CLINICAL ACCURACY OF A RAPID THERMISTOR THERMOMETER

The Welch Allyn SureTemp® Clinical Thermometer

Abstract

Oral, and rectal temperature measurements were obtained from 337 subjects, age 17 to 85 years, at 5 centers in Canada and the United States using a rapid predictive thermistor thermometer (Welch Allyn™ SureTemp®). The results indicate that this instrument and technology are highly accurate and reliable in determining body temperature in the afebrile and febrile state. Temperature measurements ranged from 96.7°F to 104.1°F (35.9°C to 44.0°C). The average error was 0.1°F (.05°C) orally, average rectal error was 0.11°F (.06°C). The standard deviation was 0.34°F (0.17°C) orally, and 0.11°F (0.06°C) rectally.

Definitions

Monitor Temperature: a function of an electronic thermometer used to monitor temperature reading until it reaches the thermal steady state (i.e. unchanging). The thermal steady state is achieved in approximately three minutes, depending on the probe material and site.

Predicted Temperature: any thermometer that renders a temperature reading before steady state is achieved is classified as a Predictive Thermometer. Predictive Thermometers reduce the time required for measurement by predicting what the temperature would be if the probe were left in place until steady state is achieved.

Introduction

Temperature is the vital sign that most often causes action to be taken. Various therapies and studies are initiated or withheld based on a patient's temperature. Therefore, determining a patients' temperature correctly is vital to patient care, and has a significant role in outcome and quality of care. For these reasons, it is important that health care personnel understand the technology of thermometry[1], and how different technology and measurement sites may affect temperature measurement in the clinical setting.

This research studied a thermistor based thermometer in two anatomic measurement sites (oral, and rectal), in a variety of clinical settings and typical uses. This was undertaken with the assistance and cooperation of several major hospitals in Canada and the United States.

Background

Although fluid filled thermometers have been in use since approximately 1610, recognition of fever as a sign of disease, as well as promotion of the clinical use of mercury thermometers is credited to Carl Wunderlich, MD, in 1868. Modern use of clinical electronic thermometers began approximately twenty-five years ago with the introduction of the first **predictive** thermometer. These instruments were designed to "predict" oral or rectal temperature in thirty or forty seconds, based on a mathematical formula derived from time temperature studies of many hundreds of patients. Since that time, and until recently, very little evolution has taken place in thermistor based temperature measurement.

Of note however, is that infrared (IR) tympanic thermometry was introduced and has become widely used over the past five to seven years. Two primary reasons for the acceptance of IR technology were speed, and the theoretical consideration of obtaining temperature measurements from a site that more closely reflected core temperature. In practice however, many clinicians have become dissatisfied with IR because they feel that they sacrificed a degree of accuracy in favor of speed. Accurate IR temperature measurement is largely dependent on the instrument visualizing IR radiation from the tympanic membrane. Unfortunately many factors influence visualization of this IR heat radiation. They include anatomical considerations, such as ear canal curvature and size, proximity of the tympanic membrane to the surface and subsequent effect of ambient temperature. Other factors influencing accuracy include the clinicians'

technique in using the instrument, cleanliness of the IR lens, and instrument calibration.

Since these factors affect the precision, accuracy and consistency in temperature monitoring, many IR users are returning to thermistor based thermometers. Due to these IR experiences, clinicians are more likely to question temperature readings. They are also more suspect of new instruments and are more prone to want to review a carefully controlled study.

Purpose

The primary purpose of this study was to compare the accuracy of predicted temperature readings from the Welch Allyn SureTemp electronic thermometer to a three minute **monitor temperature** reading, in a large inpatient and outpatient adult & pediatric population.

The secondary purpose of this study is to determine the usefulness of a thermometer having a predict time of approximately four seconds orally and fifteen seconds rectally in this same population.

Materials and Methods

Three hundred and thirty seven paired predictive and three minute monitor temperature readings, from sublingual and rectal sites, were obtained on inpatient and outpatient subjects by seven clinicians at five centers using the Welch Allyn SureTemp electronic thermometer (Welch Allyn Instruments, Inc., San Diego, CA). Study subjects were age 17 to 85 years. Temperature pairs ranged from 96.7°F to 104.1°F (35.9°C to 40.0°C).

