High Flow Oxygen Therapy - 2019

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Disclaimers

- Consultant: Breathe Technology, Ventec

Objectives

- Define HFNC and design features of current systems
- Develop management strategies based upon the unique physiology of HFNC support
- Manage patients according to the current evidence base for HFNC

High Flow Oxygen Therapy - 2019

- Definitions/Design
- Physiology of HFNC Therapy
- Clinical Trials

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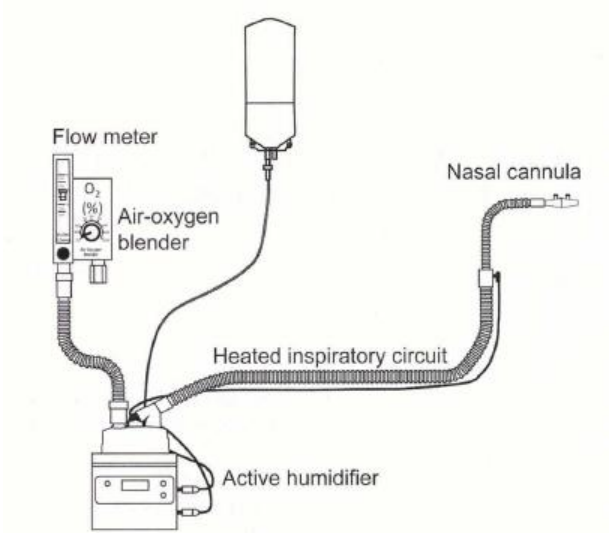
Definitions

- Non-Invasive Ventilation (NIV): Positive pressure mechanical support thru mask. Inspiratory pressure above expiratory pressure. Provides ventilatory AND oxygenation support
- Constant positive airway pressure (CPAP): Positive pressure mechanical support through mask or airway. Inspiratory pressure equals expiratory pressure. Oxygenation support only.
- Continuous oxygen therapy (COT): Oxygen supplementation throughout the respiratory cycle. When used at flows <15L/min, provides oxygenation support only.

Definitions

- High flow nasal cannula oxygen therapy (HFNC). Heated, humidified COT delivered thru wide bore nasal cannula at 30-60 L/min.
  - Flushes anatomic dead space to decrease VD. VE needs reduced, lower WOB
  - Small amount of CPAP may facilitate oxygenation



