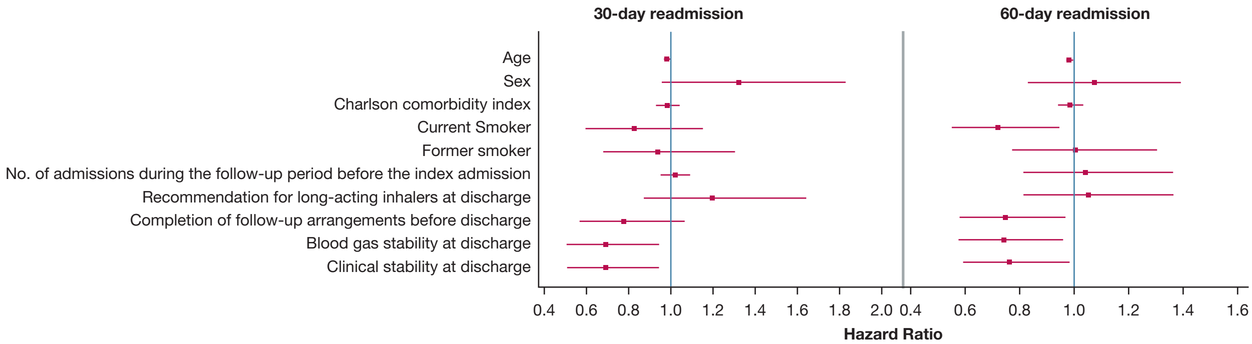

Figure 2 – *Forest plot showing ORs of different risk factors associated with readmission within 30 and 60 days after discharge.*

be modified by health systems to reduce early readmissions and hence decrease morbidity and the economic burden of COPD.

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A Simple, Inexpensive Phantom Model for Intubation Ultrasonography Training

CrossMark

VIDEO

To the Editor:

Intubation ultrasonography is used to localize an endotracheal tube in the trachea or esophagus.[1-4] We have developed phantoms that simulate the ultrasound appearance of esophageal and tracheal intubations.

Beef gelatin powder (90 mL) and 60 mL of orange-colored psyllium fiber (Metamucil sugar free; P&G) were added to 500 mL of boiling water. Once thickened, the mixture was poured into a 1-L container and refrigerated overnight at 4°C.

Two staggered holes were created 1 cm apart, using a 10-mL syringe with the tip cut off (Figs 1A-1C). One of the gelatin cores was re-introduced into the "esophagus" hole (Fig 1D).

A 250-mL volume of ballistic medical gelatin #3 (Clear Ballistics) was melted for 15 min in a crockpot. Psyllium fiber powder (5 mL) and 45 mL of ballistic gelatin dye (Clear Ballistics) were then added. Ten milliliters of this mixture was poured into a 10-mL syringe with the tip cut off, and the remainder was poured into a 1-L container. Because of the stiff consistency of the ballistic gelatin, the syringe could not be used to create the core holes. Instead, two felt markers (Crayola) were immediately embedded into the mixture (Fig 1E) and held in place for 3 min. These markers were chosen for their round shape, size

