

Emergency Cricothyroidotomy

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Client: Dr. Lenard Markman



7 minutes



Problem Statement

- **>4000 choking deaths per year [1]**
 - Caused by foreign bodies or trauma
- **Treatment: Heimlich Maneuver [2]**
 - CPR once patient is unconscious
 - No other treatments until EMS arrives
 - No devices accessible to general public

Background Material

- Cricothyroid membrane between the thyroid and cricoid cartilages [3]
- Cricothyroidotomy establishes emergency airway [4]
- Involves incision through cricothyroid membrane [4]
- Typical kits have multiple instruments

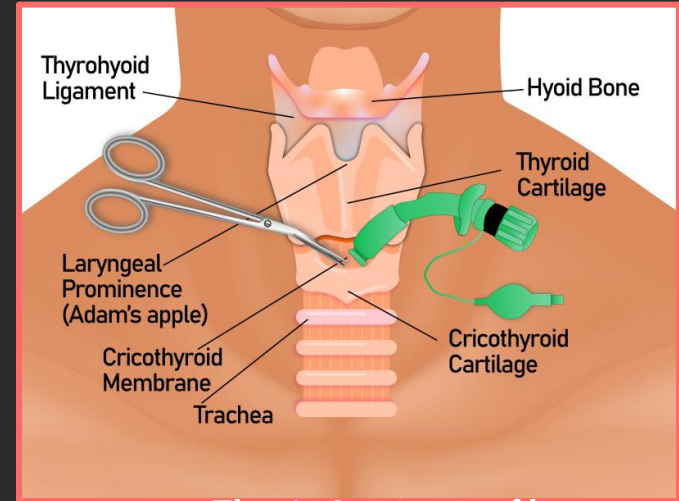


Fig. 1: Anatomy of larynx, highlighting location of the cricothyroid membrane [5]
Fig. 2: Cricothyroidotomy procedure with necessary tools [3]

Patent Constraints

US4438768A: Emergency Cricothyroidotomy Instrument

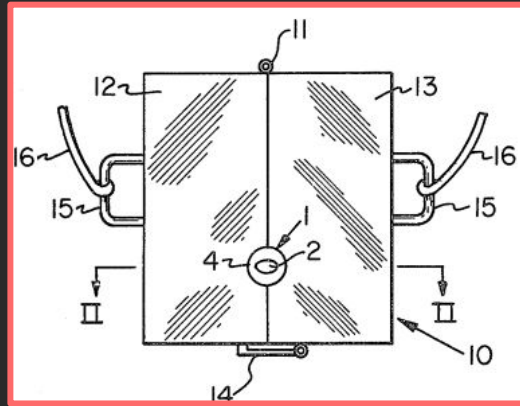
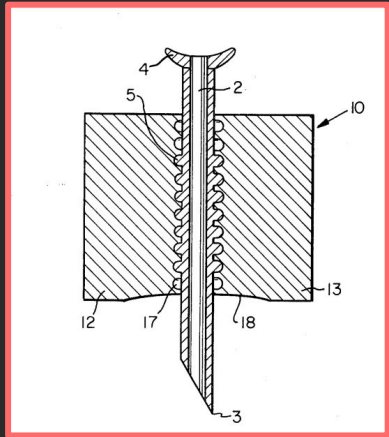


Fig. 5, 6: Emergency Cricothyroidotomy Instrument assembled from a lateral view and superior view

US4677978A: Emergency cricothyrotomy system and cricothyrotomy kit

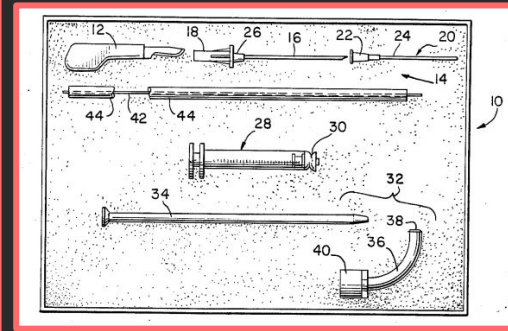
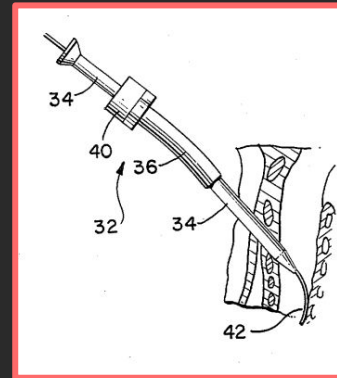


