Nasal High Flow: Evidence & Application

ICEP Spring Symposium 2022
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Fisher&Paykel HEALTHCARE

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Disclosures

Chris Hutchinson, PGDip, BE
Director of Clinical Affairs
Fisher & Paykel Healthcare

Corporate Affiliate Member ACEP, ATS & SCCM
Member, AARC

Married to Kate with three sons Alex (15), Matthew (13) & Oliver (9 mo)
Crazy about the New Zealand All Blacks Rugby Team

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Outline

1. What are the origins of HFNC?
2. What are the mechanisms of action?
3. How can high flow be used effectively in your ED? ▲ COVID-19
4. Q & A

3

*Q1: Who routinely used HFNC in their ED **before** COVID-19?*

4

*Q2: Who routinely used HFNC in their ED **during** COVID-19?*

5

*Q3: Who understands the physics and physiology **supporting** HFNC?*

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chris.hutchinson@fphcare.com

History & background


c. 1920's

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History & background

1214 DECEMBER 7, 1968 PRELIMINARY COMMUNICATIONS THE LANCET

tests demonstrated severe delayed hypersensitivity reaction, maximal at 48–72 hours. This response was to the first application after transplant and approximately 3 months after previous tests. It is probable that small amounts of the chemicals remained in the tissues and when thymic function was established, sensitisation occurred. Biopsy of a lymph-node 8 months after implantation of thymic tissue was normal for an infant of this age (fig. 4b). This finding, coupled with normal numbers of circulating lymphocytes, indicated repopulation of peripheral lymphoid tissue with small lymphocytes. After operation

CONTINUOUS CONTROLLED HUMIDIFICATION OF INSPIRED AIR

Summary It has been observed that gases can be administered through the nose at high flow-rates provided that they are at body-temperature and fully saturated with water-vapour. A simple and easily portable system has been devised for delivering gases in this way, and has been shown to be effective in volunteers. It is now proving satisfactory in clinical use, both for continuous humidification and for administration of oxygen.

Department of Anæsthesia, Rigshospitalet, Copenhagen, Denmark

NIELS LOMHOLT M.D. Copenhagen

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History & background

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Most of the problems of humidification could be solved by the use of water-vapour instead of aerosols. This would more nearly reproduce the physiological mechanism of humidification in the respiratory tract. Such a method became practicable when the author discovered that gases could be blown into one nostril at 20–30 litres per minute without discomfort, and even without perception, provided that the gas was at body-temperature and 100% saturated with water-vapour. (The highest tolerable flow of dry, cool gas is normally regarded as 6–8 litres per minute.)

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High flow fundamentals

Interface

- High flow nasal cannula (HFNC)
- High flow nasal prongs (HFNP)
- High flow oxygen (HFO)
- Humidified high flow nasal cannula (HHFNC)

- High flow therapy (HFT)
- High flow oxygen/therapy (HFO/T)
- Humidified high flow therapy (HHFT)
- Nasal high flow (NHF)

Therapy

- Optiflow™
- High velocity nasal insufflation (HVNI™)
- Comfort Flo™

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Acute adult nasal high flow

Primary Respiratory Support | Pre-Oxygenation before Intubation | Post Extubation Respiratory Support | Post Surgery Respiratory Support | Respiratory Support during Recovery

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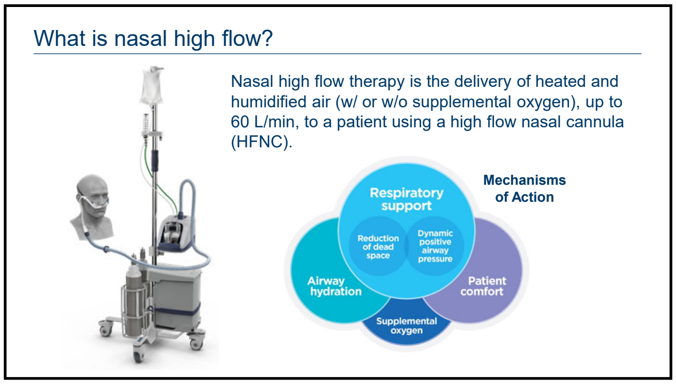

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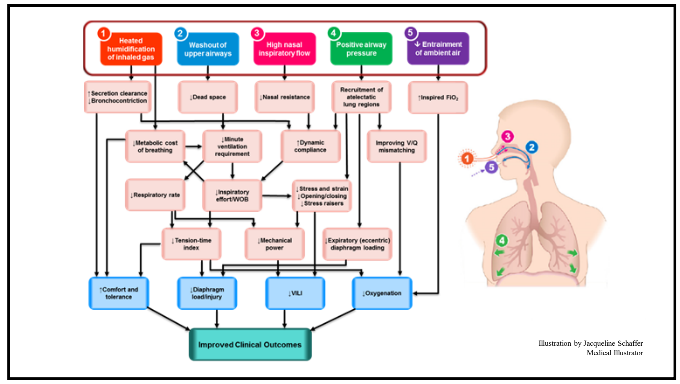

