Use of NIPPV and Portable Sleep Testing in the Inpatient Setting

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Conflict of Interest

- **I have no conflicts of interest to declare**

Lecture Objectives

- Current use of Non-invasive Positive Pressure Ventilation (NIPPV)
- Importance of NIPPV therapy in hospitalized patients
- Factors that affect the success on the application of NIPPV
- Current use of Portable Sleep Testing (PST) in hospitalized patients
- Conclusions

Current use of Non-invasive Positive Pressure Ventilation (NIPPV) in hospitalized patients

NIPPV

- Positive pressure ventilation
- Treats respiratory failure and OSA
- Gas is delivered through interface

Short-Term Goals of NIPPV

- Improves gas exchange by an increase in alveolar ventilation
- Decreases work of breathing
  - Provides rest to respiratory muscles
  - Provides PEEP (partially overcomes auto-PEEP)
  - Patient has to generate less negative inspiratory force to initiate breathing cycle
- Decrease risk of injury and avoid endotracheal intubation
- Relieve symptoms / increase comfort

Long-Term Goals of NIPPV

- Improvement of sleep
- Improvement of quality of life
- Improvement of function (ADLs)
- Decrease readmissions due to recurrent respiratory failure
- Improvement in survival for some patients

Prevalence of unspecified sleep apnea and the use of continuous positive airway pressure in hospitalized patients, 2004 national hospital discharge survey

Kathy F. Spurr · Michael A. Graven · Robert W. Gilbert

- **2004 National Hospital Discharge Survey (NHDS)**
- **371000 discharges from 439 non-federal short stay hospitals**
- **Only 5.8 % of patients with OSA were managed with CPAP during their stay**

Sleep Breath (2008) 12:229–234

Frequency of provision of CPAP in the inpatient setting: an observational study

"CPAP provision in the inpatient setting"

Adam J. Sorscher · Evan M. Caruso

- Observational study
- Review of 195 OSA patient charts from March to July 2009.
- 26% of patients were treated with CPAP during the hospitalization
- Another 10% was offered treatment but was not implemented

Sleep Breath (2012) 16:1147–1150

Reasons for not using CPAP

- Nurses might not be comfortable
- Lack of equipment in smaller hospitals (patient needs to bring own machine)
- OSA might not be considered an “urgent problem”

Trends in Mechanical Ventilation Among Patients Hospitalized With Acute Exacerbations of COPD in the United States, 2001 to 2011

Mihaela S. Stefan, MD; Meng-Shiou Shieh, PhD; Penelope S. Pekow, PhD; Nicholas Hill, MD, FCCP; Michael B. Rothberg, MD, MPH; and Peter K. Lindenauer, MD

- **Retrospective Cohort Study of 723,560 hospitalizations for exacerbation of COPD**
- **475 hospital between 2001 and 2011**
- **Primary outcome: the initial form of ventilation**
- **To determine trends and patient characteristics associated with receipt of NIPPV**

CHEST 2015; 147(4):959-968

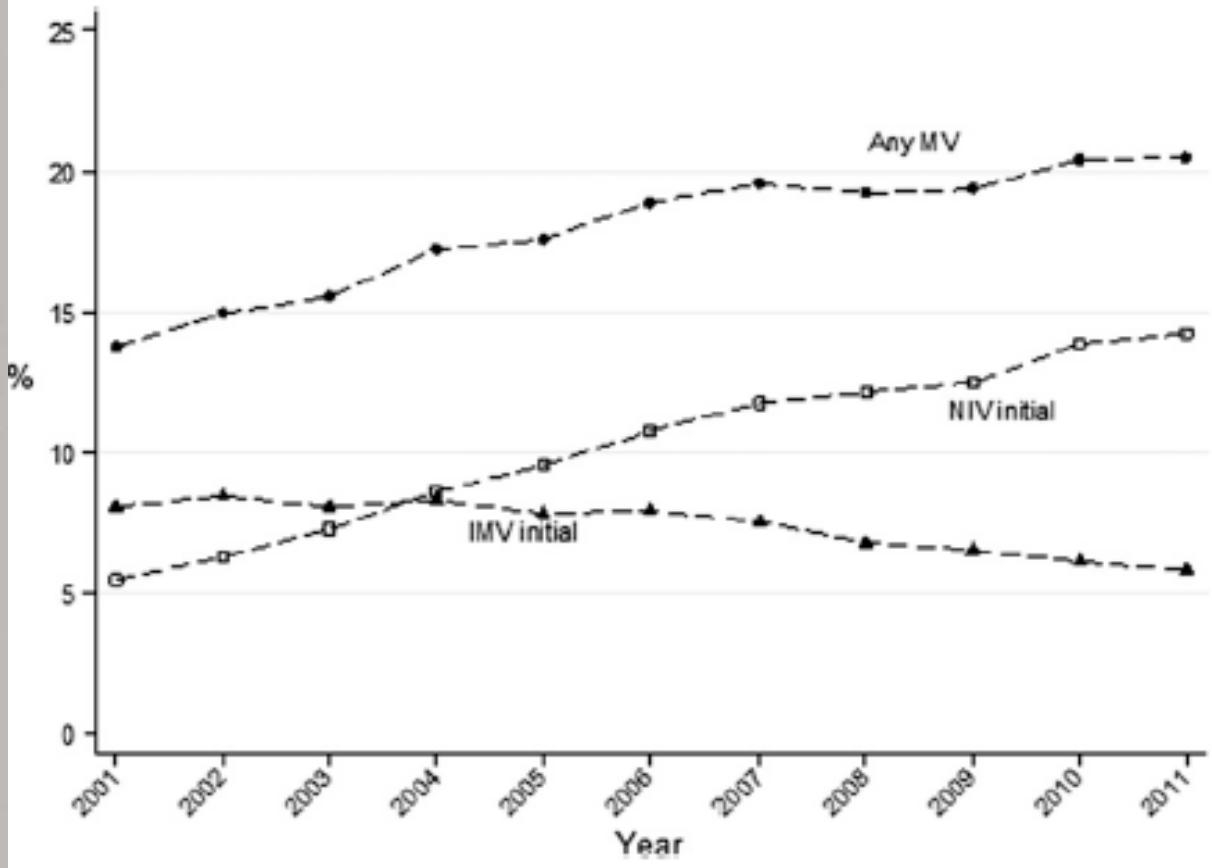


Figure 1 – *Trends in initial ventilation strategies and NIV failure. IMV = invasive mechanical ventilation; MV = mechanical ventilation; NIV = noninvasive ventilation.*

Results

- Initial NIV increased by 15.1% yearly
- Initial IMV declined by 3.2% yearly
- Annual exposure to any form of mechanical ventilation increased by 4.4%
- Age ≥ 85 had a 22% higher odds of receiving NIPPV compared with those aged < 65
- Blacks and Hispanics were less likely to be treated with NIV than were whites

Results

- **Higher NIPPV failure in cases with high burden of comorbidities and concomitant pneumonia**
- **Use of NIV increased at a faster rate among the admissions of the oldest patients relative to the youngest**

COPD

International Journal of Medical Sciences
2009; 6(2):72-76

Research Paper

High-intensity non-invasive positive pressure ventilation for stable hypercapnic COPD

Wolfram Windisch, Moritz Haenel, Jan H Storre and Michael Dreher ✉

Department of Pneumology, University Hospital Freiburg, Germany

High-intensity versus low-intensity non-invasive ventilation in patients with stable hypercapnic COPD: a randomised crossover trial

Michael Dreher,[1] Jan H Storre,[1] Claudia Schmoor,[2] Wolfram Windisch[1]

Thorax 2010;**65**:303–308. doi:10.1136/thx.2009.124263

IMJS 2009

Table I. Ventilator settings for 69 patients receiving pressure-limited NPPV

	Mean ± SD	Min	Max
IPAP (cmH_2O)	28.0 ± 5.4	17	42
EPAP (cmH_2O)	4.6 ± 1.3	2	9
b_f (/min)	21.0 ± 2.8	10	26
Supplemental oxygen (l/min)	1.6 ± 1.5	0	6

IPAP = inspiratory positive airway pressure, EPAP = expiratory airway pressure, b_f = breathing frequency; SD = standard deviation.

Thorax 2010

Table 1 Ventilator settings, pneumotachogra ventilation parameters, treatment compliance needed for NPPV acclimatisation: high-intensit NPPV

Period	LI-NPPV	HI-NPPV
IPAP (mbar)	14.6±0.8	28.6±1.9
EPAP (mbar)	4.0±0	4.5±0.7
Bf (/min)	8.0±0	17.5±2.1
Supplemental oxygen (l/min)	2.2±0.8	2.2±0.8

IMJS 2009

- Improvement in blood gases.
- 22% required hospitalization due to COPD exacerbation during first year.
- 5 year survival rate was 58%
- Improvement in lung function parameters
- HRQOL improved substantially.

Thorax 2010

- Nocturnal PaCO2 is more efficaciously corrected with HINPPV.
- Improvement in respiratory muscle rest, and improvement in lung function.
- Benefit on exercise-related dyspnea, and HRQL as mesured by SRI.
- HINPPNV was well tolerated.

COPD exacerbation

Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis

Josephine V Lightowler, Jadwiga A Wedzicha, Mark W Elliott, Felix S F Ram

BMJ VOLUME 326 25 JANUARY 2003 bmj.com

Treatment Failure:

-Combination of mortality, need for intubation, and intolerance to the treatment.

Data from seven of the studies showed that NPPV resulted in a significantly lower risk of treatment failure, compared with usual medical care.

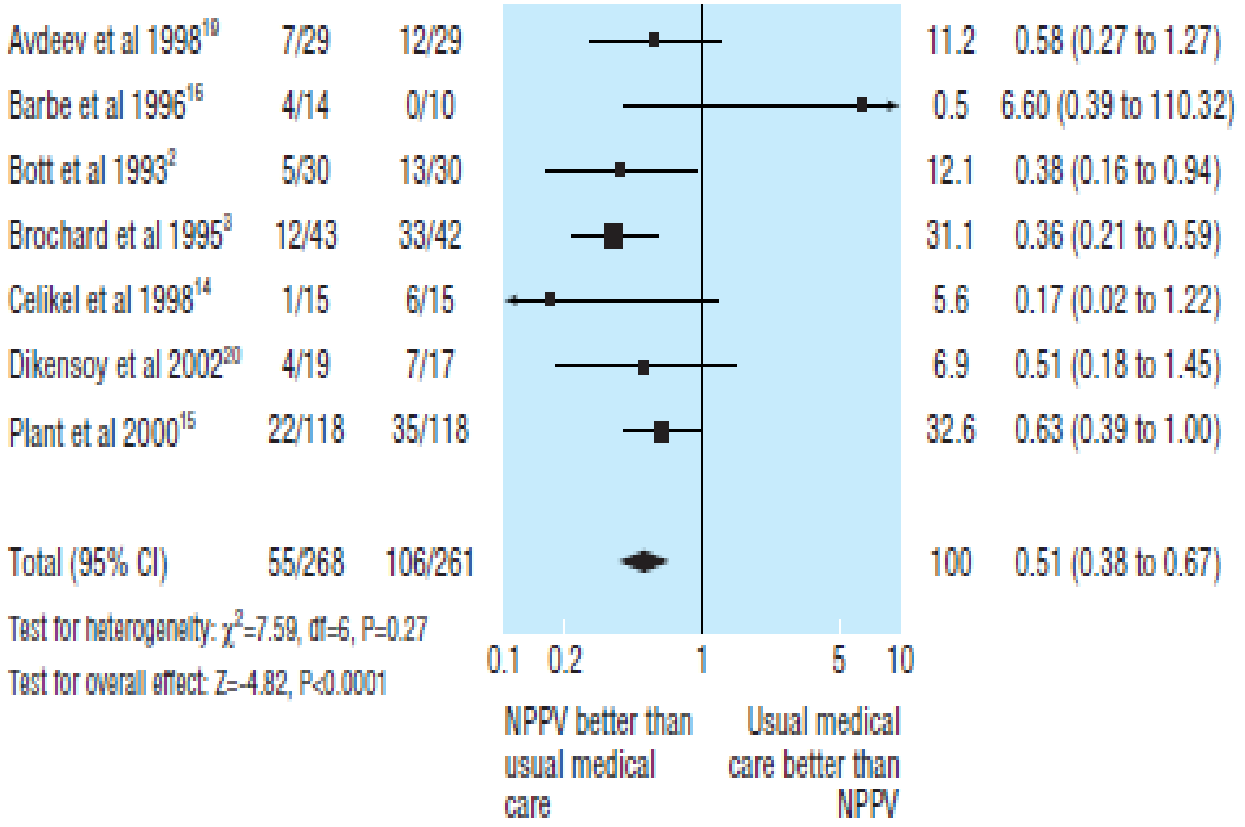


Fig 2 Risk of treatment failure (mortality, need for intubation, and intolerance) in seven studies of non-invasive positive pressure ventilation (NPPV) as an adjunct to usual medical care

NPPV reduces the risk of treatment failure.

RR:0.51

NNT:5

NPPV significantly reduces the risk of mortality.

RR:0.41

NNT:8

NPPV decreases the risk of endotracheal intubation.