Fig. 7, 8: Emergency kit assembled and laid out highlighting every part included

Product Design Specifications

- **Crafted from non-ferrous materials**
- **Exchange 500 mL of air every 3 seconds**
- **Single use**
- **Small, light, and simple to use**



Design Alternatives Considered

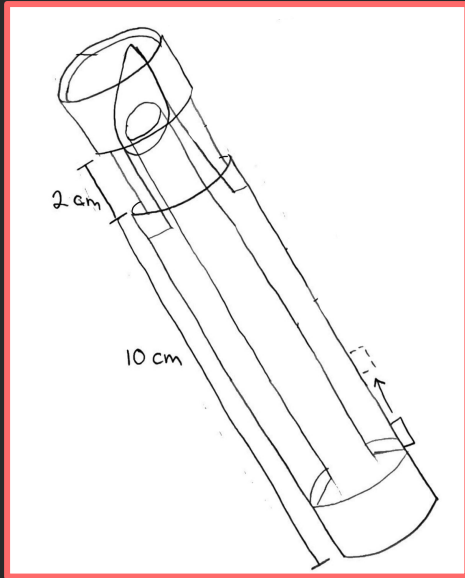


Fig. 9: Lancet design

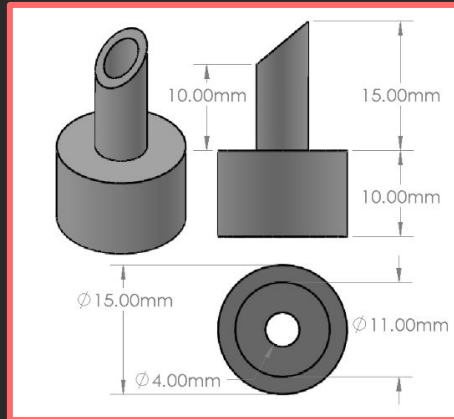


Fig. 10: Hole Puncher Design

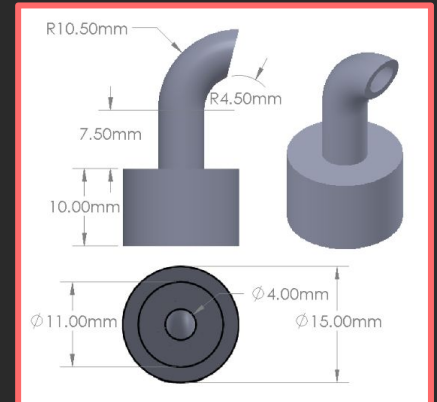


Fig. 11: Captain Hook Design

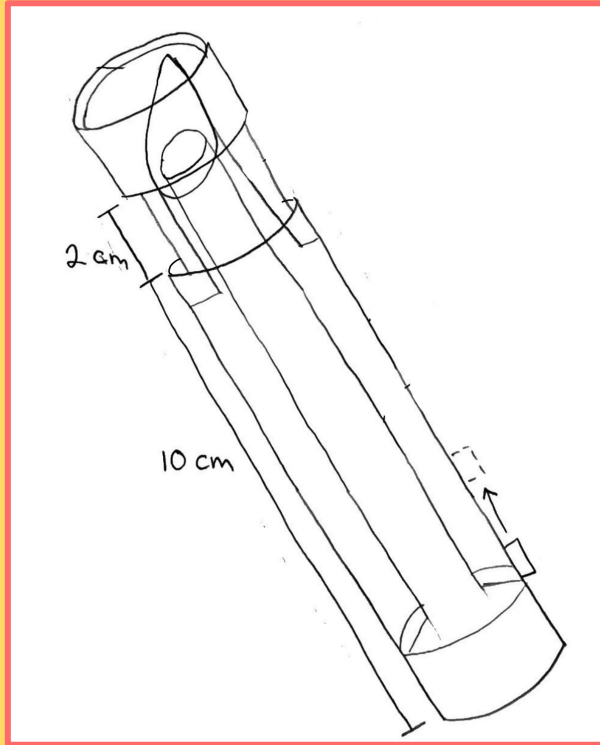


Figure 12: Lancet Design

Lancet Design

- Operates with mechanism of a lancet
- Outside shell, sharp beveled edge, inner sliding tube
- Safe, easy to use, and approachable
- Hard to manufacture