The Protocol at each center was identical, and each clinician was trained with the instrument prior to the start of the protocol. Each enrolled subject underwent a four second oral or fifteen second rectal temperature with the Welch Allyn SureTemp, followed by a three minute timed monitor temperature with the same instrument. All temperatures were measured with a hand held probe covered by a disposable plastic sheath. Probe position was kept constant between the predictive and three minute monitor measurements by the clinician holding the probe at all times. Oral probes were positioned in the most posterior medial sublingual pocket (illustration). Rectal probes were advanced approximately 1.5 to 2 cm inside the rectal sphincter.

Study Design

In clinical practice predictive thermometer temperatures are often compared to three minute glass thermometer measurements, to assess accuracy. In non research conditions routinely encountered by clinicians, the methodology used for this comparison has been completely uncontrolled, causing inaccurate and somewhat distorted results.[2] For example, glass-mercury thermometers are not checked for accuracy prior to obtaining temperature readings. A number of studies have shown that glass-mercury thermometers can vary by .05 to .16 ° C.[3] A study by Terndrup and Allegura documented the fact that electronic thermometers used in the monitor mode are more accurate and reliable than glass mercury thermometers.[7] Another common error is to use a different location within the mouth, that is, left sublingual pocket for one reading and the right sublingual for the second. Several studies have documented the variations in temperature in seemingly similar oral sites (see illustration)[4]. Some clinicians fail to recognize the importance of waiting twenty to thirty minutes after a patient has had anything hot or cold by mouth before measuring a temperature[5] This oversight can also cause significant variations in temperature readings.[6,7]

This study made direct comparisons of actual three minute monitor mode sublingual or rectal temperatures to predicted temperature readings in a multi center, non-randomized study. Each of the possible errors was controlled by careful protocol and technique development, as well as individual training and observation, by the study coordinator, of each clinician who participated. Patient education regarding the study objectives was also integral to the study.

Analysis

Data gathered from this study was analyzed by comparing the predicted temperature of the SureTemp to the three minute monitor temperature. Outliers were not removed because practicing clinicians include all temperatures obtained by their thermometer to form an overall opinion of the accuracy, repeatability and reliability of an instrument or technology.

Results

Mean bias and standard deviations were calculated for predicted and three minute monitor temperature differences.

Oral Temperatures
Oral temperatures ranged from 96.7° to 103.3°F (35.9° to 39.6°C)The average error for all oral measurements was 0.1°F (.05°C), with a standard deviation of 0.34°F (0.19°C).

Rectal Temperatures
The range for rectal readings was 97° to 104.1°F (36.1° to 40.0° C), with an average error of -0.11°F (-.06°C). The rectal standard deviation was 0.30°F (0.17°C).

These biases and standard deviations indicate that there is excellent correlation, and no statistically significant differences, between the three minute monitor temperature and the predicted temperatures from the Welch Allyn SureTemp.

Discussion

Temperature taking has always been a routine task associated with vital signs monitoring. Nonetheless the measurement of temperature has occupied the majority of time in collection of vital signs. Routine heart rate is usually collected over fifteen seconds. Blood pressure takes approximately twenty seconds and, before now, thermometry took thirty to forty seconds. With familiar comfortable technology, clinicians now have the speed promised by tympanic thermometry, without the associated problems of possible inaccuracies.

Issues including accuracy, repeatability, clinician technique, patient anatomy, patient compliance, and maintenance of fragile tympanic instruments are also greatly minimized or eliminated with SureTemp.

Many studies that compare tympanic to oral and rectal temperatures found large mean differences (errors) of 0.2° to 1.3°F (.12° to .4°C).[8, 9, 10, 11] In contrast, this study demonstrated an average error for all measurements including Rectal and Oral, of only 0.1°F (.05°C). This accuracy was consistent for febrile and afebrile subjects of all ages over a wide range of temperatures (96.7°F to 104.1°F or 35.9°C to 40.0°C). This precision makes SureTemp much more attractive than tympanic thermometers for those clinicians who demand consistent accuracy along with speed.

