

High Flow Humidification Therapy, Updates.

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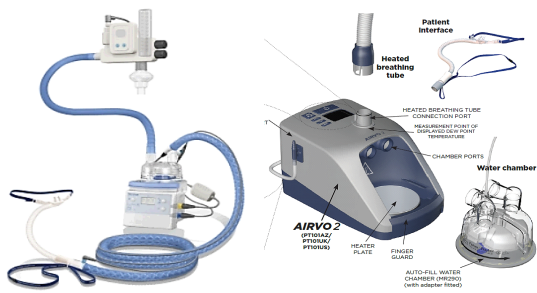
- I have no relevant financial relationships to disclose.



What is it?

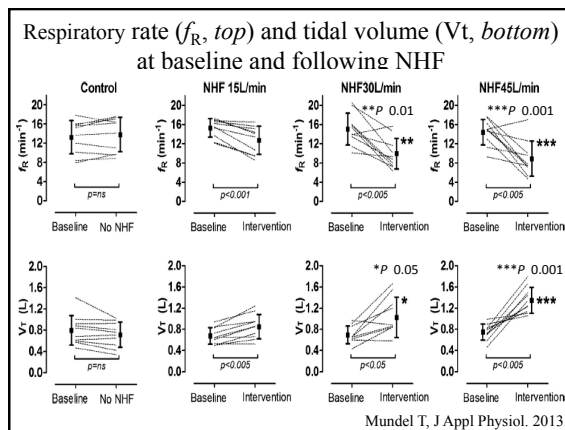
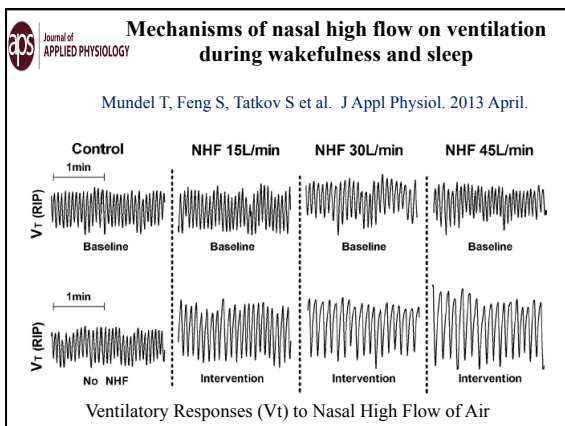
High Oxygen Flow Systems

High Air Flow Systems



How Does It Work?

- Change in tidal volume (V_t)
- Change in RR
- Reduction of death space:
- Increase in end-expiratory pressure
- Increase in end-expiratory lung volume



| | Control | NHF 15 l/min | NHF 30 l/min | NHF 45 l/min |
|------|-----------|--------------|--------------|--------------|
| ↑ Vt | 0.7 ± 0.1 | 0.8 ± 0.2 | 1.0 ± 0.2 | 1.3 ± 0.2 |
| ↓ RR | 16 ± 2 | 13 ± 3 | 10 ± 3 | 8 ± 3 |

Mundel T, J Appl Physiol. 2013.

Results:

1) Ventilatory response to NHF are dependent of sleep/wake cycle:

| Sleep/wake cycle | Awake | Sleep |
|------------------|---------|----------|
| Vt | ↑ Vt | ↓ Vt |
| RR | ↓ RR | No Δ RR |
| MV | No Δ MV | ↓ 20% MV |

3) Nasal cavity model on NHF: a) ↑ expiratory resistance, and b) ↓ inspiratory resistance

Mundel T, J Appl Physiol. 2013.

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How Does It Work?

- Reduction of dead-space ventilation.
 - ↓ CO2 concentration in trachea.
 - ↓ reduction of arterial CO2 tension
 - > Ritchie J. Anaesth Intensive Care 2011
 - > Braunlich J. Respiration 2013.

$$PaCO_2 = K V_{CO_2} / RR \times Vt (1 - Vd / Vt)$$

$$VA = Vt - Vd$$

aos Journal of APPLIED PHYSIOLOGY

Nasal high flow clears anatomical dead space in upper airway models

Moller W, Celik G A, Feng S, et al. J Appl Physiol. 2015 April.

