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## Addressing Difficulty in Communication While Wearing a Respirator Mask During the COVID-19 Pandemic by Using a Laryngophone

### ABSTRACT

**Objective:** To describe the use of a laryngophone to aid in verbal communication when wearing elastomeric respirator masks.

#### Methods:

**Design:** Instrumentation Innovation

**Setting:** Tertiary Private Training Hospital

**Participants:** Five volunteers using elastomeric respirator masks rated laryngophone use, after which they individually rated an additional volunteer on speech intelligibility before and after laryngophone use.

**Results:** On a scale of 1-10, the average score of the five volunteers for the laryngophone was 8.8 for ease of use, 8.0 for comfort, and 8.0 for ease of communication. Their average speech intelligibility score for the additional volunteer using the respirator mask alone was 2.0, and for use of the respirator mask with laryngophone was 3.6 on a scale of 1-4.

**Conclusion:** This portable laryngophone speaker may be useful in aiding otolaryngologists and health care providers using elastomeric respirator masks in verbal communication by amplifying speech without needing an external microphone, preventing vocal strain.

**Keywords:** *laryngophone, communication; COVID-19; pandemic; microphone, speaker, respirator mask*

The COVID-19 pandemic has led to the use of enhanced personal protective equipment such as elastomeric respirator masks. However, these respirator masks tend to produce a muffled voice.<sup>1</sup> This leads to challenges in communicating with patients, nurses, and colleagues. Some otolaryngologists compensate by talking in a loud voice or shouting, using portable external microphones, or lifting the for a mask momentarily to speak. However, even with the aid of a lapel or external microphone, the wearer needs to speak in a loud voice for the lapel or microphone to detect a more audible sound, causing vocal fatigue and strain. Thus, we explored the use of alternative devices, turning to the laryngophone.

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The first laryngophone or throat microphone was made by Wiley Post in 1934, an aviator who combined earphones and laryngophones into a pressure suit for long distance flights.<sup>2</sup> Laryngophones are contact microphones that absorb vibrations from the throat via a transducer which in turn detects speech using the vibrations of the soft tissue, bone and cartilage. These vibrations are then transmitted via radio to produce sound.<sup>3</sup>

We describe the use of a modified laryngophone attached to an amplifier as a novel approach to the problem of verbal communication challenges posed by respiratory protective equipment such as the elastomeric respirator mask.

**METHODS**

*Materials*

*Device Assembly*

We used a generic wired laryngophone with a sensitivity of 96dB, frequency response range of 20-20,000Hz, and resistance of 32ohm (Unbranded Generic, China). It was plugged onto a portable mini audio speaker with a maximum loudness of 128 dB (Rolton K400 Portable Wired Mini Speaker, China) via a converter (Generic AUX connector, China) and attached to a power source with a 3.7V or 18650 external battery (Unbranded Generic, China). (Figure 1A, B)

*Device Set-up*

The laryngophone was placed at the level of the hyoid and secured

using the strap of the respirator mask. The speaker was attached to the clothing. (Figure 2)

*Procedure*

*Participants and Survey*

With institutional review board approval, a total of five volunteers already familiar with using elastomeric respirator masks were asked to test our set-up and answer a feedback survey with the following parameters: ease of use, comfort, and ease of communication. Each parameter was graded 1 to 10; 1 being the lowest and 10 being the highest.

Speech intelligibility was assessed by having an additional volunteer don the laryngophone device and recite “The Rainbow Passage”<sup>4</sup> while the five initial volunteers individually scored speech intelligibility before and after use of the laryngophone. Speech intelligibility was subjectively rated on a scale of 1-4 based on the perceived percentage of understood words from the passage. A score of 1 was given to 0-25% of words understood, a score of 2 for 26-50% words, a score of 3 for 51-75% of words, and a score of 4 for 76-100% of words.

*Data Analysis*

User ratings were tabulated and averaged, while additional comments were recorded. Speech intelligibility scores before, and after use of the laryngophone were likewise recorded and averaged.

