

INTRODUCTION

- High flow nasal cannula (HFNC) is a widely-used, well-established respiratory support device used in patients with respiratory compromise.
- HFNC is associated with superior comfort, improved patient tolerance, decreased work of breathing, and decreased need for escalation of oxygen therapy in comparison to conventional oxygen therapy.¹
- Despite widespread use, the effect of HFNC on swallowing physiology is poorly understood..
- Research to date has demonstrated that impairments of the respiratory tract can diminish swallowing safety.^{2,3}
- Studies have suggested that healthy individuals may have diminished swallowing function at higher flow rates of HFNC.⁴⁻⁷
- Guidance on oral alimentation initiation while on HFNC is limited; no safe swallow flow rates have been definitively established.⁴⁻⁷
- The aim of our study was to assess the swallowing function and safety in a cohort of pre-screened, non-dysphagic, healthy individuals using Flexible Endoscopic Evaluation of Swallowing (FEES), during HFNC administration at various flow rates.

Aspiration Risk	Score	Classification	Description
No risk	1	Normal	No airway invasion.
No risk	2	Mild	Bolus enters into airway with clearing.
Risk of aspiration	3	Moderate	Bolus enters into airway without clearing
	4	Moderate	Bolus contacts vocal cords with airway clearing.
	5	Moderate	Bolus contacts vocal cords without airway clearing.
Positive aspiration	6	Severe	Bolus enters trachea and is cleared into larynx or out of airway.
	7	Severe	Bolus enters trachea and is not cleared despite attempts.
	8	Severe	Bolus enters trachea and no attempt is made to clear.

Figure 1: Penetration Aspiration Scale (PAS)⁸

METHODOLOGY

- Healthy subjects 18 to 65 years of age were enrolled.
- Exclusion criteria included score of >3 on Eating Assessment Tool-10 questionnaire, history of swallowing or respiratory disorders, history of medical conditions or medication use affecting swallowing or breathing, history of recent hospital admission.
- Five randomized rounds of testing were performed: 0, 30, 40, 50, 60 LPM.
- Each round of testing was conducted using three consistencies: thin liquids, mildly-thick liquids, and purees.
- Each trial, excluding purees, included three sub-trials: 1 cup sip, 3 consecutive cup sips, and a 5 ml bolus by teaspoon.
- Two Speech-Language Pathologists independently graded each swallow using the PAS Scale (Figure 1).
- A PAS score of 1-5 was considered a safe swallow, while a PAS score of 6-8 was considered an unsafe swallow.
- Pearson chi-square tests were used to test for significant correlation (P<0.05) between PAS result and rate of HFNC and consistency across each sub-trial of each consistency.



Figure 2: Experimental Design

RESULTS

- Twenty seven subjects were enrolled.
- Forty one percent were male with a mean age of 34 years (11 SD).
- There was no significant correlation between swallow safety and flow rate using Pearson Chi-Square test across all consistencies and across all quantities of materials (P>0.05).
- In subgroup analysis of 1 sip swallows, 99% (267/270) of swallows were safe, and 1% (3/270) were unsafe with no difference related to consistency tested.
- In subgroup analysis of 3 sips, 97% (n=263/270) of swallows were safe, and 3% (n=7/270) were unsafe with no difference related to consistency tested (Table 1).
- Of note, out of all sub-trials, the thin liquid, 3 sips trial at 60 LPM, had the largest percent of unsafe swallows (14%).
- In subgroup analysis of 5 ml trials, 99% (399/405) of swallows were safe, while only 2% (6/405) were unsafe.

			LPM					Total	
Consistency	PAS	Safe PAS	0	30	40	50	60		
			Count	26	26	26	27	23	128
Thin	Safety	% within LPM	96%	96%	96%	100%	85%	95%	
		Unsafe PAS	Count	1	1	1	0	4	7
	% within LPM	4%	4%	4%	0%	15%	5%		
	Total	Count	27	27	27	27	27	135	
% within LPM	100%	100%	100%	100%	100%	100%			
Mildly-Thick	Safety	Safe PAS	Count	27	27	27	27	135	
		% within LPM	100%	100%	100%	100%	100%	100%	
	Total	Count	27	27	27	27	27	135	
	% within LPM	100%	100%	100%	100%	100%	100%		
Total	Safety	Safe PAS	Count	53	53	53	54	50	263
		% within LPM	98%	98%	98%	100%	93%	97%	
	Unsafe PAS	Count	1	1	1	0	4	7	
	% within LPM	2%	2%	2%	0%	7%	3%		
Total	Count	54	54	54	54	54	270		
% within LPM	100%	100%	100%	100%	100%	100%			

Table 2. Safe swallow events based on PAS versus Liter Per Minute (LPM) flow when 3 sip swallow was tested with different consistencies

DISCUSSION

- Our analysis demonstrated no significant correlation between swallowing safety and rate of HFNC using Pearson Chi-Square tests across all consistencies and across all quantities of materials.
- We demonstrate that in non-dysphagic, healthy individuals, increasing rates of HFNC does not diminish swallowing safety.
- The same results were found when PAS scores of 1-2 were defined as safe swallows, and scores of 3-8 were considered unsafe swallows.
- Our finding that thin liquid swallows are more frequently unsafe at higher flow rates than lower rates is consistent with prior studies that showed thin liquids have higher risk of aspiration due to diminished bolus control.
- This study adds new data to the very limited literature examining swallowing safety while on HFNC.
- Our study is the first to use FEES for swallowing safety assessment in patients on HFNC.

CONCLUSION

- Our results suggest that healthy individuals can safely have an oral diet while on HFNC.
- We advocate for continued use of caution when considering oral feeding in critically-ill patients on HFNC.
- More research is needed to better understand how swallowing physiology is affected by respiratory support and what levels of respiratory support can be safely used in ill patients with impaired swallowing function without increasing risk of aspiration.

REFERENCES

- Lu Z, Chang W, Meng SS, et al. Effect of high-flow nasal cannula oxygen therapy compared with conventional oxygen therapy in postoperative patients: A systematic review and meta-analysis. *BMI Open*. 2019;9(8):1-10.
- Hori R, Isaka M, Oonishi K, Yabe T, Oku Y. Coordination between respiration and swallowing during non-invasive positive pressure ventilation. *Respirology*. 2016;21(6):1062-1067.
- Niimi A, Barber CM, Curran AD, Fishwick D, Mishima M. Impaired cough reflex in patients with recurrent pneumonia. *Thorax*. 2003;58(7):152-153.
- Sasaki T, Mishima G, Kiriishi K, et al. Effect of nasal high-flow oxygen therapy on the swallowing reflex: An in vivo volunteer study. *Clin Oral Investig*. 2017;21(3):915-920.
- Eng K, Jose Flores M, Gerrity E, et al. Evaluation of swallow function on healthy adults while using high-flow nasal cannula. 2019;4(6):1516-1524.
- Allen K, Galek K. The influence of airflow via high-flow nasal cannula on duration of laryngeal vestibule closure. *Dysphagia*. 2021;36(4):729-735
- Arizono S, Oomagari M, Tawara Y, et al. Effects of different high-flow nasal cannula flow rates on swallowing function. *Clin Biomech*. 2021;89:105477.
- Rosenbek JC, Robbins JA, Roecker EB, Coyle JL, Wood JL. A penetration-aspiration scale. *Dysphagia*. 1996;11(2):93-98.