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Application note


# Temperature: Measurement and monitoring in EMS

## Introduction

This application note familiarizes you with the modern techniques and trends in temperature measurement and monitoring in the EMS environment, and the measurements and monitoring capabilities the HeartStart MRx and Intrepid monitor/defibrillatiors.

Temperature is a measure of the body's ability to generate and dissipate heat. In 1861, a German physician Carl Wunderlich measured the armpit (axillary) temperatures of 25,000 people and found the mean to be 37.0°C (98.6°F).[1] Since then, the clinical and diagnostic value of this traditional measurement continues to increase.

Close monitoring and regulation of body temperature is crucial in the care of many types of patients. Used in conjunction with other data, body temperature helps to determine the presence of illness and extent of a patient's response to it. In fact, close monitoring of low body temperature has gained popularity in the prehospital environment for post cardiac arrest induced hypothermia.[2,3]

Monitoring of a patient's temperature is part of the basic assessment of vital signs (temperature, pulse, respiration, and blood pressure). The temperature indicates the body's reaction to the current condition. For example, body temperature can respond to infection, inflammatory processes, exposure to heat or cold, adverse reaction to medications, or other causes.

## Temperature measurement basics

There are different methods and approaches to temperature measurement.

### How temperature is measured

**Direct-reading temperature**
The oldest and simplest method is the direct-reading temperature measurement. It involves placing a sensor close to the body; then, after some time, when the sensor temperature reaches the body temperature, the reading is taken.

**Predictive temperature**
The predictive temperature technique provides reliable temperature estimates within a second of the application, while the direct-reading methods take up to several minutes to report the measurement.

In the predictive mode, the thermometer senses the rate at which the temperature is changing and displays the predicted value before the sensor actually reaches that temperature. This method is based on the fact that if a cold sensor contacts a hot body, the hotter the body is, the faster the sensor heats up. Therefore, the hot body temperature can be extrapolated from the rate of the sensor heating (see Figure 1).

Temperature of the sensor at moment **A** predicts the body temperature, while the traditional direct-reading method has to wait until moment **B** when the sensor temperature reaches the body temperature

**Remote temperature measurement**
Infrared thermometers measure temperature using infrared radiation emitted from the body. This method is fast and allows remote measurement, but is not very precise and prone to user error.

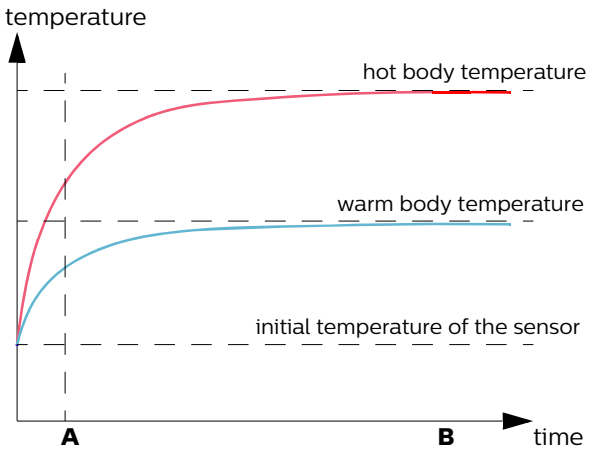


**Figure 1: Predicting Temperature.**

### Where temperature is measured

Temperature is measured at different body parts, depending on:

- Patient age
- Patient condition
- Medical necessity

In some situations, like prehospital post cardiac arrest induced hypothermia, or frostbite, simultaneous temperature monitoring of several sites may be useful.[3]

**Core body temperature**
Core body temperature (CBT) is the temperature of the deep tissues of the body like the heart, brain, and other vital organs. Although it is more difficult to measure than surface temperature, CBT is the most reliable thermal indicator of the body's condition. Skin surface temperature is not core and has a larger margin of error.

**Spot check vs. continuous monitoring**
Spot check temperature measurement means the temperature is measured only at the moments when the clinician takes the measurement.

Only about 10% of EMS temperature data are continuous monitoring (in comparison with 33% in the hospital environment). However, temperature is continuously monitored during induced hypothermia.[2,3]

Table 1 shows some of the typical locations for temperature measurement and related characteristics in the EMS setting.

| Body part or site | Typical purpose | Variation from CBT[6] | Advantages | Drawbacks | Reliability |
|---|---|---|---|---|---|
| Abdomen / skin surface | Infants and neonates | < 1.2°C | Easy access in infants and small children | Indicator of skin temp, not CBT | Dwell time is important for accuracy |
| Axilla (armpit) | Children under 5 years old | < 1.2°C | Easy access, familiar | Indicator of skin temp, not CBT | Dwell time is important for accuracy |
| Esophagus[4] | Cardiac arrest and multi-system trauma patients (including head injuries) | Close | Allows continuous monitoring. Usable for induced hypothermia treatment. | Temperature affected by eating, drinking, etc. Catheters may form into a U-shape in swallowing | Probe should be inserted at the same level as the heart |
| Groin | Infants and neonates | < 1.2°C | Easy access in infants and small children | Requires leg to be drawn up against abdomen | Dwell time is important for accuracy |
| Oral (mouth) | Instant clinical use in adults and children over 5 years old | < 0.4°C | Easy access, familiar, minimally invasive | Temperature affected by eating, drinking, etc. | Requires continuous sublingual placement |
| Tympanic membrane (ear) | Used during anesthesia, routinely at accidental hypothermia | Close | Reflects brain temperature; fast | May be uncomfortable | Variable |

**Table 1: Typical temperature measurement locations for EMS.**

The following temperature measurement locations are characteristic of hospital settings:

- Nasopharynx – During anesthesia
- Rectum – The standard, especially in pediatric patients
- Toe – ICU, incubators
- Vein, bladder, pulmonary artery – In surgery and emergency or critical care[4,5]

## Temperature measurement equipment

Table 2 presents and evaluates four types of temperature sensors and probes available in the healthcare industry.

| Type | Description |
|---|---|
| Mercury | The oldest type. Risk of breaking; not safe for the patients and environment. In rapid decline. |
| Infrared | Convenient, fast, and often non-contact (remote); however, presents a significant risk of user error. |
| Digital | Largest segment. The sensor is combined with the display as a single device. |
| Electronic | Clinically trusted, meets continuous temperature monitoring needs in hospitals and EMS. The sensor is separated from the display device. |

**Table 2: Types of sensors and probes.**

The HeartStart MRx and Intrepid monitor/defibrillators offer both spot check and continuous temperature monitoring using a number of different electronic sensors and probes. Please consult your device Instructions for Use for a list of the temperature probes and cables validated for use with each monitor/defibrillator model To find out the many different options available, contact your authorized Philips representative.

At Philips Healthcare, all reusable probes plug directly into the device, while all disposable probes use an extension cable with a 2-pin connector.

### EMS temperature measurement with HeartStart MRx and HeartStart Intrepid

The HeartStart MRx and HeartStart Intrepid offer:

- A range of locations, including skin, nasal, bladder, rectal, esophageal, arterial, venous
- A temperature range from 0°C to 45°C
- Alarm increments as small as 0.1°C
- Numerical and trend views
- MRx only: Site labels clearly displayed on the screen
- A choice of Fahrenheit or Celsius scale
- A wide variety of compatible probes and sensors

## Conclusion

Temperature measurement and monitoring is an essential function of EMS. The prehospital post cardiac arrest induced hypothermia treatment makes it even more important.

Philips Healthcare provides a variety of temperature measurements and monitoring capabilities that can meet your patient care needs.

## References


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