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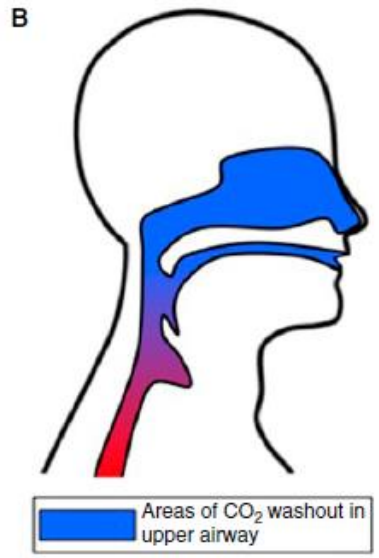
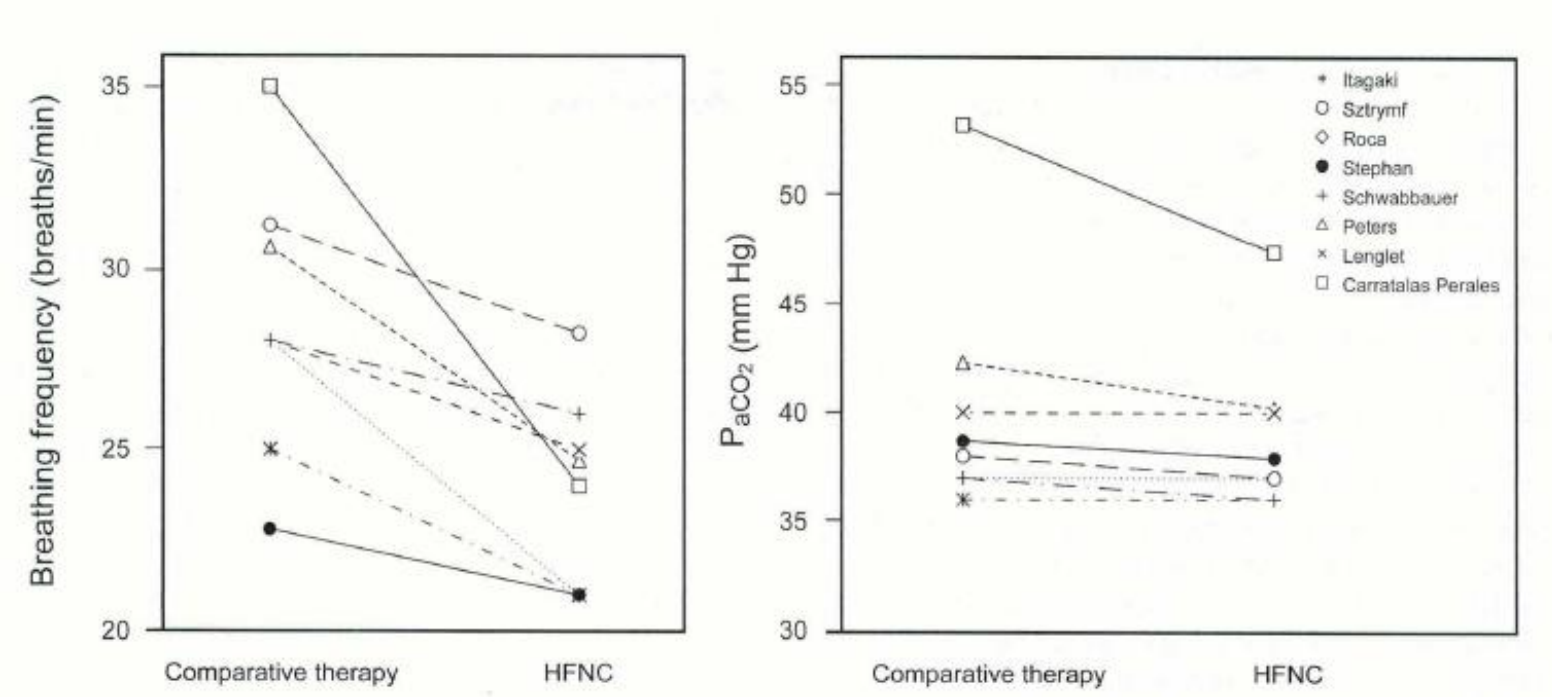
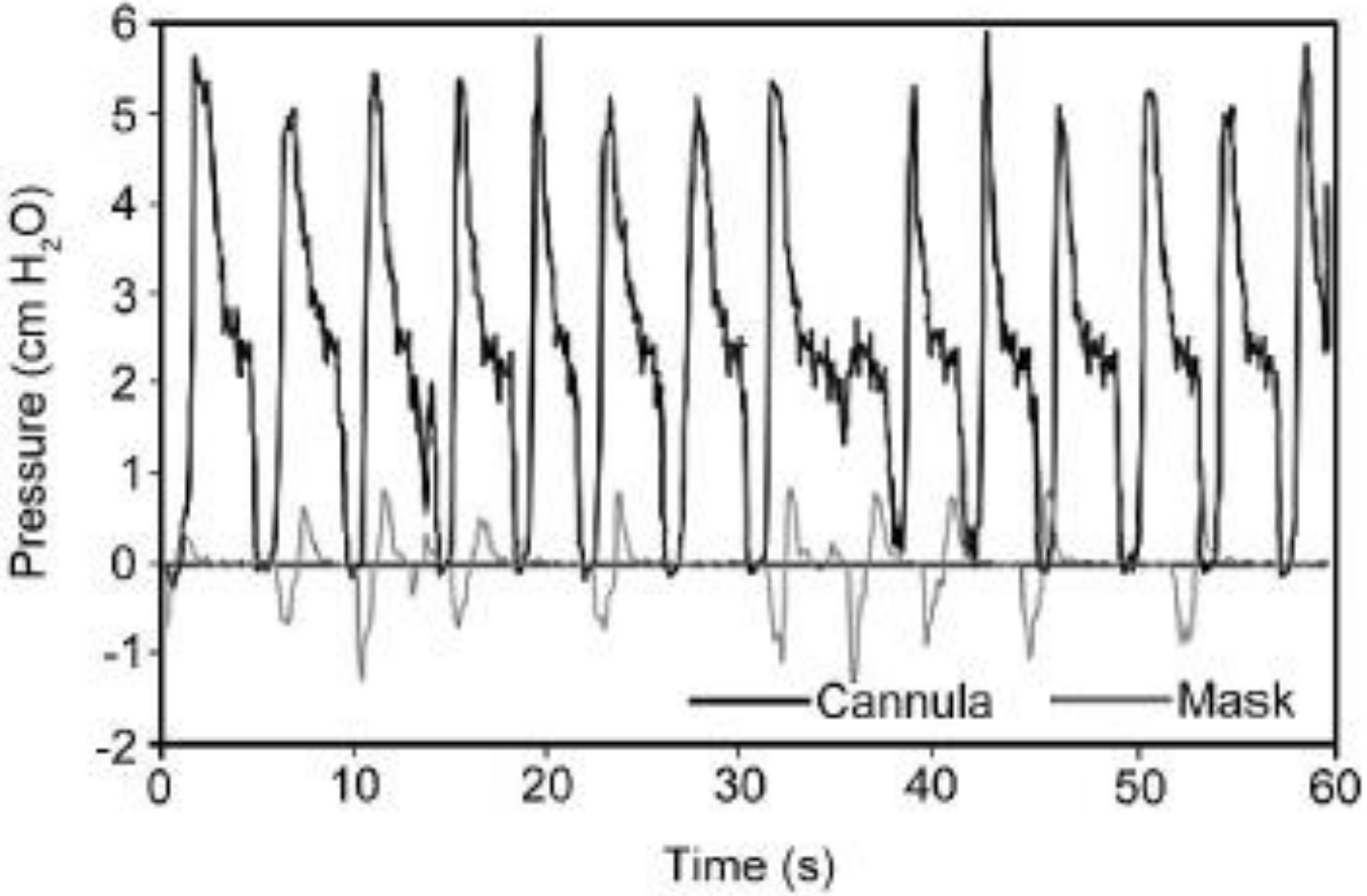
HFNC Reduces VD and thus Reduces VE and WOB





