Oxygen Therapy, CPAP, and NIV

Dean Hess PhD RRT Assistant Director of Respiratory Care Associate Professor of Anesthesia

Oxygen Delivery Devices

Low-flow devices

- Oxygen flow less than inspiratory flow of patient
- FIO₂ variable and depends on oxygen flow, volume of reservoir, breathing pattern

Cannula, simple mask, nonrebreather

- High-flow devices
 - Flow greater than inspiratory flow of patient

Low Flow Devices

Nasal cannula

 FIO₂ 0.24 - 0.40 at 1 - 6 L/min

 Simple mask

 FIO₂ 0.3 - 0.6 at 5 - 10 L/min

 Nonrebreathing mask

 FIO₂ 0.6 - 0.8 at 10 - 15 L/min







Reservoir Cannula and Transtracheal Catheter



Air Entrainment Mask (Venturi Mask)

- High flow delivery device
- Available in various fixed oxygen concentrations



Not convenient; requires good mask fit

Cool Aerosol

flow meter (10 - 15 L/min)oxygen concentration control drain tube water bottle aerosol tubing to patient

 FIO_2 setting 0.28 - 1.0. At $FIO_2 > 0.50$, the total flow from the nebulizer is significantly reduced and room air dilutes the delivered oxygen concentration.

O ₂ Flow	O ₂ Setting	Air: O ₂	Total Flow
10	0.28	10:1	110
10	0.40	3:1	40
10	0.6	1:1	20
10	1.0	0:1	10

*FIO*₂ *decreases as FDO*₂ *increases!*

High Flow Oxygen

High Flow Air and O₂ Flowmeters to Titrate FIO₂

Oxygen Analyzer

Humidifier

Face Mask or Trach Mask

Oxygen Therapy Myths

Oxygen decreases respiratory drive

 PaCO₂ may increase, but usually not due to suppressing hypoxic drive

 Cannula cannot be used if the patient

is a mouth breather

Nonrebreather delivers 100% oxygen
 Cool aerosols can deliver high FIO₂

NIV vs CPAP



No ventilation assistance with CPAP, but increased lung volume and intrathoracic pressure.

Mask CPAP for Hypoxemic Respiratory Failure

- Patients randomized to O₂ or mask CPAP
- After 1 hr, subjective response and PaO₂/FIO₂ were higher with CPAP
- No difference in intubation rate or mortality
- Higher number of adverse events in patients receiving CPAP

Delclaux, JAMA 2000; 284:2352

Mask CPAP for Post-Op Hypoxemia

 Patients with hypoxemia after major abdominal surgery randomized to 7.5 cm H₂O CPAP or oxygen

PaO₂ improved more rapidly for CPAP

Lower intubation rate (1% vs 10%), lower pneumonia rate (2% vs 10%), fewer ICU days (1.4 vs 2.6 d) with CPAP

Squadrone, JAMA 2005; 293:589

Benefits for Mask CPAP

Acute cardiogenic pulmonary edema
Post-operative atelectasis
Obstructive sleep apnea
OSA, CSR, and CSA associated with CHF

NIV for COPD Exacerbation

Outcome	Number of studies contributing data	Total number of patients	Relative risk (95% Cl)	Number needed to treat (95% CI)
Treatment failure	7	529	0.51 (0.38 to 0.67)	5 (4 to 7)
Mortality	7	523	0.41 (0.26 to 0.64)	8(6 to 13)
Intubation	8	546	0.42 (0.31 to 0.59)	5 (4 to 7)
Complications	2	143	0.32 (0.18 to 0.56)	3 (2 to 4)

