



ABSTRACT

Cricothyroidotomy is an emergency procedure used by EMS professionals to create an airway in patients with upper airway obstructions. The proposed design combines multiple steps and parts into one, saving valuable time during choking emergencies.

MOTIVATION

- > 4000 choking deaths per year in the US [1]
- Heimlich maneuver is 86.5% successful [2]
- Average EMS arrival time is 7 minutes [3]
- Permanent brain damage is likely after 4 minutes of choking [4]

PROBLEM STATEMENT

Current devices used to perform a cricothyroidotomy require multiple moving parts and specialized training. Time is everything in choking situations and victims lives rely on the response time of EMS. The device aims to be easy to use and incorporate multiple parts into one while also being adaptable to EMS tools.

BACKGROUND RESEARCH

- Cricothyroid membrane (CM) located under adam's apple [5]
- Cricothyroidotomy steps
 - Palpate skin for CM
 - Incise skin vertically
 - Palpate CM and incise CM horizontally
 - Insert bougie and trach tube [6]

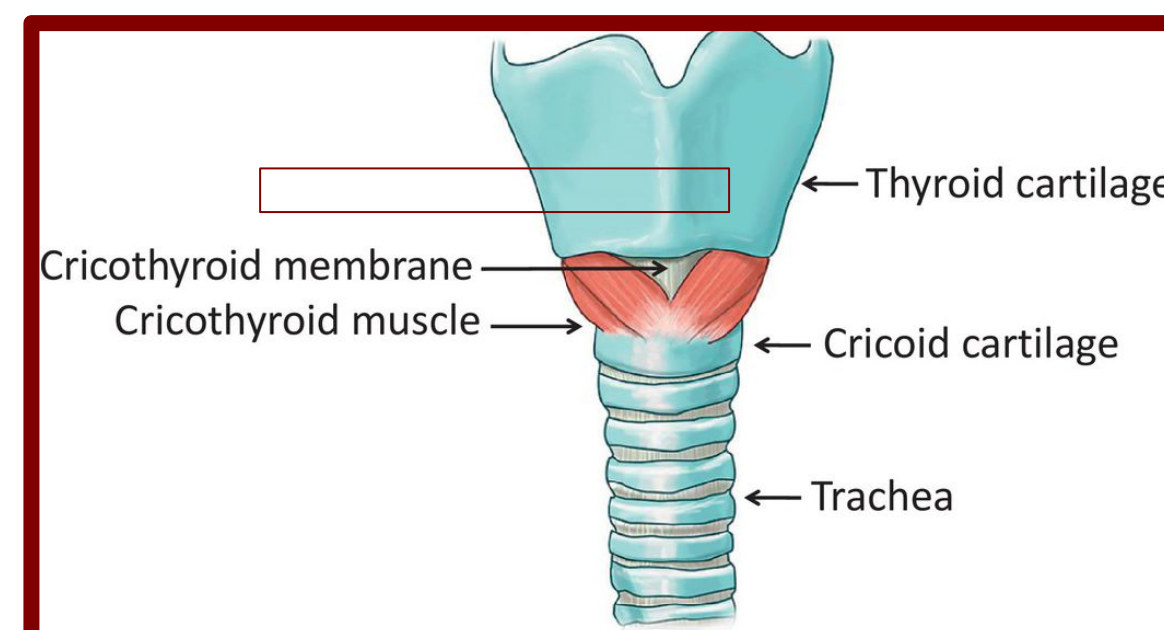


Figure 1: Anatomy of Larynx [8]

- Current market devices:
 - Require assembly and training
 - Not available to public
 - \$30-\$200 [7-9]