Resp Care 2016; 61:529

HFNC Provides Low Level CPAP



Resp Care 2013;58:98

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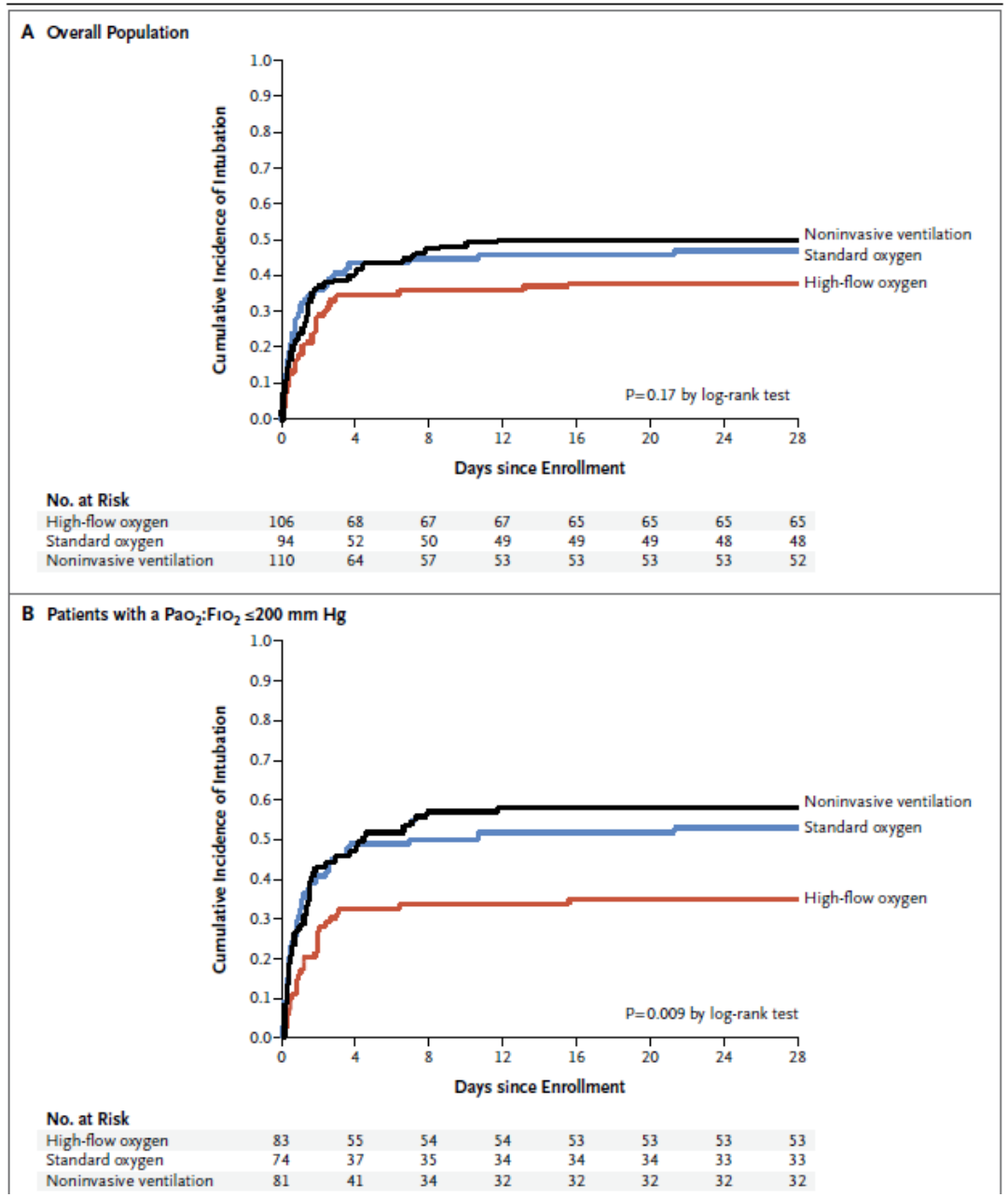
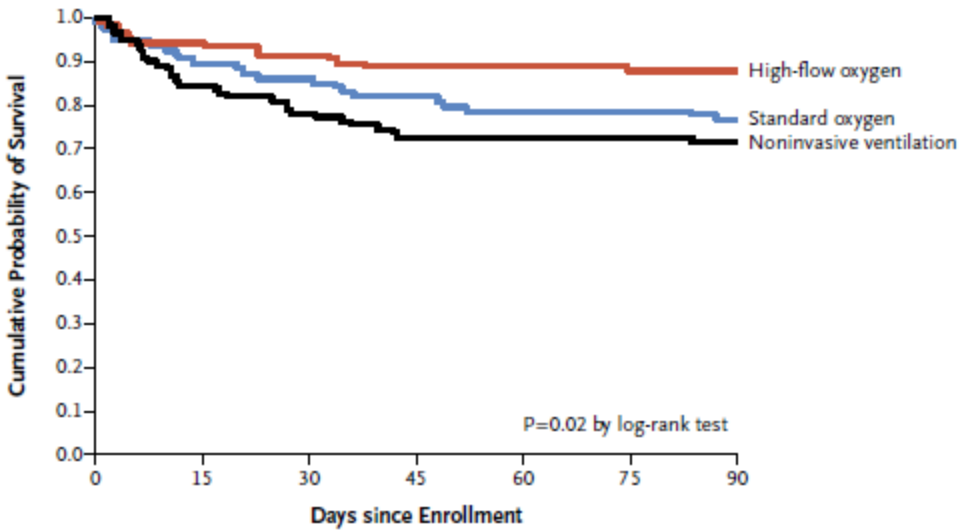


