

# Comparison of FiO<sub>2</sub> Delivery With Low Flow vs High Flow Cannulas: A Simulation Study

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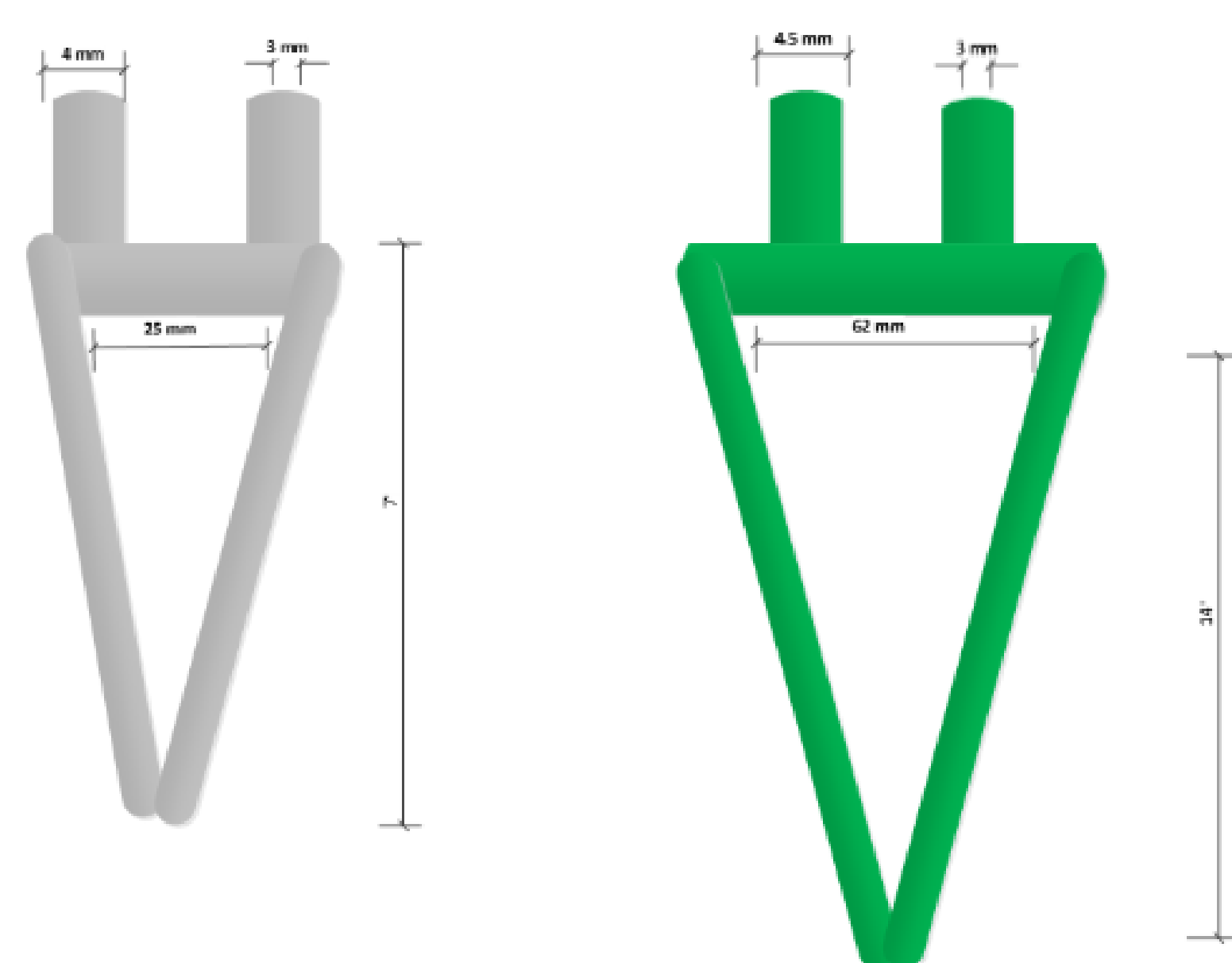
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## Background

There are two nasal cannulas on the market. One is advertised as a “low-flow” nasal cannula (LFNC) and the other advertised as a “high flow” nasal cannula (HFNC). Depending on distributors websites, the LFNC is designed for flows 1-6 L/min and the HFNC device is recommended for flows >6 L/min up to 15 L/min. Both devices are designed to directly attach to an oxygen flowmeter or to an unheated bubble humidifier, which is connected to the flowmeter. Both devices allow a clinician control over oxygen source flow, but no direct control of FiO<sub>2</sub>.

Upon clinical observation, it has been noted that clinicians believe there is an inherent difference between a LFNC and a HFNC. If a patient is on a 6L/min LFNC and has an increase in oxygen needs, the clinician will place the patient on a flow > 6 L/min using a HFNC.

The purpose of this study was to test this assumption by comparing FiO<sub>2</sub> delivery for LFNC and HFNC across a range of flow.



## Methods

An adult mannequin head (Michigan Instruments Inc.) was attached to a breathing simulator (IngMar ASL 5000), which is capable of measuring FiO<sub>2</sub> at the simulated alveolar level. Evidence-based values were used to set the simulator to closed-loop volume control mode with VT = 490 mL, C = 50 mL/cm H<sub>2</sub>O, R = 4 cm H<sub>2</sub>O/L/s, f = 15, increase = 25%, hold = 0%, release = 30%.

A LFNC (Westmed 0556) and HFNC (Westmed 0549) were attached to the nares of the mannequin (mouth opening blocked) and run at 5, 10, and 15 L/min (verified with a Citrix H4 flowmeter). Between trials the simulator continued to run until FiO<sub>2</sub> was below 22%. Each experiment was repeated once.