Hole Puncher Design

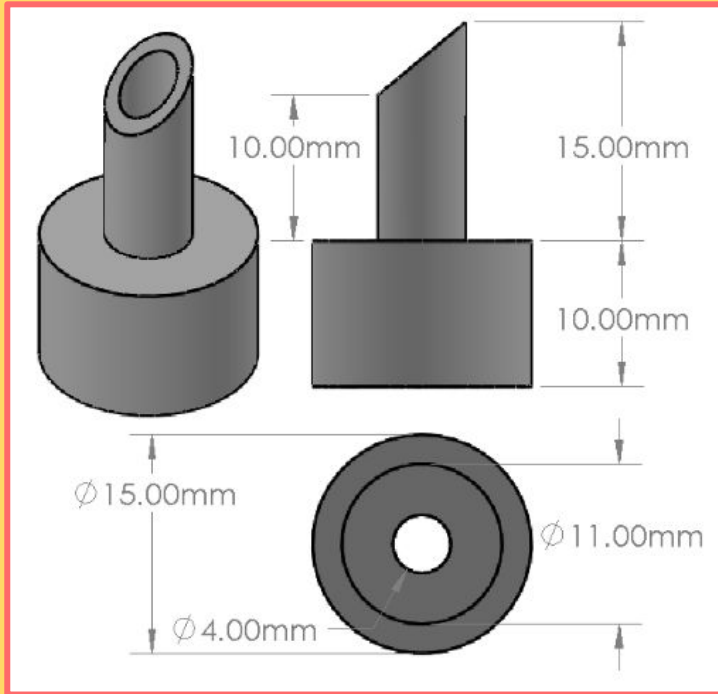


Figure 13: Hole Puncher Design

- Client's initial prototype
- Sharp beveled edge
- Attaches to BVM
- Flange prevents injury
- Simple, portable, cost-effective

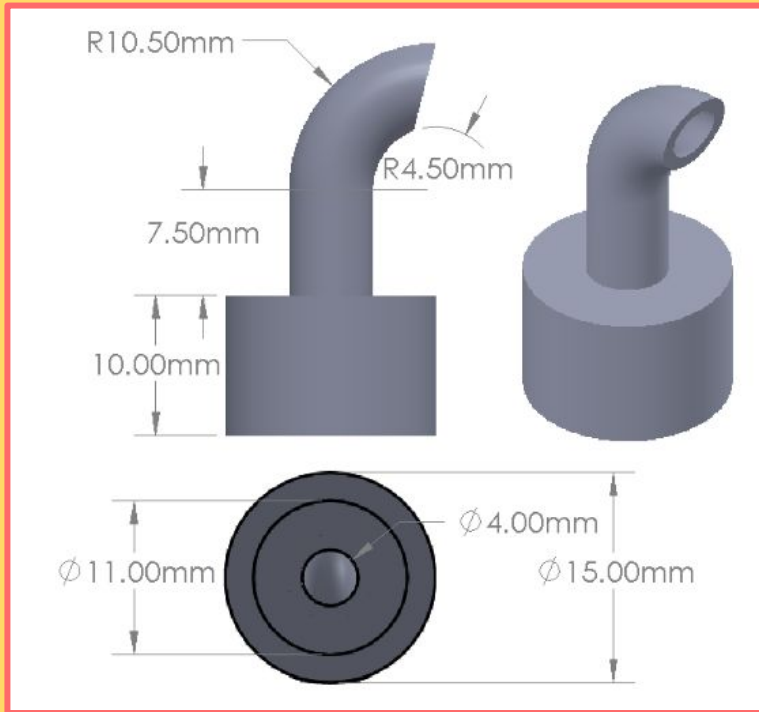


Figure 14: Captain Hook Design

Captain Hook Design

- Iteration on Hole Puncher: bevel, BVM, flange
- Ergonomics and device usage
- Curve follows angle of placement
- More intuitive operation