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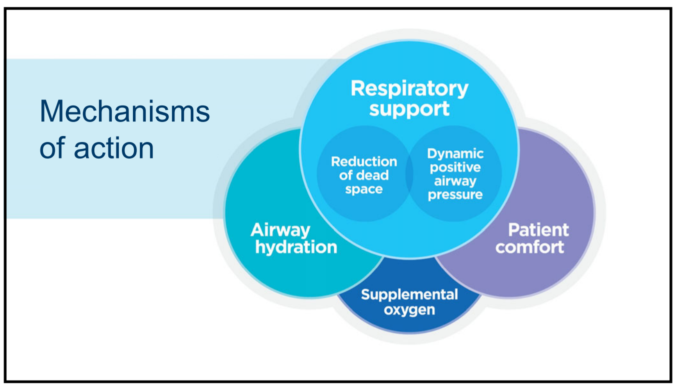

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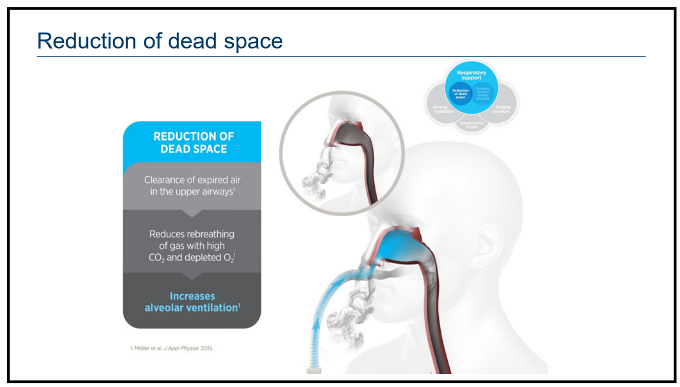

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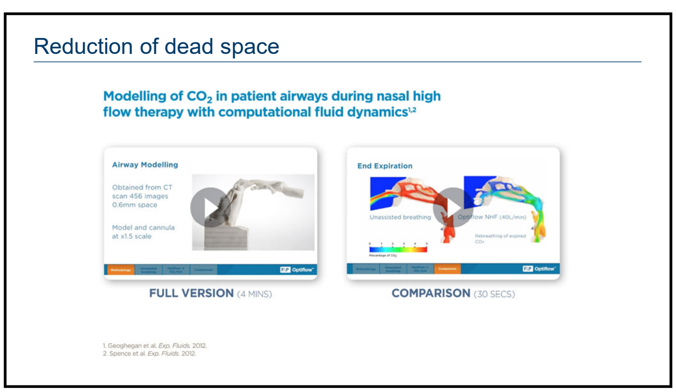

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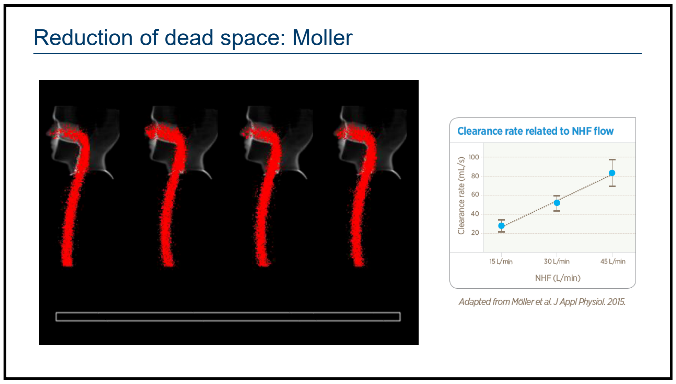

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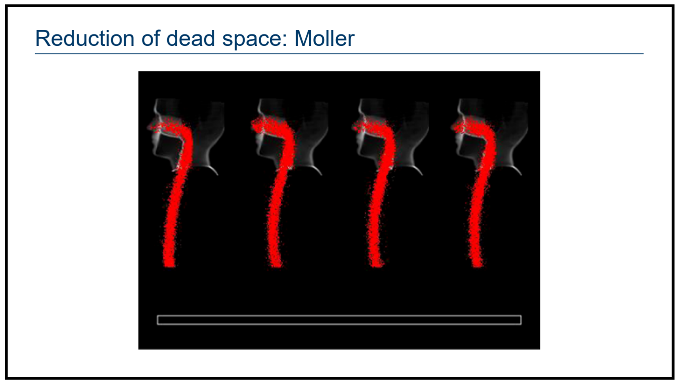