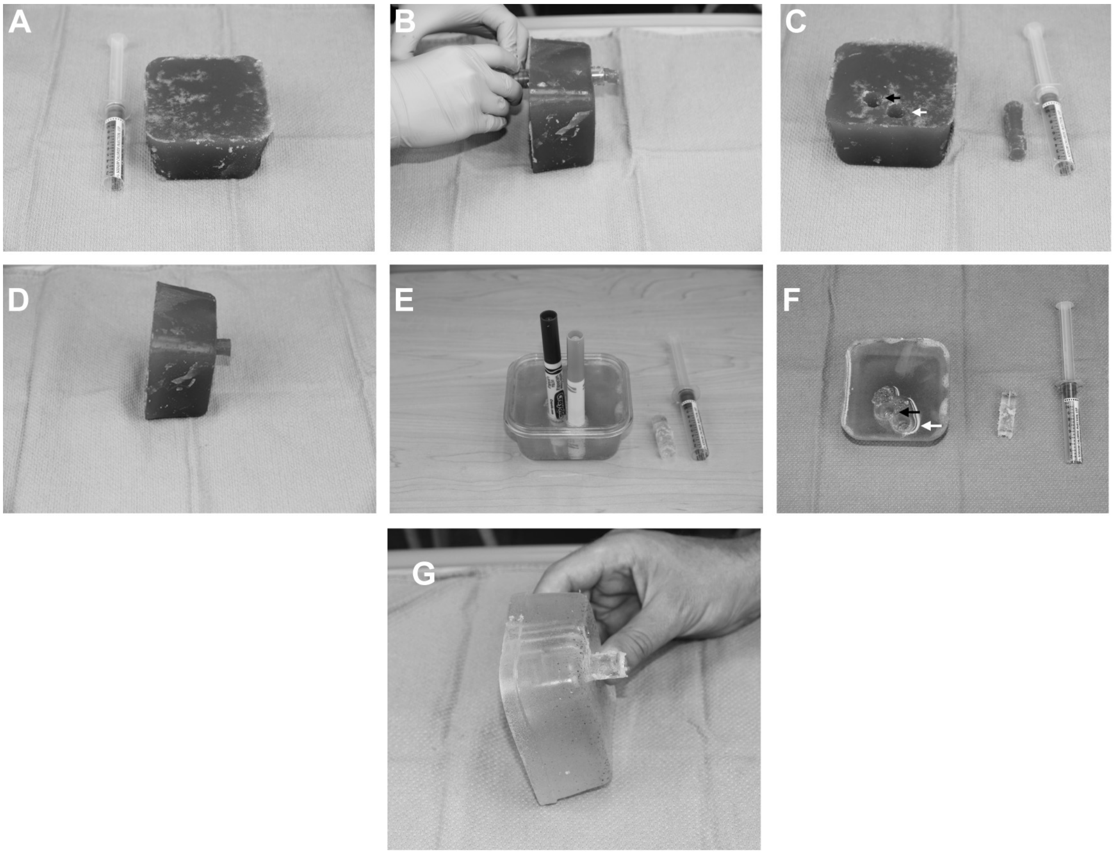

Figure 1 – *Construction of beef gelatin and ballistic gelatin models. A, A beef gelatin and psyllium fiber block, with cutoff 10-mL syringe barrel. B, With cutoff 10-mL syringe barrel being used to create staggered hollow cylinders within the block. C, Block with staggered hollow cylinders, with retained plug from cylinder creation. More superior cylinder is simulated trachea (white arrow), and more inferior cylinder is simulated esophagus (black arrow). D, Plug partial insertion into more inferior cylinder. E, The ballistic gelatin, psyllium fiber, and gelatin dye in plastic container with two felt markers embedded with an offset of 5 mm from each other relative to the container wall. F, The ballistic gelatin model out of the plastic container, with two holes simulating trachea (white arrow) and esophagus (black arrow) with ballistic gelatin plug once removed from the syringe. G, Plug partial insertion into more inferior ("esophagus") cylinder.*

(1 cm), heat resistance, availability, and inexpensiveness. After 60 min, the markers were removed (Fig 1F). The gelatin core was ejected from the syringe and introduced into the "esophagus" hole of the gelatin block (Fig 1G).

With the phantom holes parallel to the table surface (Fig 2A), a linear transducer (14-5 MHz; Zonare) was held in the transverse position while a towel was used to hide the core location (Figs 2B, 2C).

With the gelatin core in the "esophagus" hole, the ultrasound appearance mimicked tracheal intubation (Figs 3A-3C). With the core removed, the ultrasound appearance mimicked esophageal intubation (Figs 3D-3F; Video 1).