DESIGN SPECIFICATIONS

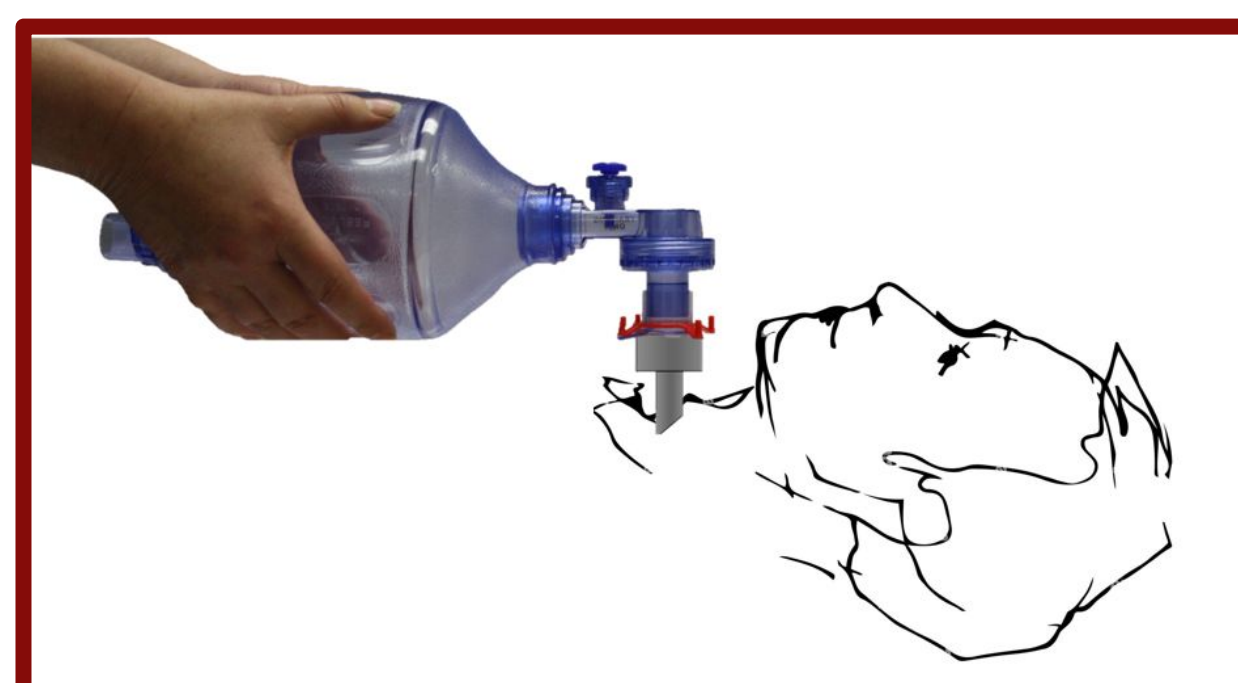


Figure 2: Schematic of device with BVM

- Singular component
- Connects to bag valve mask
- Non-ferrous material
- Exchange 500 mL air every 3 seconds
- Puncture depth: 2.9 cm (female), 4.5 cm (male)
- Single use
- Sterile

FINAL DESIGN AND VALIDATION

- Device features
 - Sharp beveled point for puncture
 - Compatible with a bag valve mask
 - Inexpensive, lightweight, and non-ferrous
- Testing fixation device
 - Holds skin in tension
 - Stabilizes samples
- Device validation
 - Qualitative puncture testing on porcine tissues
 - Time to complete the procedure
 - CAD airflow simulations