RR:0.42

NNT:5

Table 1 Effects of non-invasive positive pressure ventilation as an adjunct to usual medical care, compared with usual care alone: overall results of the review for dichotomous outcome measures

Outcome	Number of studies contributing data	Total number of patients	Relative risk (95% CI)	Number needed to treat (95% CI)
Treatment failure	7[2 3 14-16 19 20]	529	0.51 (0.38 to 0.67)	5 (4 to 7)
Mortality	7[2 3 14-16 19 20]	523	0.41 (0.26 to 0.64)	8 (6 to 13)
Intubation	8[2 3 14-17 19 20]	546	0.42 (0.31 to 0.59)	5 (4 to 7)
Complications	2[3 19]	143	0.32 (0.18 to 0.56)	3 (2 to 4)

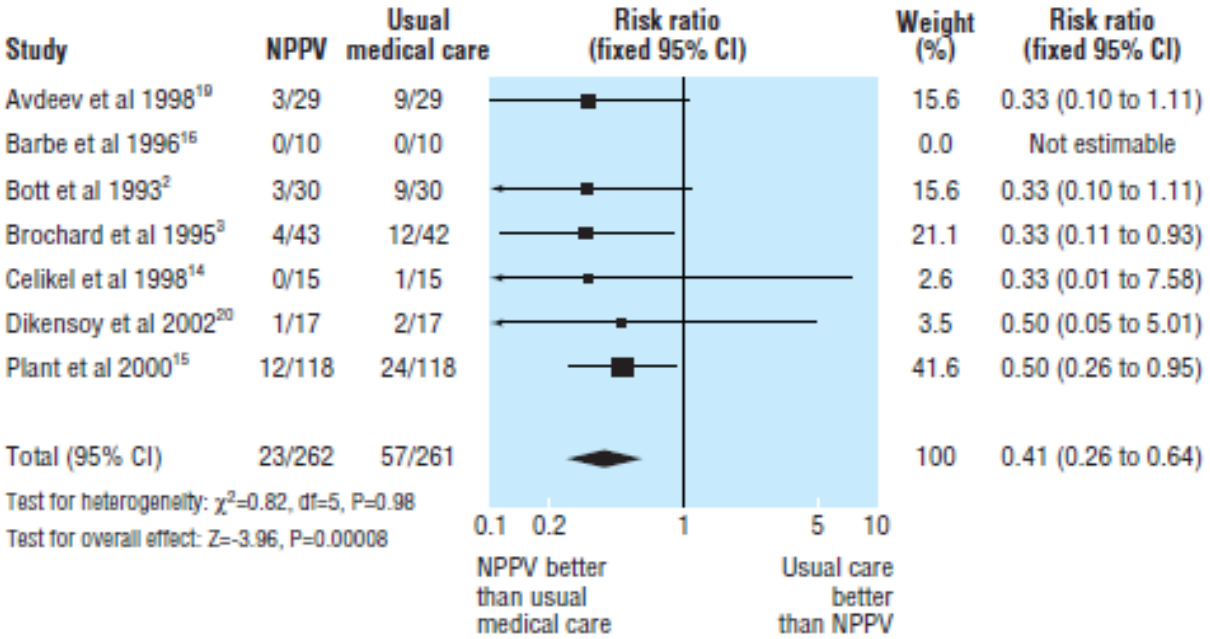


Fig 3 Mortality in seven studies of non-invasive positive pressure ventilation (NPPV) as an adjunct to usual medical care

NPPV reduces the length of stay in hospital

NPPV decrease the risk of intubation.

Table 2 Effects of non-invasive positive pressure ventilation as an adjunct to usual medical care, compared with usual care alone: overall results of the review for continuous outcome measures

Outcome	Number of studies contributing data	Total number of patients	Weighted mean difference (95% CI)
Length of stay in hospital (days):			
Trials in intensive care units	3[3 14 17]	138	–3.28 (–6.09 to –0.67)
Trials in wards	5[2 15 16 19 20]	408	–3.20 (–4.51 to –1.89)
Total	8[2 3 14-17 19 20]	546	–3.24 (–4.42 to –2.06)
Respiratory rate (breaths per minute) at 1 hour	5[3 14 15 19 20]	380	–3.08 (–4.26 to –1.89)
pH at 1 hour	5[2 3 14 15 20]	408	0.03 (0.02 to 0.04)
$PaCO_2$ (kPa) at 1 hour	5[2 3 14 15 20]	408	–0.40 (–0.78 to –0.03)
PaO_2 (kPa) at 1 hour	4[2 3 15 20]	378	0.27 (–0.26 to 0.79)

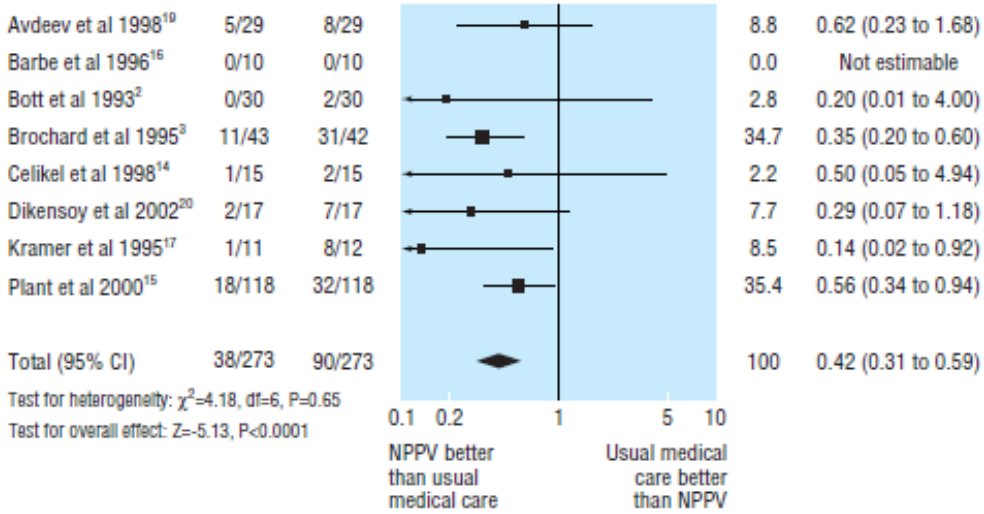


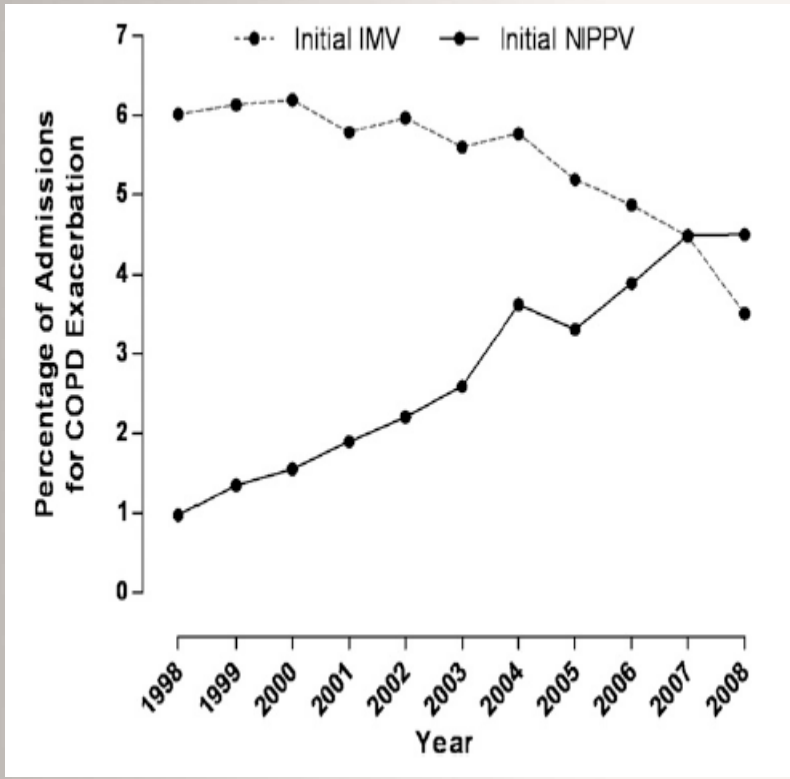
Fig 4 Risk of endotracheal intubation in eight trials of non-invasive positive pressure ventilation (NPPV) as an adjunct to usual medical care

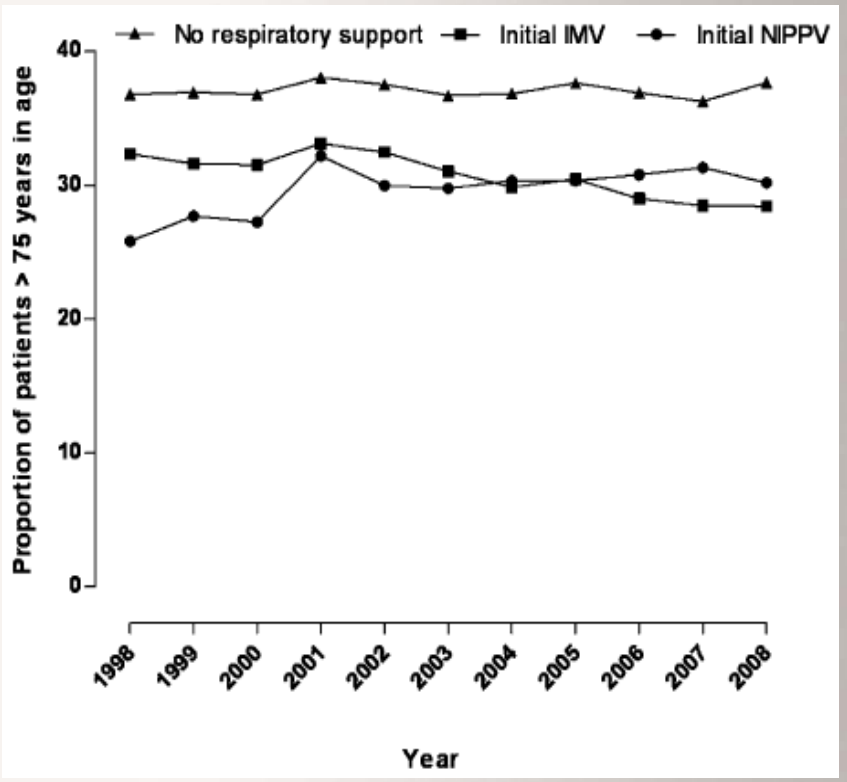
Outcomes of Noninvasive Ventilation for Acute Exacerbations of Chronic Obstructive Pulmonary Disease in the United States, 1998–2008

Divay Chandra[1*], Jason A. Stamm[1*], Brian Taylor[2], Rose Mary Ramos[1], Lewis Satterwhite[2], Jerry A. Krishnan[3], David Mannino[4], Frank C. Sciurba[1], and Fernando Holguín[1]

- **Patient population:**
  - **Data from the Nationwide Inpatient Sample of Healthcare Cost and Utilization Project from 1998 to 2008**
- **Data analysis:**
  - **- 3 outcomes: in-hospital mortality, length-of-stay, and total charges of hospitalization**
- **Outcomes were compared between patients receiving NPPV, IMV and no respiratory support**

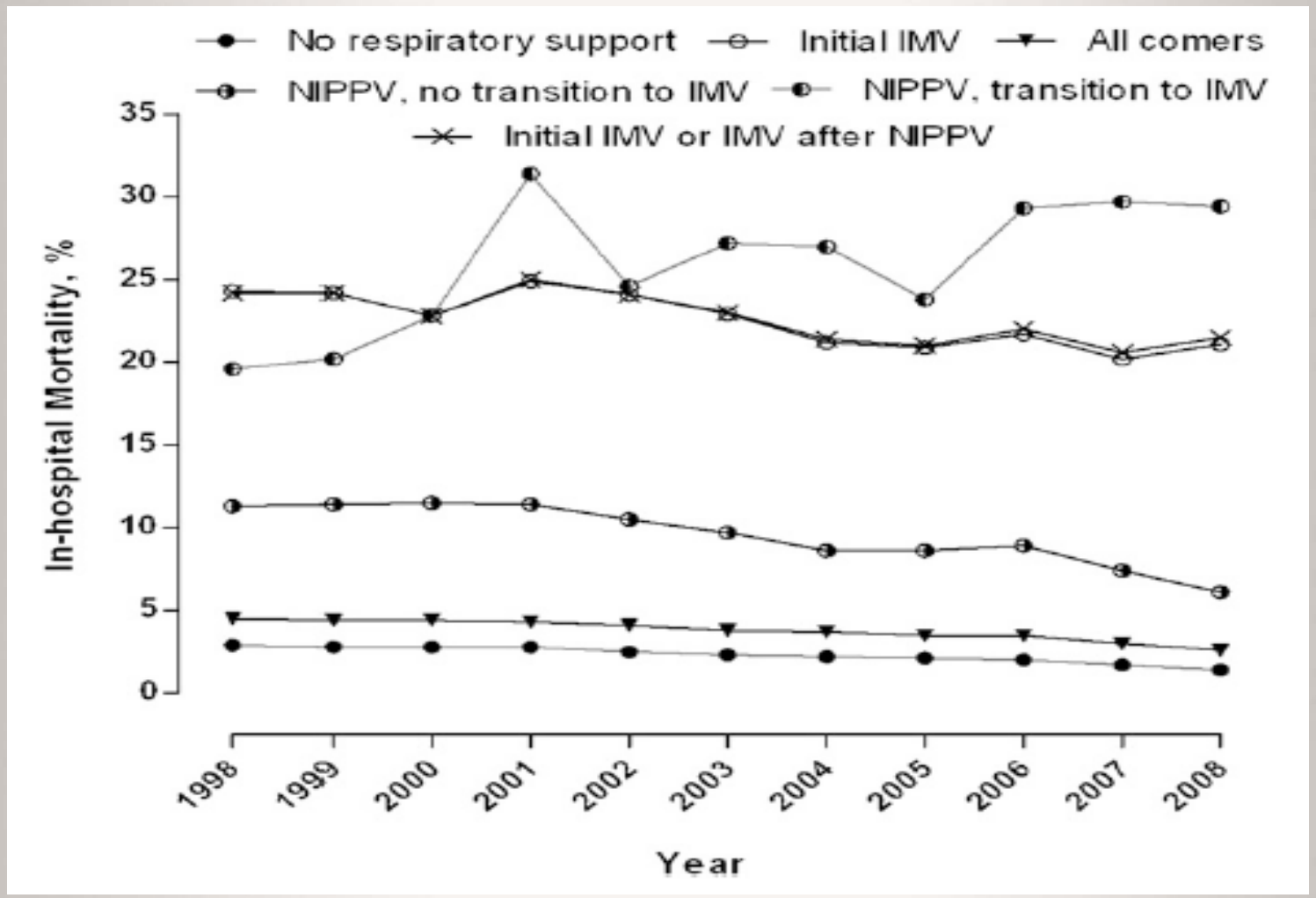
Am J Respir Crit Care Med Vol 185, Iss. 2, pp 152–159, Jan 15, 2012





- Progressive increase in the use of NPPV, and decrease in the use of IMV.

