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Techniques and Procedures

AN INEXPENSIVE ESOPHAGEAL BALLOON TAMPONADE TRAINER

Timothy P. Young, MD, Heather M. Kuntz, MD, Bradley Alice, MD, Jon Roper, MD, and Mike Kiemeney, MD

Department of Emergency Medicine, Loma Linda University Medical Center, Loma Linda, California

Corresponding Address: Timothy P. Young, MD, Loma Linda University Medical Center, Emergency Medicine, 11234 Anderson Street, A108, Loma Linda, CA 92354

□ **Abstract—Background: Emergency medicine practitioners must be able to perform rare, life-saving procedures. One such example is esophageal balloon tamponade, which is complex, fraught with complications, and difficult to demonstrate and practice. Discussion: We constructed a simple, inexpensive model esophagus and stomach that we attached to a mannequin, allowing emergency medicine residents to visualize and practice esophageal balloon tamponade device placement. Conclusion: Our esophageal balloon tamponade model was easy to construct and allowed demonstration, conceptual visualization, and simulated performance of the procedure. © 2017 Elsevier Inc. All rights reserved.**

□ **Keywords—esophageal balloon tamponade; esophageal varices; medical education; simulation**

INTRODUCTION

Emergency medicine practice requires the ability to perform infrequent, life-saving procedures. Clinical practice alone is unlikely to offer sufficient opportunities to teach and practice these skills. Simulation models offer one solution to this problem and can provide trainees with planned, hands-on learning opportunities.

One such procedure is the placement of an esophageal balloon tamponade device (1). This can be a life-saving maneuver when other methods of upper gastrointestinal hemorrhage control fail or are unavailable. Major complications of esophageal balloon tamponade devices have been reported, mostly because of inadvertent inflation in other structures (2–6). This makes opportunities to learn and practice the procedure important. The mechanics of tube placement are complex and require that the operator pass the gastric balloon distal to the esophagus into the stomach, inflate the balloon, then retract the balloon to engage the cardia and fundus of the stomach and provide tamponade of bleeding vessels. If necessary, the esophageal balloon is then inflated to tamponade bleeding from esophageal vessels. It is critical that the gastric balloon be inflated inside the thick-walled stomach; the large size of the balloon can cause other structures to rupture.

Recently, several well-made videos have appeared online describing placement of multiple types of balloon tamponade devices (7,8). While these videos allow for conceptualization and visualization of balloon placement, they do not offer the opportunity for guided practice and feedback. Guided practice is especially important when learning to retract the gastric balloon against the stomach. We have found the procedure to be difficult to teach because of the inability to demonstrate this crucial step. We are unaware of any commercially available models made expressly for the purpose of teaching esophageal balloon tamponade. We created an inexpensive model and describe it below.

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Figure 1. The esophagus and stomach model.

THE MODEL

The stomach was constructed from a clear 1-L beverage bottle (Glacéau Smartwater, Coca-Cola Company, Atlanta, GA) cut in the middle (Figure 1). Based on the average diameter of an adult esophagus, 1-in inner diameter vinyl tubing was used for the model esophagus (9). Semirigid material was chosen to support retraction of the inflated balloon and allow simulation of pressure tamponade. A zip tie secured the tubing to the bottle. The esophagus was cut to a length of 4 in, which allowed it to span the distance to the mannequin diaphragm. A short stretch of rigid 1-in PVC pipe was used to allow connection to the partial mannequin esophagus. The total cost for the materials was less than $10.

Emergency medicine residents placed a Minnesota esophageal tamponade device through the clear esophagus, which allowed visualization of the procedure as balloons were inflated and the tube was retracted (Figures 2 and 3) (10). This helped to conceptualize the mechanics of the procedure.

We used our model with a Laerdal NG Tube and Trach Care Trainer (Laerdal Medical, Wappingers Falls, NY). We imagine that with modification, the model could be adapted to any other mannequin or mannequin head that has a partial esophagus. We have also used our model with a Trucorp Airsim mannequin head (Trucorp Ltd., Belfast, Northern Ireland). The vinyl tubing can be cut to a length suitable for the mannequin with which it is used. Alternatively, the model can be used without a mannequin by leaving the tubing longer. If the model were to be used without a mannequin, a reasonable esophageal length would be 9 in (11).