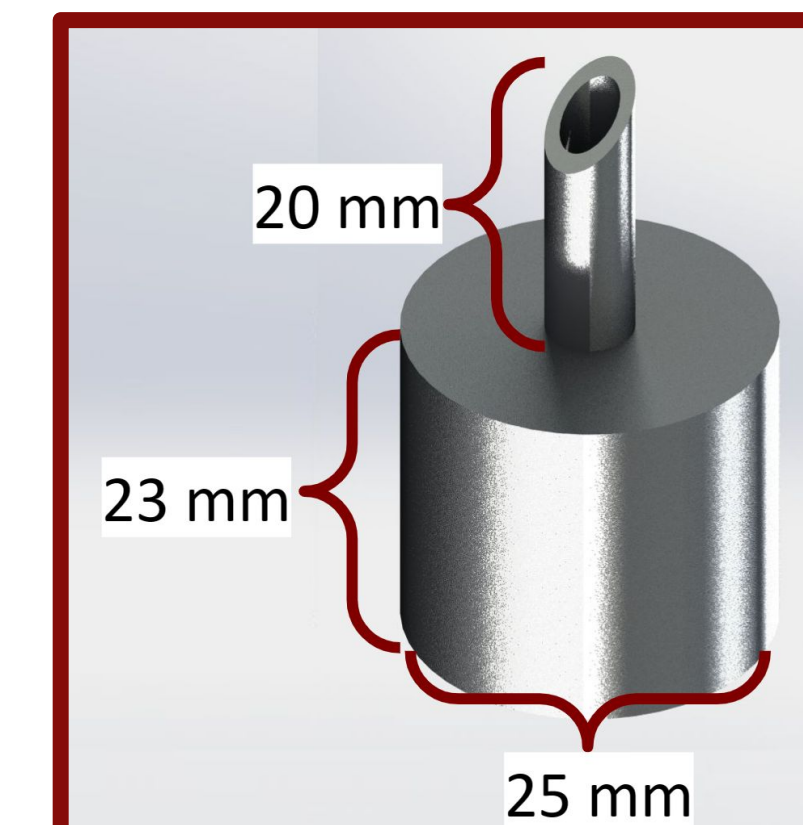


Figure 3: Final design with dimensions

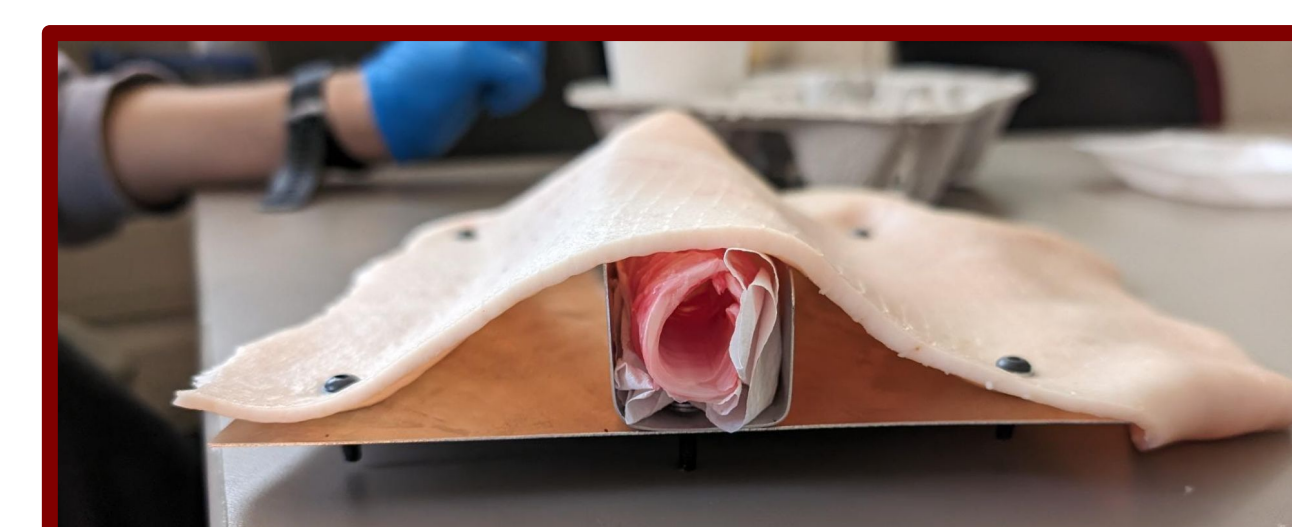


Figure 4: Testing fixation device

RESULTS

CAD Airflow Simulation:

