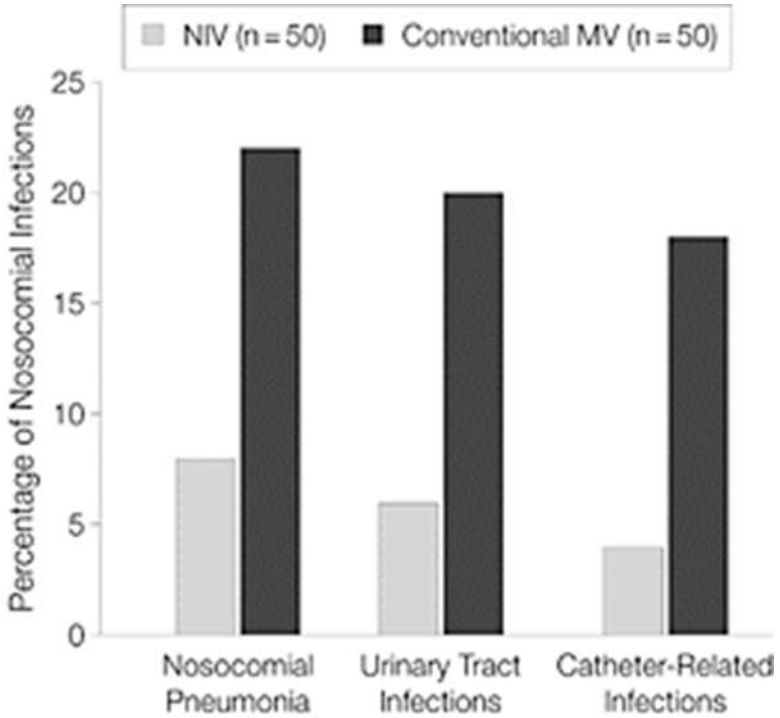
Η χρήση μη επεμβατικού αερισμού -πότε αρχίζει-πότε σταματάει

Ευμορφία Κονδύλη
Αναπ/τρια Καθηγήτρια Εντατικής Ιατρικής,
Ιατρική Σχολή - ΠΚ, ΜΕΘ -ΠΑΓΝΗ

NIV – Benefits

- Decrease the rate of
  - Intubation
  - Sedation
  - ICU
  - ICU-related Infections



Association of Noninvasive Ventilation With Nosocomial Infections and Survival in Critically Ill Patients
JAMA. 2000;284(18):2361-2367.

Contraindications of NIV

Absolute	Cardiac or respiratory arrest
	Anatomical abnormality (unable to fit the interface)
	Inability to keep patent airway (uncontrolled agitation, coma[a] or obtunded mental status)
	Refractory hypotension
Relative	Mild agitation or poor cooperation
	Mild hypotension
	Upper gastrointestinal haemorrhage or vomiting
	Inability to expectorate copious secretions
	Recent frail upper gastrointestinal or airway surgery
	Multiorgan failure
	Isolated right ventricular failure

When to start NIV

Indications

Bedside observations

- Increased dyspnoea—moderate to severe
- Tachypnoea (>24 breaths per min in obstructive, >30 per min in restrictive)
- Signs of increased work of breathing, accessory muscle use, and abdominal paradox

Gas exchange

- Acute or acute on chronic ventilatory failure (best indication), $PaCO_2$>45 mm Hg, pH<7·35
- Hypoxaemia (use with caution), PaO_2/F_iO_2 ratio< 300

Criteria For termination of NIV

- Hemodynamic instability
- Decrease level of consciousness
- Worsening PH and PaCO2
- Worsening PaO2
- Tachypnea >30 b/min

Dyspnea intensity ≥4 after the first NIV was independently associated with NIV failure (OR, 2.41, p=0.001) and mortality (OR, 2.11; p=0.009), Dangers et al , *ERJ 2018*

- Signs of increase WOB
- Inability to clear secretions
- Agitation or intolerance to NIV with progressive respiratory failure

