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Measured Expiratory Resistance of the Blue and Green Acapella Devices as Setting is Increased From 1–5; Amplitude 20, 30, 40

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Abstract

Background: After reviewing the literature on both high flow and low flow Acapella devices, it was determined that most researchers evaluated only three frequency dial settings. Due to this gap, we chose to determine the expiratory resistance at each frequency dial setting for both high flow and low flow Acapella devices, as patient effort (amplitude) is increased on an electronic lung simulator. Hypothesis: 1) As the frequency dial setting is increased on the Acapella, the expiratory resistance will increase, and 2) as the patient effort (amplitude) is increased, the expiratory resistance will increase.

Methods: Each Acapella device was attached, separately, via a female-to-female adapter to the Hans Rudolph 1101 Electronic Lung Simulator. HR 1101 settings: Resistance 5 cm H2O/L/sec, Compliance 50 mL/cm H2O, Respiratory Rate 20/minute, Amplitude 10, 20, 30 and 40 cm H2O (to simulate patient effort), Percent Inhale 30 %, Targeted Volume 3000 mL, Load Effort Normal. Initially, amplitude was set at 10 cm H2O and the Acapella was set at the lowest setting. After allowing for stabilization, Peak Pressure and Peak Expiratory Flowrates were recorded for 20 consecutive breaths. The Acapella dial was then increased to the next setting; pressure and flowrates were recorded again as previously described. This process was continued until reaching the highest Acapella setting. Next, data was gathered at amplitudes of 20, 30 and 40 cm H2O, following the same procedure as stated for amplitude of 10 cm H2O. Resistance was calculated as (P1-P2)/Flow. P1 = averaged peak pressure for 20 breaths; P2 = 0 (ambient pressure); Flow = averaged Peak Expiratory Flowrate for 20 breaths.

Results: The expiratory resistance increased as the frequency dial setting was increased and the expiratory resistance increased as amplitude increased. At an amplitude of 20 cm H2O, the expiratory resistance increased from 25.83 to 47.02 cm H2O/L/sec on the blue Acapella and from 12.56 to 38.24 cm H2O/L/sec on the green Acapella device as the frequency dial setting was increased from 1-5 (Figure 1).

Conclusion: The expiratory resistance increased as the frequency dial setting increased from 1 to 5 on both Acapella devices. The expiratory resistance increased as the amplitude increased at 10, 20, 30 and 40 cm H2O, on both devices, confirming our hypothesis.

Keywords
expiratory resistance, Acapella devices

Disciplines
Respiratory System

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Background: After reviewing the literature on both high flow and low flow Acapella devices, it was determined that most researchers evaluated only three frequency dial settings. Due to this gap, we chose to evaluate the expiratory resistance at each frequency dial setting for both high flow and low flow Acapella devices, as patient effort (amplitude) is increased.

Methods: Each Acapella device was attached, separately, via a female-to-female adapter to the Hans Rudolph 1101 Electronic Lung Simulator. HR 1101 settings: Resistance 5 cm H2O/Lsec, Compliance 50 mL/cm H2O, Respiratory Rate 20/minute, Amplitude 10, 20, 30 and 40 cm H2O for the Acapella patient effort, Percent Inhale 30%, Targeted Volume 300 mL, Load Effort Normal, Targeted Volume 300 mL. Pressure and flow rates were recorded for 20 consecutive breaths. The Acapella dial was then increased to the next setting and pressure and flow rates were recorded again the same procedure was followed.

Results: The calculated expiratory resistance, as the dial setting was increased, is as follows:

<table>
<thead>
<tr>
<th>Amplitude (cm H2O)</th>
<th>Resistance (cm H2O/L/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12.56</td>
</tr>
<tr>
<td>20</td>
<td>19.01</td>
</tr>
<tr>
<td>30</td>
<td>24.35</td>
</tr>
<tr>
<td>40</td>
<td>29.84</td>
</tr>
</tbody>
</table>

Discussion: The purpose of this study was to evaluate the effect of frequency dial setting and patient expiratory effort on expiratory resistance. As shown in the results, as the frequency dial setting was increased, expiratory resistance increased and as patient expiratory effort increased, the expiratory resistance increased.

While performing this study, it was noted that at an Amplitude of 10 cm H2O (patient expiratory effort), the Acapella devices would not perform to an extremely high expiratory resistance (see table for exact values). It is possible that a patient’s disease state may result in an increased airway resistance and may also affect the performance of this device. Further research would need to investigate this concept and include patient’s disease state in the study.

Conclusion: The expiratory resistance increased as the amplitude increased at 10, 20, 30 and 40 cm H2O, on both devices, confirming our hypothesis.