

Emergency Surgical Airway Simulator (ESAS): A State-of-the-art Task Trainer Combining 3D-printed Larynx-trachea Model and Innovative Approaches for Cricothyroidotomy Training



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Thank You

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Cricothyroidotomy

- Airway and breathing are key focuses in medical simulation training.
 - Patient can die in minutes without effective ventilation.
- All medical professions should acquire basic techniques in airway management and the training need is huge.
- applicable for life-saving purpose when patient “cannot intubate and cannot oxygenate”
- an emergency surgical airway procedure
 - to make an incision in the cricothyroid membrane and insert an endotracheal or a tracheotomy tube into the trachea
 - scalpel finger Bougie technique

Comparison of Models

Before 2019
**Animal Tissue
(Pig Neck)**



Considerations

- Untrue human anatomy
- Unstable market supply
- Logistic concerns
- Hygiene concerns

2019
**First 3D-printed
Larynx-Trachea**



- Based on human Image
- Rigid texture (Difficult to intubate due to high friction)
- Artificially enlarged height of cricothyroid membrane by 30% (to facilitate intubation; lose fidelity)

2020
**Modified 3D-printed
Larynx-Trachea**



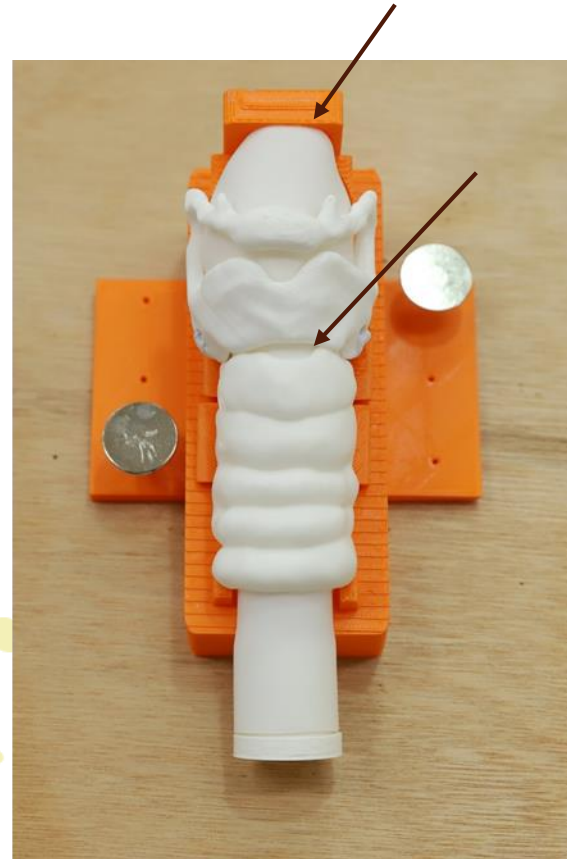
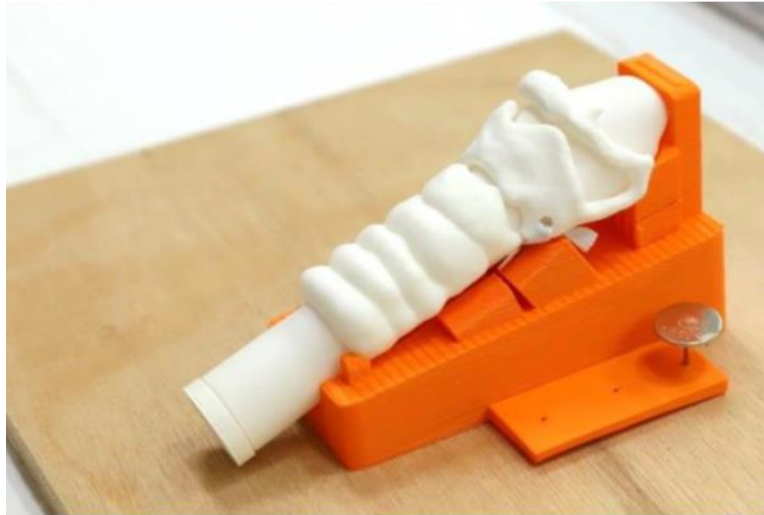
Different printing materials

- PLA - Hard
- PVC-P - Soft (Allow direct puncture)

(simulate closely to human cricothyroid membrane)

