Figure 11-59 Colourimetric capnographers.

Figure 11-60 A capnometer.

should see corresponding chest expansion. Increased resistance (decreased ventilation compliance) during ventilations may indicate gastric distension, esophageal intubation, or tension pneumothorax. Any of these conditions warrant immediate reassessment and corrective action.

End-tidal carbon dioxide ($ETCO_2$) detectors detect the presence of carbon dioxide in exhaled air. Because carbon dioxide is not present in the esophagus, use of the $ETCO_2$ detector is a very reliable method for confirming proper tube placement and is a *mandatory* method to confirm endotracheal tube placement in the prehospital setting. $ETCO_2$ detectors may be colourimetric, digital, or digital/waveform. A capnographer attaches in between the ET tube and bag-valve-mask device. It contains colourimetric paper, which should turn yellow during exhalation, indicating proper tube placement **Figure 11-59** ▲. A capnometer performs the same function and attaches in the same way as a capnographer, but provides a readout of the patient's exhaled carbon dioxide **Figure 11-60** ▲. Ongoing assessment with digital capnometry is an excellent indicator of continued correct placement of the ET tube, especially in the back of a moving ambulance, where breath sounds are often difficult to hear. If the patient's $ETCO_2$ begins to fall, it should alert you that a problem exists, such as inadvertent ET tube displacement or inadequate ventilation. Note that capnography may be inaccurate in patients with cardiac arrest, who are severely acidotic and only eliminating minimal carbon dioxide.

The steps for performing $ETCO_2$ detection are listed here and shown in **Skill Drill 11-26** ▸.

1. Detach the ventilation device from the ET tube **Step 1**.
2. Attach an in-line capnographer or capnometer to the proximal adapter of the ET tube **Step 2**.
3. Reattach the ventilation device to the ET tube, and resume ventilations **Step 3**.
4. Monitor the capnographer or capnometer for appropriate reading (appropriate colour change or digital reading) **Step 4**.

The $ETCO_2$ detector should be in place as soon as the ET tube is inserted to help confirm correct tube placement.

Although $ETCO_2$ detection is useful to confirm tube placement, quantitative measurement of $ETCO_2$ is more useful clinically. Many portable monitor/defibrillators used in the prehospital setting can display a numerical real-time measurement of exhaled $ETCO_2$. This numeric value is clinically relevant. Prehospital studies have shown that inadequate or excessive ventilation of intubated patients can lead to hypercarbia or hypocarbia. The abnormally high or low $ETCO_2$ is potentially harmful. Once a patient is intubated, close monitoring of $ETCO_2$ helps direct the rate of ventilation and tidal volume to prevent hypocapnia and hypercapnia. Failure to properly monitor $ETCO_2$ and maintain it in the appropriate range is known to be harmful and can lead to poor patient outcome. This is particularly true in patients with closed head injuries. Protocols that target prehospital ventilation and prevent hypocapnia and hypercapnia are just as important as providing supplemental oxygen and monitoring oxygen saturation to prevent hypoxia. Monitoring the $ETCO_2$ waveform is now also recommended for intubated patients throughout the periarrest period of a cardiac arrest resuscitation. The waveform helps monitor CPR quality and can detect a return or loss of spontaneous circulation by increases or decreases in $ETCO_2$, respectively. Paramedics performing tracheal intubation should know if their monitor measures quantitative $ETCO_2$ and whether their local or regional protocols have $ETCO_2$ target ranges for patients who are intubated and ventilated.

The esophageal detector device (EDD) is another method of helping confirm proper ET tube placement. The EDD is a bulb or syringe with a 15/22-mm adapter. With the syringe model, the syringe is attached to the end of the ET tube and the plunger is withdrawn, creating negative pressure **Figure 11-61** ▸. If the tube is in the trachea (which has rigid, noncollapsible walls), air is easily drawn into the syringe and the plunger does not move when released. Unlike the trachea, however, the esophagus is a flaccid, easily collapsible tube. Thus, if the tube is in the esophagus, a vacuum is created as the EDD's plunger is withdrawn and the plunger moves back toward zero when released.