Results:

- 1) Flow –dependent tracer-gas clearance, linear response
- 2) Complete tracer gas removal within 1 sec.

Moller W, Celik G A, Feng S, et al. J Appl Physiol. 2015 April.

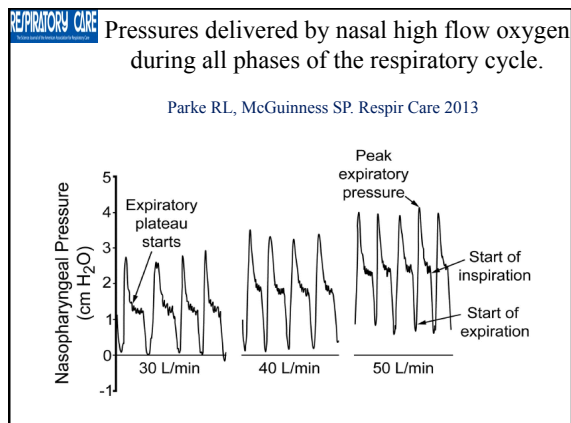
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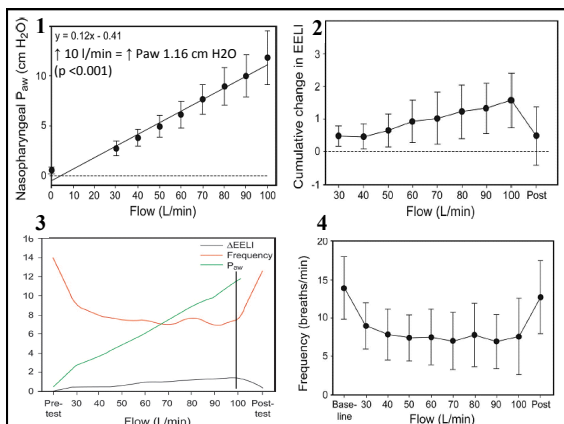
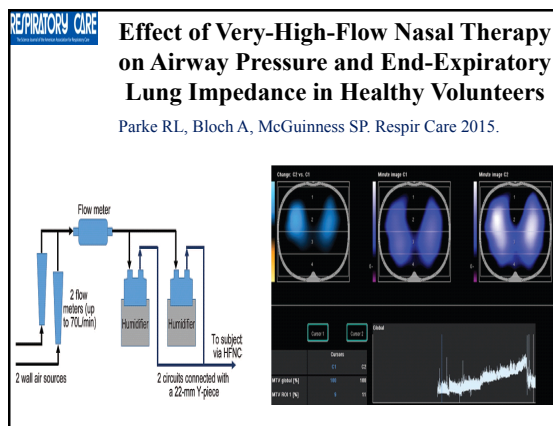


Airway Pressures Delivered by Nasal High Flow.

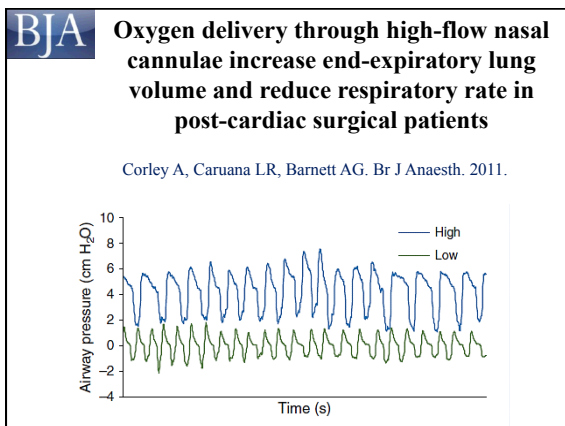
| Flow (L/min) | Mean Airway pressure (cmHO2) | Expiratory Plateau Pressure (cmHO2) | Peak Expiratory Pressure (cmHO2) |
|--------------|------------------------------|-------------------------------------|----------------------------------|
| 30 | 1.52 ± 0.6 | 1.71 ± 0.73 | 3.01 ± 1.18 |
| 40 | 2.21 ± 0.8 | 2.48 ± 0.94 | 3.81 ± 1.45 |
| 50 | 3.10 ± 1.2 | 3.41 ± 1.24 | 4.86 ± 1.79 |

Mean ± SD

Parke RL, Respir Care. 2013.