- 1.5mm Thickness of model

Final Model



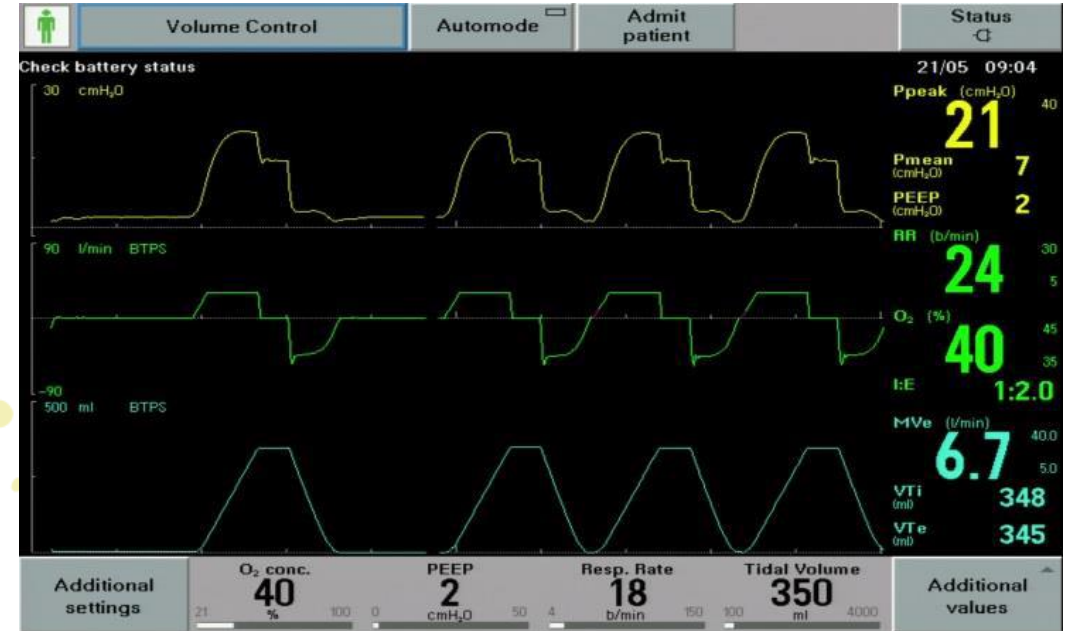
Set-up



Compliance profile of the simulated lung



Test Lung



Our simulated lung

Features of the 3D printed model

- Enhanced Realism with Special Effect
 - Realistic human anatomical model
 - Effect of Bleeding upon skin incision
 - Air gushing-out during cricothyroid membrane incision
 - Effect of chest rise on bagging
 - Fogging within endotracheal tube
- More Hygienic
- Affordable
 - Costs = USD 80/pcs

Trail run



Evaluation

- **Scales of Emergency Surgical Airway Simulator (SESAS-17)**

- developed by multi-disciplinary expert panel
 - Consultant surgeon
 - Consultant anesthesiologist
 - Consultant intensivist
 - Simulation center manager
 - Technician
 - Research officer (Psychometrician)
- maintain content validity and item reliability

- **Result from Trial Run:**

- Invited General Surgeons / surgical trainee (N = 9)
- Showed statistically positive responses on the model
 - mean scores ranged from 4 to 5
 - medians = 5; $p < .001$ for all categories