Monitoring NIV

- Patient
  - Respiratory rate
  - Other vital signs
  - Dyspnoea/accessory muscle use/abdominal paradoxical breathing
  - Level of consciousness
  - Comfort with the interface
  - Collaboration
- Ventilator parameters
  - Tidal volume (>4 mL/Kg: 6–7 mL/Kg) and minute ventilation
  - Air leakage volume (<0, 4 L/s or < 25 L/min)
  - Pressure support and PEEP settings
  - Asynchrony (ineffective efforts, auto-triggering, double-triggering, short/long cycle)[a]
  - Trigger/slope (ramp)/Inspiration time/expiration settings
  - Auto-PEEP
  - Alarms (apnoea or high respiratory rate, low/high minute ventilation, others)
- Gas exchange
  - Continuous pulse-oximetry (SpO_2)
  - Arterial or venous blood gas samples[b]

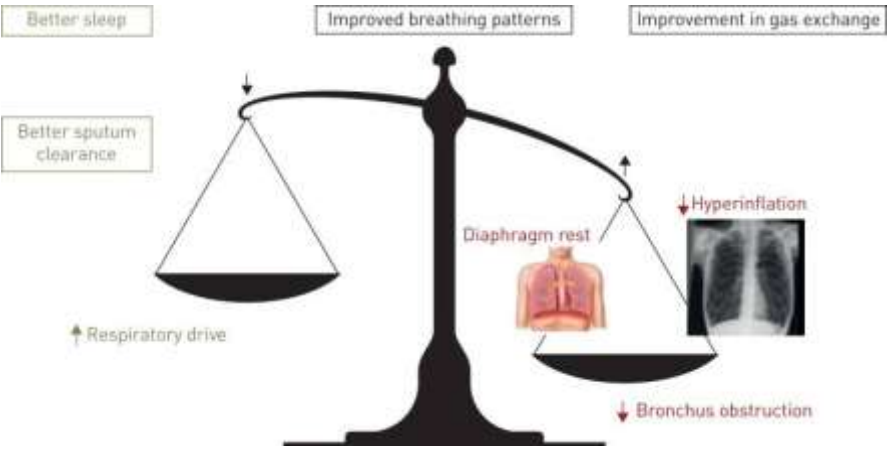
- Risk factors of failure
  - Before initiation
    - Lung infection
    - Altered mental status
    - Hypotension
    - High severity scores
    - Copious secretions
    - Extremely high respiratory rate
    - Severe hypoxaemia in spite of high F_iO_2
  - After initiation
    - Inappropriate ventilator settings
    - Unfitting interface
    - Excessive air leakage
    - Asynchrony with the ventilator
    - Poor tolerance to NIV
  - After 60–90 min
    - No reduction in respiratory rate or carbon dioxide
    - No improvement in pH or oxygenation ($\downarrow SpO_2$ or $\downarrow PaO_2/FiO_2$)
    - Signs of fatigue
    - Neurological or underlying disease impairment
- Criteria for endotracheal intubation

- Acute exacerbation of COPD
- Acute asthma

- Cardiogenic pulmonary edema
- de novo ARF-ARDS/Pneumonia

- Immunocompromised patients
- Post-operative acute respiratory failure

Acute exacerbation of COPD



The New England
Journal of Medicine

Volume 333 SEPTEMBER 28, 1995 Number 13

NONINVASIVE VENTILATION FOR ACUTE EXACERBATIONS OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

LAURENT BROCHARD, M.D., JORDI MANCEBO, M.D., MARC WYSOCKI, M.D., FRÉDÉRIC LOFASO, M.D., GIORGIO CONTI, M.D., ALAIN RAUSS, M.D., GÉRALD SIMONNEAU, M.D., SALVADOR BENITO, M.D., ALESSANDRO GASPARETTO, M.D., FRANÇOIS LEMAIRE, M.D., DANIEL ISABEY, PH.D., AND ALAIN HARF, M.D.

Table 2. Patients Requiring Endotracheal Intubation after Assignment to Standard Treatment or Noninvasive Ventilation, According to the Participating Center.