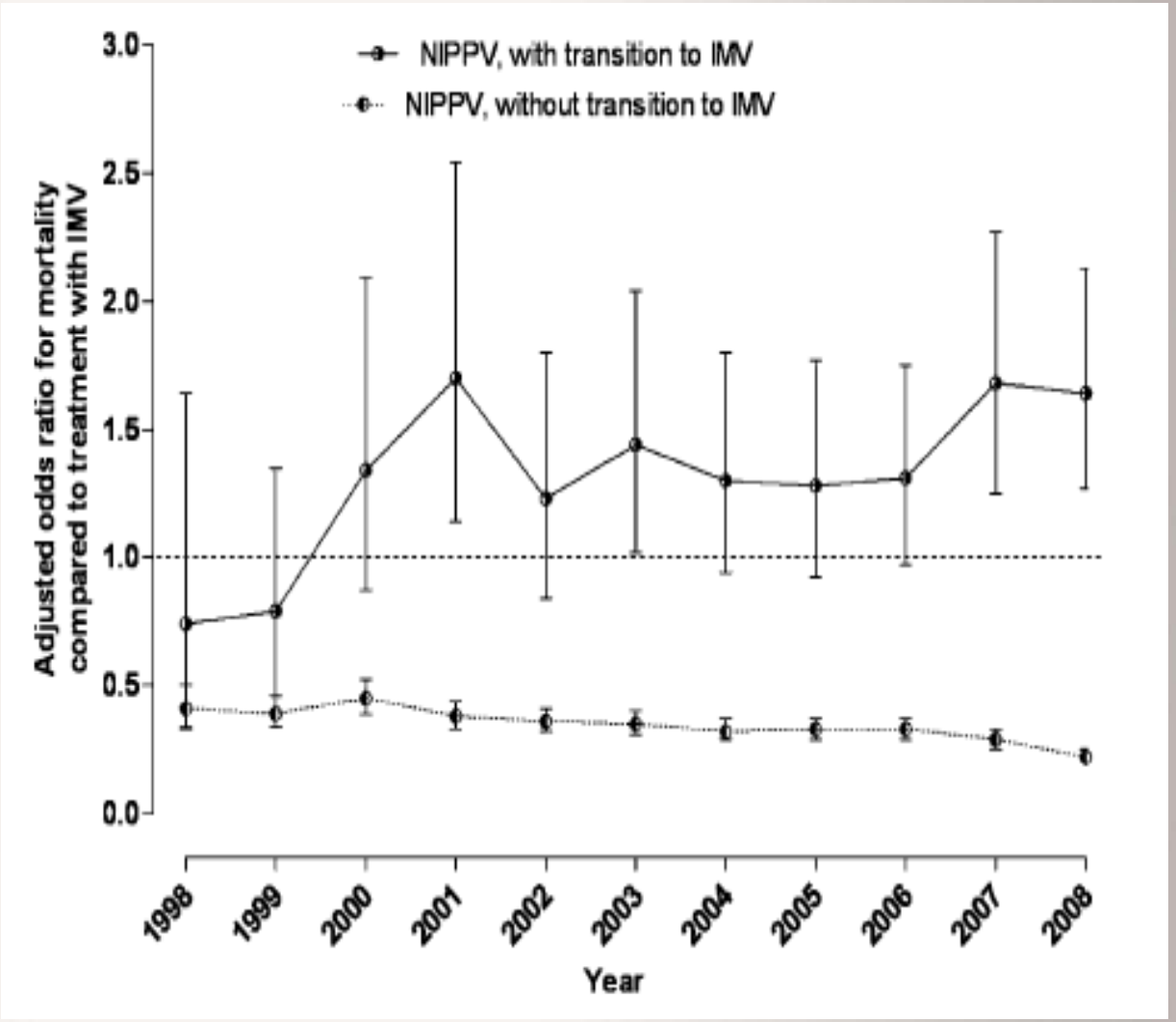
Am J Respir Crit Care Med Vol 185, Iss. 2, pp 152–159, Jan 15, 2012



Am J Respir Crit Care Med Vol 185, Iss. 2, pp 152-159, Jan 15, 2012

In 2008 the adjusted odds ratio for death comparing those transitioned from NPPV to IMV versus treated initially with IMV was 1.61 (95% CI, 1.24-2.09).

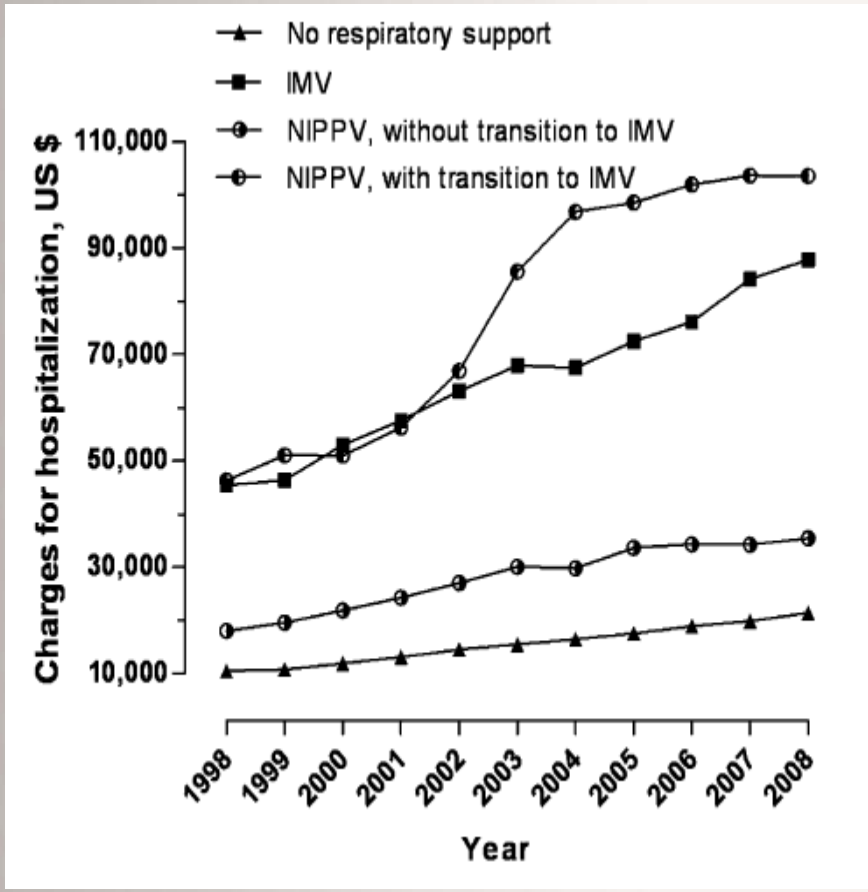
Overall, the risk of death among those treated with NPPV alone versus those requiring transition from NPPV to IMV, appeared to be diverging away from each other over time.

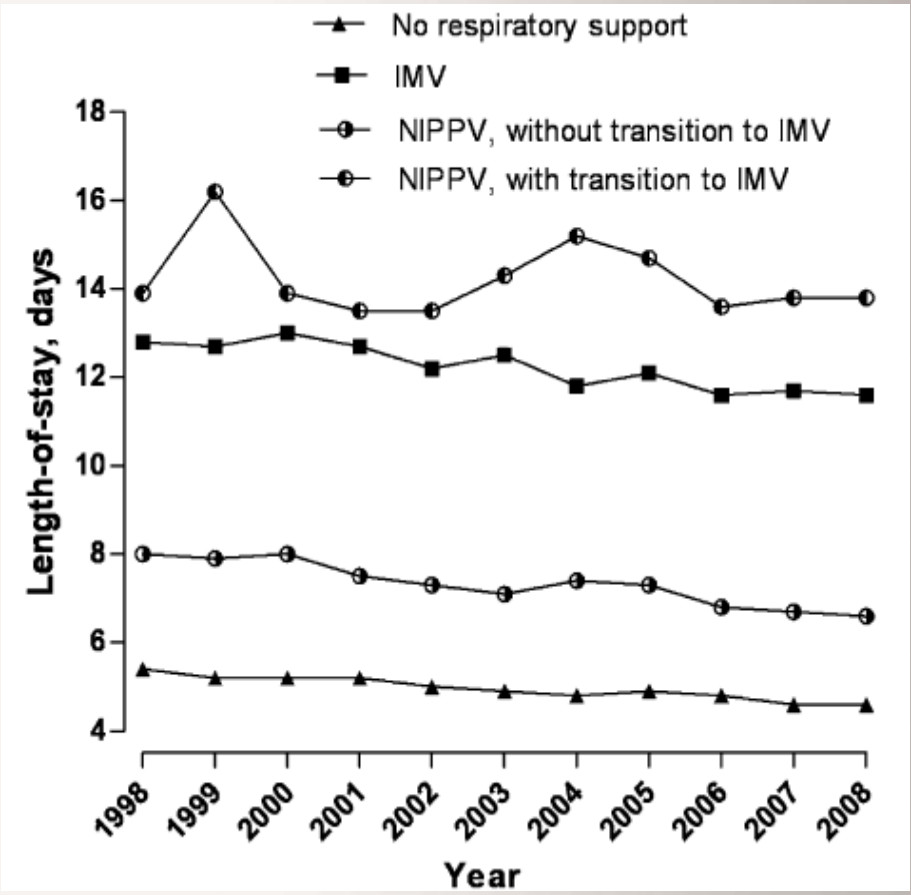


Am J Respir Crit Care Med Vol 185, Iss. 2, pp 152-159, Jan 15, 2012

- **Who is going to fail?**
  - **High acuity of illness (impairment in level of consciousness)**
  - **Severe acidosis (pH<7.25)**
  - **High APACHE score**
  - **Presence of complications from sepsis**
  - **Poor functional status before admission**
  - **Failure to demonstrate early response to NPPV (no improvement in pH, $PaCO_2$, and level of consciousness within 1 hour of initiation of NPPV)**

- **Why the high mortality?**
  - **Increasing the use of NPPV in patients who are difficult to ventilate**
  - **Continuation of NPPV despite lack of early improvement**





Am J Respir Crit Care Med Vol 185, Iss. 2, pp 152–159, Jan 15, 2012

Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease (Review)

Ram FSF, Picot J, Lightowler J, Wedzicha JA

Results

- 14 studies included in the review
- NPPV resulted in:
  - Decreased mortality (RR 0.52)
  - Decrease need for intubation (RR 0.41)
  - Reduction in treatment failure (RR 0.48)
  - Rapid improvement within the first hour in pH, $PaCO_2$ and BR
  - Reduction in complications associate with treatment (RR 0.38)
  - Reduction on hospital stay (-3.24 days)

Acute Cardiogenic Pulmonary edema.

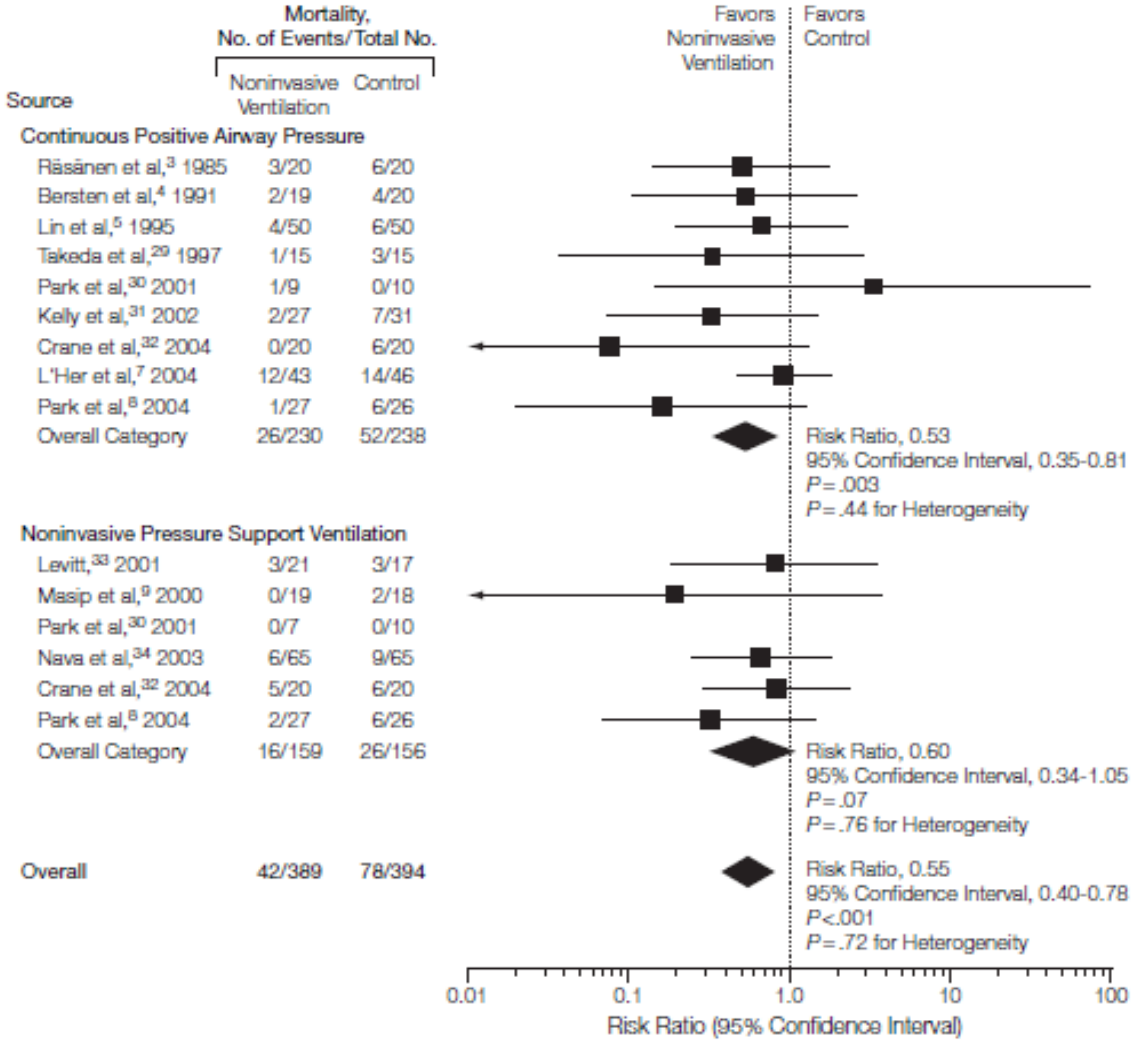
Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema

Systematic Review and Meta-analysis

- **Parallel RCT comparing NIV to conventional oxygen or to another NIV modality**
- **Primary outcome: treatment failure → "need to intubate", and in-hospital mortality**
- **ICU length of stay, hospital length of stay, 1-year mortality, adverse effects were not analyzed due to lack of this information in many of the studies**

- **Trial: 559 → 15**
- **Causes of acute pulmonary edema:**
  - **ACS (31%), HTN: 27%, worsening HF (14%), others (28%)**
- **All trials used oro-nasal masks.**
- **CPAP: 2.5-12.5 (10 cm H2O).**
- **BiPAP:**
  - **IPAP: 14.5 – 20 (15 cm H2O).**
  - **EPAP: 5 cm H2O.**

Figure 2. Effects of Noninvasive Ventilation on Death



Data markers are proportional to the amount of data contributed by each trial.