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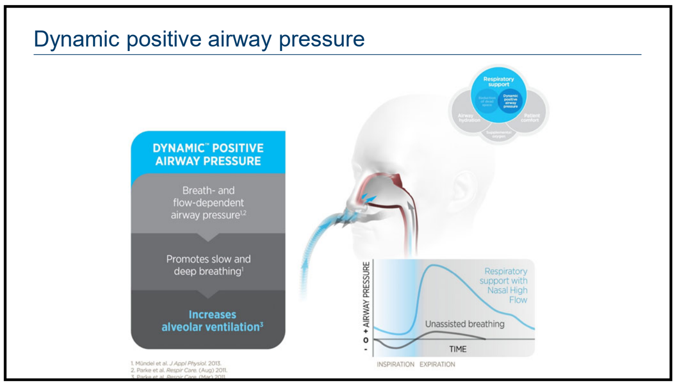

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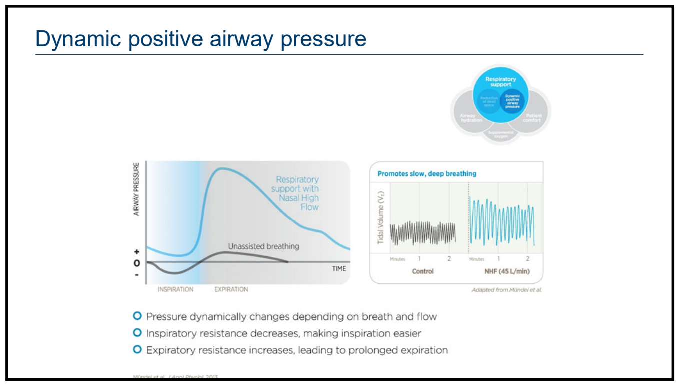

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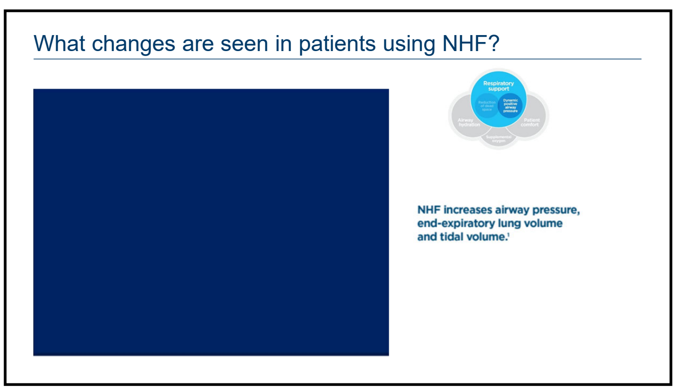

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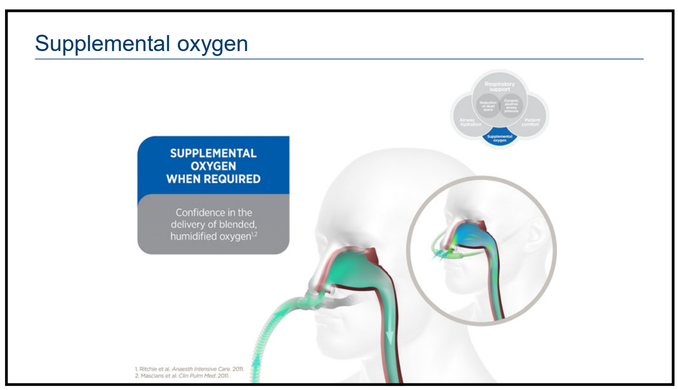

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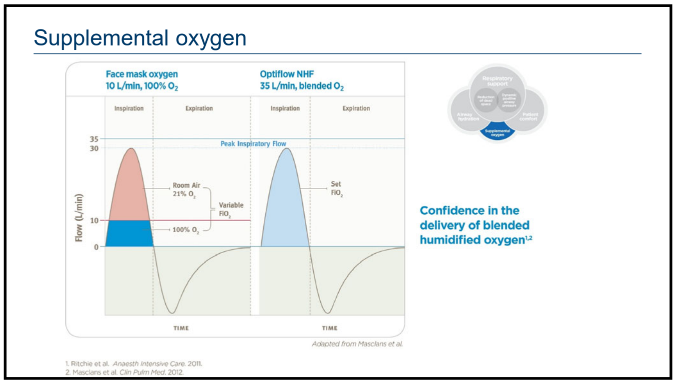

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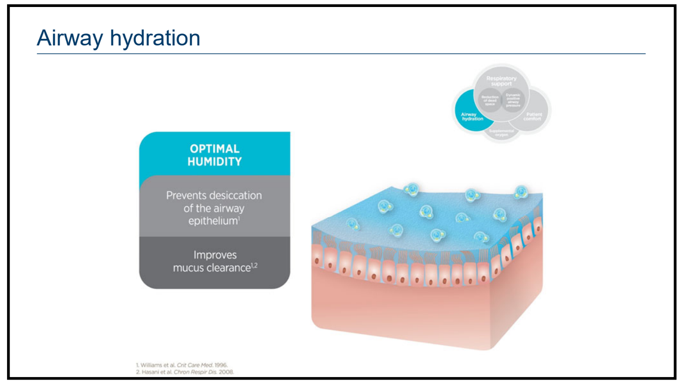

