

MAKERSPACE MODEL INSTRUCTIONS

Arizona Simulation Technology & Education Center

Basic Ultrasound IV Trainer

1. OVERVIEW

The Ultrasound Peripheral Line trainer allows educators to teach how to perform ultrasound-guided placement of intravenous (IV) catheters. There are three components to this trainer: the mold base, ballistics gel simulating soft tissue, and latex tubing simulating both deep and superficial blood vessels. This trainer can be used with both novice and experienced learners.

2. EQUIPMENT AND MATERIALS

- A 3D printer with Polylactic Acid (PLA) filament¹
- Chemical fume hood²
- Multicooker³
- Vacuum Chamber
- Scale
- Bar clamps (2)
- Hemostats (2)
- Metal stirrer
- Paint brush
- Syringe (60 mL)
- Clear Ballistics Gel #1 (1.25 L)
- Corn starch (22.5 g)
- 1/4" OD Latex Tubing (2 feet)
- 3/8" OD Latex Tubing (1 foot)
- Flex Seal
- Ease Release Spray

¹These materials are required for making the mold base from a 3D printer. The mold base could also be made using any rectangular container which has been modified to accommodate the latex tubing.

²If you do not have a chemical fume hood, perform these steps in a well-ventilated area.

³Instead of a multicooker, the ballistics gel can be melted in an oven at 250F, checking every 30 minutes to ensure the gel does not heat over 280F.

3. MOLD

The first step is to 3D print the mold.

MATERIALS

- Flex Seal
- 3D printer with Polylactic Acid (PLA) filament
- Paint brush

We use the Ultimaker S7 Pro Bundle 3D printer with PLA filament. The print bed needs to be at least 10 by 10 inches. We have an .stl file available that can be used to print the mold, which takes 13 hours to print.

After 3D printing is completed, spray the mold with Flex Seal under a chemical fume hood. Use the paint brush to ensure the surfaces are completely covered. Allow this to dry overnight.

4. LATEX TUBING

The second step is to prepare the latex tubing, which will simulate the deep and superficial blood vessels of the model.

MATERIALS

- Mold base
- 1/4" OD Latex tubing (2 feet)
- Ease Release
- Paint brush
- Hemostats (2)

Cut about 2 feet of the latex tubing (1/4" OD). Cut a 1" slanted edge on one end and string the tubing across the mold. Make sure the tubing completely seals the holes in the mold base. On one end of the mold base, twist the tubing and clamp with a hemostat. Repeat this process on the other end.

Under the chemical fume hood, spray the tubing and mold with Ease Release. Use the brush to completely cover the surface of the tubing inside the mold base. Allow this to dry at least 5 minutes.

5. BALLISTICS GEL

The third step is to prepare the ballistics gel, which will simulate the soft tissue surrounding the blood vessels.

MATERIALS

- Mold base
- Cornstarch (22.5 g)
- Metal stirrer
- Clear Ballistics Gel #1 (1.25 L)
- Bar clamps (2)
- Ease Release
- Paint brush
- Heat protectant gloves
- Multicooker
- Vacuum chamber

A. MELTING

We recommend using 18 g of cornstarch for every liter of ballistics gel. The amount of ballistics gel needed may vary depending on the mold size. Our model holds about 1 L of ballistics gel; however, we recommend making 1.25 L total. Before beginning the melting process, measure out 22.5 g of cornstarch and set aside. Break apart about 1.25 L of clear ballistics gel #1 into small pieces and place in the multicooker.

In the chemical fume hood, turn on the multicooker to a temperature of 250-270F. Add all the ballistics gel to the multicooker and allow to melt, stirring occasionally. It should take less than 5 minutes to completely melt.

Once the ballistics gel is completely melted, add a small amount of the melted ballistics gel to the cup containing the cornstarch. Mix until combined, and add the cornstarch to the melted gel, stirring until fully combined. This helps to reduce clumps of cornstarch when added to the ballistics gel.

B. VACUUM CHAMBER

To remove all bubbles, place the entire multicooker into the vacuum chamber. Turn the vacuum chamber up to 40 kPa for three to five minutes. Return the multicooker to its heating source. Refrain from stirring, to avoid adding more air to the mixture. Evaluate the mixture by dipping a stir stick in and observing the number of bubbles. Repeat vacuum chamber and heating until bubbles are removed.

If you do not have a vacuum chamber, you can bake the model in an oven after adding the cornstarch at 250F until the bubbles are removed.

C. POURING BALLISTICS GEL

Once the ballistics gel is fully melted and bubbles are removed, use heat protectant gloves, and carefully pour the ballistics gel into the mold. Make sure the gel mixture completely fills the mold. Using a stir stick, quickly scrape off any remaining bubbles on the surface before the clear ballistics gel starts to cure. Before the ballistics gel starts to cure, bar clamp the hemostats to the counter. Make sure the tubing is tight to ensure it does not move. Allow the gel to fully set for a minimum of 12 hours.

6. CREATING A FLUID CIRCUIT

Once the ballistics gel has cured, the fluid circuit can be created which will fill the simulated deep and superficial blood vessels. If there are bubbles on the surface of the cured ballistics gel, we recommend using a heat gun to remove them before creating the fluid circuit.

MATERIALS

- Mold base with tubing and hemostats
- 4" pieces of 3/8" OD Latex tubing (3)
- Syringe (60 mL)
- Water

After the gel has fully set, remove the hemostats and latex tubing from the model. Using the 3/8" OD latex tubing, cut one 6" piece and two 3" pieces to create the fluid circuit.

Connect the longer piece of latex tubing to both ports on one side of the model, creating the closed end of the fluid circuit. On the other end, attach one 3" long piece to each of the ports, creating the open ends of the fluid circuit.

Prepare a 60 mL syringe with water and have a hemostat nearby. Using one of the open ends, push water into the model, until it starts to come out of the other open end. Place a hemostat on both open ends. The model is now ready to use.

7. CONCLUSION

This model provides the opportunity to practice peripheral line placement in blood a superficial and deep blood vessel. To clean and maintain the model, wipe off the ultrasound gel and remove water from the vessels after use. The model can be stored at room temperature.

A. REUSING THE MODEL

This model can be reused with minimal additional materials. Once you have the mold base created, it takes only 2 days to remake the model. Remove the ballistics gel from the model and set aside. Add new ¼" OD latex tubing as described previously and spray with Ease Release. Break apart the ballistics gel and remelt it. There is no need to add more cornstarch. Remove bubbles using the vacuum chamber before pouring into the model, as described above. Once this has set for 12 hours, the fluid circuit can be made as previously described.