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Challenges in Surgical Education

A Dynamic Pericardiocentesis Model for Resident Training

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Background: Cardiac tamponade is a rare and fatal condition caused by excess fluid accumulation in the pericardium. Pericardiocentesis, in which the excess fluid is aspirated through an ultrasound-guided needle, reverses cardiac tamponade¹. Healthcare providers, such as residents, must train on advanced pericardiocentesis training models that mirror real-world scenarios to learn and improve their technique.

Current Challenges: Current models are expensive, time-consuming to assemble, lack considerable reusability, and are physiologically inaccurate, especially when static heart models are used. This leads to suboptimal procedural efficacy, compromised patient safety, and less-than-ideal treatment outcomes.

Need of Innovation: Our prototype was built upon a previous model using ballistics gel, known for its cost-effectiveness, reusability, and time-saving features, but it utilized a static heart model. Our solution introduces a balloon-in-balloon system: the inner balloon, filled with water and red dye, represents the heart and connects to a blood pressure pump; the outer balloon, filled with water, mimics the fluid-filled pericardium; and a container with the balloons encased in ballistic gel simulates the thoracic cavity's soft tissue, all designed to be ultrasound-compatible. This model meets key customer requirements by being more affordable than commercial pericardiocentesis models, easy to assemble, and featuring a dynamic heart for a more realistic experience. To test durability, we used a syringe to puncture the model, observing leakage after 27 punctures. Applying Tegaderm film at the puncture site significantly enhanced reusability, withstanding 63 punctures. Future steps include testing with residents to gather user compatibility data, adding a rib cage model for improved anatomical accuracy, and motorizing the pump to simulate heart function more precisely.

¹ Willner, D. A., & Grossman, S. A. (2023, July 19). Pericardiocentesis. National Library of Medicine.