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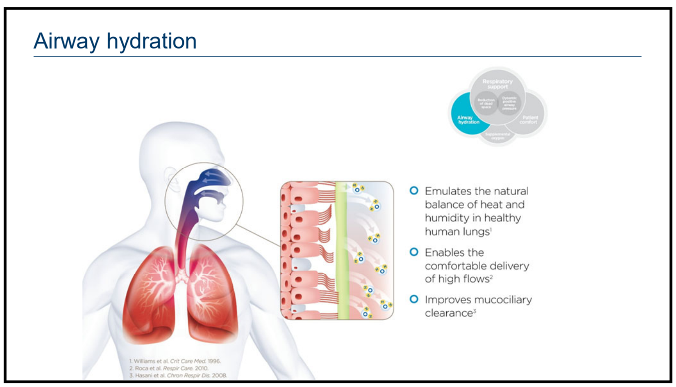

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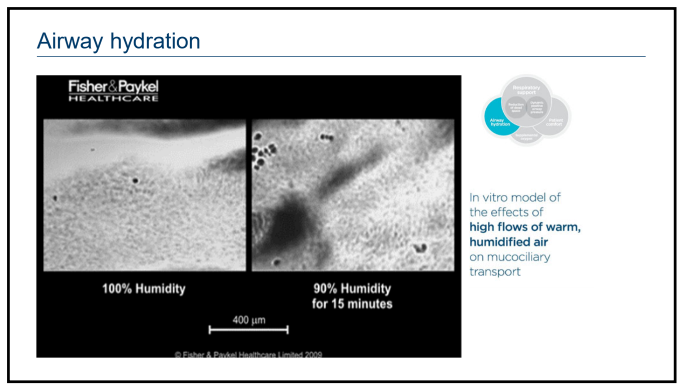

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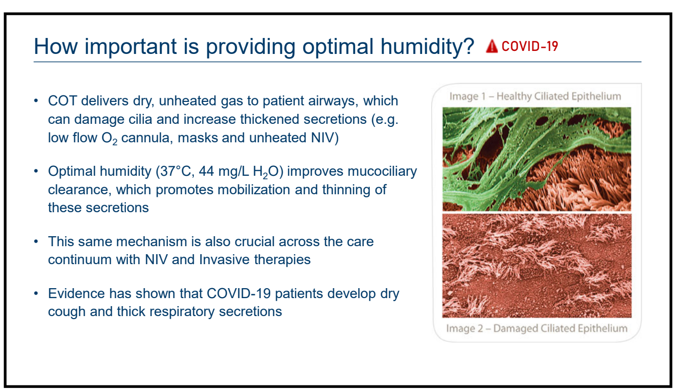

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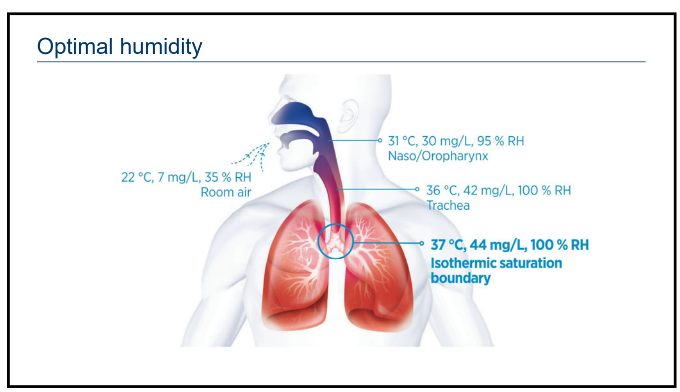

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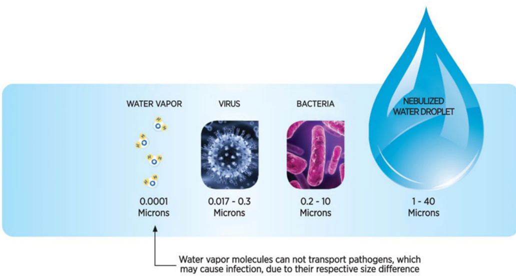
Water vapor and water droplets



COVID-19

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Patient comfort

COMFORTABLE[1,2] AND EASY TO USE

OPEN SYSTEM
No seal required

Patient tolerance[1,3]

1. Roca et al. *Respir Care.* 2010.
2. Maggiore et al. *Am J Respir Crit Care Med.* 2014.
3. Frat et al. *N Engl J Med.* 2015.

