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Evaluation of the Cadi ThermoSENSOR Wireless Skin-Contact Thermometer Against Ear and Axillary Temperatures in Children☆,☆☆

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The Cadi ThermoSENSOR skin-contact thermometer measures body temperature continuously and transmits readings wirelessly to a central server. This study evaluated the ThermoSENSOR against ear temperatures (ETs) measured by a Braun ThermoScan ear thermometer and axillary temperatures (ATs) measured by a Terumo digital clinical thermometer. The test participants consisted of 109 children aged 6 months to 16 years from a pediatric ward. The sensor was attached to the lower abdomen at least 15 minutes before the first measurement. ET, AT, and ThermoSENSOR temperatures (TTs) were recorded up to three times at the usual measurement times. The TTs differed from ETs by −0.23°C ± 0.47°C (mean ± standard deviation, $n = 271$) and from ATs by +0.21°C ± 0.46°C ($n = 270$). The ETs differed from ATs by +0.43°C ± 0.42°C ($n = 315$). These results suggest that the TTs were comparable to the ETs and ATs.

BODY TEMPERATURE IS an important physiological parameter used routinely in the clinical management of critically ill patients. For both children and adults, it is usually measured manually using rectal, ear, oral, or axillary methods (Asher & Northington, 2008; National Institute for Health and Clinical Excellence, 2007; O'Grady et al., 2008). In patients with fever, body temperature is assessed frequently, causing constant disturbance to the patients and increasing nursing workload. Automated wireless monitoring of temperature enables nurses and clinicians to monitor a patient's temperature continuously without disturbing the patient, enhancing patient comfort and mobility. It also enables readings to be automatically stored, retrieved, and analyzed for trends, saving time and minimizing errors associated with manual recording and analysis.

In view of the worldwide shortage of nurses (Oulton, 2006; World Health Organization, 2006) and the ongoing need to improve patient care, KK Women's and Children's Hospital in Singapore explored the use of an automated wireless system for monitoring body temperature. Developed by Cadi Scientific in Singapore as part of an integrated wireless system for temperature monitoring and location tracking, this system uses a reusable skin-contact thermo-

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☆ Potential conflict of interest: Dr. Zenton Goh is CEO and a director of Cadi Scientific, and Dr. Soh-Min Lim is the chief marketing officer and also a director of the company. Dr. Kim-Gau Ng participated in the study out of educational interest, on a voluntary basis, and on his personal time; he received no financial rewards and no in-kind benefits for the participation. In addition, at the time of the study and at the writing of this article, Dr. Ng was not involved in the development or marketing of temperature monitoring systems and was not affiliated with any other organization that develops or markets such systems, so he had no conflict of interest.

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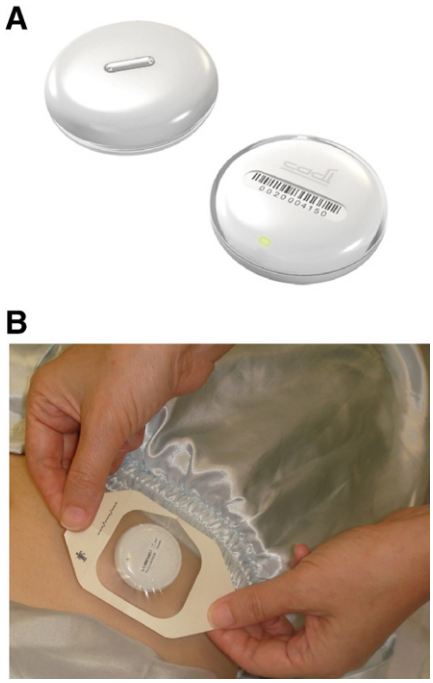

Figure 1 (A) The ThermoSENSOR wireless thermometer. The disc has an elliptical cross-section, and the sensing element consists of a metal strip located at the center of the skin-contact side. (B) A ThermoSENSOR, having been placed over the first piece of hypoallergenic adhesive film dressing on the lower abdomen, about to be secured to the lower abdomen by a second piece of the same dressing.

meter or sensor called the ThermoSENSOR. This thermometer takes the form of a small disc that can be easily adhered to the patient's skin, and each disc is assigned a unique radio frequency identification (RFID) number (Figure 1). The thermometer measures body temperature continuously and transmits a temperature reading and the RFID number approximately every 30 seconds to a computer or server through one or more signal receivers (nodes) installed in the vicinity of the patient (Figure 2).