Figure 2 – *Ultrasound being performed on the model. A, A linear probe is placed over the side of the model to obtain images in the transverse plane. B, A towel with a square hole of 1 × 3 cm. C, The towel placed over the ballistic gelatin model to hide the location of the plug from the ultrasound operator.*

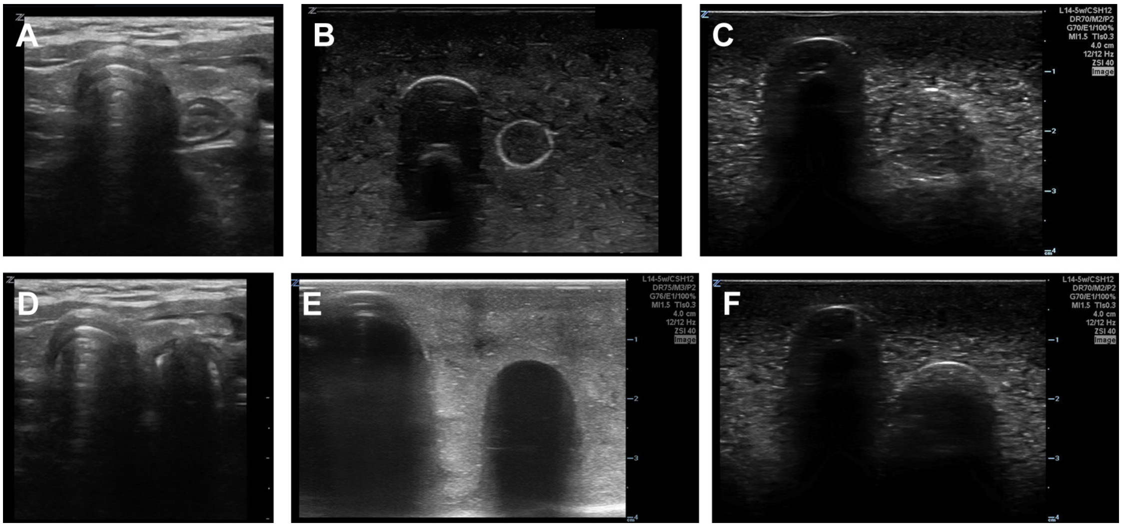

Figure 3 – *Simulating tracheal and esophageal intubation. A, Static ultrasound image of a tracheally intubated patient, with linear ultrasound probe held in transverse orientation over the anterior neck at the level of the sternal notch. B, Static ultrasound image of beef gelatin model with plug inserted into simulated esophagus, simulating the ultrasound appearance of a tracheally intubated patient. C, Static ultrasound image of ballistic gelatin model with plug inserted into simulated esophagus, simulating the ultrasound appearance of a tracheally intubated patient. D, Static ultrasound image of an esophageally intubated patient, with linear ultrasound probe held in transverse orientation over the anterior neck at the level of the sternal notch. E, Static ultrasound image of beef gelatin model with plug removed from simulated esophagus, simulating the ultrasound appearance of an esophageally intubated patient. F, Static ultrasound image of ballistic gelatin model with plug removed from simulated esophagus, simulating the ultrasound appearance of an esophageally intubated patient.*

The beef gelatin model produced better mimicry but was more delicate and lasted only a few days. The ballistic gelatin model had lower fidelity but was more durable and could be stored without refrigeration for several months. Material cost was $5 USD for the beef gelatin model, and $27 USD for the ballistic gelatin model (after international shipping of ballistic gelatin).

Because of its durability and ease of use, we preferred the ballistic gelatin model. The ballistic gelatin could be remelted easily to create other training models for ultrasound-guided procedures, such as vascular access, abscess drainage, biopsies, and nerve blocks. This re-usability seems to justify the higher initial material cost of the ballistic gelatin.

We describe the first intubation ultrasonography phantom. Its low cost and ease of construction will facilitate acquisition of this skillset for ultrasound learners.

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Additional information: The Video can be found in the Supplemental Materials section of the online article.

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