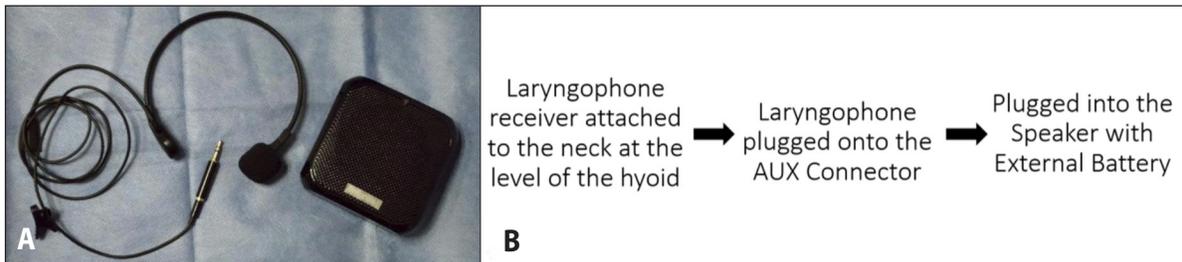
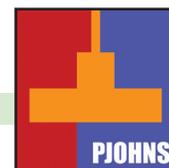


Figure 1 A. Laryngophone and speaker; and B. Schematic outline of set-up Device Set-up



Figure 2. Laryngophone receivers positioned at the level of the hyoid and speaker attached to the protective gown.



## RESULTS

The five volunteers included a 35-year-old female otolaryngologist, a 54-year-old male otolaryngologist, a 60-year-old male otolaryngologist, a 32-year-old female audiometry technician, and a 24-year-old female ENT Center technician. Their ages ranged from 24-60 years old ( $M = 41$ ;  $SD = 15.29$ ). The additional volunteer was a 33-year-old female ENT resident physician. All six volunteers had been using an elastomeric respirator mask since April to May 2020.

The average score of the five volunteers for the laryngophone was 8.8 out of 10 for ease of use of the device, 8.0 out of 10 for comfort, and 8.0 out of 10 for ease of communication. Additional comments were that the laryngophone was "significantly better than regular lapel," "comfortable to wear," "comfortable to wear and does not restrict movements," "placement of the position of the laryngophone is very particular but once in the right position, intelligibility of speech is not bad," "a bit hard to use with respirator mask but it has promise," and "clearer speech as compared to just a mask."

Their average speech intelligibility rating for the additional volunteer who recited "the Rainbow Passage" using the respirator mask alone was 2.0 out of 4, and for use of the respirator mask with laryngophone was 3.6 out of 4.

## DISCUSSION

Respiratory protective equipment covering the nose and mouth decrease speech intelligibility and impair verbal communication.<sup>1</sup> This is because they attenuate sound transmission and impinge on the nasal alae. Compromised speech with elastomeric respirator mask use can occur even at ambient noise levels as low as 40dB (e.g. quiet library sounds, refrigerator humming).<sup>4</sup> In a normal hospital setting, peak noise levels may exceed 85-90dB due to alarms and machines leading to challenges in verbal communication.<sup>5</sup> In a hospital staff survey in Ontario, Canada after the Severe Acute Respiratory Syndrome (SARS) in 2002, 47% of the 2,001 respondents reported that wearing facial and respiratory personal protective equipment was associated with difficulty in communication.<sup>6</sup> A study in occupational therapy in 2016 revealed that the use of elastomeric respirator masks has a speech intelligibility rating of 72%.<sup>7</sup>

A laryngophone detects vibrations from speech and converts them into acoustic signals. These acoustic signals are then transmitted via radio to enable communication. We modified the laryngophone to enable direct output to a speaker. To use a laryngophone as a microphone, it must be attached to a converter, speaker, and a power source.<sup>3</sup> Speech is clearer at the level of the hyoid because of the vibrations received from formed pronunciation of words and resonance of voice. The laryngophone can be used safely, as it is positioned outside the mask,

such that it does not compromise the respiratory protection provided by the mask nor does it violate mask approvals and certification. Furthermore, placement did not obstruct the user's movements and was lightweight. Our survey confirmed a good rating for ease of use, comfort and ease of communication. Another advantage of this device is that it is less sensitive to external or environmental noise, although it is sensitive to internal noises such as swallowing or whispering. However, these noises seemed negligible in this pilot study. The speech intelligibility scores of the respirator mask with a laryngophone were higher compared to those using a respirator mask alone.

Our pilot study has several limitations. First, there may be selection bias since the participants were all part of the same healthcare team. There was also lack of blinding. Although our resources were constrained due to the ongoing pandemic, a larger sample of healthcare personnel wearing elastomeric respirator masks may be considered for future studies, with blinding and controls. Moreover, our rating scale was not validated, and future studies should consider using a validated scoring system for speech discrimination.

Despite these limitations, we think that our device may be useful in aiding healthcare personnel wearing elastomeric respirator masks in verbal communication without needing an external microphone and preventing vocal strain. Future studies involving more participants may evaluate speech intelligibility based on a validated scoring tool.

## ACKNOWLEDGEMENTS

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