Figure 4. Effects of Continuous Positive Airway Pressure vs Noninvasive Pressure Support Ventilation

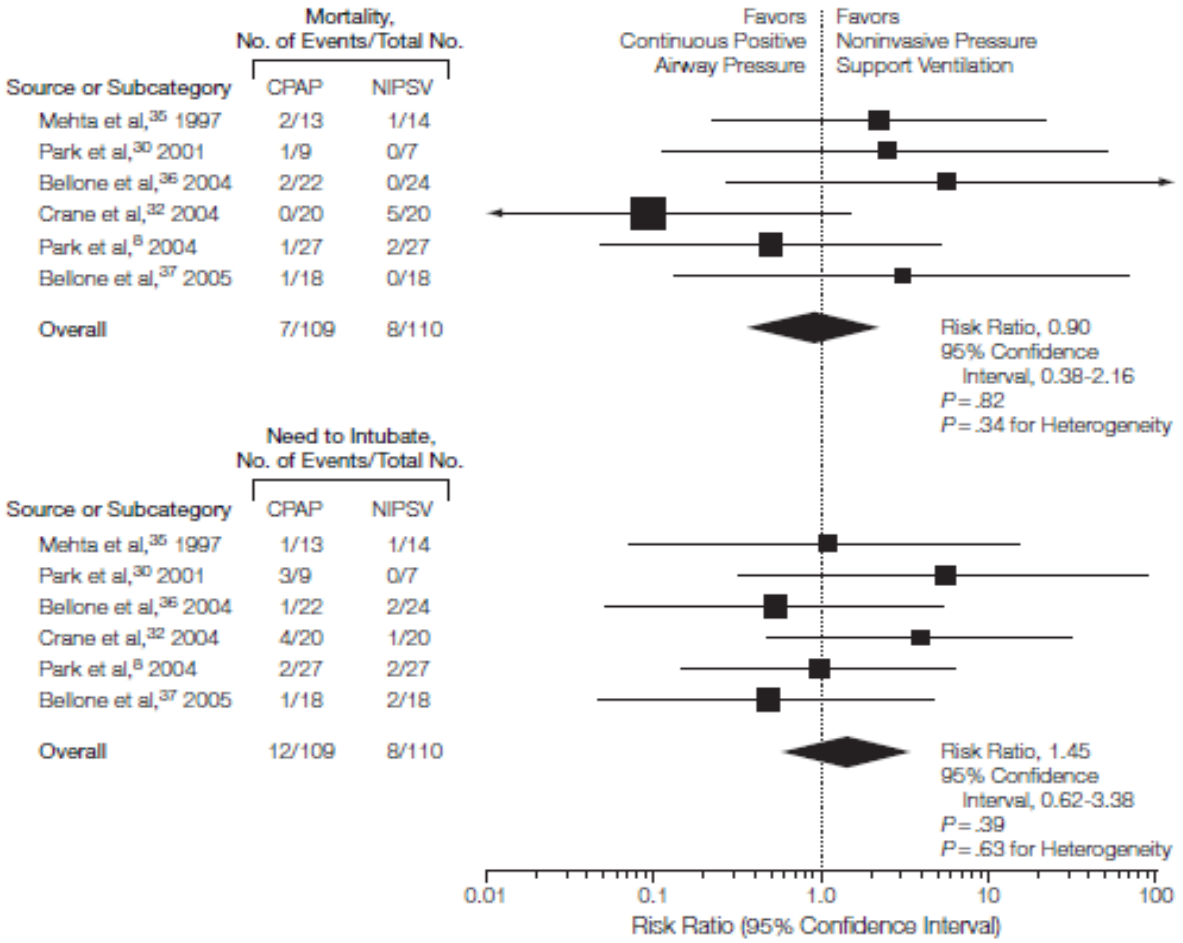
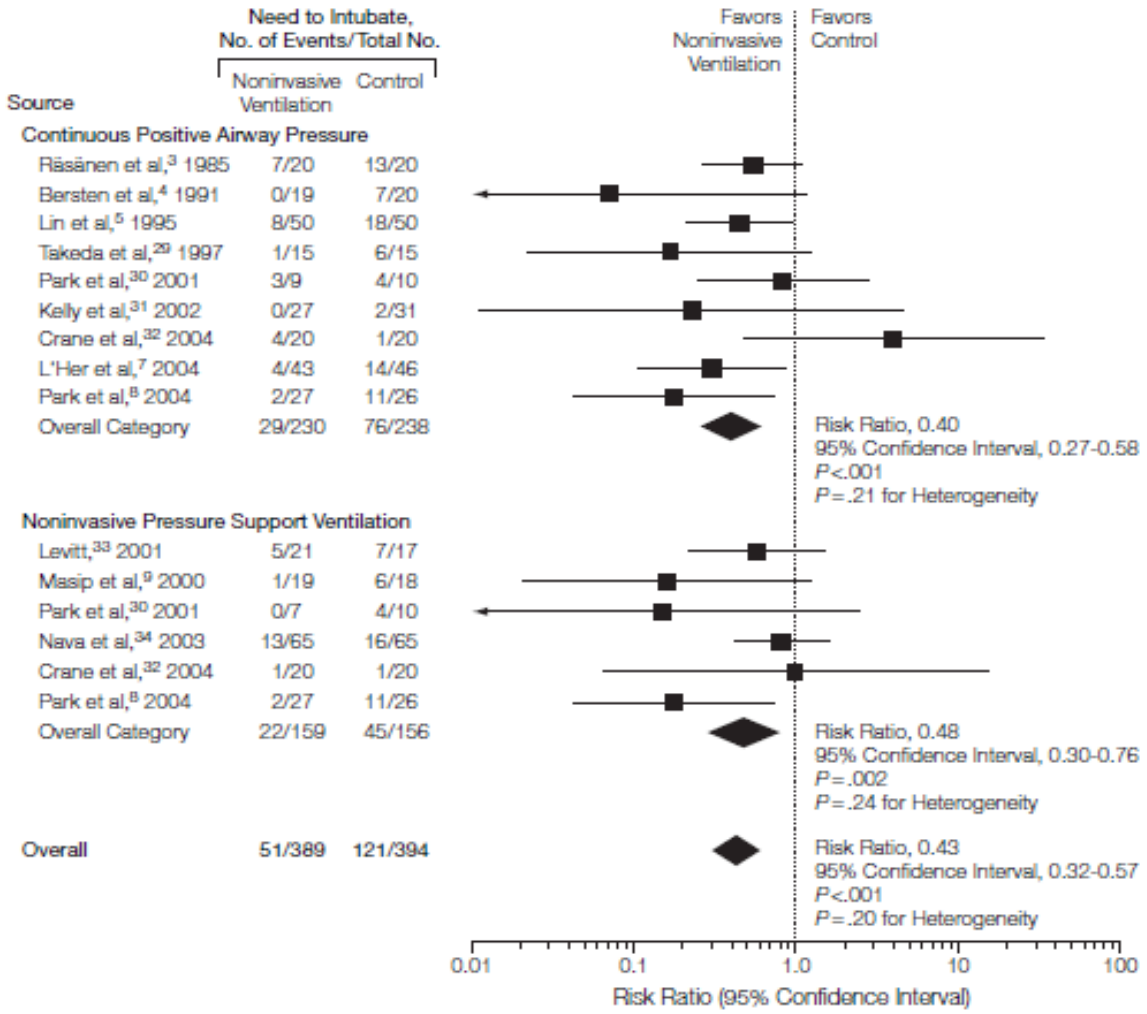


Figure 3. Effects of Noninvasive Ventilation on Need to Intubate



Effect of non-invasive positive pressure ventilation (NIPPV) on mortality in patients with acute cardiogenic pulmonary oedema: a meta-analysis

John Victor Peter, John L Moran, Jennie Phillips-Hughes, Petra Graham, Andrew D Bersten

- **CPAP was associated with reduction in mortality vs standard therapy**
- **A non-significant trend favoring a reduction in mortality with BiPAP over standard therapy**
- **No significant difference in mortality risk between BiPAP and CPAP**
- **CPAP and BiPAP were associated with significant reductions in the need for invasive mechanical ventilation**
- **LOS was not reduced by either CPAP or BIPAP**