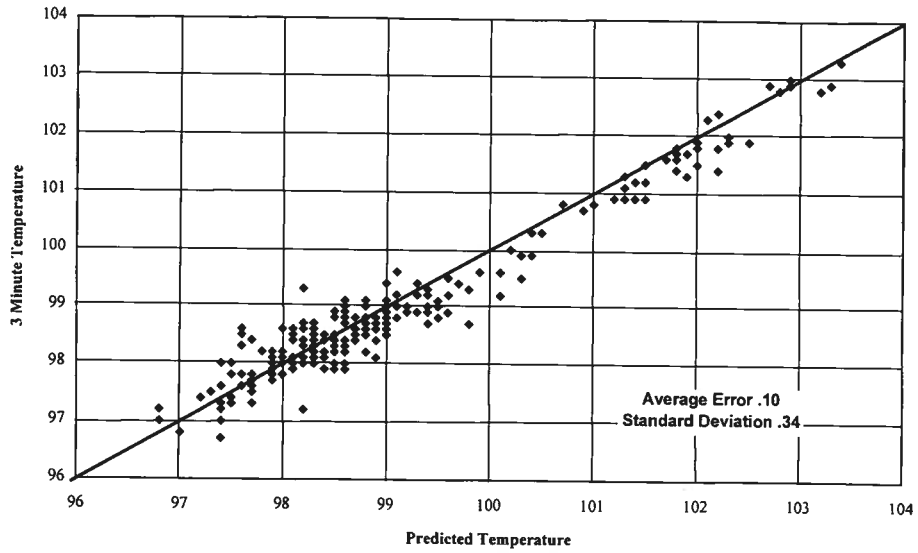
This combination of benefits gives clinicians more time to concentrate on other patient needs, while maintaining accuracy in temperature measurement.

Conclusions

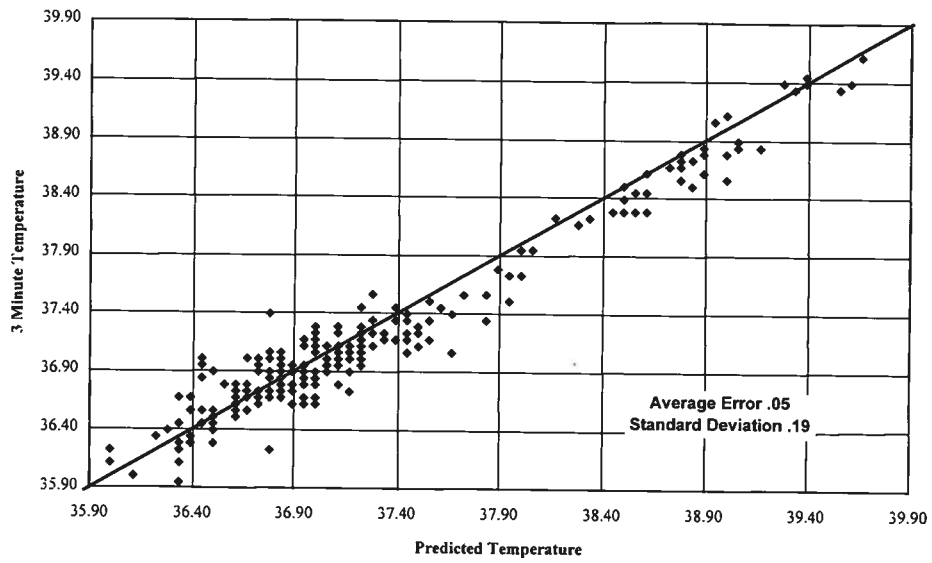
The authors sought to determine whether any clinically significant differences existed between the "gold standard" three minute monitor temperature measurements, and predictive temperatures from the SureTemp. No significant differences could be demonstrated in oral or rectal, inpatient or outpatient temperatures.