- Input velocity: 12 m/sec [10]
- Output flow: 1.5 L/sec

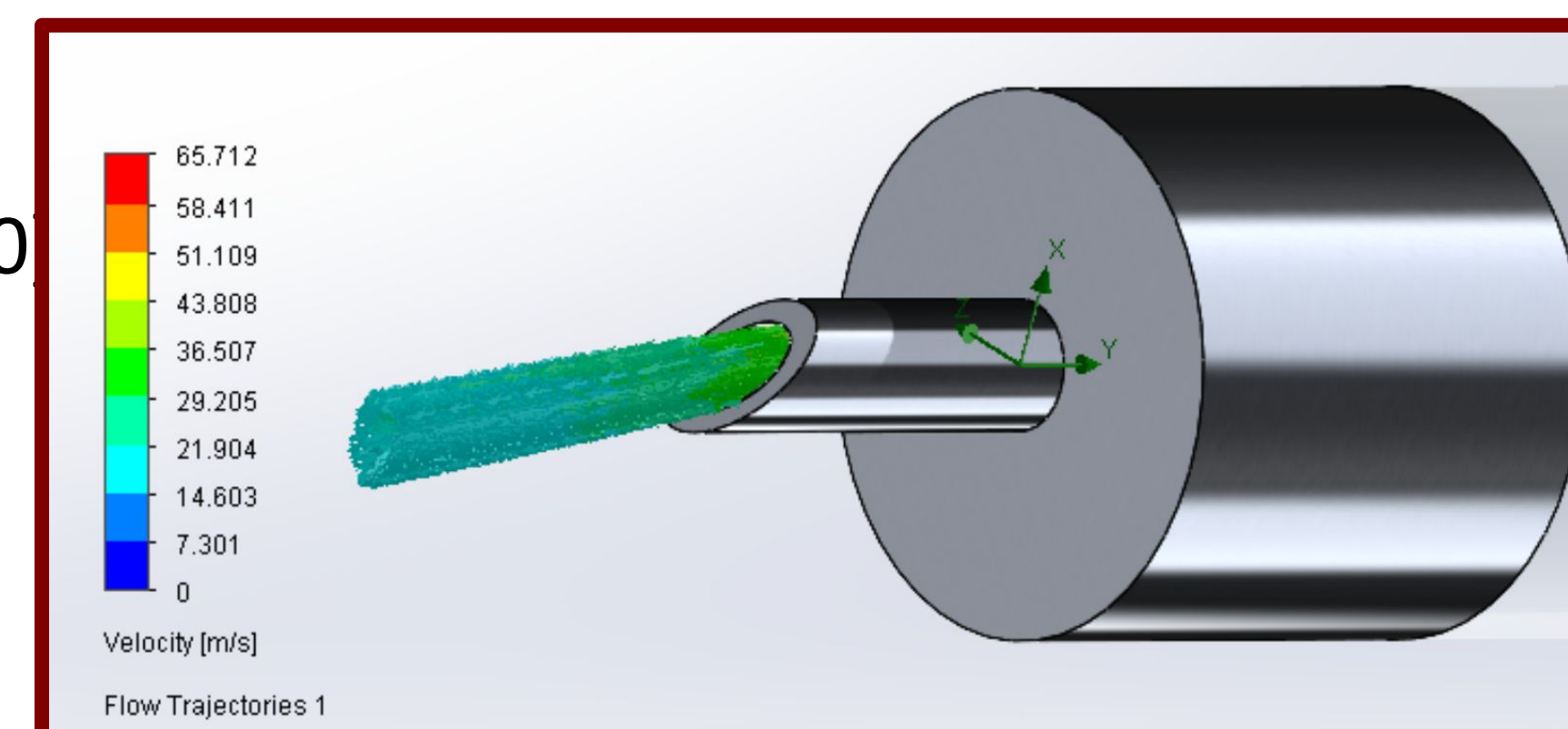


Figure 5: SOLIDWORKS Results of Airflow Testing



Puncture Size (n=5):

Average width: 3.96 ± 0.234 mm

Average length: 4.18 ± 0.47 mm

Timing (n=5):