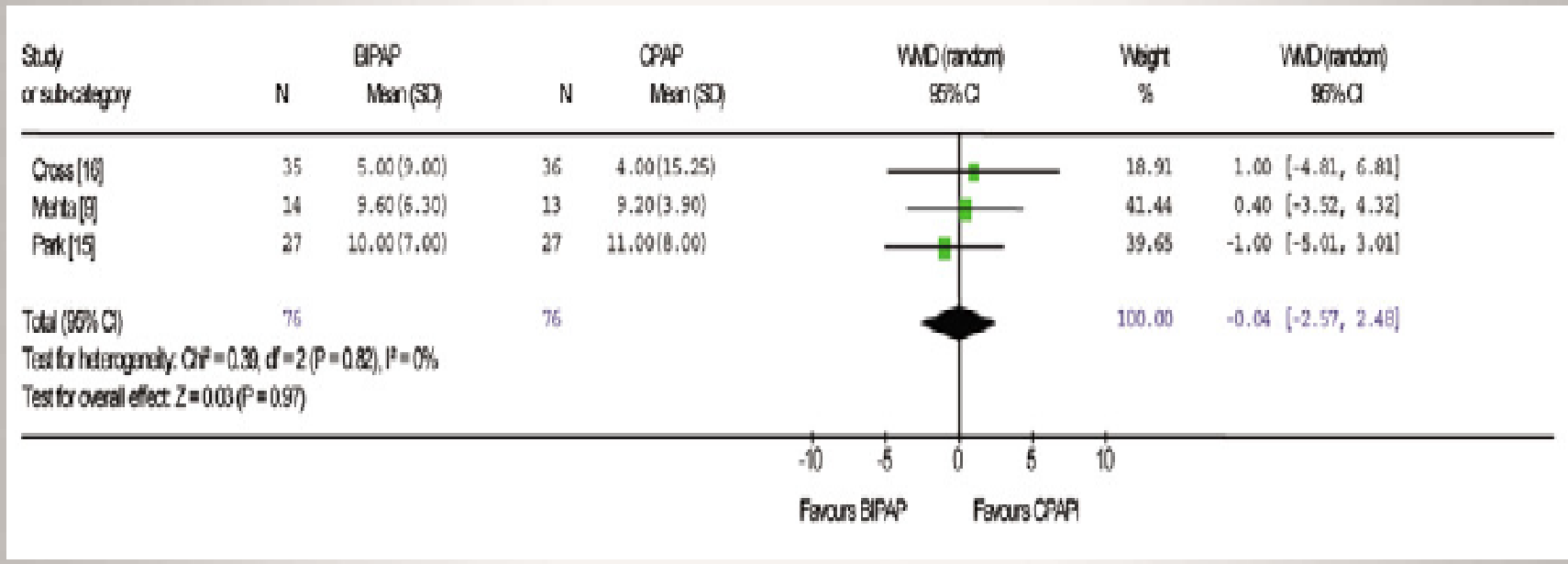
Lancet, April 2006, vol 367, 1115-1163

Research

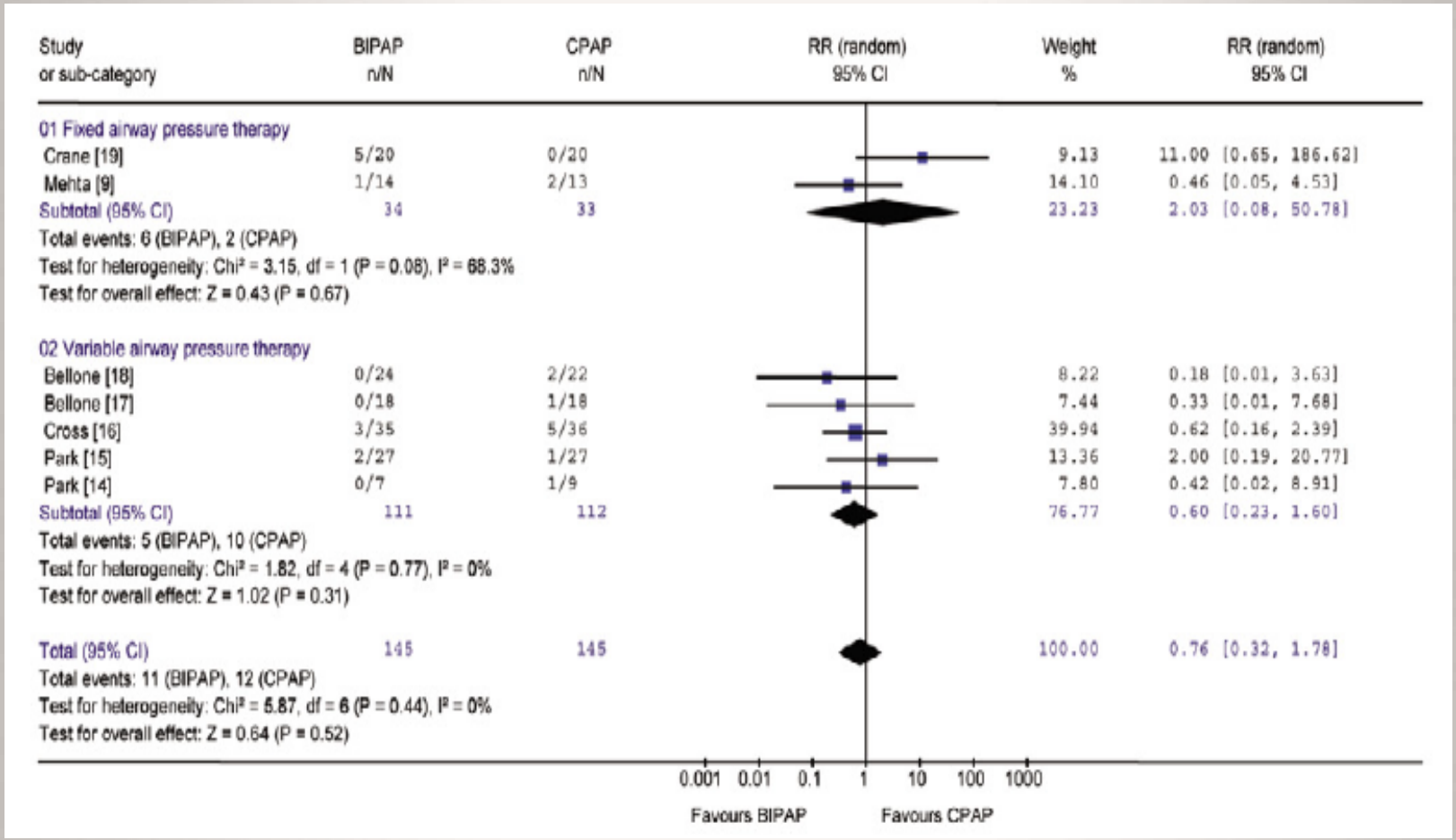
Open Access

A comparison of continuous and bi-level positive airway pressure non-invasive ventilation in patients with acute cardiogenic pulmonary oedema: a meta-analysis

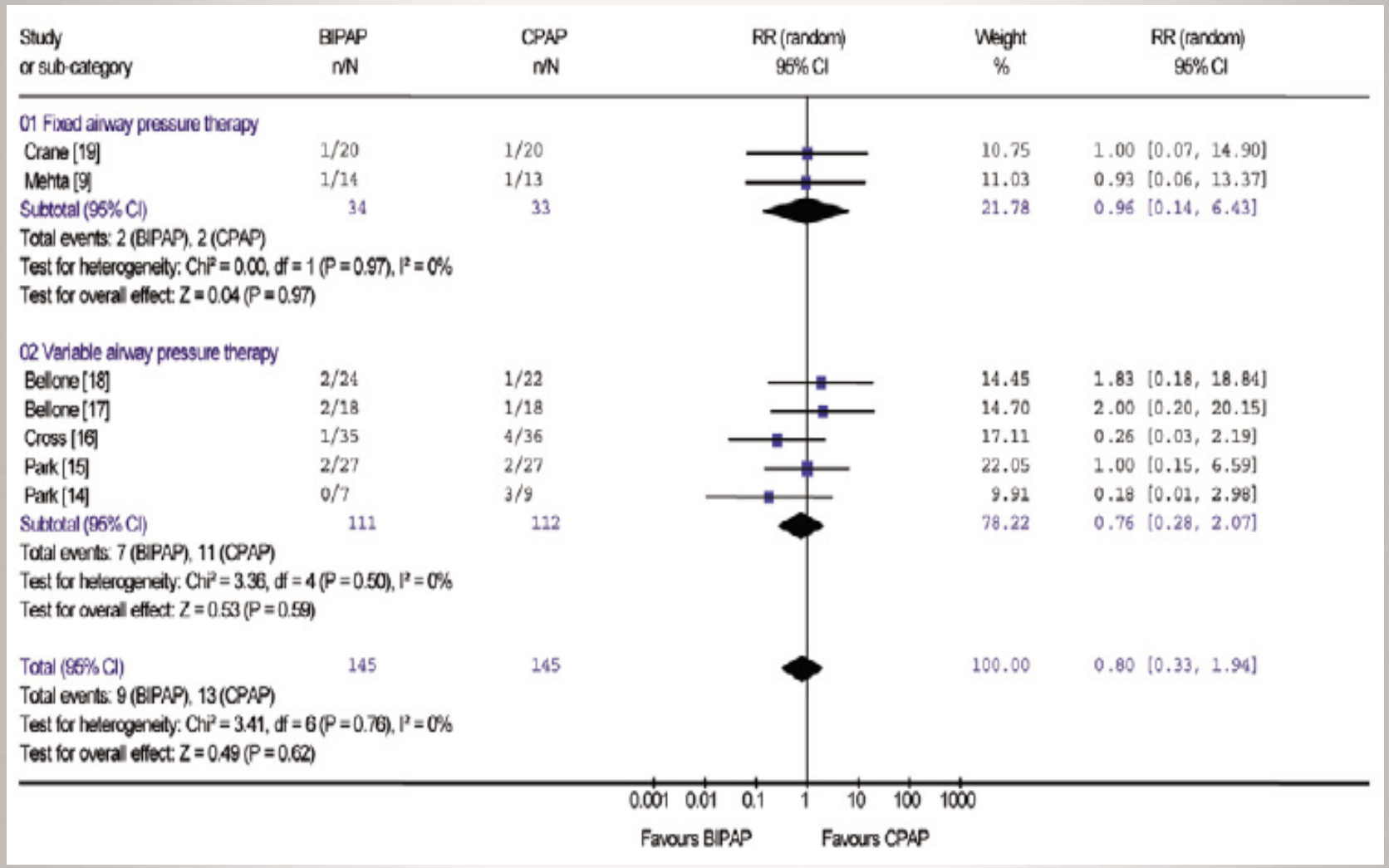
Kwok M Ho[1,2] and Karen Wong[1]



effect of BiPAP and CPAP on length of hospital stay.



effect of BiPAP and CPAP on hospital mortality.



effect of BiPAP and CPAP on risk for requiring invasive ventilation.

- **BiPAP was associated with a trend toward increased risk for new onset acute MI compared with CPAP**
- **Patients were, by nature, at high risk for developing MI**
- **Rapid correction of $PaCO_2$ values with potential coronary vasoconstriction and asynchrony between patients and bilevel ventilator, which could induce adverse physiological changes**

ARDS

Is there a role for noninvasive ventilation in acute respiratory distress syndrome? A meta-analysis

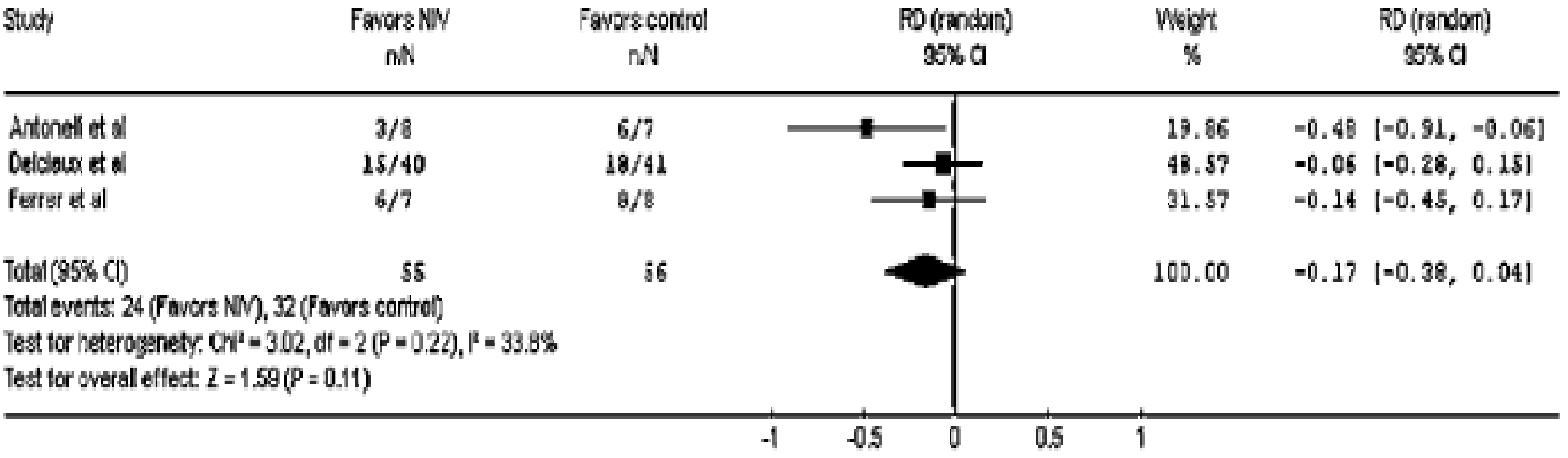
Ritesh Agarwal*, Chandana Reddy, Ashutosh N. Aggarwal, Dheeraj Gupta

Department of Pulmonary Medicine, Postgraduate Institute of Medical Education and Research, Sector-12, Chandigarh-160012, India

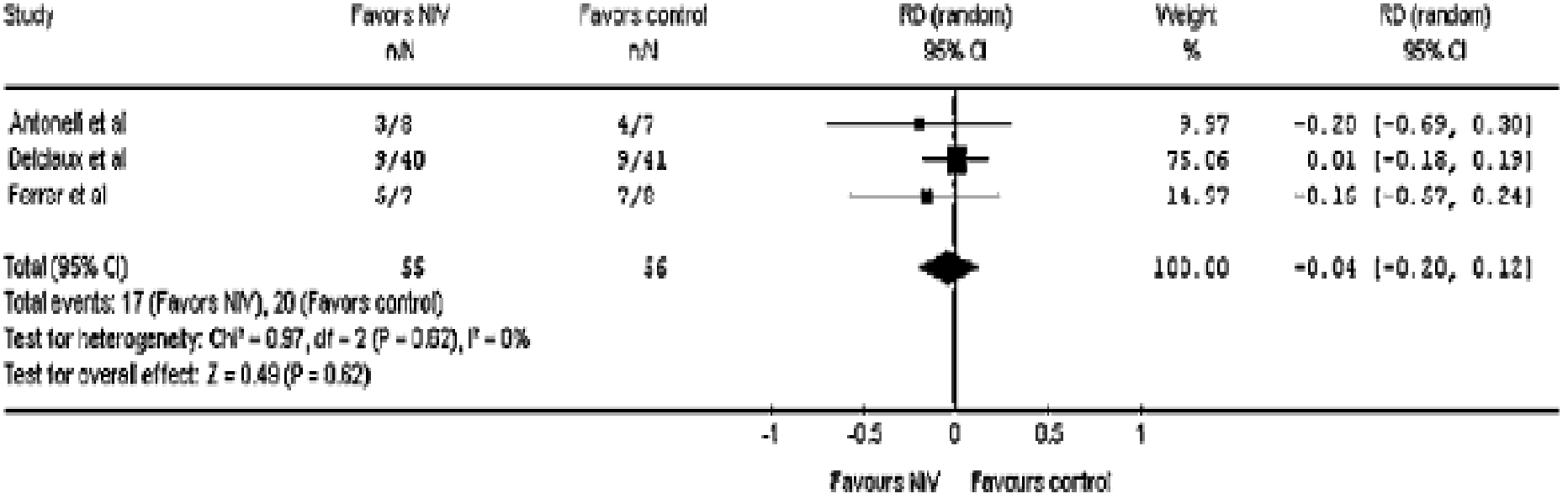
- **MEDLINE from 1980 to 2005 of RCT in ARDS patients**
- **Intervention: NIV and standard therapy vs standard therapy alone**
- **Outcomes: need for endotracheal intubation and/or ICU survival**
- **1098 studies → 3 RCT**
- **All the trials were prospective, randomized but none were blinded**

Respiratory medicine (2006);100,2235-2238

Intubation rates



Mortality rates



Acute asthma

Noninvasive positive pressure ventilation in acute asthmatic attack

A. Soroksky*, E. Klinowski*, E. Ilgyev*, A. Mizrachi*, A. Miller*, T.M. Ben Yehuda*, I. Shpirer# and Y. Leonov*

Eur Respir Rev 2010;19:115,39-45

- Meduri et al.: NPPV improve gas exchange in status asthmaticus. Significant reduction PaCO2. Improvement in oxygenation.
- Fernandez et al.: NPPV vs IMV. PaCO2 decreases similarly in both groups. Similar improvement in PaO2.
- Soroksky et al.:BiPAP significantly improves PFTs (increase of at least 50% in FEV1). Decrease hospitalization rate.
- Soma et al.: improvement in FEV1in the high pressure group.
- Gehlbach et al.: NPPV vs ETI. ETI is associated with a prolongued hospital stay, and an increased rate of complications, such as barotraumas, muscle weakness, organ failure and hospital acquired infections.

- Selected patients with severe asthmatic attacks can benefit from a carefully and closely monitored trial of NPPV.

- The key to successful NPPV application is choosing the right patient.

TABLE 2 Risk factors and diagnostic criteria of severe asthma exacerbation

Patients at risk for respiratory failure who could benefit from NPPV trial
Diagnostic criteria of severe asthma (at least one of the following)
Use of accessory muscles
Paradoxical pulse >25 mmHg
*f*c >110 beats·min^{-1}
Respiratory rate >25–30 breaths·min^{-1}
Limited ability to speak
PEF or FEV_1 <50% pred
Arterial oxygen saturation <91–92% with oxygen flow of ⩽10 L·min^{-1}
Risk factors for severe asthma exacerbation
Recent hospitalisation
Prior ICU admission with mechanical ventilation
Poor adherence to therapy
High allergen exposure

NPPV: noninvasive positive pressure ventilation; *f*c: cardiac frequency; PEF: peak expiratory flow; FEV_1: forced expiratory volume in 1 s; % pred: % predicted; ICU: intensive care unit.

