pediatric emergency department. *South Med J* 1993;86:855-8.
- Hooker EA, Houston H. Screening for fever in an adult emergency department: oral vs. tympanic thermometry. *South Med J* 1996;89:230-4.
- Stewart JV, Webster D. Re-evaluation of the tympanic thermometer in the emergency department. *Ann Emerg Med* 1992;21:158-61.
- 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(4 Suppl):24-9.
- Romano MJ, Fortenberry JD, Autrey E, Harris S, Heyroth R, Parmeter P, Stein F. Infrared tympanic thermometry in the pediatric intensive care unit. *Crit Care Med* 1993;21:1181-5.
- Jaffe DM. What's hot and what's not: the gold standard for thermometry in emergency medicine. *Ann Emerg Med* 1995;25:97-9. ■