Average time to complete procedure: 13.062 \pm 2.312 seconds

t-test against literature values: p value = 0.0012



Figure 6: Puncture results

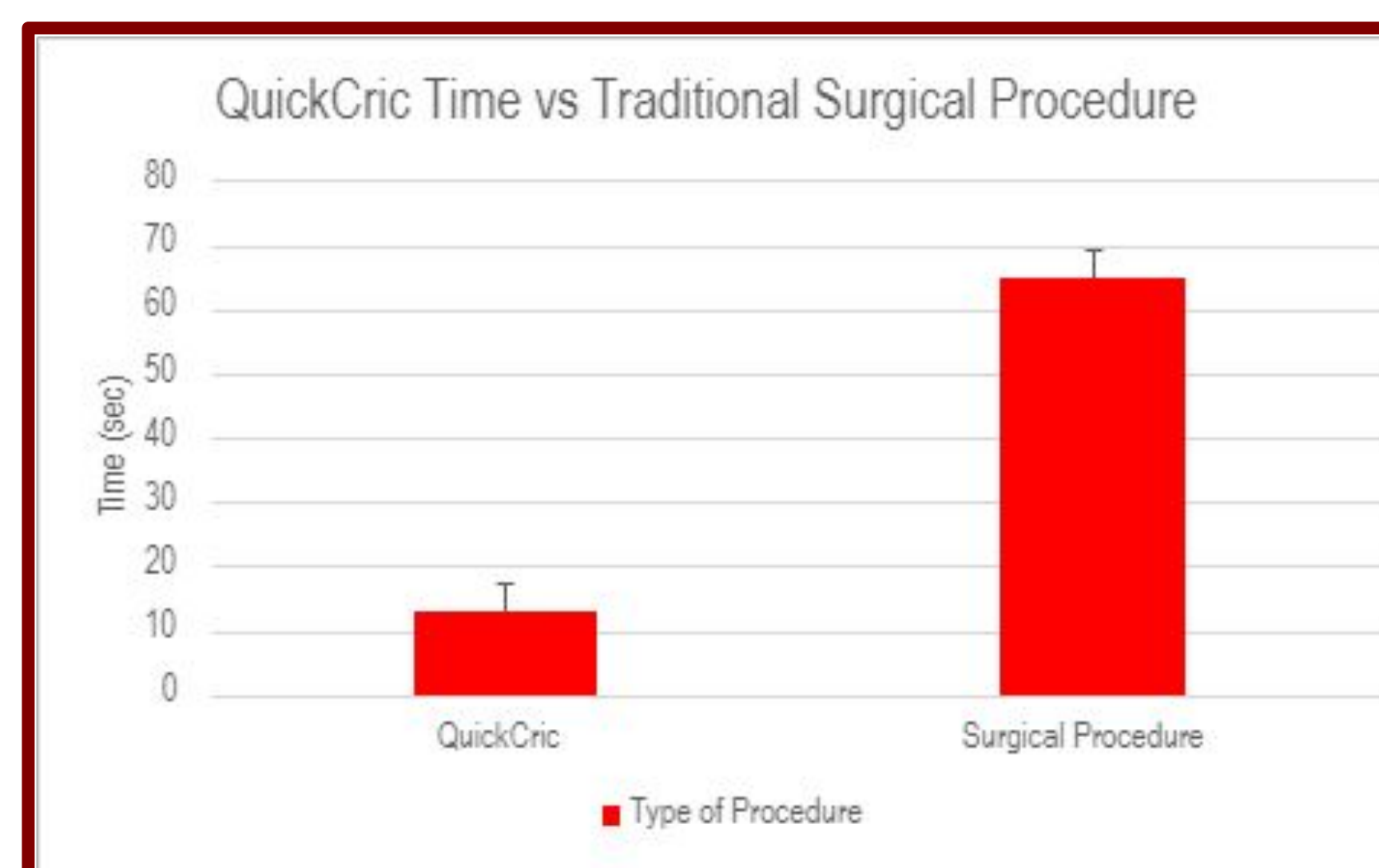


Figure 7: Timing of Quick Cric vs traditional Surgical technique

CONCLUSIONS



Figure 8: Final Sharpened Prototype

- Device delivers sufficient airflow to meet client requirements and provide adequate ventilation
- Device could consistently puncture through: trachea, skin, cricothyroid membrane
- Testing fixation device succeeded in mimicking realistic skin tension
- Emergency simulation showed that device can be used quickly and effectively

FUTURE WORK

- Continue developing device packaging and user experience
 - Mockup of device packaging created
 - Usability testing with laypeople, develop easy-to-understand instructions and indications
- Pursue commercialization of device
 - Mass manufacturing, CNC contracting
 - Sterilization using an autoclave, packaged in plastic/paper pouch
 - Accessible locations, areas with high choking risk
 - Available for purchase privately and to institutions or businesses

