Senior Design BS Project
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Resuscitation Mouthpiece: An Improved Design to Improve Patient Recovery

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Abstract

Modern CPR mask designs have the potential to leak air when improperly applied to a patient's face. The Resuscitation Mouthpiece is meant to circumvent these issues by utilizing a minimalistic design that uses the internal moisture present within the oral cavity to form an airtight seal in a wider range of patients [1].

Introduction

Patients undergoing cardiac or respiratory arrest need to re-establish a steady state of oxygen to vital organs in order to increase their chances of survival and minimize long-term organ trauma. This is often possible through the work of first responders and medical devices that can provide these critical rescue breaths to the patient [2].

Many devices (such as the one shown in **Figure 1 -** left) use inflated cushions around the edges to form the airtight seal necessary to give these rescue breaths. Those with moderate to heavy beards or atypical facial features are often unable to fully form a seal, resulting in a loss of air and increased chances of organ trauma.

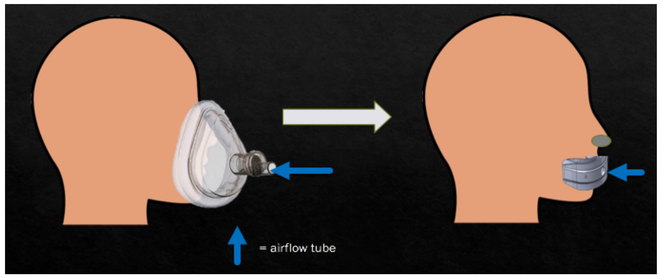


Figure 1: The over-the-face CPR Mask (left) utilizes a one-way valve to distribute oxygen through the nasal and oral cavities. It uses an inflated cushion to produce an airtight seal. The Resuscitation Mouthpiece (right) distributes oxygen through the oral cavity and uses internal moisture in order to form this seal.

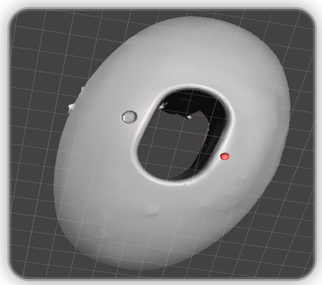
Methods I Design I Analysis

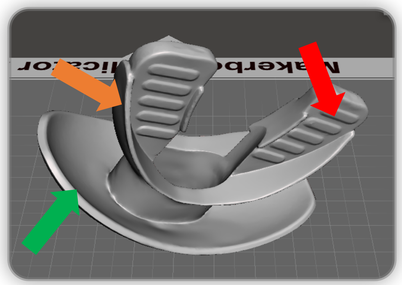
Methods:

- Testing results were analyzed using the mean volume exchange and successful ventilation measurement frequency of the Resuscitation Mouthpiece compared to the CPR mask
- Efficacy of ventilation can be analyzed on human simulation mannequins and commercially compared to available devices
- Trained simulation technicians handle the device to replicate standard procedure for operation in the field or bedside settings

Device Design Highlights:

Red Arrow: Bite Guards – Increase contact area with mouth to improve friction and maintain device positioning
Orange Arrow: Inner Seal – Utilizes moisture in mouth to form an airtight seal
Green Arrow: Outer Seal – Protects user from possible bodily fluids and maintains pressure of the lips onto inner seal





Results

	Face Mask	Mouthpiece
Mean	307.83 mL	388.1 mL
SD	139.59 mL	83.15 mL
Vent. Rate	54.54%	90.90%

Figure 2: Comparison of inspiration volumes for face mask and mouthpiece. Zeroes are failed ventilations and are used to indicate successful ventilation frequency only and kept apart from the average tidal volume

Conclusion

Resurgence was developed to create a better solution to the CPR mask by decreasing the air leakage issue on some individuals and increasing the number of successful attempts at resuscitation. The new mouthpiece is a 3D printable Tango Black material mouthpiece that is intended to be connected to a standard BV device then inserted into a patient's mouth. This allows the administration of rescue breaths and subsequent resuscitation of the patient. According to preliminary testing, the new mask shows promise at increasing successful ventilation and achieving greater volume exchange when compared to the standard CPR mask. Future renditions of the mouthpiece can be designed to include a nose plug in a single "kit". Furthermore, we aim to use the Taguchi method to optimize the inner and outer shield's curvature and thickness to be both more effective and cost-efficient. With these upgrades, the mask will be a product that can be used in various professions such as emergency first responders, lifeguards, and hospital staff.

Acknowledgments

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References

[1] G. Umesh, G. V. Gotur, A. K. Rao, and T. T. Joseph, "EO technique provides better mask seal than the EC clamp technique during single handed mask holding by novices in anaesthetized and paralyzed patients," (in eng), *Indian J Anaesth,* vol. 62, no. 10, pp. 780-785, Oct 2018.

[2] M. Vanessa Moll, DESA. Overview of Respiratory Arrest [Online]. Available: https://www.merckmanuals.com/professional/critical-care-medicine/respiratory-arrest/overview-of-respiratory-arrest