Lightowler, BMJ 2003; 326:185

NPPV for Acute CPE



Masip, JAMA 2005;294:3124

Mask CPAP and CPE

Need for endotracheal intubation

Btudy or sub-category	CPAP n/N	NPP∨ n/N	RD (random) 95% Cl	RD (random) 95% Cl
Bellone et al. 2005	1/18	2/18		-0.06 [-0.24, 0.12]
Bellone et al. 2004	1/22	2/24		-0.04 [-0.18, 0.10]
Park et al. 2004	2/27	2/27		0.00 [-0.14, 0.14]
Mehta et al. 1997	1/13	1/14	_ _	0.01 [-0.19. 0.20]
Bermudez et al. 2002	4/39	2/41		0.05 [-0.06, 0.17]
Crane et al. 2004	4/20	1/20		0.15 [-0.05, 0.35]
Park et al, 2001	3/9	0/7		0.33 (-0.01, 0.67)
otal (95% CI)	148	151	•	0.03 [-0.04, 0.09]
otal events: 16 (CPAP), 10 (NP	PV)		а.	
est for heterogeneity: Chi2 = 6.	78, df = 6 (P = 0.34), P = 11	5%		
est for overall effect: Z = 0.83	(P = 0.41)			
		-1	-0.5 0 0.5	1
			Favours CPAP Favours NPPV	
Mortality				
Study	CPAP	NPPV	RD (random)	RD (random)
or sub-category	N/n	n/N	95% CI	95% CI
Crane et al. 2004	0/20	5/20	20 - 100 - 1	-0.25 (-0.45, -0.05)
Park et al. 2004	1/27	2/27		-0.04 [-0.16, 0.08]
Bellone et al. 2005	1/18	0/18		0.06 [-0.09, 0.20]
Vehta et al, 1997	2/13	1/14		0.08 [-0.16, 0.32]
Bermudez et al, 2002	5/39	2/41		0.09 [-0.04, 0.20]
Bellone et al, 2004	2/22	0/24	+	0.09 [-0.05, 0.23]
Park et al. 2001	1/9	0/7		0.11 [-0.17, 0.39]
	140	151	•	0.02.1-0.05.0.101
Total (95% CI)	140			0.02 [-0.06, 0.10]
fotal (95% Cl) fotal events: 12 (CPAP), 10 (NF	PPV)	(SAP)		0.02 (-0.06, 0.10)
Total (95% CI) Total events: 12 (CPAP), 10 (NF Test for heterogeneity: Chi² = 10	PPV) 0.79, df = 6 (P = 0.10), P = 4	4.4%		0.02 (-0.08, 0.10)
total (95% CI) total events: 12 (CPAP), 10 (NF test for heterogeneity: Chi ² = 10 test for overall effect: Z = 0.47	PPV) 0.79, df = 6 (P = 0.10), P = 4 (P = 0.64)	4.4%		0.02 [-0.06, 0.10]
iotal (95% CI) iotal events: 12 (CPAP), 10 (NF iest for heterogeneity: Chi ² = 10 iest for overall effect: Z = 0.47	PPV) 0.79, cff = 6 (P = 0.10), F = 4 (P = 0.64)	4.4%		

Winck, Critical Care 2006, 10:R69

Evidence for NPPV

COPD Exacerbations	****
Acute cardiogenic pulmonary edema	****
Prevent extubation failure	**
Respiratory failure following lung resection	*
Transplantation, immunocompromise	*
Acute hypoxemic respiratory failure	?
Asthma	?
Do not intubate/Do not Resuscitate	?
Failed extubation	_

Patient Selection for NIV

Inclusions:

- Respiratory distress
- Tachypnea, accessory Unable to fit mask muscle use
- Acute respiratory acidosis

Exclusions:

- Airway protection
- Severity of illness
- Uncooperative patient
- Patient wishes

Step 1: Patient needs mechanical ventilation Step 2: No exclusions for NPPV

Knowing When to Stop

Lack of improvement within 1-2 hrs of initiation of therapy
Patient intolerance of therapy
Adverse effects: hypotension
Patient wishes

When to keep patient on ward, when to transfer to ICU or RACU?

Equipment for NIV/CPAP





PS (or PC) = IPAP - EPAP

Noninvasive Respiratory Support

Oxygen delivery devices
CPAP
NIV

Aerosol bronchodilator
Airway clearance
Heliox