COVID-19

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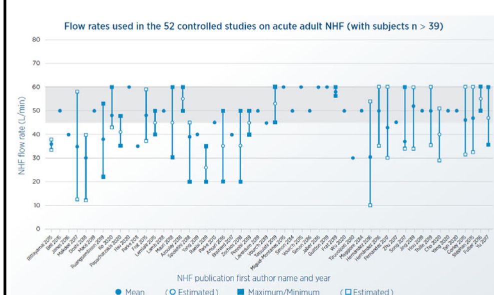
Wide body of evidence supporting nasal high flow



A recent systematic search of the PubMed database found 52 acute adult NHF controlled studies.

- 85% reported flow rates above 45 L/min
- 94% reported using F&P Optiflow systems

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What is the clinical evidence specific to the ED?

Nasal high flow can decrease the need for escalation and might decrease the need for intubation

(Meta-analysis; nasal high flow compared with COT and NIV)

- Huang, et al. Emerg Med Int. 2019.

"Patients with HFNC were much more likely to recover from respiratory failure."

(Compared with COT in patients with acute hypoxemic respiratory failure)

- Mace, et al. Am J Emerg Med. 2019.

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Nasal high flow in the ED: clinical studies summary

	Flow rate (L/min)/ Temp	Population	↓ Reduced escalation	↓ Reduced respiratory rate	↑ Improves oxygenation	↓ Reduced $PaCO_2$	↑ Improves comfort	↓ Reduced dyspnea
Huang 2019 Meta-analysis	35 – 50		●				●	●
Macé 2019	50 (37 °C)	Acute hypoxemic respiratory failure			●			●
Bell 2015	50 (37 °C)*	Undifferentiated shortness of breath	●	●			●	●
Lenglet 2012	40 (37 °C)*	Acute respiratory failure		●	●			●
Jeong 2015	Not reported (37 °C)*	Acute hypoxemic respiratory failure (INC. HYPERCAPNIC PTS.)		●	●	●		
Makdee 2017	35 (37 °C)*	Mild to moderate cardiogenic pulmonary oedema		●	●			
Rittayamai 2015	35 (37 °C)	Acute dyspnea and hypoxemia					●	●

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Evidence based guidelines for clinical mgmt. of COVID-19

Guideline	Nasal High Flow
WHO	May be used in patients with mild ARDS
NIH	Recommended over NIV in patients with AHRF despite COT
SSC*	Suggest use over COT and NIV in patients with AHRF
ANZICS	Considered for patients with hypoxemia

COVID-19

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Evidence based guidelines for clinical mgmt. of COVID-19

Guideline — **Systematic Reviews w/ Meta Analyses**

WHO

NIH

SSC*

ANZICS

- Zhao et al. 2017
- Ou et al. 2017
- Ni et al. 2018
- Rochwerg et al. 2019
- Agarwal et al. 2020

82% of studies required flows > 45 L/min

COVID-19

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Evidence based guidelines for clinical mgmt. of COVID-19

- ACEP Respiratory Support for Adult Patients with COVID-19 suggest the use of **high flow nasal oxygen (HFNO)** was associated with lower mortality in hypoxemic respiratory failure. Compared to conventional oxygen therapy, HFNO is associated with decreased risk of subsequent intubation and need for ICU admission.
- ATS Diagnosis and Management of COVID-19 Disease Guidelines recommend early use of oxygen by **high-flow nasal cannula (HFNC) in patients requiring more than standard nasal O_2** without indications for immediate intubation.
- DoD COVID-19 Practice Management Guide suggest although an area of controversy, early expert opinion favors **high flow nasal cannula (HFNC)** over other non-invasive modalities because it appears to be well tolerated, more efficacious than BIPAP and less provider intensive. There is presently no definitive evidence that HFNC augments transmission of virus.

COVID-19

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When a respiratory compromised patient presents in your ED

If hypoxemic:

Low levels of blood oxygen
- SpO_2 < 92%, ABG: PaO_2 < 75mm Hg

Frat. NEJM. 2015.
- 23 ctr RCT, 310 pts AHRF, NHF vs COT vs NIV
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Ischaki. Eur Resp Rev. 2017.
- Literature review (99 papers) and treatment algorithm

Clinical Practice Guidelines
- ESICM, 2020 – **recommend HFNC over COT**
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High partial pressure of blood carbon dioxide
- $PaCO_2$ > 45 mmHg, pH < 7.35

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Guidance
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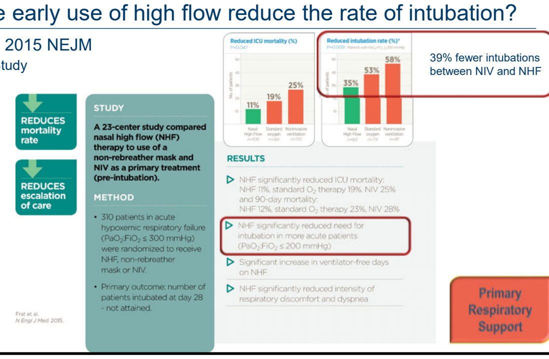
Can the early use of high flow reduce the rate of intubation?