NEJM 2015: epub May 15 2015



No. at Risk

High-flow oxygen	106	100	97	94	94	93	93
Standard oxygen	94	84	81	77	74	73	72
Noninvasive ventilation	110	93	86	80	79	78	77

Figure 3. Kaplan–Meier Plot of the Probability of Survival from Randomization to Day 90.

NEJM 2015: epub May 15 2015

Table 2. Prospective trials evaluating high-flow nasal cannula oxygenation in medical patients

Study	Design/*N*	Patients	Comparison	Outcomes
Acute hypoxemic respiratory failure				
FLORALI Frat and colleagues, 2015 (18)	RCT 310	Pa_{O_2}/Fi_{O_2} ≤300	HFNC 50 L/min vs. COT or NIV	Fewer intubations with HFNC (38%) than with COT (47%) and NIV (50%) Lower 90-d mortality with HFNC
HOT-ER Jones and colleagues, 2016 (19)	RCT 303	Sp_{O_2} ≤92% and RR ≥22 breaths/min Admitted to ED	HFNC 40 L/min vs. COT	5.5% of HFNC vs. 11.6% of COT intubated within 24 h ($P = 0.053$) No difference in 90-d mortality
Immunosuppressed				
Coudroy and colleagues, 2016 (36)	Observational cohort 115	Pa_{O_2}/Fi_{O_2} ≤300 RR ≥25 breaths/min	HFNC 50 L/min vs. NIV	Fewer intubations with HFNC than with NIV (35 vs. 55%) Lower 28-d mortality with HFNC (20 vs. 40%)
Frat and colleagues, 2016 (34)	*Post hoc* study of RCT 82	Pa_{O_2}/Fi_{O_2} ≤300	HFNC 50 L/min vs. COT or NIV	31% of HFNC, 43% of COT, and 65% of NIV intubated by 28 d Age and NIV use as first-line therapy independently associated with need for intubation
Lemiale and colleagues, 2015 (80)	RCT 100	>6 L/min COT or symptoms of respiratory distress	HFNC 40–50 L/min vs. Venturi mask with 60% Fi_{O_2}	No difference in intubations or comfort HFNC applied for only 2 h
Lemiale and colleagues, 2017 (37)	*Post hoc* study of RCT 353	Pa_{O_2} <60 mm Hg RR >30 breaths/min or respiratory distress	Propensity-matched analysis of HFNC 40 L/min (10–50) vs. COT	No difference in intubations No difference in 28-d mortality
Prevention of reintubation				
Hernández and colleagues, 2016 (52)	RCT 527	Successfully passed SBT Low risk for reintubation	HFNC 30 L/min vs. COT	Fewer reintubations within 72 h with HFNC (4.9%) than with COT (12.2%) No difference in time to reintubation
Hernández and colleagues, 2016 (53)	RCT 604	Successfully passed SBT High risk for reintubation	HFNC 50 L/min vs. NIV	Similar reintubation rates (22.8% in HFNC vs. 19.1% in NIV) over 72 h Less respiratory failure overall in HFNC (26.9% vs. 39.8%) More adverse events with NIV
Maggiore and colleagues, 2014 (51)	RCT 105	Pa_{O_2}/Fi_{O_2} ≤300 at time of extubation	HFNC 50 L/min vs. Venturi mask	HFNC reduced desaturations, reintubations, and NIV Improved comfort with HFNC
Tiruvoipati and colleagues, 2010 (12)	Randomized crossover 42	Successfully passed SBT	HFNC → HFFM or vice versa 30 L/min	No difference in RR or gas exchange Improved comfort with HFNC
Palliative				
Peters and colleagues, 2013 (43)	Prospective cohort 50	Do-not-intubate status, in respiratory distress	HFNC 30–60 L/min, no comparison	HFNC improved RR and oxygenation

