Novel microphone to facilitate communication during non-invasive ventilation (NIV)

ReddyPort™ non-invasive ventilation products

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Introduction

The use of non-invasive ventilation (NIV) in hospitalized patients is expanding and it is often the first therapeutic option for patients with respiratory distress[1]. A major drawback of NIV is impaired communication,[2,3] which can result in high anxiety for the patients and the caregivers.[4] The mask, the noise of the ventilator, and the high rate of airflow reduce intelligibility of speech. This also reduces the ability to engage in conversations around patients' goals of care. Intermittent removal of the mask can facilitate speech and communication. However, removal of the mask leads to loss of positive pressure and derecruitment of alveoli, which often causes a deterioration in respiratory status. Communication impairment assumes even more significance in patients requiring NIV for palliative support at the end of life. Innovations to improve communication in these patients are much needed.[5]

For this study, we tested a new microphone *(ReddyPort™ Microphone; ReddyPort Inc., Salt Lake City, UT)* that amplifies speech during NIV. To use the microphone, the elbow of an NIV mask is replaced with an adapter that has a one-way, self-sealing valve. This design maintains positive pressure and allows access to the oral cavity without causing any air to leak. The microphone fits into the adapter without interrupting NIV airflow or positive pressure *(figure 1)*. The microphone is a single-patient-use device with a reusable controller. The microphone works by amplifying the patient's voice with an integrated speaker, while clarifying the output by using digital signal processing to remove background breathing and ventilator noise. The digital signal processing also naturalizes the patient's voice.

Continued on the next page.

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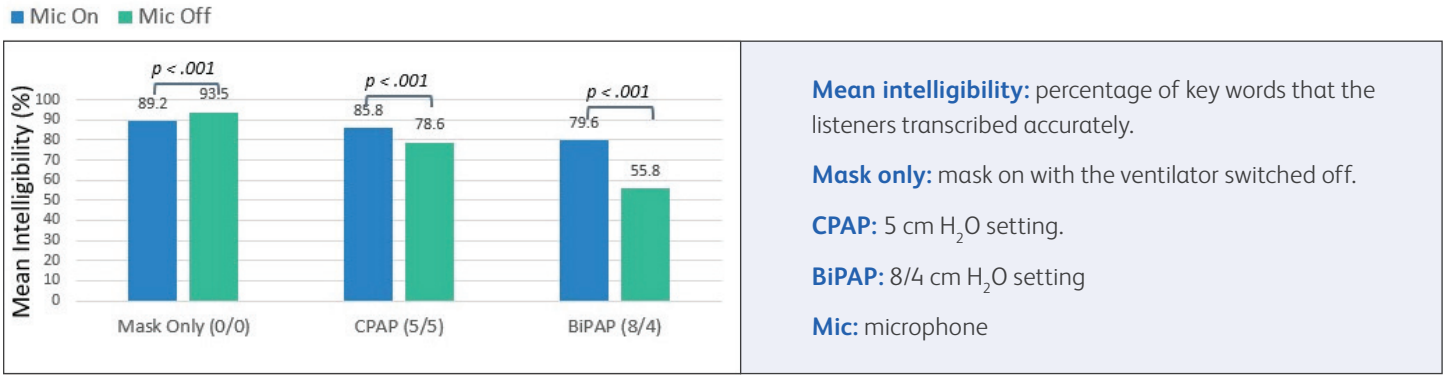
Figure 1: ReddyPort Microphone attached to an NIV mask.

In this study, we tested the improvement in intelligibility of speech using ReddyPort Microphone in healthy volunteers on NIV. In a sound-treated booth, five healthy adult volunteers were recorded reading ten standard IEEE sentences while wearing an oronasal NIV mask *(Phillips Respironics AF541)*. Study subjects were closely monitored for effects of hyperventilation. Audio recordings were obtained with the microphone off and on during three separate NIV conditions: Baseline *(no airflow)*, Continuous Positive Airway Pressure (CPAP) 5 cm H_2O and Bi-level Positive Airway Pressure (BiPAP) 8/4 cm H_2O. Recorded sentences were then presented to 12 blinded listeners who transcribed what they heard. Each response was scored as a percentage of keywords correct. Linear mixed-effects models were used to analyze the effects of NIV condition and microphone setting. Between the microphone off and on conditions, sentence keyword intelligibility increased significantly from 78.6% to 85.8% with CPAP ($z = 5.16$, $p < 0.001$) and from 55.8% to 79.6% with BiPAP ($z = 13.41$, $p < 0.001$). As expected, the baseline condition with no airflow showed little change in intelligibility, from 93.5% to 89.2% ($z=-4.83$, $p< 0.001$) *(figure 2)*. The study was approved by the Institutional Review Board of University of Utah *(IRB Nos. 56031 and 56030)*. It was conducted in the Voice, Airway, and Swallowing Transitional Laboratory and the perceptual experiment was carried out by personnel from the Speech Acoustics and Perception Laboratory.

Results of intelligibility testing



Mean intelligibility: percentage of key words that the listeners transcribed accurately.

Mask only: mask on with the ventilator switched off.

CPAP: 5 cm H_2O setting.

BiPAP: 8/4 cm H_2O setting

Mic: microphone

Figure 2: results of intelligibility testing.

Two other devices that can improve communication while on NIV are available and have been reported.[6,7] First is a speech enhancement device utilizing a throat sensor that converts vocal cord vibrations into an acoustic voice signal.[6] The second is a Positive Airway Pressure communication device that was shown to improve intelligibility of speech in an out-patient setting in patients with obstructive sleep apnea using continuous positive airway pressure mask.[7] The advantage with the microphone evaluated in this study is the opportunity to detect and adjust for in-mask ventilator noise, weak patient voices, and unnatural voice quality. Moreover, with this microphone, the improvement appears to be more pronounced with increasing pressure settings because of decreasing baseline intelligibility from the ventilator noise.

Conclusion

Using the ReddyPort Microphone integrated into the NIV mask improved sentence keyword intelligibility in healthy volunteers on NIV. Utility of this microphone in patients in an ICU setting and with higher levels of BiPAP is currently being evaluated. The microphone has the potential to provide a significant improvement towards enhancing communication in critically ill patients treated with NIV.

For more information call **801.899.3036**.

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