Frat et al. 2015 NEJM
FLORALI Study



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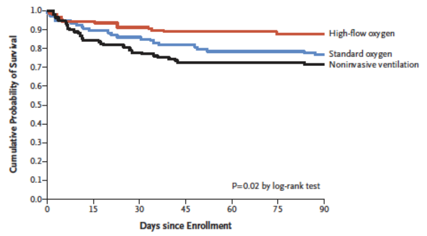
RCT of NHF vs NIV vs COT in AHRF



Frat JP et al, NEJM 2015

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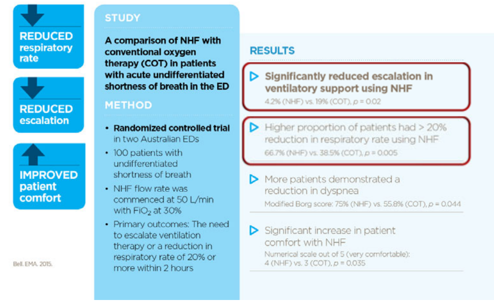
Bell et al. 2015 Emergency Medicine Australasia



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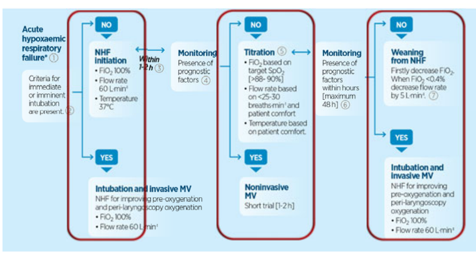
Treatment algorithm for AHRF patients

Ischaki et al. 2017
Ischaki. Eur Respir Rev. 2017.



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Clinical Practice Guidelines for hypoxemic patients

ESICM:
The role for high flow nasal cannula as a respiratory support strategy in adults: a clinical practice guideline.
Rochwerg B, et al. 2020

"We **recommend** using HFNC compared to COT for patients with acute hypoxemic respiratory failure."

ACP (American College of Physicians):
Appropriate use of high flow nasal oxygen in hospitalized patients for initial or postextubation management of acute respiratory failure: A clinical guideline.
Qaseem A, et al 2021

"**Use** high-flow nasal oxygen rather than noninvasive ventilation in hospitalized adults for the management of acute hypoxemic respiratory failure."

Society of Critical Care Medicine:
Surviving Sepsis Campaign, 2021: international guidelines for management of sepsis and septic shock
Evans L, et al. 2021

"For adults with sepsis-induced hypoxemic respiratory failure, we **suggest** the use of high flow nasal oxygen over noninvasive ventilation."

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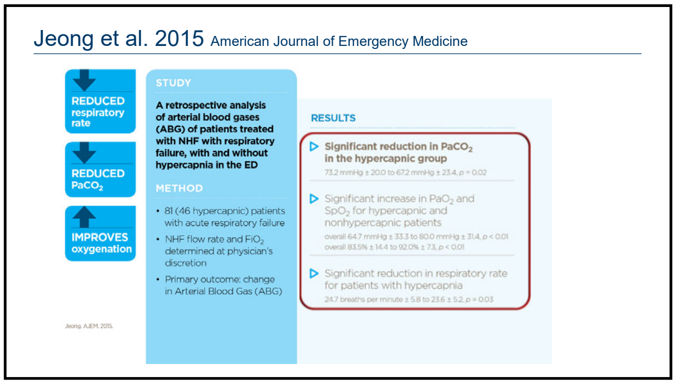

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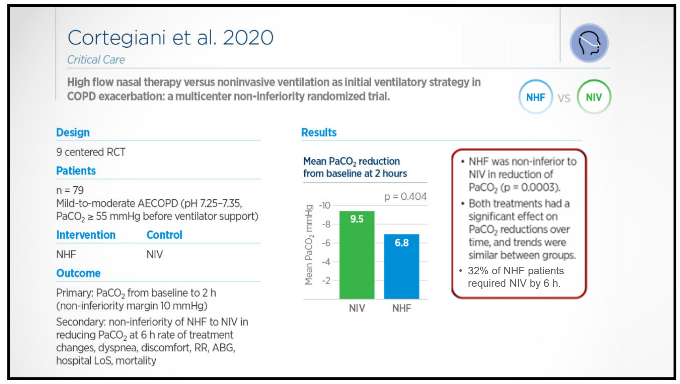

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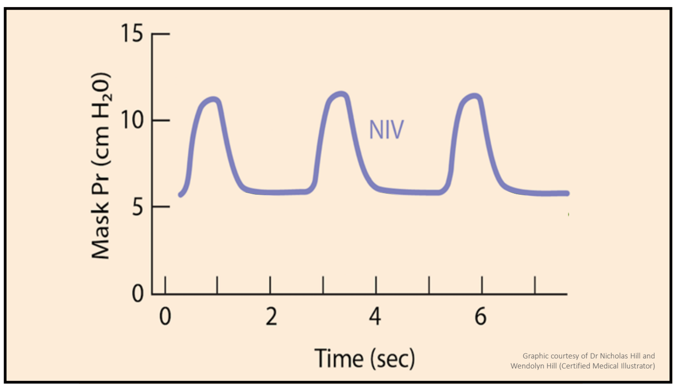