- A trial of NPPV in the wrong patient might delay an inevitable ETI, and subject them to unnecessary risks.

TABLE 4 Criteria for use of noninvasive positive pressure ventilation (NPPV)

Criteria for selecting severe asthmatic patients for NPPV trial[#]
Tachypnea with respiratory rate >25 breaths·min^{-1}
Tachycardia with *f*C >110 breaths·min^{-1}
Use of accessory muscles of respiration
Hypoxia with a $P_{a,O_2}/F_{I,O_2}$ ratio >200 mmHg
Hypercapnia with P_{a,CO_2} <60 mmHg
FEV_1 <50% pred[¶]

*f*C: cardiac frequency; P_{a,O_2}: arterial oxygen tension; F_{I,O_2}: inspiratory oxygen fraction; P_{a,CO_2}: arterial carbon dioxide tension; FEV_1: forced expiratory volume in 1 s; % pred: % predicted. [#]: in the absence of absolute contraindication the presence of at least one criterion would suffice for an NPPV trial; [¶]: FEV_1 <50% pred after at least two consecutive nebulisations with salbutamol 2.5 mg and ipratropium 0.25 mg.

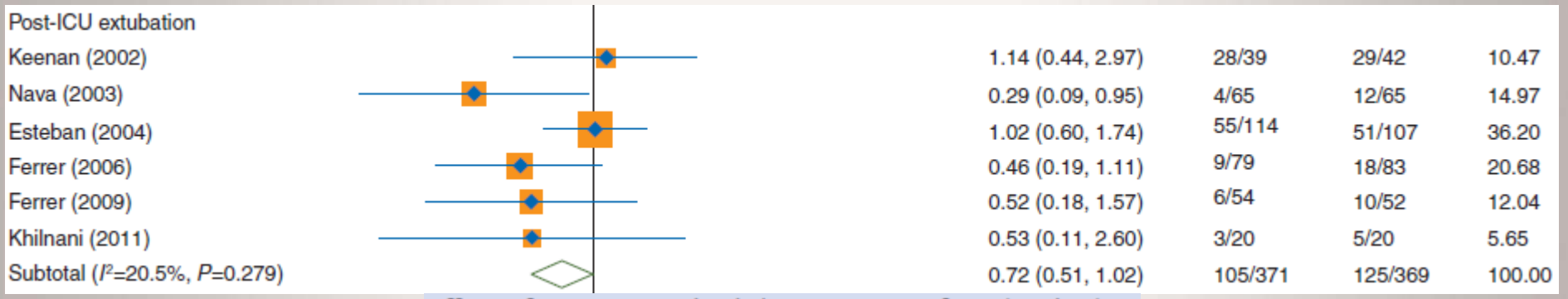
- Recommendations:
  - Do not use CPAP alone without pressure support.
  - Adding pressure support to CPAP increases tidal volume and helps to unload fatigued respiratory muscles.
- Risks:
  - Delay in endotracheal intubation.
  - Inadvertent application of extrinsec PEEP that is higher than auto-PEEP could contribute further to dynamic hyperinflation.
- Conclusion:
  - In the appropiate enviroment, a cautious trial of NPPV may be tried in selected asthmatic patients.

NIPPV after extubation

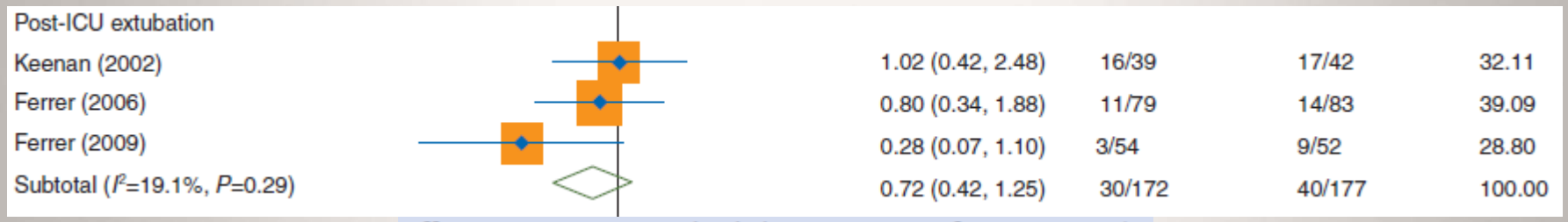
- Systematic review and meta-analysis of only RCT on the use of NIV post-extubation vs standard care
- 3 groups of patients: post-extubation in ICU (6), weaning of patients from MV (5), and postoperative patients (5).
- Post-extubation in ICU: 740 patients.
  - Medical treatment: 371.
  - NIV: 369

Effect of NIV *vs* standard therapy on unstandardized ICU length of stay.

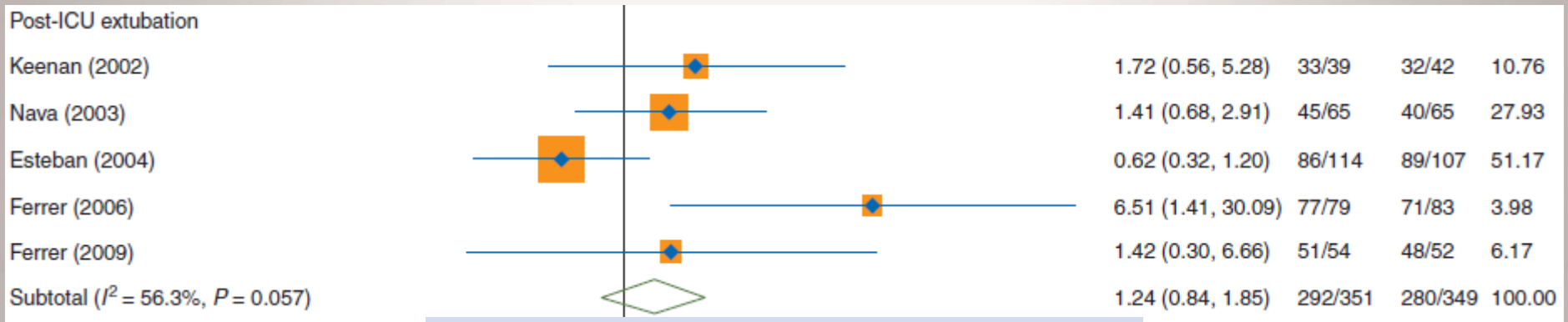
Effect of NIV *vs* standard therapy on unstandardized hospital length of stay.



Effect of NIV *vs* standard therapy on OR for reintubation.



Effect on NIV *vs* standard therapy on OR for pneumonia.



Effect of NIV *vs* standard therapy on OR for ICU survival.

Table 4. Practical Approach to the Use of NPPV in the Postextubation Setting

NPPV in Patients At Risk for Postextubation Respiratory Failure
(Preferred approach for the use of NPPV in the postextubation setting)
Identify high-risk features
Elderly patients (age > 65 y)
More than one consecutive failure of weaning trial
Chronic heart failure
P_{aCO_2} > 45 mm Hg after extubation
More than one medical/surgical co-morbid illness
Poor cough reflex
Upper-airways stridor at extubation that does not require immediate reintubation
APACHE II score > 12 on the day of extubation
Severely obese patients (body mass index > 35 kg/m^2)
NPPV in Established Postextubation Respiratory Failure
Use judiciously
Likely to benefit selected patients (eg, acute COPD, hypercapnic pulmonary edema)
Trial of NPPV for 2 hours
Close monitoring of respiratory, cardiovascular and arterial blood gas variables
Facilities for intubation and invasive ventilation readily available

OSA / OHS

Diagnosis and Management of Obesity Hypoventilation Syndrome in the ICU

Won Y. Lee, MD[a], Babak Mokhlesi, MD, MSc[b,*]

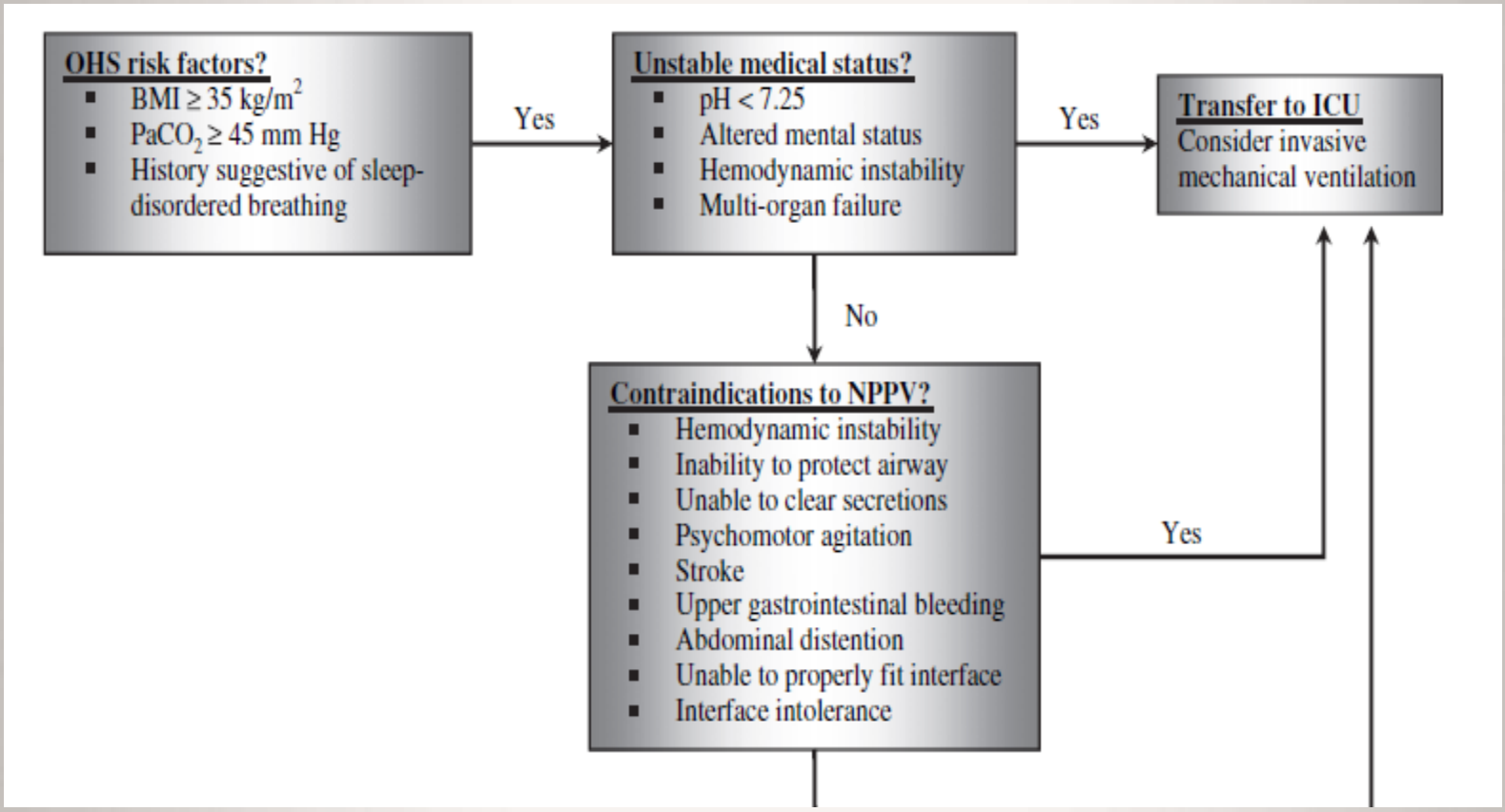
- CPAP should not be used in cases of acute-on-chronic hypercapnic respiratory failure due to its inability to improve alveolar ventilation.
- Goals of treatment:
  - Relieve upper airway obstruction.
  - Increase alveolar ventilation.
- Therapy of choice: NPPV.
  - EPAP: maintains upper airway patency.
  - Δ IPAP and EPAP: represents PSV, and increasing delta leads to large TV and increases ventilation.
- NPPV: improves oxygenation and ventilation.

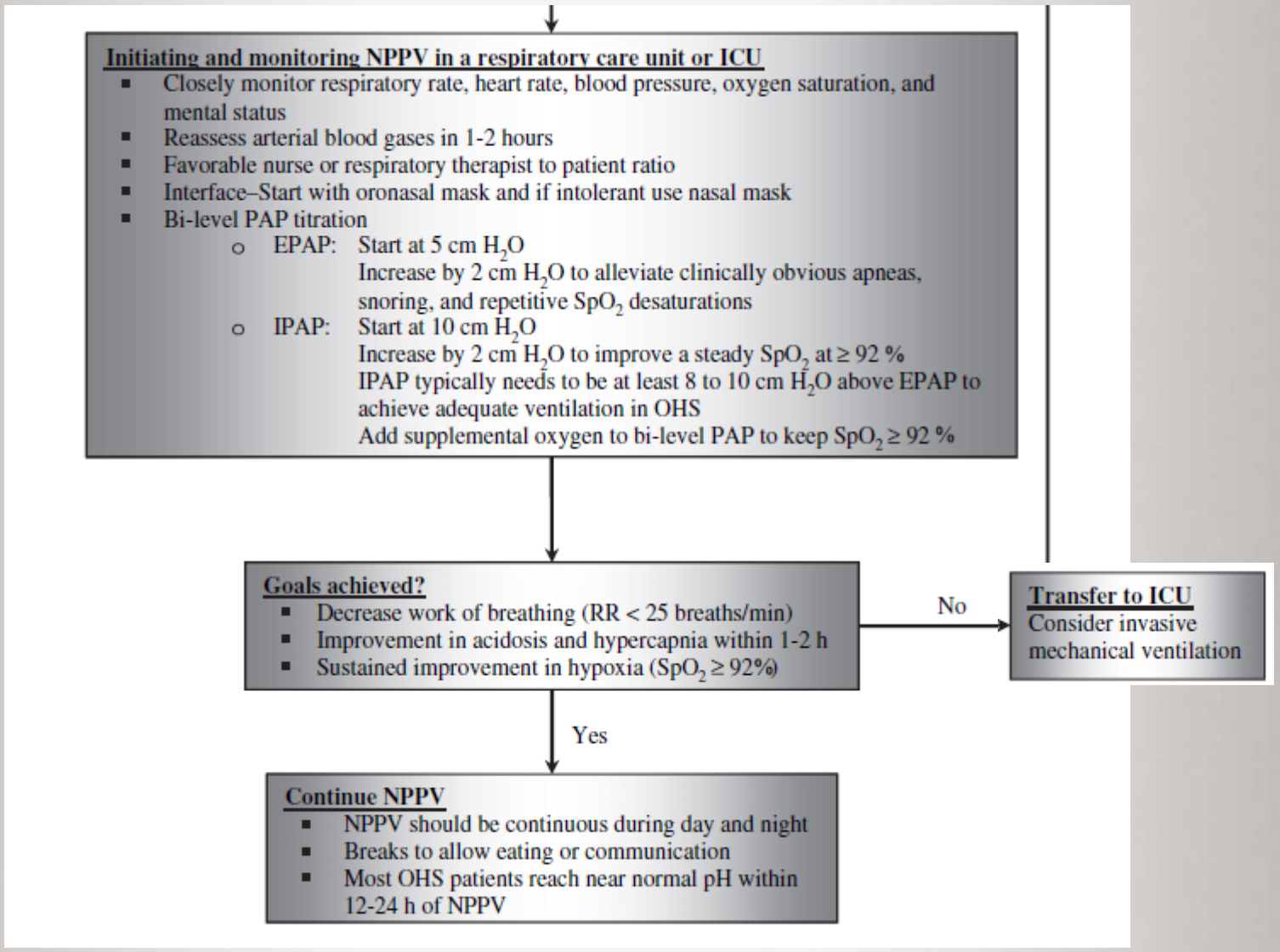
- Successful alveolar ventilation leads to TV 8-10 ml/kg, and decreases RR to fewer than 25 breaths/min.
- The best predictor of early NPPV failure (1-3h) is the lack of improvement in pH and pCO2 after 1 hour.