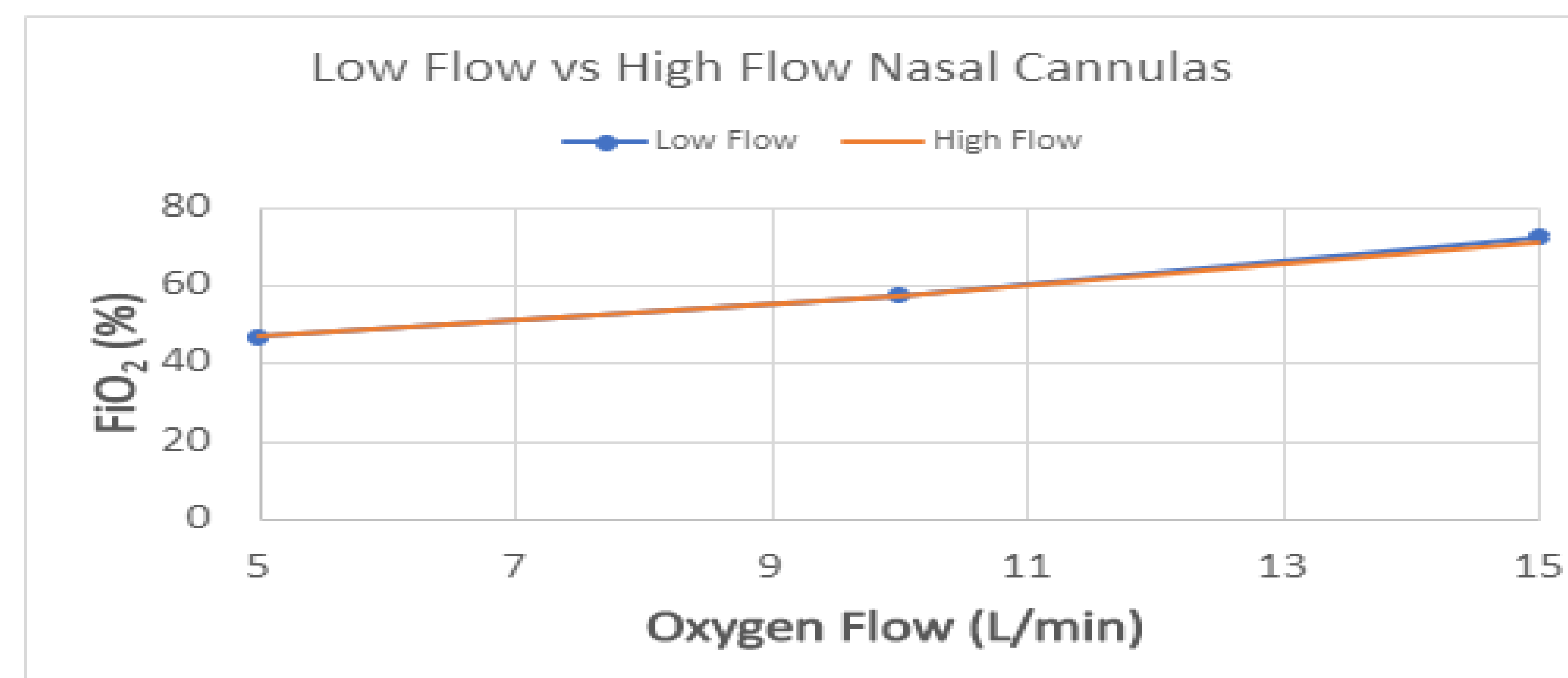
The FiO<sub>2</sub> measurements were averaged and compared using a two-tailed unpaired t-test with p<0.05 indicating significance.

## Results

There was no difference in FiO<sub>2</sub> between LFNC and HFNC at 5 and 10 L/min. There was a significant, but clinically unimportant difference at a flow of 15 L/min.(see Table 1).

Table 1. LFNC vs HFNC Experimental Results.  
Δ= FiO<sub>2</sub> High Flow- FiO<sub>2</sub> Low Flow

Flow (L/min)	FiO <sub>2</sub> (%)				Δ	p-value
	Low Flow		High Flow			
	Mean	SD	Mean	SD		
5	46.60	0.00	46.50	0.14	0.10	0.50
10	57.00	0.57	56.95	0.92	0.05	0.95
15	72.30	0.00	70.65	0.07	1.65	0.02



## Conclusions

This study shows that the assumption of needing different types of cannulas depending on flow is false.

This simulation-based study demonstrates that the differences in the dimensions of the LFNC and HFNC have negligible effect on FiO<sub>2</sub> delivery at the same oxygen source flow. Though the FiO<sub>2</sub> measured at 15 L/min is scientifically significant, the small difference in FiO<sub>2</sub> (~1.65%) is not clinically important. These findings suggest that changing the interface from a LFNC to a HFNC on a patient whose oxygen requirements exceed 6 L/min is not necessary.

## References

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- Maggiore SM, Idone FA, Vaschetto R, et al. Nasal high-flow versus Venturi mask oxygen therapy after extubation. Effects on oxygenation, comfort, and clinical outcome. *Am J Respir Crit Care Med*. 2014;190(3):282-288.

## Disclosures

Conflicts of Interest: Morgan Sorg : none; Robert L. Chatburn: Consultant for IngMar Medical, Vyair Medical, Inovytec, Temple, Aires, Ventis Medical, and Promedic Consulting.