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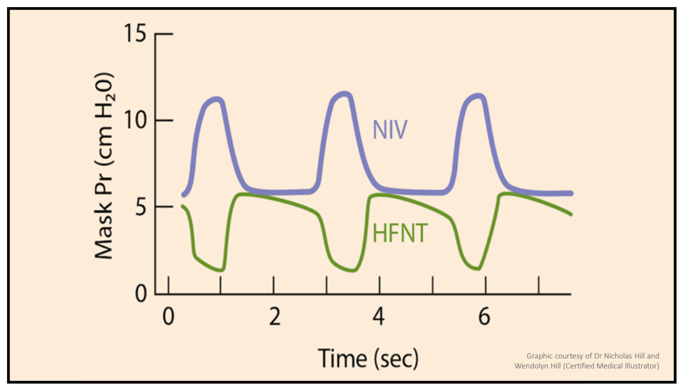

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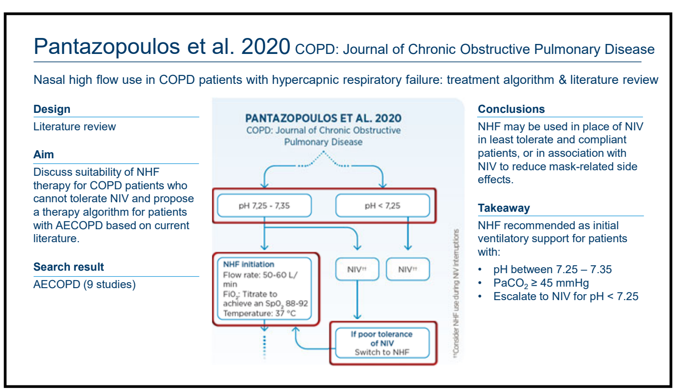

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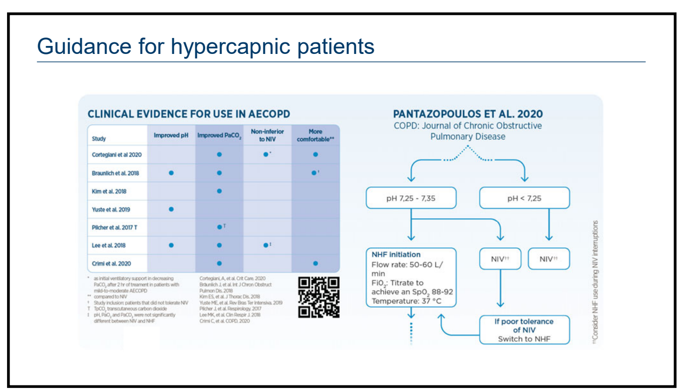

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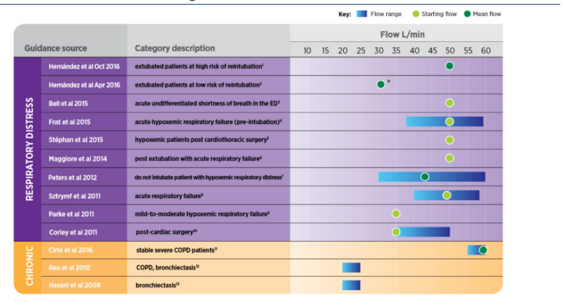
What flow rates and ranges are used?



* at 12 hours post extubation

1. Hernández et al. JAMA. Oct 2016. 2. Hernández et al. JAMA. Apr 2016. 3. Bell et al. Emerg Med Australas. 2015. 4. Frat et al. N Engl J Med. 2015. 5. Stéphan et al. JAMA. 2015. 6. Maggiore et al. Am J Respir Crit Care Med. 2014. 7. Peters et al. Respir Care. 2012. 8. Sztrymf et al. Intensive Care Med. 2011. 9. Parke et al. Respir Care. 2011. 10. Corley et al. Br J Anaesth. 2011. 11. Cirio et al. Respir med. 2016. 12. Rea et al. Respir Med. 2010. 13. Hasani et al. Chron Respir Dis. 2008.

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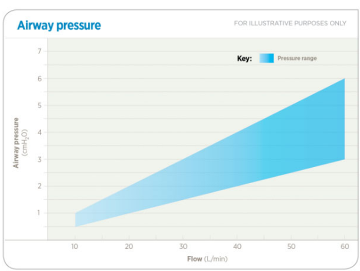
How much pressure is generated?



