PASSIVE WARMING OF AIRWAY GASES (ARTIFICIAL NOSE) IMPROVES ACCURACY OF ESOPHAGEAL TEMPERATURE MONITORING

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ABSTRACT. The most efficient site for monitoring heart and lung sounds by esophageal stethoscope is not the warmest segment of the esophagus. This study investigated the ability of passive warming of airway gases to increase the accuracy of temperatures measured at this site (i.e., to decrease their difference from core temperature). In 15 adult patients undergoing general anesthesia and endotracheal intubation, esophageal temperatures were measured before and after use of a heat and moisture exchanger (an artificial nose) that passively warmed inspired gases. The resulting values were compared with nasopharyngeal temperatures, which represented core temperature. Before use of the heat and moisture exchanger, esophageal and nasopharyngeal temperatures differed significantly (mean difference ± SD, 0.9 ± 0.4°C; P < 0.001). After passive warming of inspired gases, esophageal temperatures increased significantly (mean increase ± SD, 0.5 ± 0.2°C; P < 0.001) but inconsistently (range, 0.1 to 1.2°C). However, the mean difference between esophageal and nasopharyngeal temperatures was still significant (0.5 ± 0.3°C; P < 0.001). Discrepancies between esophageal and core temperatures persist when a currently available esophageal stethoscope with adjacent auscultation chamber and temperature probe is used, despite passive warming of airway gases.


Monitoring body temperature is common practice during anesthesia. Numerous sites (the nasopharynx, axilla, rectum, tympanic membrane, bladder, and esophagus) have been used for this purpose [1]. Recently, temperature probes have been incorporated into esophageal stethoscopes. Unfortunately, because of the temperature gradient along the length of the esophagus, the site most efficient for auscultation (i.e., the location where both heart and lung sounds are most audible, called “best sounds”) is not the site of the most clinically useful temperature (i.e., the temperature most closely resembling that in the heart and the brain) [2].

To be more useful clinically, the temperature probe of the esophageal stethoscope must better reflect core temperature when the probe is placed where heart and breath sounds are loudest. There are at least two possible ways of improving the relationship between core and esophageal temperatures. One could increase airway temperature to limit cooling of the esophagus by airway gases. Kaufman [2], however, suggested that measured esophageal temperatures would be artificially high if inspired gases were actively heated with a heater-humidifier. This likely tendency for overestimation effectively limits this alternative to passive heating.
Another possible solution would be to redesign the temperature probe so that it would be more distal in the esophagus.

This study tested a variation on the first approach: We passively warmed airway gases and then measured esophageal temperature at the site of best sounds. Using nasopharyngeal temperature to represent core temperature, we determined whether warming of airway gases influenced temperature measured in the esophagus.

**METHODS**

We obtained institutional review board approval to study 15 adult patients undergoing general anesthesia and endotracheal intubation and obtained informed consent from each patient. Anesthesia was maintained with nitrous oxide–oxygen and isoflurane. Ventilation was adjusted to maintain eucapnia as confirmed by mass spectrometry. After intubation, we inserted an 18-French esophageal stethoscope (Hi-Lo, Mallinckrodt, St Louis, MO) with a temperature sensor located within the hollow tip of the esophageal stethoscope, approximately 1 cm distal to the auscultation chamber of the probe (greatest amplification of heart and breath sounds). The thermistor was attached to a device that allowed temperature to be displayed on a monitor (Datascope 2000, Datascope Corp, Paramus, NJ) in the operating room. As usually occurs clinically, the anesthesiologist adjusted the position of the esophageal stethoscope to achieve satisfactory heart and breath sounds. A second temperature probe was placed transnasally into the nasopharynx to a depth approximating the external auditory meatus surface landmark. The temperature of the nasopharynx (representing core temperature) was displayed on the second temperature channel of the monitor. The positions of the esophageal stethoscope and nasopharyngeal probe were not changed during the study.

For each patient, we allowed 20 minutes for equilibration of temperature before recording esophageal and nasopharyngeal temperatures. We then attached a heat and moisture exchanger (Edith 1000, Engstrom, Lincolnshire, IL), an artificial nose, to the endotracheal tube between the mass spectrometer sampling site and the flanged endotracheal tube adapter. After a second 20-minute period of equilibration, we again recorded nasopharyngeal and esophageal temperatures. For each patient, we recorded four consecutive measurements separated by 20-minute periods of equilibration. During two measurements the heat and moisture exchanger was in place, and during two measurements it was not. Differences in temperature were subjected to analysis of variance and paired t-test to determine significance.

**RESULTS**

The Figure shows the difference between mean esophageal and nasopharyngeal temperatures before and after placement of the heat and moisture exchanger and, for each site, the differences obtained by comparing the temperatures before and after placement of the heat and moisture exchanger.

Before placement of the heat and moisture exchanger, differences in temperatures measured at the nasopharyngeal mucosa and the esophagus ranged from 0.3 to 1.7°C (mean difference, 0.9 ± 0.4°C, P < 0.001) (see Figure). After placement of the heat and moisture exchanger, esophageal temperature increased significantly (P < 0.001), the mean increase being 0.5 ± 0.2°C (range, 0.1 to 1.2°C) (Table). Ten of 15 patients had increases of at least 0.5°C. In contrast, nasopharyngeal temperature did not change significantly. Despite the increase in esophageal temperature associated with the use of the heat and moisture exchanger, the mean difference between nasopharyngeal and esophageal temperatures (0.5 ± 0.3°C) was still significant (P < 0.001).

**DISCUSSION**

Body temperature is monitored continuously in most patients during general anesthesia. Each of the sites commonly used for monitoring reflects core temperatures (i.e., the temperatures of the brain and the heart)