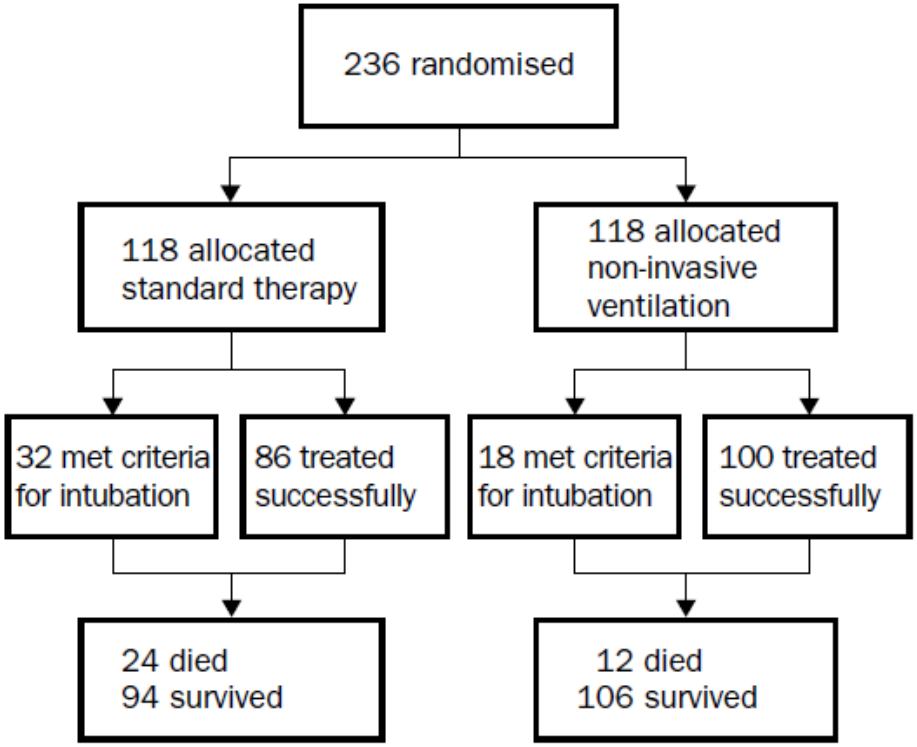
CENTER NO.	STANDARD TREATMENT		NONINVASIVE VENTILATION	
	NO. OF PATIENTS	NO. INTUBATED (%)	NO. OF PATIENTS	NO. INTUBATED (%)
1	9	9 (100)	9	3 (33)
2	6	5 (83)	5	2 (40)
3	9	4 (44)	8	1 (13)
4	4	3 (75)	5	0
5	14	10 (71)	16	5 (31)
Total	42	31 (74)	43	11 (26)

Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial

Lancet 2000; **355:** 1931–35

P K Plant, J L Owen, M W Elliott

RR >23/min
pH 7·25–7·35 with a PaCO2> 45 mmHg



- **Need for IMV**
  15%/ 27%, p=0·02
- **In-hospital mortality**
  10%/20% ,p=0·05
- **More rapid** improvement in pH in the first hour ,p=0·02
- **Greater fall in respiratory rate** at 4 h ,p0·035.

Cochrane Library
Cochrane Database of Systematic Reviews

Non-invasive ventilation for the management of acute hypercapnic respiratory failure due to exacerbation of chronic obstructive pulmonary disease (Review)

Osadnik CR, Tee VS, Carson-Chahhoud KV, Picot J, Wedzicha JA, Smith BJ

- 17 RCT involving 1264 participants
- BiPAP versus standard care alone
- AECOPD pH < 7.35 and $PaCO_2$> 45 mmHg

- Decrease mortality by 46%
- Decrease intubation by 65%
- Similar results in subgroups
  - **pH 7.30-7.35 vs. pH < 7.30**
  - **ICU vs. ward setting**

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

? Should NIV be used in ARF due to a COPD exacerbation to prevent the development of respiratory acidosis?

- **We suggest NIV not be used - Conditional recommendation, low certainty**

? Should NIV be used in established acute hypercapnic respiratory failure due to a COPD exacerbation?

- **We recommend bilevel NIV - Strong recommendation, high certainty**

Eur Respir J 2017; 50: 1602426

Acute asthma

- A few uncontrolled studies and RCTs have compared NIV versus routine care in patients with acute asthma.

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

- ? Should NIV be used in ARF due to acute asthma?

- Given the uncertainty of evidence we are unable to offer a recommendation on the use of NIV for ARF due to asthma.