Pressure increases approximately 0.5 – 1 cmH_2O per 10 L/min of flow[1-3]

For example, flows of 50 L/min generate 2.5 – 5.0 cm H_2O

1. Parke et al. Respir Care. (Aug) 2011.
2. Groves et al. Aust Crit Care. 2007.
3. Ritchie et al. Anaesth Intensive Care. 2011.

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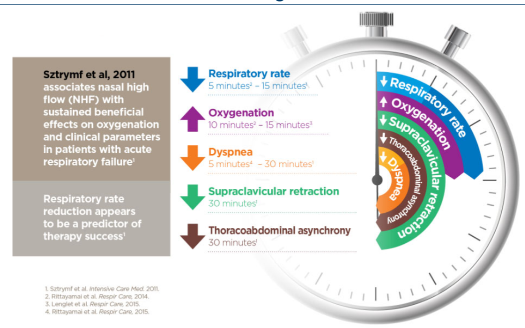
When are the effects of nasal high flow observed?



1. Sztrymf et al. Intensive Care Med. 2011.
2. Rittayamai et al. Respir Care, 2014.
3. Lenglet et al. Respir Care, 2015.
4. Rittayamai et al. Respir Care, 2015.

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How do we know if nasal high flow will be successful?

- First look at the ROX index: defined by three common noninvasive measurements:

$$\frac{SpO_2 / FiO_2}{RR} = \text{ROX index}$$

- Roca & colleagues conducted derivation (2016) and validation (2019) studies of the ROX index to predict the success of HFNC in pneumonia patients with AHRF
- Oxygen saturation measured by SpO_2 / FiO_2 had a greater weight than RR

$$\frac{SpO_2/FiO_2}{\text{Respiratory rate}} = \text{ROX index}$$

'Healthy' example: $\frac{95/0.21}{15} = 30.2$

'Patient' example: $\frac{95/0.85}{37} = 3.0$

Roca et al. 2016

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Using the ROX index to predict the outcome of Nasal High Flow

Roca et al. 2019

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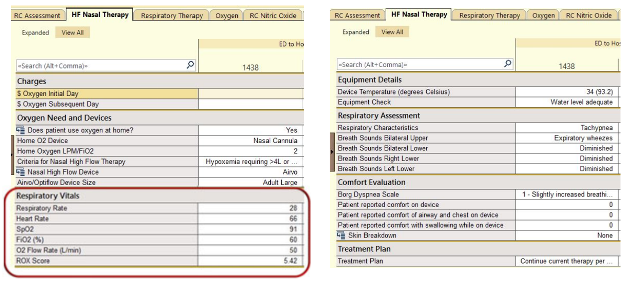
Chris Hutchinson, Director of Clinical Affairs
chris.hutchinson@fphcare.com

EPIC flowsheet



RC Assessment | HF Nasal Therapy | Respiratory Therapy | Oxygen | RC Nitric Oxide

Expanded | View All

«Search (Alt+Comma)»	ED to Ho 1438
Charges	
$ Oxygen Initial Day	
$ Oxygen Subsequent Day	
Oxygen Need and Devices	
Does patient use oxygen at home?	Yes
Home O2 Device	Nasal Cannula
Home Oxygen LPM/FiO2	2
Criteria for Nasal High Flow Therapy	Hypoxemia requiring >4L or ...
Nasal High Flow Device	Airvo
Airvo/Optiflow Device Size	Adult Large
Respiratory Vitals	
Respiratory Rate	28
Heart Rate	66
SpO2	91
FiO2 (%)	60
O2 Flow Rate (L/min)	50
ROX Score	5.42

RC Assessment | HF Nasal Therapy | Respiratory Therapy | Oxygen | RC Nitric Oxide

Expanded | View All

«Search (Alt+Comma)»	ED to Hos 1438
Equipment Details	
Device Temperature (degrees Celsius)	34 (93.2)
Equipment Check	Water level adequate
Respiratory Assessment	
Respiratory Characteristics	Tachypnea
Breath Sounds Bilateral Upper	Expiratory wheezes
Breath Sounds Bilateral Lower	Diminished
Breath Sounds Right Lower	Diminished
Breath Sounds Left Lower	Diminished
Comfort Evaluation	
Borg Dyspnea Scale	1 - Slightly increased breathi...
Patient reported comfort on device	0
Patient reported comfort of airway and chest on device	0
Patient reported comfort with swallowing while on device	0
Skin Breakdown	None
Treatment Plan	
Treatment Plan	Continue current therapy per ...

Courtesy of UnityPoint Health, Des Moines, IA

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Review

1. What are the origins of HFNC?
2. What are the mechanisms of action?
3. How can high flow be used effectively in your ED? ⚠ COVID-19
4. Q & A

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Any volunteers to experience nasal high flow?

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Thank you from Fisher & Paykel Healthcare

Open for any questions

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Chris Hutchinson, Director of Clinical Affairs
chris.hutchinson@fphcare.com