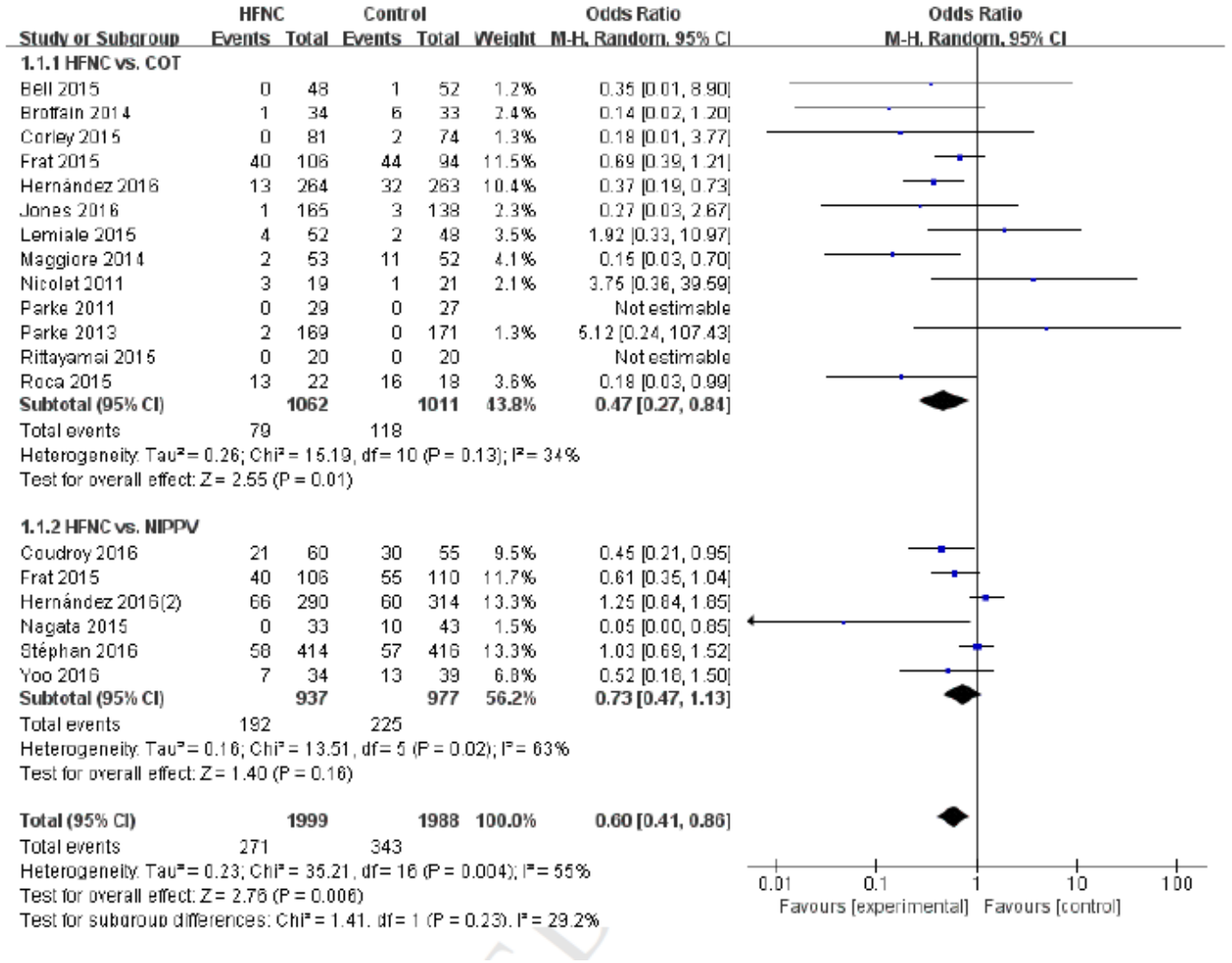
Table 3. Prospective trials of high-flow nasal cannula oxygenation in surgical patients