Design Matrix



Ease of Use



Portability



Cost



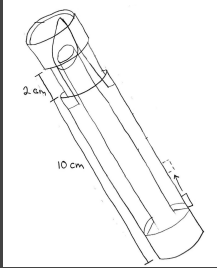
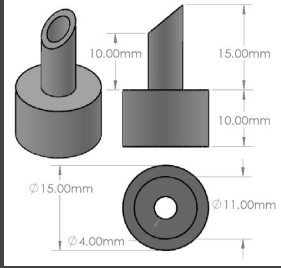
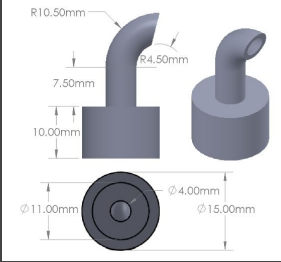
Ease of Fabrication



Ergonomics



Safety

Criteria	Weight	Design 1: The Lancet	Design 2: The Hole Puncher	Design 3: Captain Hook
				
Ease of Use	25	5/5 (25)	4/5 (20)	3/5 (20)
Portability	25	4/5 (20)	5/5 (25)	3/5 (15)
Cost	20	2/5 (8)	5/5 (20)	4/5 (16)
Ease of Fabrication	15	3/5 (9)	5/5 (15)	4/5 (12)
Ergonomics	10	5/5 (10)	3/5 (6)	4/5 (8)
Safety	5	5/5 (5)	3/5 (3)	2/5 (2)
Total:	100	77	89	73



Future Work

- 3D print or mold
- Porcine testing
- EMS feedback

References

- [1] “The Heimlich Maneuver: Breaking Down the Complications | SMJ.” Accessed: Sep. 30, 2023. [Online]. Available: <https://sma.org/southern-medical-journal/article/the-heimlich-maneuver:-breaking-down-the-complications/>
- [2] J. Borke, “CPR - adult and child after onset of puberty: MedlinePlus Medical Encyclopedia.” Accessed: Sep. 19, 2023. [Online]. Available: <https://medlineplus.gov/ency/article/000013.htm>
- [3] U. F. O. Themes, “Chapter 2 – Cricothyroidotomy,” Anesthesia Key. Accessed: Sep. 30, 2023. [Online]. Available: <https://aneskey.com/chapter-2-cricothyroidotomy/>
- [4] “Emergency cricothyrotomy (cricothyroidotomy) in adults - UpToDate.” Accessed: Sep. 30, 2023. [Online]. Available: <https://www.uptodate.com/contents/emergency-cricothyrotomy-cricothyroidotomy-in-adults>
- [5] P. McKenna, N. M. Desai, A. Tariq, and E. J. Morley, “Cricothyrotomy,” in *StatPearls [Internet]*, StatPearls Publishing, 2023. Accessed: Sep. 18, 2023. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK537350/>
- [6] “Cricothyrotomy | US | Teleflex.” Accessed: Sep. 30, 2023. [Online]. Available: <https://teleflex.com/usa/en/product-areas/military-federal/airway-management/cricothyrotomy/index.html>
- [7] “The Quick Fix Adult Cric Kit,” QuadMed, Inc. Accessed: Sep. 19, 2023. [Online]. Available: <https://quadmed.com/the-quick-fix-adult-cric-kit/>
- [8] R. W. Barrickman, “Emergency cricothyroidotomy instrument,” US4438768A, Mar. 27, 1984 Accessed: Sep. 19, 2023. [Online]. Available: <https://patents.google.com/patent/US4438768/en>
- [9] R. J. Melker, “Emergency cricothyrotomy system and cricothyrotomy kit,” US4677978A, Jul. 07, 1987 Accessed: Sep. 30, 2023. [Online]. Available: <https://patents.google.com/patent/US4677978/en>
- [10] Google Images, “Presentation Clipart,” Accessed: Oct. 4, 2023. [Online]. Available: <https://images.google.com/>



Questions?
Thanks for listening!