Box 6. Clinical features suggestive of noninvasive positive pressure ventilation failure and need for invasive mechanical ventilation

Deterioration of mental status or psychomotor agitation
pH persistently less than 7.25 or lack of improvement in hypercapnia after 1 to 2 hours of NPPV
Persistent and refractory hypoxemia
Lack of improvement in tachypnea and dyspnea
Hypotension or bradycardia
Increased use of accessory muscles with impending respiratory failure
Increased risk for aspiration and inability to clear secretions
Poor tolerance of the interface

Algorithm


OHS risk factors?
BMI ≥ 35 kg/m²
PaCO₂ ≥ 45 mm Hg
History suggestive of sleep-disordered breathing
Yes
Unstable medical status?
pH < 7.25
Altered mental status
Hemodynamic instability
Multi-organ failure
Yes
Transfer to ICU
Consider invasive mechanical ventilation
No
Contraindications to NPPV?
Hemodynamic instability
Inability to protect airway
Unable to clear secretions
Psychomotor agitation
Stroke
Upper gastrointestinal bleeding
Abdominal distention
Unable to properly fit interface
Interface intolerance
Yes


Initiating and monitoring NPPV in a respiratory care unit or ICU
Closely monitor respiratory rate, heart rate, blood pressure, oxygen saturation, and mental status
Reassess arterial blood gases in 1-2 hours
Favorable nurse or respiratory therapist to patient ratio
Interface–Start with oronasal mask and if intolerant use nasal mask
Bi-level PAP titration
EPAP: Start at 5 cm H_2O
Increase by 2 cm H_2O to alleviate clinically obvious apneas, snoring, and repetitive SpO_2 desaturations
IPAP: Start at 10 cm H_2O
Increase by 2 cm H_2O to improve a steady SpO_2 at ≥ 92 %
IPAP typically needs to be at least 8 to 10 cm H_2O above EPAP to achieve adequate ventilation in OHS
Add supplemental oxygen to bi-level PAP to keep SpO_2 ≥ 92 %
Goals achieved?
Decrease work of breathing (RR < 25 breaths/min)
Improvement in acidosis and hypercapnia within 1-2 h
Sustained improvement in hypoxia (SpO_2 ≥ 92%)
No
Transfer to ICU
Consider invasive mechanical ventilation
Yes
Continue NPPV
NPPV should be continuous during day and night
Breaks to allow eating or communication
Most OHS patients reach near normal pH within 12-24 h of NPPV

NIPPV Protocols

- Known OSA or high risk for OSA without $PaCO_2$ > 50 without hypoxemia
- High likelihood of OSA with hypercarbia ($PaCO_2$ >50)
  - OSA with OHS ($PaCO_2$>50) or chest wall disorder
  - OSA with lung disease (Overlap syndrome, mainly COPD +OSA)
- Hypoventilation due to neuromuscular or chest wall disorder, low risk for OSA

High risk for OSA/no hypercarbia/no hypoxemia

- Autopap 5 to 20 cmH2O
- Before discharge portable sleep test can be done to guarantee delivery of machine
- If poor tolerance to autopap mode, to use autobipap mode
  - with delta of 4
  - starting at 8/4
  - Maximum inspiratory pressure 25
- Mask fitting to comfort

High likelihood of OSA with PaCO2 >50

- Autobipap order
- Starting pressure 12/4
- Keep PSV 8
- Machine will titrate itself to increase EPAP for obstructive events and will increase the IPAP keeping a delta of 8
- Maximum IPAP 25
- Mask fitting to comfort (by RT)
- If PaCO2 does not improve despite maximal pressure patient can tolerate, to add back up rate (CO2 not dropping by 10 points despite overnight use)

Hypoventilation due to neuromuscular or chest wall disorder- low risk for OSA

- No autobipap (IVAPS could be consider)
- To adjust bipap with a goal of 8 cc/kg (450 to 500 cc)
- Start at 12/4. Increase delta to decrease PaCO2 to 45 or to keep tv of 450 or 500.
- If hypoxemia, mild increase in epap can help or will need addition of oxygen to keep sat at 90%
- For ALS or neuromuscular respiratory weakness, bipap ST should be used (RR 10 to 12, to comfort)
- Mask fitting to comfort

Operator dependent factors implicated in failure of non-invasive positive pressure ventilation (NIPPV) for respiratory failure

Hammad Bhatti[1], Avinash Ramdass[2], James D. Cury[2], Lisa M. Jones[2], Adil Shujaat[3], Mariam Louis[2], Vandana Seeram[2] and Abubakr A. Bajwa[2]

- Retrospective chart review of consecutive patients who were initiated on and failed NIPPV between 1/2009 and 12/2009
- Among 1095 patients screened, 111 failed NIPPV.

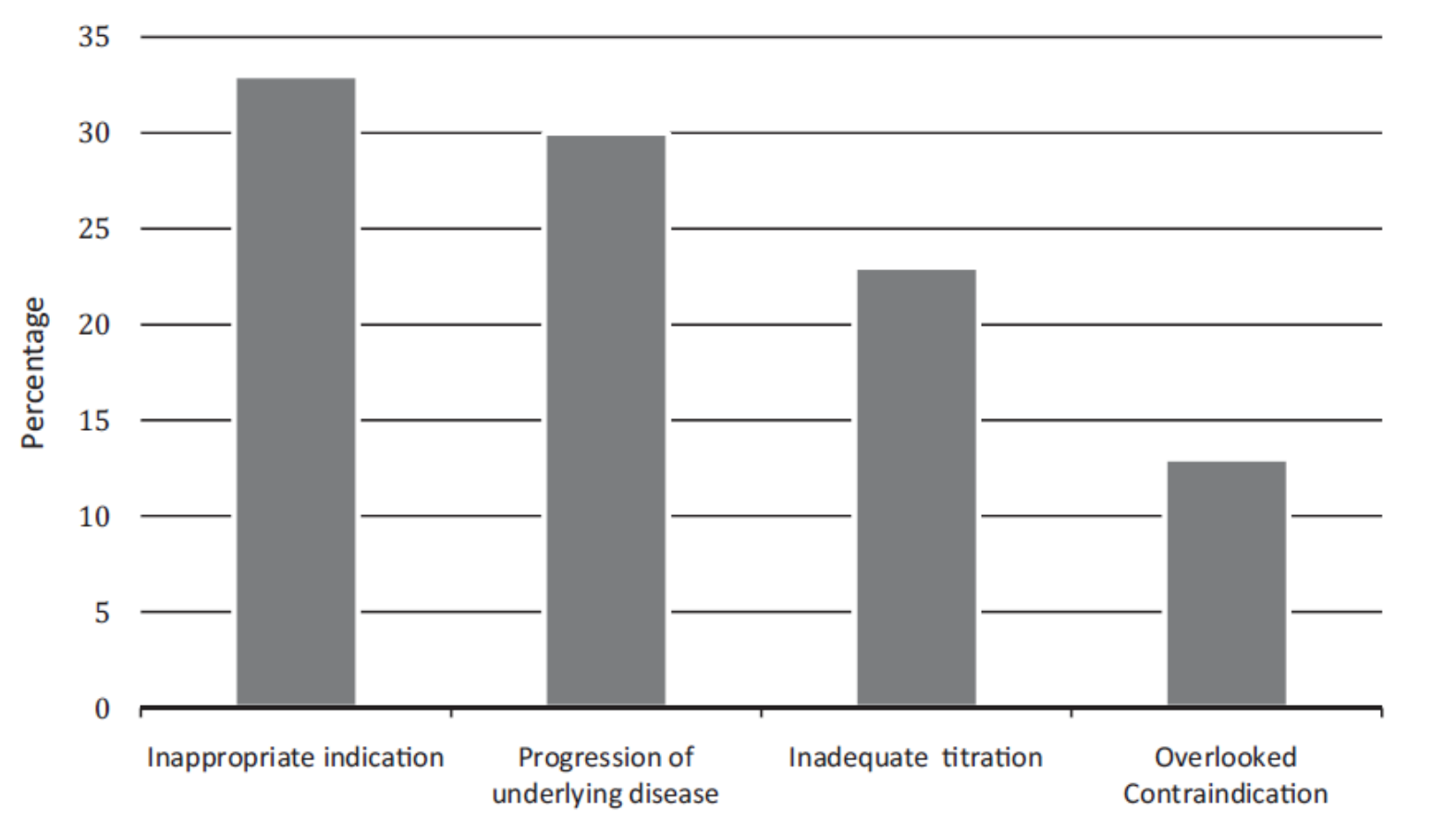
The Clinical Respiratory Journal (2015)

Table 1. Categories of modifiable operator dependent factors related to failure

Category 1	Inappropriate indication or Overlooked contraindication: • AMS/GCS < 11 • PaO2 < 50 mmHg • SBP < 90 mmHg • Acute coronary syndrome • Pneumothorax • Bowel obstruction
Category 2	Inadequate initial NIPPV settings
Category 3	Inadequate patient reassessment/monitoring
Category 4	Inadequate titration of CPAP/EPAP/IPAP/FiO2

Table 2. Demographics total $n = 111$

Age, years, Mean ± SD	60 ± 15
Gender	
Male, *n* (%)	65 (59)
Female, *n* (%)	46 (41)
Modality	
CPAP, *n* (%)	6 (5)
Initial CPAP, median, cm H_2O	6
BPAP, *n* (%)	105 (95)
Initial IPAP, median, cm H_2O	10
Initial EPAP, median, cm H_2O	5
Indications, *n* (%)	60 (54)
COPD exacerbation, *n* (%)	27 (24)
Pneumonia, *n* (%)	26 (23)
Heart failure	24 (22)
Ventilator wean assist	10 (9)
Hypoventilation	7 (6)
Asthma Exacerbation	6 (5)
Pneumonia in Immune-compromised host	4 (4)
Interstitial lung disease Exacerbation	2 (2)
Pulmonary embolism	2 (2)
Post initiation titration indicated, no (%)	49 (44)
Titration performed, no (%)	23 (47)
Overall mortality, *n* (%)	24 (22)


35
30
25
20
15
10
5
0
Percentage
Inappropriate indication
Progression of underlying disease
Inadequate titration
Overlooked Contraindication

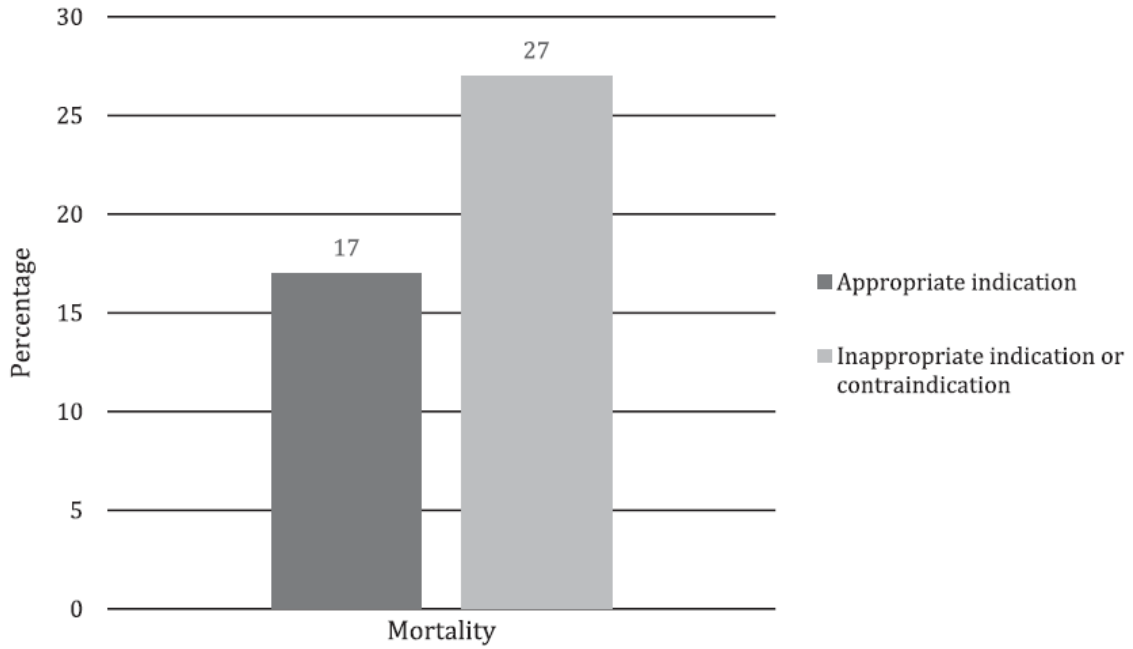


Figure 2. Mortality among appropriateness of indication categories.