Study	Design/*N*	Patients	Comparison	Outcomes
Prevention of reintubation after cardiac surgery				
Corley and colleagues, 2015 (59)	RCT 155	BMI ⩾30 kg/m^2	HFNC 35–50 L/min vs. COT	No difference in Pa_{O_2}/FI_{O_2} after 24 h No difference in atelectasis by Day 5
Parke and colleagues, 2013 (58)	RCT 340	Not stratified by reintubation risk	HFNC 45 L/min vs. usual care	No difference in Sp_{O_2}/FI_{O_2} on Day 3 Fewer in HFNC group required escalation of respiratory support
Parke and colleagues, 2011 (60)	RCT 60	Surgical ICU Most were post–cardiac surgery	HFNC 35 L/min vs. COT	Lower NIV use with HFNC (10%) vs. COT (30%) Fewer desaturation events with HFNC
Stephán and colleagues, 2015 (57)	RCT 830	Previously failed extubation or high risk for reintubation	HFNC 50 L/min vs. NIV	No difference in reintubations or ICU mortality More skin breakdown with NIV
Prevention of reintubation after abdominal surgery				
Futier and colleagues, 2016 (61)	RCT 220	High risk for reintubation	HFNC 50–60 L/min vs. COT	No difference in reintubations, hypoxemia, or in-hospital mortality
Thoracic surgery				
Ansari and colleagues, 2016 (64)	RCT 59	Post–lung resection	HFNC 20–50 L/min vs. COT	HFNC reduced hospital LOS No difference in 6MWT on POD 2 Imbalance in baseline 6MWT may have influenced results
Yu and colleagues, 2017 (63)	RCT	Post-lobectomy High risk for reintubation	HFNC 35–60 L/min vs. COT	HFNC reduced intubations and hypoxemia

Table 4. Prospective trials of high-flow nasal cannula oxygenation for intubation and bronchoscopy

