the device we tested. This experience has been replicated by one of our authors on 2 episodes with no adverse effects except for some tiring of the diaphragm and a mild sensation of suffocation. We are fairly confident that positive pressure ventilation through either our device or through the ballpoint pen described by Adams and Whitlock would allow for sufficient oxygenation to an average-sized adult to prevent hypoxic cardiac arrest or cerebral injury if the patient's pulmonary and cardiac function is otherwise preserved. Using supplemental oxygenation and allowing the patient to exhale through their mouth or nose would further facilitate the use of these small diameter tubes for oxygenation and ventilation.

As Adams and Whitlock describe in the case report portion of their study, the most important considerations in improvisational cricothyroidotomy is having a tube, getting the tube into the trachea, and creating or allowing the patient to achieve some air exchange. Important secondary considerations include one's ability to attach a bag valve device to the tube, secure the tube to the patient's neck, and avoid injury to the posterior wall of the trachea. Although air exchange is certainly easier with larger internal diameter tubes, we believe that devices with internal diameters as small as 3.5 mm would allow for acceptable levels of oxygenation given the pressure gradient achieved using bag valve or mouth-to-tube ventilations. When faced with a patient with a failed airway without a 6.0 cuffed endotracheal tube or a sports bottle straw, we encourage practitioners to put an IV spike and drip chamber or a trimmed ball point pen into a patient's neck.

Timothy F. Platts-Mills, MD
Department of Emergency Medicine
University of California, San Francisco
Fresno, CA, USA

Matthew R. Lewin, MD
Division of Emergency Medicine
University of California, San Francisco
San Francisco, CA, USA

References

1. Fisher JA. A "last ditch" airway. *Can Anes Soc J.* 1979; 26(3):225-230.
2. Adams BD, Whitlock WL. Bystander cricothyroidotomy performed with an improvised airway. *Military Medicine.* 2002;167(1):76-78.
3. Platts-Mills TF, Lewin MR, Wells J, Bickler P. Improvised cricothyrotomy provides reliable airway access in an unembalmed human cadaver model. *Wilderness Environ Med J.* 2006;17(2):81-86.

A Cost-Effective Simulation Model for Surgical Airway Placement

To the Editor:

We hold an annual continuing medical education event that challenges providers to perform a number of simulated emergency procedures.¹ The event occurs in a wilderness setting with simultaneous supervision and monitoring of a relatively large number of learners. Typically, participants are required to demonstrate airway management including acquiring a surgical airway. The course participants have a large variation in experience and training and include non-medical personnel, EMT/paramedics, nurses, medical students, residents, and attending physicians. In order to run this course we have created an airway model that allows learners to perform a surgical airway. This model is inexpensive and allows rapid turnover. It is easily constructed and offers reasonable anatomic verisimilitude. We offer it here as a suggestion to other instructors who have similar needs and a limited budget.

We used Styrofoam mannequin heads, corrugated polyethylene respiratory tubing, foam pipe insulation, foam tape, and ketchup packets (Figure 1) to create our model. The corrugated tubing approximates the adult trachea, with the corrugations simulating tracheal rings. Sections of the pipe insulation simulate the thyroid cartilage. Strips of foam tape serve to hold the tracheal portion of the model in place and to simulate the overlying skin and soft tissues. The ketchup packets provide additional soft tissue and simulated bleeding.

To construct the model, a 3-inch section of the corrugated tubing is cut to create a trachea and is covered by a ketchup packet. A 1-inch section of pipe insulation is placed over the ketchup packet, holding it in place, creating the simulated airway (Figure 2). The airway is placed in a channel cut into the neck portion of the mannequin and covered with foam tape (Figure 3).

Ideally a novice provider will practice a surgical airway before performing this procedure on an actual patient. Methods of practice include the use of high-fidelity simulators, cadaver labs, and live-animal models. Purchase of a simulator on which multiple procedures can be performed may cost from \$5000 to 30 000 (Medical Education Technologies Inc; [888]462-7920, 6000 Fruitville Rd, Sarasota, FL 34232; Simulab Corp, [206]297-1260, 1144 NW 52nd St, Seattle, WA 98107). The same simulator may be rented for \$600 to \$800 for a several-day course. The cost of an animal or cadaver lab will vary between institutions. At our facility it costs between \$800 and \$1200 to run a single-afternoon pig lab. This method uses live tissue but is time intensive and only

Figure 1. The necessary equipment.

Figure 2. Construction of the tracheal portion of the model.

Figure 3. Mounting the tracheal portion.

Figure 4. The model in use.

allows 1 cricothyroidotomy per animal. Special procedure courses may use cadavers at a cost of \$275 to \$325 per student (The Emergency Medicine Procedure Course, Premier Health Care Services Educational Division, [937]312-3627, 332 Congress Park Dr, Dayton, OH 45459), again with the limitation of 1 procedure per cadaver.

Our model offers several advantages in terms of cost and convenience. The heads can be purchased by mail order for \$3.95 (Display Forms, [888]421-4241, PO Box 2288, Whittier, CA 90610-2288; www.valuedisplay.com). Enough tubing and foam tape was provided by the hospital to build 60 models. Using prices given to us by the hospital supply office we placed their total value at \$34.26. A medical student obtained the ketchup packets free at a fast-food establishment, but their cost was estimated at \$2. We estimate the average unit cost at \$4.60. Furthermore, multiple uses can be accomplished simply by replacing the tracheal portion of the model (cost, \$0.65).

The ideal method to teach surgical airway skills is in real time with the direct supervision of experienced providers. An emergent cricothyroidotomy is a rare procedure, and prudence dictates that a novice should have practiced the procedure prior to actually performing it.

We offer our model as an inexpensive way to provide a large number of students with an opportunity to per-

Figure 5. The result of 3 hours work.

form their initial cricothyroidotomy (Figure 4). In our situation, this model allowed us to test 60 participants nearly simultaneously using 15 preceptors, each supervising 4 airway stations (Figure 5). In this manner, every member of a typical first-year medical school class could perform a simulated surgical airway in an hour at a cost of less than \$300 for a first-time set-up. Subsequent sessions could be run for less than \$70.

Our model is not intended for more experienced providers. It does not offer the challenge or accuracy of a cadaver or simulator. It does provide a relative approximation of the anatomic structures pertinent to the performance of the procedure. It allowed us to rapidly take

a large group of learners through a procedure that is usually practiced at a much higher cost.

David Ledrick, MD, MEd, FAAEM

Michael Omori, MD, FACEP

Toledo, OH, USA

Christopher Calvert, MD

Dayton, OH, USA

Reference

1. Ledrick D. The Medical Wilderness Adventure Race (MedWAR): a 2-year perspective on a unique learning experience. *Wilderness Environ Med.* 2003;14:273–276.