

Performance of Different Low-Flow Oxygen Delivery Systems in the Acute Emergency Setting

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Abstract

Background: The delivery of a high and consistent F_{IO_2} is imperative to treat acute hypoxemia. The objective of this study was to analyze the effective inspired oxygen concentration delivered by different low-flow oxygen therapy systems challenged with different oxygen flows and respiratory patterns in an experimental lung model.

Methods: An adult lung model ventilated in volume control mode simulated different respiratory patterns to obtain mean inspiratory flow of 22.5, 30.0, 37.5, or 45.0 L/min. The oxygen concentration sampled inside the lung model by nasal cannula, simple face mask, non-rebreather mask, and double-trunk mask above nasal cannula tested at oxygen flows of 10, 12.5, and 15 L/min was quantified. The 3 masks were sealed tight onto the model's airway opening. They were also tested with standardized leaks to determine their clinical performance.

Results: All oxygen delivery systems delivered higher oxygen concentration with increasing oxygen flows, regardless of the respiratory pattern. Within each device, the increase in inspiratory flow decreased oxygen concentration when using nasal cannula ($P = .03$), the simple face mask ($P = .03$), but not the non-rebreather mask ($P = .051$) nor the double-trunk mask ($P = .13$). In sealed condition, the double-trunk mask outperformed the non-rebreather mask and simple face mask ($P < .001$); mean oxygen concentration was 84.2%, 68.5%, and 60.8%, respectively. Leaks amplified oxygen concentration differences between the double-trunk mask and the other masks as the oxygen delivery decreased by 4.6% with simple face mask (95% CI 3.1-6.1%, $P < .001$), 7.8% with non-rebreather mask (95% CI 6.3-9.3%, $P < .001$), and 2.5% with double-trunk mask (95% CI 1-4%, $P = .002$). With leaks, the oxygen concentration provided by the simple face mask and the non-rebreather mask was similar ($P = .15$).

Conclusions: Lung oxygen concentration values delivered by the double-trunk mask were higher than those obtained with other oxygen delivery systems, especially when leaks were present.

Keywords: double-trunk mask; low-flow oxygen therapy; non-rebreather mask; oxygen face mask; performance; respiratory distress.