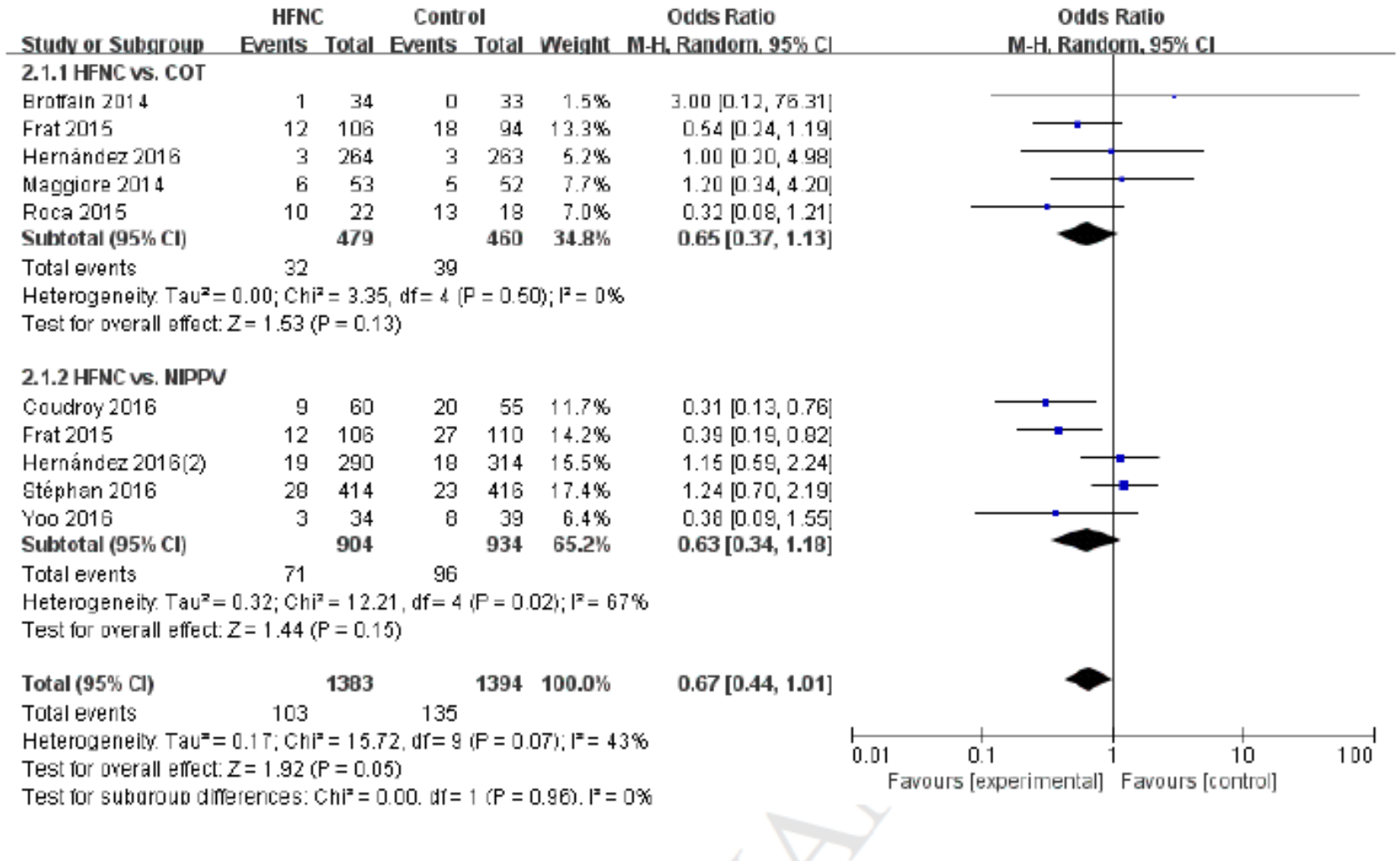
Study	Design/*N*	Patients	Comparison	Outcomes
Preoxygenation and apneic oxygenation for intubation				
Jaber and colleagues, 2016 (67)	RCT 49	RR ⩾30 breaths/min, F_{IO_2} >50% Pa_{O_2}/F_{IO_2} <300 requiring MV	Preoxygenation with HFNC 60 L/min + NIV vs. NIV alone	HFNC + NIV combination improved oxygenation vs. NIV alone
Miguel-Montanes, and colleagues, 2015 (71)	Before-after 101	All patients requiring MV	Before: NRB After: HFNC 60 L/min	HFNC reduced severe hypoxemia (Sp_{O_2} <80%)
Semler and colleagues, 2016 (70)	RCT 150	All patients requiring MV	HFNC 15 L/min during laryngoscopy vs. no oxygen	No difference in hypoxemia
Simon and colleagues, 2016 (69)	RCT 40	Pa_{O_2}/F_{IO_2} <300 requiring MV	HFNC 50 L/min before/during laryngoscopy vs. bag mask before	No difference in hypoxemia
Vourc'h and colleagues, 2015 (68)	RCT 124	RR ⩾30 breaths/min, F_{IO_2} ⩾50%, Pa_{O_2}/F_{IO_2} <300 requiring MV	HFNC 60 L/min before/during laryngoscopy vs. face mask before	No difference in hypoxemia No difference in adverse events
Bronchoscopy				
Lucangelo and colleagues, 2012 (75)	RCT 45	Diagnostic bronchoscopy No respiratory or cardiac failure	HFNC 40 L/min, HFNC 60 L/min, or Venturi mask 40 L/min	60 L/min HFNC improved hypoxemia and Pa_{O_2}/F_{IO_2} ratio better than 40 L/min HFNC and Venturi mask
Simon and colleagues, 2014 (76)	RCT 40	Diagnostic bronchoscopy Pa_{O_2}/F_{IO_2} <300	HFNC 50 L/min vs. NIV	Similar oxygenation during procedure One HFNC, three NIV required intubation within 24 h Approximately three-fourths of patients were on NIV or HFNC at baseline