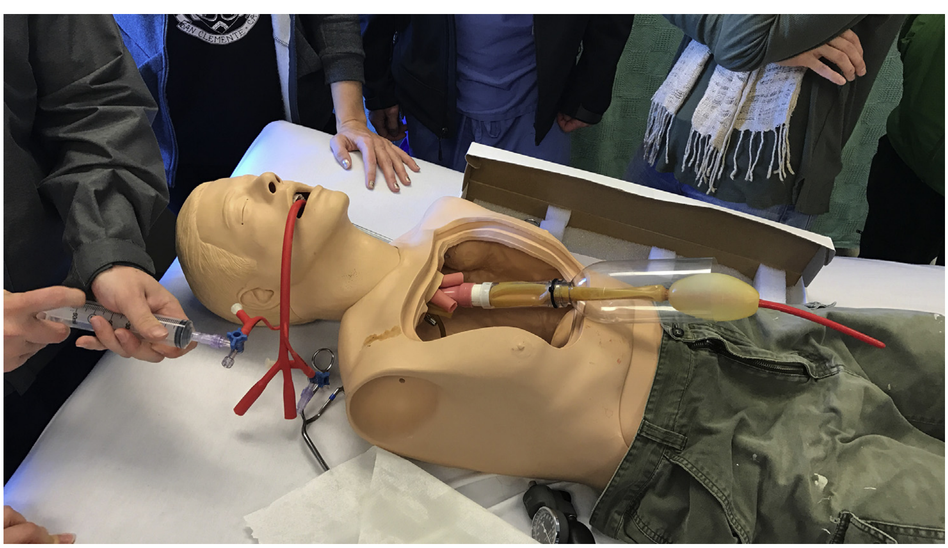

Figure 2. Inflation of the gastric balloon.

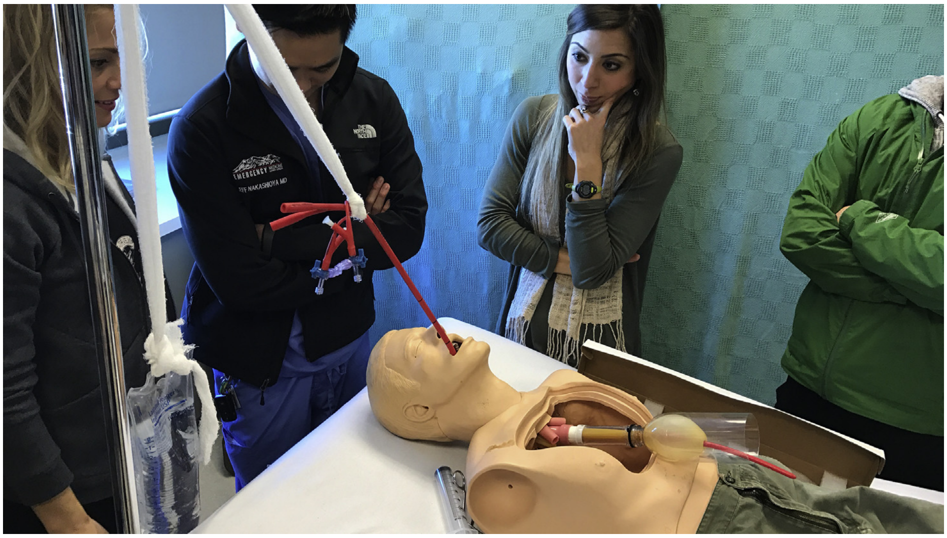

Figure 3. Completion of the procedure.

DISCUSSION

Like other low-cost models built by physician educators, our esophageal balloon tamponade model offers a cost-effective means of practicing a difficult procedure outside of the clinical environment (12–14). Perhaps equally as important, the transparent construction allows learners to see the entire procedure. Motor learning is facilitated by input from multiple senses (15). Unlike live placement, our model provides learners with the opportunity to see the crucial steps of the procedure and develop a visual understanding of the entire process. Complications are often related to balloon misplacement, so understanding of the placement process for this procedure is critical. Inadequate inflation can lead to migration of the gastric balloon into the esophagus, resulting in extrinsic airway compression and obstruction (16,17). The gastric balloon can also damage structures past the stomach if the tube is inflated too distally (4,18). Our model allowed learners to see when the tube was positioned improperly or the gastric balloon was not adequately inflated. Our method of balloon inflation was to use a syringe and 3-way stopcock to draw in air from the environment and then direct it to the balloon. We discovered that this technique allowed air to escape and the balloon to deflate slightly if the stopcock was turned too slowly. When this occurred, residents had immediate visual feedback and were able to adjust their technique. Because of the importance of placement confirmation before inflation, many sources recommend a chest radiograph before complete gastric balloon inflation. However, the chest radiograph must be interpreted correctly to detect malposition. Esophageal rupture has been reported when the gastric balloon was inflated in the esophagus even though its position was visible on a chest radiograph (5). The clear construction of our model facilitated understanding of the importance of balloon location confirmation before inflation. The activity was used as a springboard to review images of correct and incorrect placement that could be correlated to the anatomy of the model.

CONCLUSION

Our esophageal balloon tamponade model was inexpensive and allowed complete demonstration and simulated performance of a rare, life-saving procedure. The transparent construction allowed trainees to use visual feedback to optimize their understanding and performance of the technique.

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