NHF in Postoperative Normocapnic-hypoxemia.



HFN compared with low-flow oxygen:

| Variable | Low-flow oxygen (mean (sd)) | HFNC (mean (sd)) | Mean difference (mean (sd)) | 95% confidence interval | P-value |
|--|-----------------------------|------------------|-----------------------------|-------------------------|---------|
| End-expiratory lung impedance (units) | 419 (212.5) | 1936 (212.9) | 1517 (46.6) | 1425, 1608 | <0.001 |
| Mean airway pressure (cm H ₂ O) | -0.3 (0.9) | 2.7 (1.2) | 3.0 (1.3) | 2.4, 3.7 | <0.001 |
| Respiratory rate (bpm) | 20.9 (4.4) | 17.5 (4.6) | -3.4 (2.8) | -2.0, -4.7 | <0.001 |
| Borg score | | | | | |
| 0-10 | 2.7 (2.6) | 1.9 (2.3) | -0.8 (1.2) | -0.1, -1.4 | 0.023 |
| Tidal variation (units) | 1512 (195.0) | 1671 (195.1) | 159 (21.6) | 117, 201 | <0.001 |
| PaO ₂ /FIO ₂ ratio (mm Hg) | 160 (53.7) | 190.6 (57.9) | 30.6 (25.9) | 17.9, 43.3 | <0.001 |

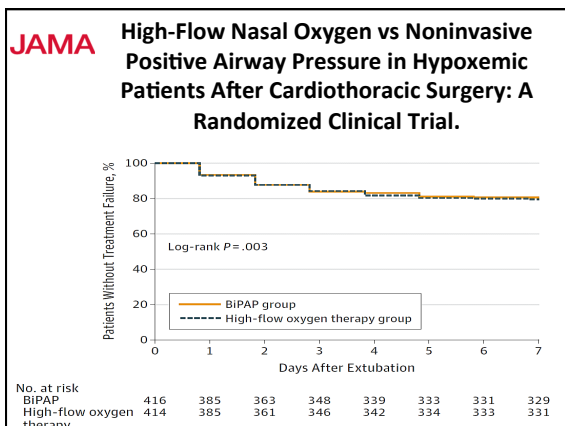
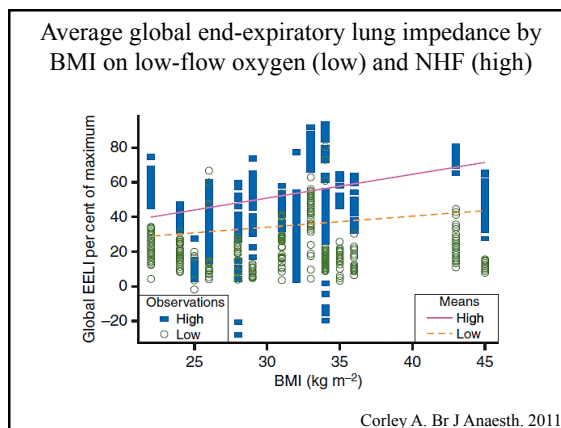
Corley A. Br J Anaesth. 2011.

HFN compared with low-flow oxygen:

Results: in comparison to low flow oxygen, NHF:

- 1) ↑ end-expiratory lung volume by 25.6% (95% CI 24.3,26.9)
- 2) ↑ Paw by 3.0 cmH₂O (95% CI 2.4,3.7)
- 3) ↓ 3.4 bpm. (95% CI 1.7,5.2)
- 4) ↑ PaO₂ / FIO₂ by 30.6 (95% CI 17.9,43.3)
- 5) Strong correlation between Paw and end-expiratory lung volume (r= 0.7, p<0.001)

Corley A. Br J Anaesth. 2011.

