

Background

- Endotracheal intubations are performed over 15 million times annually, so it is a critical technique for medical students [1]
- Current teaching strategies for this skill rely on manikins that do not accurately mimic a real-life patient
 - Hard, plastic, unrealistic weight
 - Too easy or too difficult to intubate
 - Not adjustable to simulate diverse anatomies

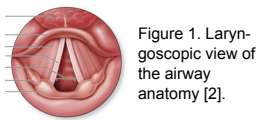


Figure 1. Laryngoscopic view of the airway anatomy [2].



Figure 2. Example of current airway simulation mannikin

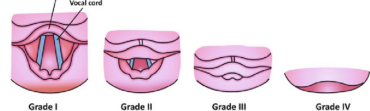


Figure 3. Cormack-Lehane grades that represent different laryngeal views [3].

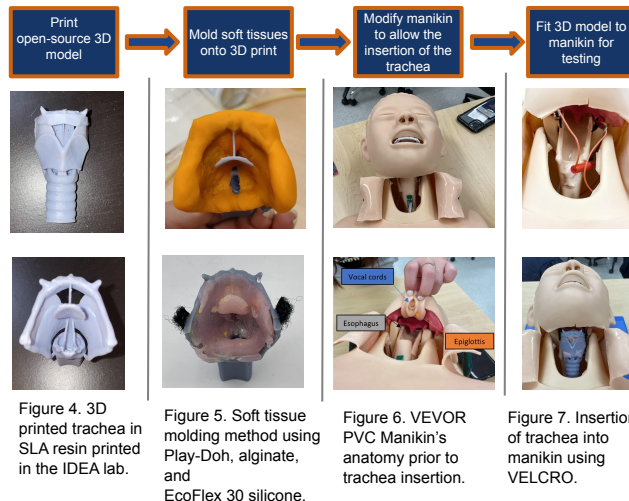
Needs Statement

Medical students need a way to better simulate the intubation technique in order to master the skill more efficiently, be less dependent on senior providers and video laryngoscopes, and improve outcomes for patients.

Design Criteria

Input	Output
Match anatomical structures for different airways	Create 4 trachea inserts based on the 4 Cormack-Lehane grades
Mimic soft tissues	Use a material that matches physiological stiffness (29–42 MPa) [4]
Realistic head weight	~10–11 lbs [5]
Intuitive to new users of this device	Someone skilled in intubation devices can learn how to adjust the manikin in less than 15 minutes
Easily adjustable	A trained user can modify/adjust manikin in less than 5 minutes
Comparable cost to current manikin solution	Less than \$1500 market cost

Prototyping



Testing

- Verified our proof of concept through discussion of anatomical structure with Shandra Jamison, manager of Carle Illinois College of Medicine's Jump Simulation Center
 - Using a size 3 MacIntosh blade, Shandra shifted our molded epiglottis away and confirmed the placement of the trachea inside a manikin
- Future testing:
 - Tensile testing of soft tissues
 - Focus group of experts to further verify our soft tissues
 - Time measurement to teach someone how to use the device and interchange the tracheas



Figure 8. MacIntosh blade placement within manikin.

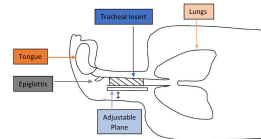
Standards

Standard	Description
ISO 14971	Application of risk management to medical devices
ISO 13485	Medical device quality management
ASTM 52910 - 18	Additive Manufacturing - design requirements, guidelines, and recommendations
ASTM E1373 - 18	Standard Guide for Decommissioning and Disposal of Medical Equipment
ASTM F3357 - 19	Standard Guide for Designing Reusable Medical Devices for Cleanability
STP1247	Effects of Mechanical Stiffness and Vibration on Wear
STP1173	Biomaterials' Mechanical Properties
FDA	Class I

Future Directions

- Make soft tissue more realistically model different anatomies and physiological conditions
- Have a reproducible and durable soft tissue for replication and resistance to damage
- Build manikin from scratch
 - compatible with tracheal inserts
 - correct head weight
 - adjustable thyromental distance

Figure 9. Diagram of adjustable thyromental distance.



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