HFNC and Intubations



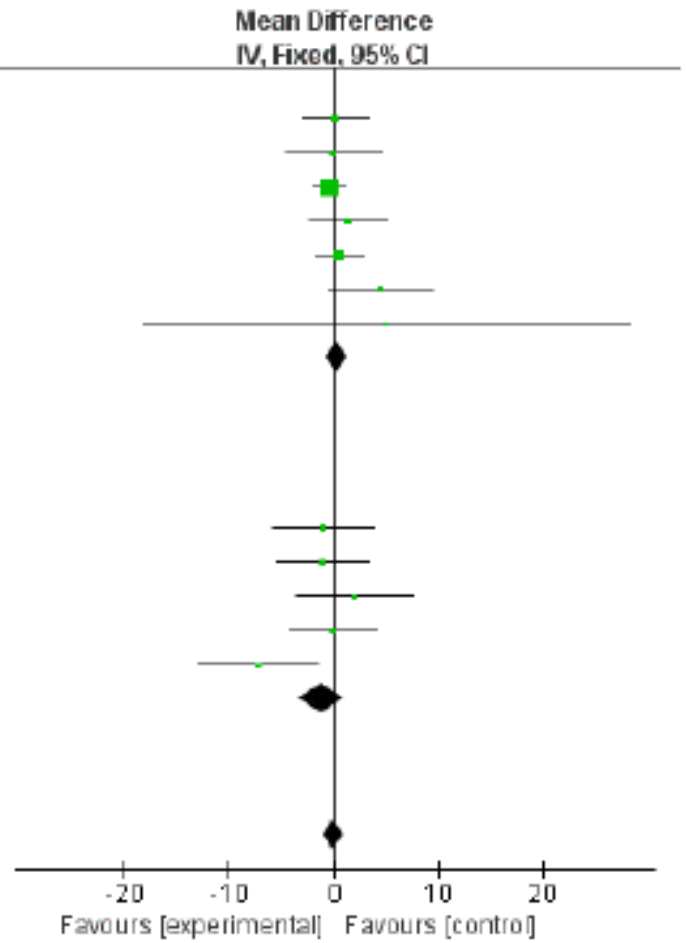
Chest. Published online January 19, 2017. 10.1016/j.chest.2017.01.004

HFNC and ICU Mortality



HFNC and ICU LOS

Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
3.1.1 HFNC vs. COT								
Brotfain 2014	10.7	6.2	34	10.5	7.3	33	8.8%	0.20 [-3.05, 3.45]
Hernández 2016	6	24.87	264	6	28.86	263	4.4%	0.00 [-4.61, 4.61]
Jones 2016	4.5	7.21	165	4.9	6.89	138	36.6%	-0.40 [-1.99, 1.19]
Maggiore 2014	11.7	10.2	53	10.4	8.5	52	7.2%	1.30 [-2.29, 4.89]
Nicolet 2011	6	4	19	5.5	3	21	19.0%	0.50 [-1.71, 2.71]
Parke 2013	33.4	22.8	169	28.9	24	171	3.7%	4.50 [-0.48, 9.48]
Roca 2015	14	26.32	22	9	44.37	18	0.2%	5.00 [-18.26, 28.26]
Subtotal (95% CI)			**726**			**696**	**79.9%**	**0.30 [-0.78, 1.37]**
Heterogeneity: Chi² = 3.99, df = 6 (P = 0.68); I² = 0%								
Test for overall effect: Z = 0.54 (P = 0.59)								
3.1.2 HFNC vs. NIPPV								
Coudroy 2016	7	9.88	60	8	15.14	55	4.2%	-1.00 [-5.72, 3.72]
Hernández 2016(2)	3	21.72	290	4	31.64	314	5.0%	-1.00 [-5.30, 3.30]
Nagata 2015	6	11.72	33	4	13.38	43	2.9%	2.00 [-3.66, 7.66]
Stéphan 2015	6	31.22	414	6	31.14	416	5.2%	0.00 [-4.24, 4.24]
Yoo 2016	13.4	10.3	34	20.6	14.2	39	2.9%	-7.20 [-12.84, -1.56]
Subtotal (95% CI)			**831**			**867**	**20.1%**	**-1.21 [-3.35, 0.94]**
Heterogeneity: Chi² = 5.89, df = 4 (P = 0.21); I² = 32%								
Test for overall effect: Z = 1.10 (P = 0.27)								
Total (95% CI)			**1557**			**1563**	**100.0%**	**-0.01 [-0.97, 0.96]**
Heterogeneity: Chi² = 11.39, df = 11 (P = 0.41); I² = 3%								
Test for overall effect: Z = 0.01 (P = 0.99)								
Test for subgroup differences: Chi² = 1.51, df = 1 (P = 0.22), I² = 33.8%								



Words of Caution

- Doesn’t always work – NIV and/or intubations still needed
  - Delayed intubations adversely affect outcomes
- Always be on lookout for hyperoxia – keep SpO2 <95
- Monitoring important to assure device functioning properly

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