A search of the published literature revealed the use of two types of continuous wireless thermometry systems—one type that measures core temperature using a disposable ingestible capsule (Byrne & Lim, 2007) and another type that measures skin temperature using a disposable dermal patch (Racinais, Gaoua, & Grantham, 2008). In these systems, temperature readings are transmitted wirelessly at regular intervals to a patient monitor or data recorder. Ingestible thermometers have been used to study the thermoregulation of sports persons and soldiers during physical exercise (Gant, Atkinson, & Williams, 2006; Lim, Byrne, & Lee, 2008) and investigated for use in monitoring body temperature during cardiac surgery (Markides, Omorphos, Kotoulas, & Prendergast, 2007), but they are not suitable for routine monitoring of temperature in young children. The published literature also revealed the use of a skin-contact thermometer that automatically measures skin temperature at predetermined intervals, but its temperature readings are not transmitted wirelessly, are stored in the thermometer, and have to be downloaded to a computer by wired means (Sarabia, Rol, Mendiola, & Madrid, 2008; van Marken Lichtenbelt et al., 2006). In comparison, although the ThermoSENSOR is also a skin-contact thermometer, its readings are intended to reflect core temperature.

As with any physiological parameter, accurate temperature measurement is critical to accurate patient assessment. For this reason, a study was conducted to evaluate the accuracy of the ThermoSENSOR against ear temperature (ET) and axillary temperature (AT) in a pediatric population. This article reports on this evaluation.

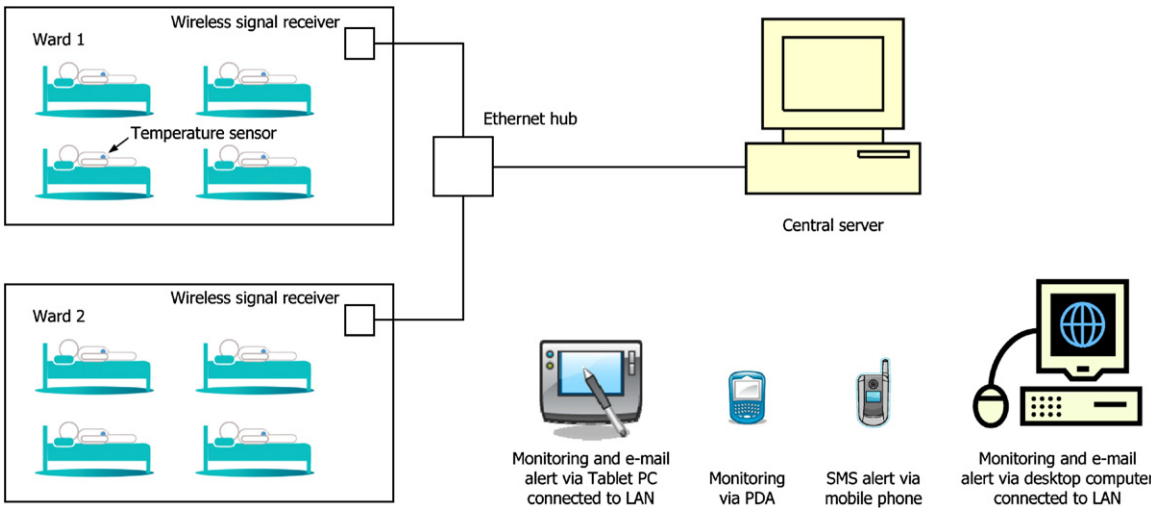

Figure 2 A setup of the ThermoSENSOR wireless temperature monitoring system. Each sensor transmits data wirelessly to a signal receiver (node) that is within the prescribed transmission range. The signal receiver uploads the data to a central server through the LAN, through which the data can be accessed from computers and other devices that are connected, wirelessly or by wired means, to the LAN. The server can be configured to send out e-mail and short message service (SMS) alerts.