This study showed that SureTemp allows accurate and rapid measurement of body temperature using accepted, durable, and familiar technology. These benefits allow clinicians to utilize this new instrument with very little additional training and minimal instrument maintenance.

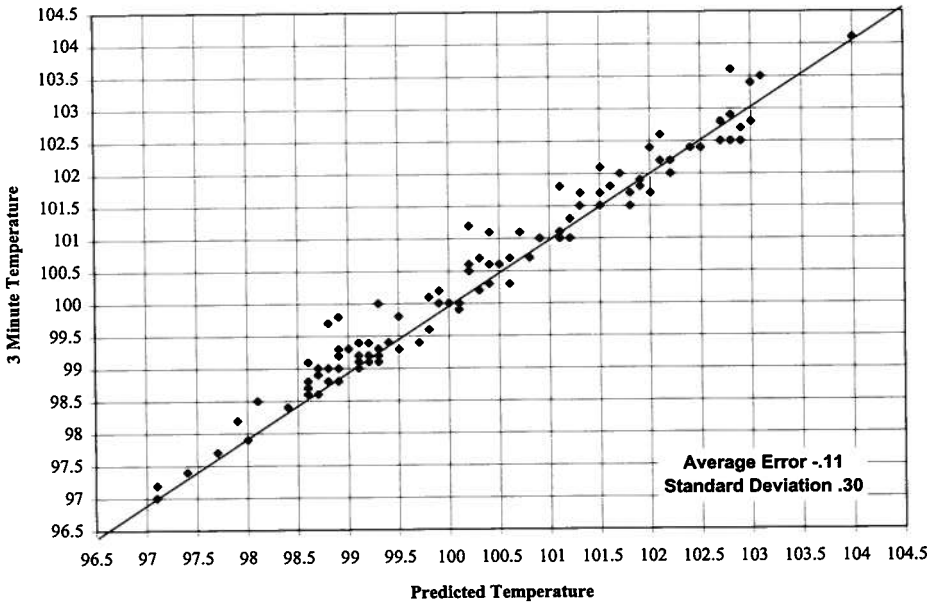
SureTemp vs 3 Minute Oral Temperature



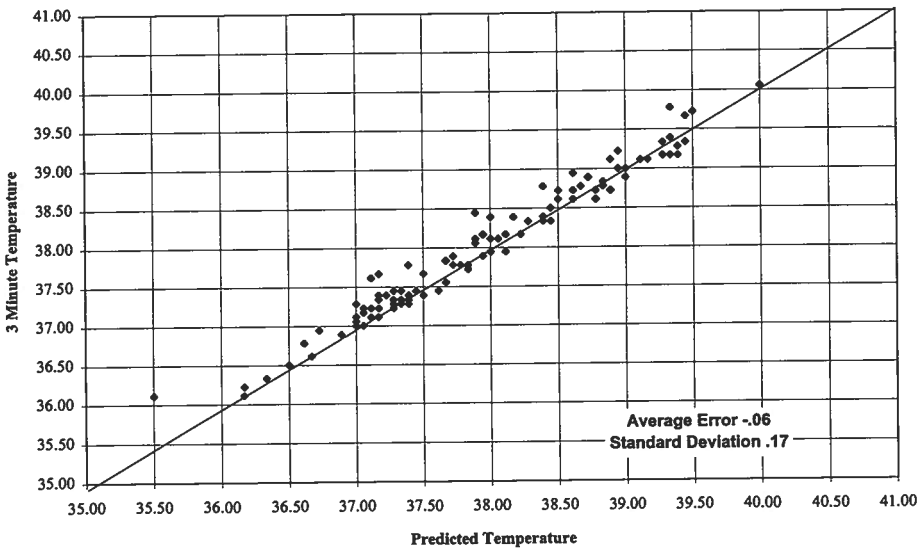
SureTemp vs 3 Minute Oral Temperature



SureTemp vs 3 Minute Rectal Temperatures



SureTemp vs 3 Minute Rectal Temperature



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