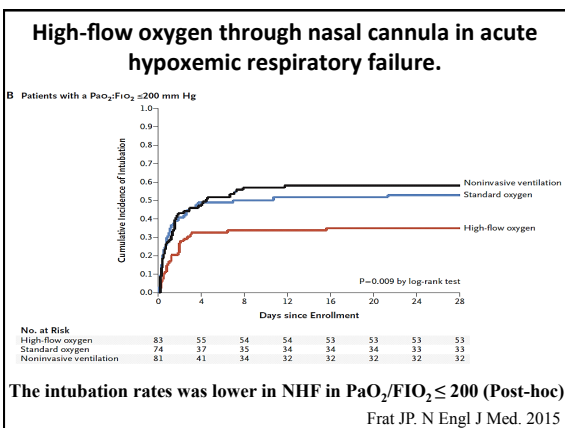
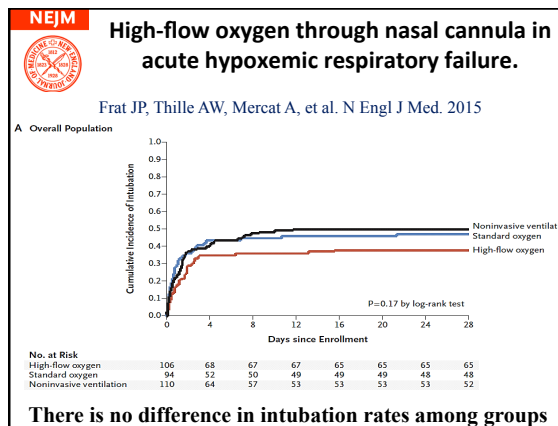


Results: in comparison to BIPAP, NHF:

- 1) No difference in treatment failure:
 - a) NHF failure 87 out of 414 pts (21.0%)
 - b) BIPAP-S failure 91 out of 416 pts (21.9%)
- 2) No difference in ICU mortality
- 3) BIPAP associated with higher PaO₂/FIO₂ ratio
- 4) NHF associated with lower RR and PaCO₂ (washout effect?)

Stéphan F, et al. JAMA. 2015.

NHF in
Medical ICU
Normocapnic-Hypoxemia.



Results:

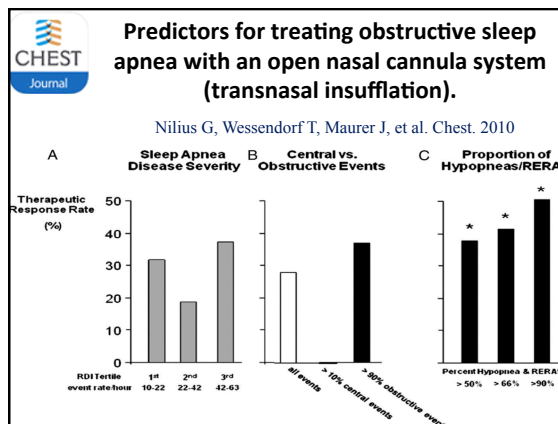
- The crude ICU mortality in comparison to NHF:
 - Low flow oxygen HR 1.85 (95% CI, 0.84-4.09)
 - NIV HR 2.55 (95% CI, 1.21-5.35)

p=0.04
- The crude 90-day mortality in comparison to NHF:
 - Low flow oxygen HR 2.01 (95% CI, 1.01-3.99)
 - NIV HR 2.50 (95% CI, 1.31-4.78)

p=0.02
- Decrease in favor of NHF of ventilator-free days

Frat JP. N Engl J Med. 2015

NHF in Sleep Disorders



Results:

- 1) NHF reduced RDI < 10/h (50% reduction) in 27% (around one quarter) of patients who required CPAP
- 2) Significant response rate to:
 - a) RERAs
 - b) Hypopneas
 - c) REM > NREM
- 3) Poor response rate to:
 - a) Apneas
 - b) Central apneas (> 10% of CSA)

Take Home Message:

- NHF: ↓ Vd, RR and ↑ EELV.
- Among cardiothoracic patients, NHF is not inferior to NIV in postoperative hypoxemic RF.
- Among Medical ICU hypoxemic RF (CAP), NHF is not different than NIV or low flow O2 in intubation rates but ↑ ventilator-free days, and ↓ ICU and 90-day mortality.
- NHF is therapeutic in SDB with RDI >90% hypopneas and/or RERAs

Thank you