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Determination of air way pressure generated by positive expiratory pressure device (blow bottle) using computational fluid dynamic analysis

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Positive expiratory pressure (PEP) therapy is used by respiratory physiotherapists to prevent post-operative pulmonary complications such as atelectasis and pneumonia. PEP therapy involves breathing out against a resistor which generates a positive pressure in the airways which prevents airway closure. The blow bottle is a device easily assembled using a bottle with water and tubing. PEP is generated by the resistance caused when exhaling into the water via the tubing. In order to have airflow through the blow bottle, the patient has to establish a higher airway pressure than pressure at the bottom of the bottle during expiration. Studies on blow bottle PEP suggest that 10 cm H₂O pressure has to maintain at the bottom of the bottle. The aim of this study was: 1) to determine the airway pressure generated by a blow bottle constructed with commercially available tubes of 40 cm length with 10 mm and 11mm inner diameter and 10 cm water column in the bottle, at 5, 10, 15, 20 and 25 L/min flows, and 2) to determine if the blow bottle is a threshold resistor device when constructed this way. The boundary element method in Analysis System (ANSYS) was used for the analysis of pressure variation along the tube from the bottom of the bottle to airway opening. The airway pressure tested for above mentioned flow rates varied between 9.5 cm H₂O-10.8 cm H₂O for a tube with 10 mm inner diameter and 9.8 cm H₂O -11.2 cm H₂O for a tube with 11mm inner diameter. The results are within recommended pressure range for PEP. Hence tubes with 10 mm - 11mm inner diameter, 40 cm length and 10 cm water height maintained in the tube are suitable for a PEP device generating approximately 10 cm H₂O pressure at the water seal.

Keywords: Airway pressure, computational fluid dynamic analysis, positive expiratory pressure device

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