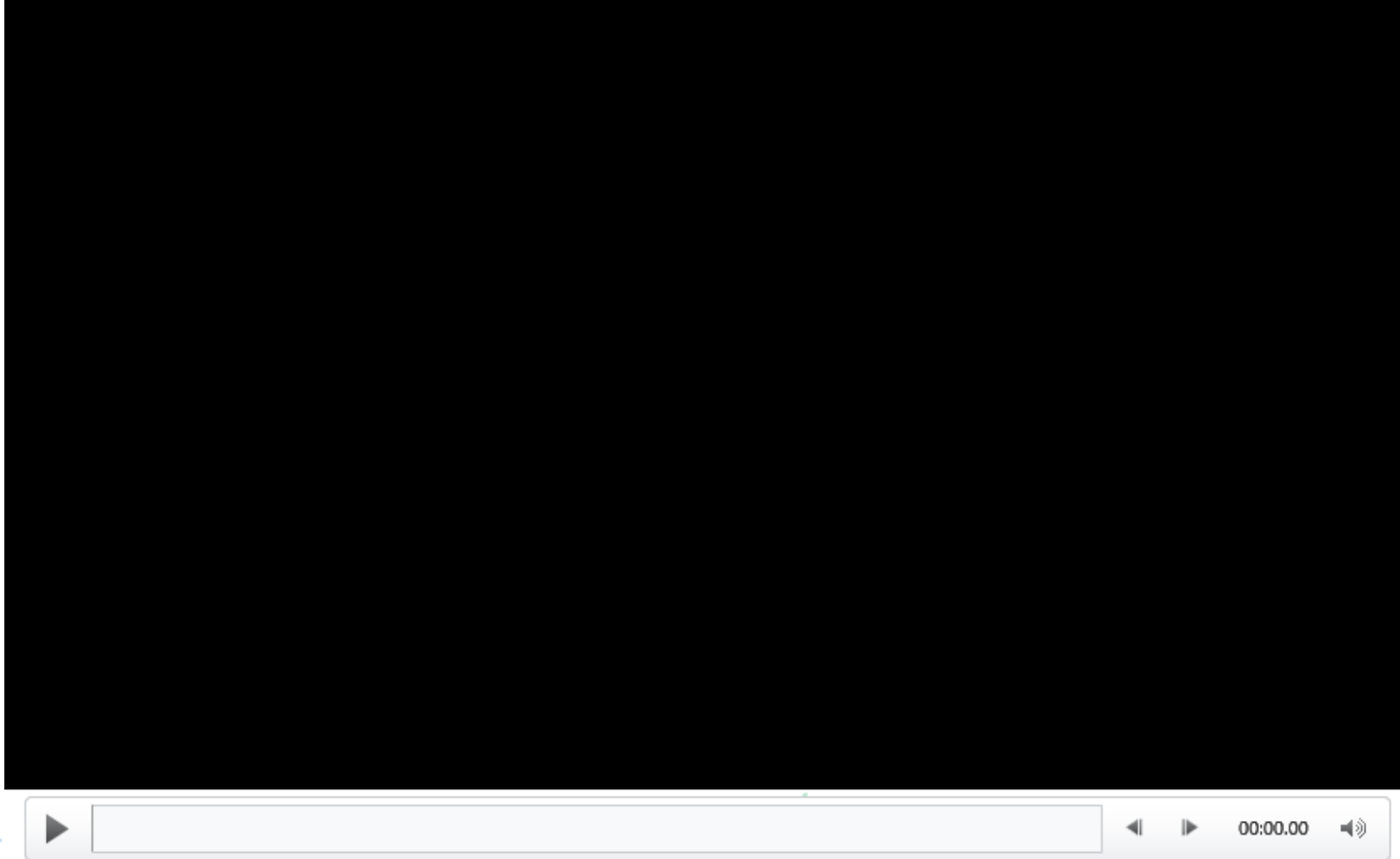
Scales of Emergency Surgical Airway Simulator (SESAS-17)

Please circle the appropriate rating on question #1 to #17

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
01. The airway model is well featured with reference to real human anatomy.	1	2	3	4	5
02. Tactile sensation on bagging is enhanced. It feels like bagging on a real patient.	1	2	3	4	5
03. The model enables clinicians to mimic the whole procedure of surgical cricothyroidotomy.	1	2	3	4	5
04. The effect of air leak upon incision of cricothyroid membrane looks real.	1	2	3	4	5
05. The effect of bleeding after incision of skin looks real.	1	2	3	4	5
06. On bagging after successful intubation, chest rise and fogging of ET tube reassure correct position.	1	2	3	4	5
07. The model is useful in knowledge and skills acquisition.	1	2	3	4	5
08. The model is an effective tool to transfer acquired skills from practice to clinical operation.	1	2	3	4	5
09. With the model, I am capable of conducting performance assessment for trainees. <i>[For Trainer ONLY]</i>	1	2	3	4	5
10. It is easy to handle the model during practice.	1	2	3	4	5
11. I feel confident using this model alone without technical support.	1	2	3	4	5
12. I am overall satisfied with the model.	1	2	3	4	5
13. I will recommend this simulation tool in cricothyroidotomy training to my colleagues.	1	2	3	4	5
14. I prefer the airway model to pig larynx in training.	1	2	3	4	5
15. I prefer the new model to rigid 3D printed model.	1	2	3	4	5
16. The model is safe to use with minimal risk of infection.	1	2	3	4	5
17. This model has low restriction in use. <i>(e.g., I can practice the procedure out of wet lab)</i>	1	2	3	4	5
18. Please apply "✓" if you have experience in using items below: <input type="checkbox"/> Pig larynx-trachea model <input type="checkbox"/> Basic 3D printed larynx-trachea model					
19. Other comments on the model:					
20. Suggestions for improvement:					

This is the end of SESAS-17. Thank you.

Video for Demonstration



Carbon Dioxide Delivery Box




QUESTIONS?



#IMSH2021

SIMULATION: BRINGING LEARNING TO LIFE



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THANK YOU!