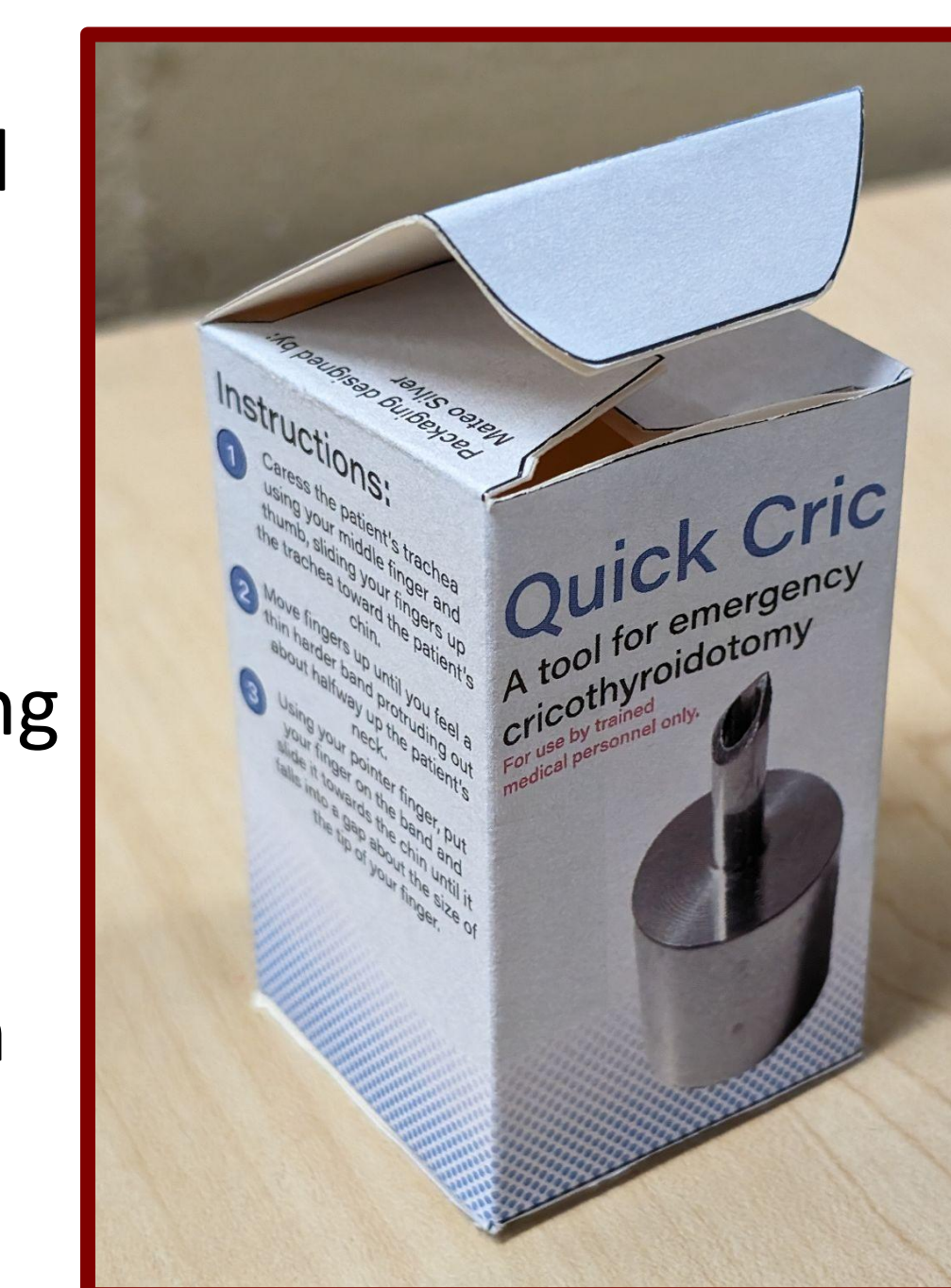


Figure 9: Final Device Packaging

ACKNOWLEDGEMENTS

The team would like to extend our appreciation to Dr. Lenard Markman for guiding the development of this project. Additional thanks to Dr. Darilis Suarez-Gonzalez for her ongoing support. The team would also like to recognize the TEAM lab for their help with design consultations and the Meat Sciences department for sourcing porcine tissue for testing. This project would not be possible without the support of the UW Department of Biomedical Engineering.

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