Portable Sleep Testing

Original Article

Prevalence of undiagnosed obstructive sleep apnea among adult surgical patients in an academic medical center

Kevin J. Finkel [a], Adam C. Searleman [a], Heidi Tymkew [a], Christopher Y. Tanaka [a], Leif Saager [a], Elika Safer-Zadeh [a], Michael Bottros [a], Jacqueline A. Selvidge [a], Eric Jacobsohn [b], Debra Pulley [a], Stephen Duntley [c], Colleen Becker [d], Michael S. Avidan [a,*]

[a] Washington University School of Medicine, Department of Anesthesiology, 660 S Euclid Ave, Campus Box 8054, St. Louis, MO 63110, USA
[b] University of Manitoba, Department of Anesthesia, Lennox Bell Lodge, LB315, 60 Pearl St., Man., Canada R3E1X2
[c] Washington University School of Medicine, Sleep Medicine Center, 212 N Kings Highway Suite 237, St. Louis, MO 63108, USA
[d] Barnes-Jewish Hospital, Perioperative Services, One Barnes-Jewish Hospital Plaza, #90-72-408, St. Louis, MO 63110, USA

- **2877 patients; 661 (23.7%) screened high risk for OSA, of whom 534 (81%) did not have diagnosed OSA**
- **The PST detected OSA in 170/207 (82%) high risk OSA patients without prior diagnosis of OSA**
- **Post-op there were:**
  - **No respiratory arrests**
  - **Two unanticipated ICU admissions**
  - **Five documented respiratory complications**

Sleep Medicine 10 (2009) 753–758

Results

Table 2
Severity of OSA in the high-risk patients (n = 207) without a prior diagnosis of OSA as measured by home sleep studies.

OSA severity	Number	Percentage
No OSA (0–5)	37	18.0%
Mild OSA (6–20)	97	47.1%
Moderate OSA (21–40)	40	18.9%
Severe OSA (>40)	33	16.0%
Mild to severe OSA	170	82.0%

The numbers in parentheses represent the apnea–hypopnea index range defining the OSA classification. OSA, obstructive sleep apnea.

In-hospital Testing for Sleep Disordered Breathing in Hospitalized Patients with Decompensated Heart Failure-Report of Prevalence and Patient Characteristics

Rami N Khayat, MD[1], **David Jarjoura, PhD**[2], **Brian Patt, B.S.**[3], **Todd Yamokoski, RN**[3], and **William T Abraham, MD, FACC**[3]

[1] Division of Pulmonary Critical Care and Sleep, Ohio State University

[2] Center for Biostatistics and College of Public Health, Ohio State University

[3] Division of Cardiovascular Medicine, Ohio State University

J Card Fail. 2009 November ; 15(9): 739–746.

Results

- 395 patients with Acute Decompensated Heart Failure (ADHF) underwent PST
- 298 (75%) had SDB
  - 226 (57%) OSA
  - 72 (18%) central SDB
  - 25% with no SDB
  - In-lab PSG 6 to 8 weeks post discharge was 100% positive in a subgroup of OSA patients

ORIGINAL ARTICLE

Detection of postoperative sleep-disordered breathing using a portable monitoring device

Ian D. Weir · Khaleel Mohammed Ahmed · Steve Korbuly · Anil Achaen · Mary O'Malley · Ed O'Malley · Christopher Manfredi · Dorothy B. Wakefield · Jonathan M. Fine · Stephen M. Winter

Table 2 Postoperative sleep-disordered breathing and oxygenation

Classification	All patients (n=100)	No oxygen (n=56)	Oxygen (n=44)
Sleep-disordered breathing			
Respiratory disturbance index ≥5 (%)	51	62	36
Respiratory disturbance index >15 (%)	17	20	14
Mean RDI ± SD	8.8±12.3	10.3±12.5	6.8±9.2
Oxygenation			
Oxygen desaturation index ≥5 (%)	42	55	25
Oxygen desaturation index >15 (%)	17	21	11
Mean ODI ± SD	7.7±10.1	7.5±11.3	4.9±7.5
Mean ± SD time <90% saturation (%)	8.0±17.5	14.8±7.3	1.4±2.7
Mean ± SD lowest oxygen saturation (%)	85.3±6.4	84.6±7.6	85.9±5.6

Sleep Breath (2012) 16:881–886

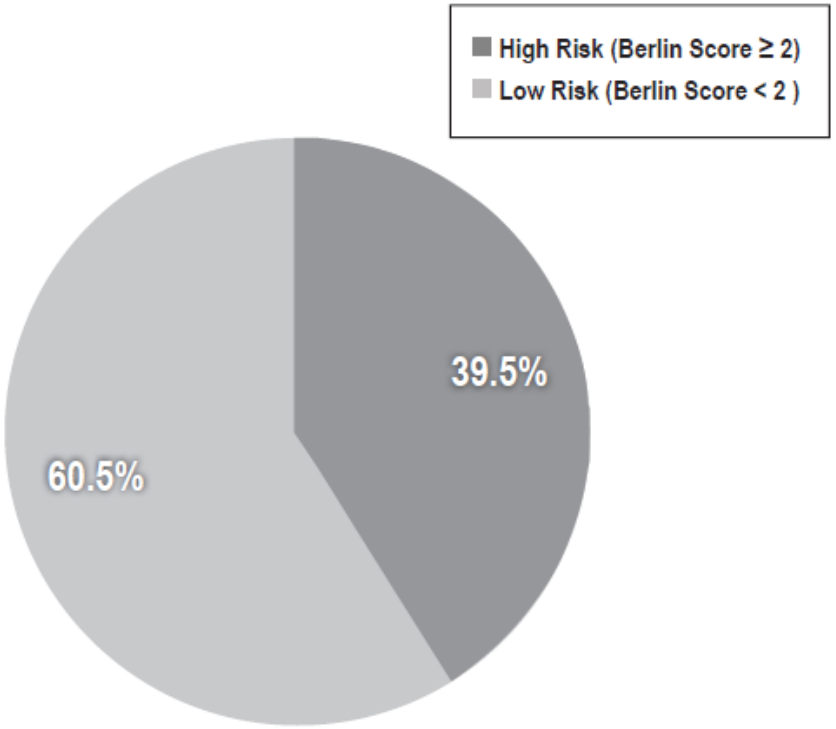
Risk of Sleep Apnea in Hospitalized Older Patients

Talia C. Shear, B.A.[1]; Jay S. Balachandran, M.D.[2,3]; Babak Mokhlesi, M.D., M.Sc., F.A.A.S.M.[2,3]; Lisa M. Spampinato, B.S.[2]; Kristen L. Knutson, Ph.D.[2,3]; David O. Meltzer, M.D., Ph.D.[2]; Vineet M. Arora, M.D., M.A.P.P.[2,3]

[1]Pritzker School of Medicine, University of Chicago, Chicago, IL; [2]Department of Medicine, University of Chicago, Chicago, IL; [3]Sleep, Metabolism and Health Center, University of Chicago, Chicago, IL

- Prospective cohort study
- 424 hospitalized patients ≥ 50 yo without a sleep disorder diagnosis (mean age 65 yo, 57% female, 72% African American)
- Measures: Berlin questionnaire, wrist actigraphy, Karolinska Sleep Quality Index (KSQI)

Figure 2—Percentage of hospitalized patients screened at high risk for obstructive sleep apnea (total n = 424).



Percentage of hospitalized patients on the general medicine service at the University of Chicago screened as at high or low risk for obstructive sleep apnea (OSA) using the Berlin questionnaire. High risk for OSA is defined as a score on the Berlin questionnaire of ≥ 2.

Table 2—Association between OSA risk[a] and in-hospital sleep.

	Sleep Duration (min)		Sleep efficiency (%)	
# of obs = 580[b] # of groups = 322	**Model 1[c] Beta [95% CI]**	**Model 2[c] Beta [95% CI]**	**Model 3[c] Beta [95% CI]**	**Model 4[c] Beta [95% CI]**
High Risk OSA	-39.6 [-66.5, -12.8]	-30.5 [-59.1, -1.81][d]	-5.50 [-9.96, -1.05][d]	-3.31 [-8.05, 1.43]
African American	–	13.3 [-17.4, 44.0]	–	2.78 [-2.30, 7.87]
Age 56-63[e]	–	6.78 [-31.8, 45.4]	–	3.52 [-2.87, 9.90]
Age 63-74	–	18.1 [-19.9, 56.2]	–	5.48 [-0.82, 11.8]
Age 74-93	–	37.6 [-0.94, 76.2]	–	3.40 [-2.99, 9.78]
Sex	–	37.5 [10.1, 64.8][d]	–	6.38 [1.86, 10.9][d]
Charlson Indices 2-3[f]	–	-3.8 [-33.6, 26.0]	–	1.35 [-3.59, 6.29]
Charlson Indices 4-8	–	-11.9 [-50.0, 26.2]	–	1.02 [-5.29, 7.34]

[a] High OSA risk is defined by score on the Berlin questionnaire ≥ 2. [b] n = 580 nights of recording from 322 subjects. [c] Random effects linear regression analyses were done to assess the relationship between score on the Berlin questionnaire and sleep duration with and without patient demographics as covariates. Coefficients (minutes) and 95% confidence intervals are reported. [d] $p < 0.05$. [e] Reference age group is 50-56 years old. [f] Charlson comorbidity index by tertiles: Tertile 1: 0-1, Tertile 2: 2-3, Tertile 3: 4-8.

Diagnosis and Treatment of Sleep Disordered Breathing in Hospitalized Cardiac Patients: A Reduction in 30-Day Hospital Readmission Rates

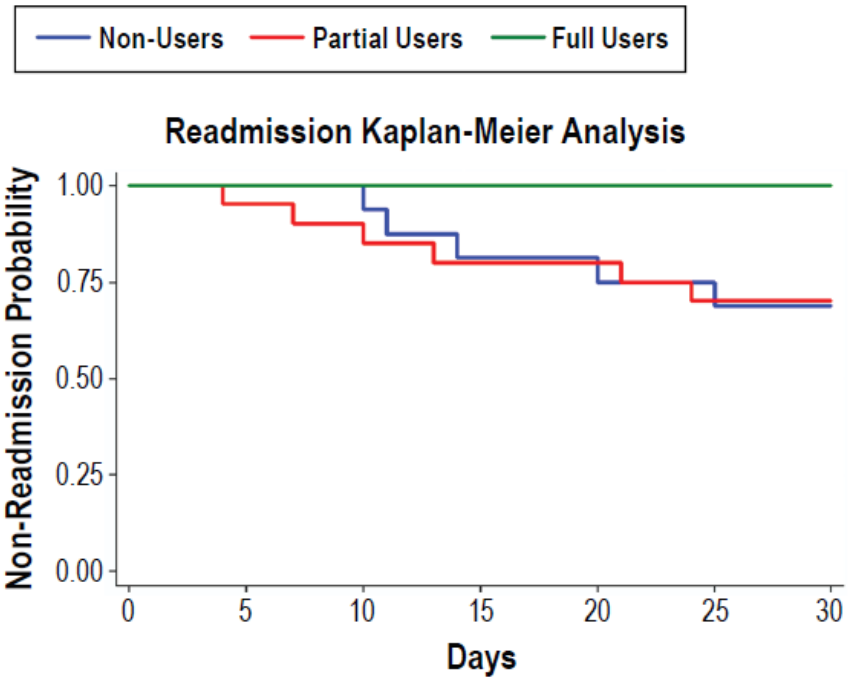
Shilpa R. Kauta, M.D.[1]; Brendan T. Keenan, M.S.[1]; Lee Goldberg, M.D.[2]; Richard J. Schwab, M.D.[1]

[1]*Center for Sleep and Circadian Neurobiology, University of Pennsylvania, Philadelphia, PA;*
[2]*Department of Cardiology, University of Pennsylvania, Philadelphia, PA*

- **106 consecutive cardiac patients hospitalized for heart failure, arrhythmias, and myocardial infarction and who reported symptoms of SDB were evaluated.**
- **Patients underwent a type III PST**
- **If positive for OSA, PAP therapy started**
- **104 patients had conclusive PST**
- **78% (81/104) had SDB (AHI ≥ 5 events/hour)**
- **80% (65/81) had mainly OSA and 20% (16/81) had mainly CSA**

J Clin Sleep Med 2014;10(10):1051-1059.

- 0/19 (0%) patient with adequate PAP adherence were readmitted at 30 days
- 6/20 (30%) with partial PAP use and 5/17 (29%) of patients who did not use PAP were readmitted to the hospital or visited the ED for a cardiac issue within 30 days from discharge



Full users were defined as patients with use of PAP ≥ 4 h per night on 70% of nights during a consecutive 30-day period in the first 90 days of PAP treatment. Readmission was defined as hospitalization or visit to the emergency department from 48 h to 30 days after discharge. PAP, positive airway pressure.

Conclusions

- **Use of NIPPV reduces mortality, prevents intubation, decreases length of stay, decreases costs and improves quality of life, if used at the right time and on the right patients**
- **NIPPV is indicated in patients with AE COPD, Asthma, NM weakness, Acute Pulmonary Edema, OSA/OHS, chest wall disorders and immunosuppressed patients (BMT) with respiratory distress**
- **Studies have not shown efficacy in ARDS or pneumonia, so it should be avoided in these cases**

Conclusions

- A multidisciplinary team composed by RTs, nurses, case managers, social workers and physicians; all well trained in NIPPV is required to be successful
- The treatment does not end necessarily after discharge. Patients should continue treatment after discharged from the hospital to prevent readmissions
- Usage of PST can help identify patients with OSA while inpatient and provide the means to start treatment in the hospital and continue upon discharge
- PST use in the inpatient could decrease readmissions