Acute cardiogenic pulmonary edema

Cardiovascular

↓ Venous return → ↓ RV preload → ↓ LV preload

↑ Pulmonary vascular resistance → ↑ RV afterload → RV enlargement → ↓ LV Compliance

↓ LV afterload (↓ systolic wall stress)

↓ Systemic blood pressure → ↓ Cardiac output[a]

Respiratory

Recruitment of collapsed alveoli → ↑Functional residual capacity

Maintenance continuously opened alveoli→ Gas exchange during the whole respiratory cycle

Intra-alveolar pressure against oedema

↓ Work of breathing

↑ Oxygenation

Acute cardiogenic pulmonary edema

- *Cochrane Database Syst Rev. May 2013*
- 32 RCTs involving 2916 participants
- CPAP/BiPAP+ usual care vs. usual care alone
- Decrease mortality by 33%
- Decrease intubation by 48%
- similar incidence of AMI
  - **15%**
  - **RR=1.24 CI=0.79-1.95**

In summary, there is no relationship between use of NIV and risk of AMI, and NIV may be considered in patients with ACPE complicating a Type II AMI or a non-STEMI. Further data are necessary to assess the role of NIV in patients with STEMI.

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

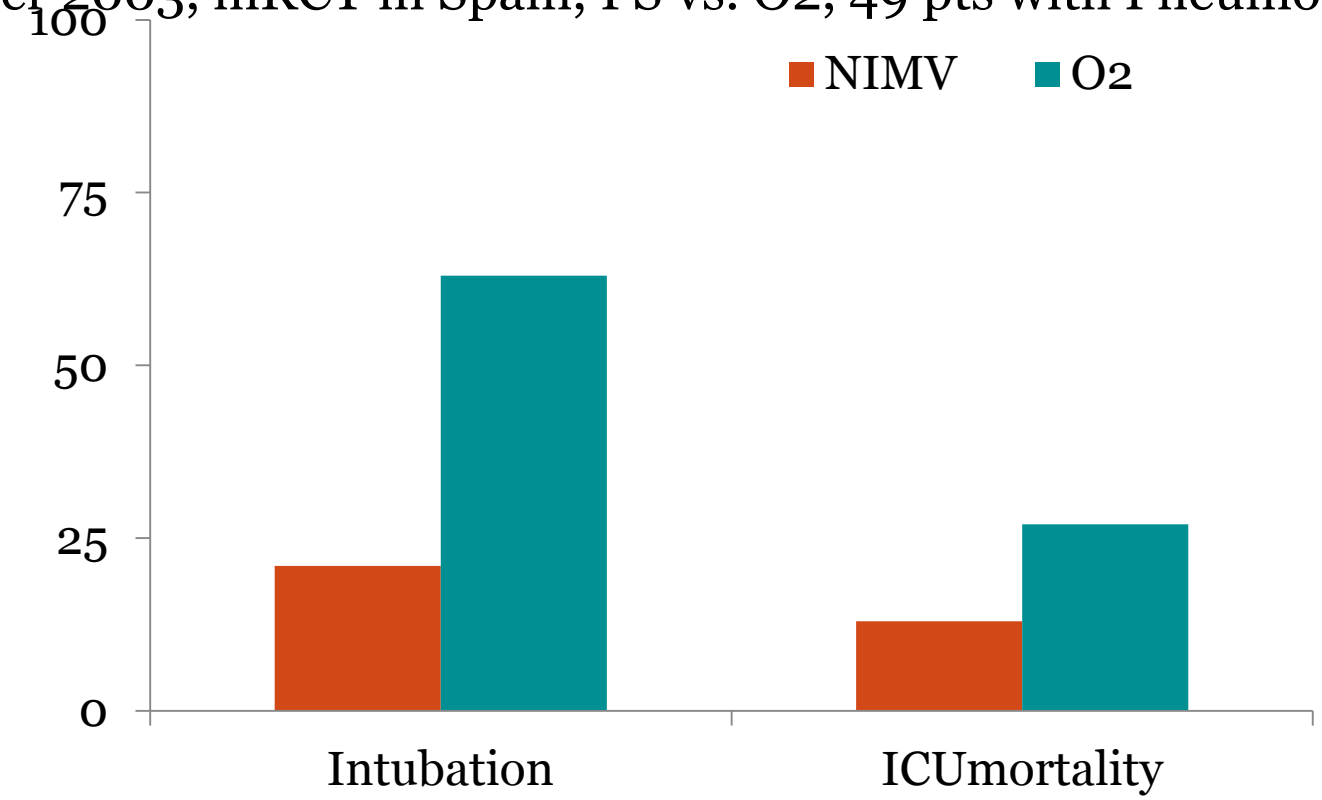
? Should NIV be used in ARF due to cardiogenic pulmonary oedema?

- We recommend either bilevel NIV or CPAP - Strong recommendation, moderate certainty of evidence

Studies suggest the early timing of application of NPPV in patients with ARF due to cardiogenic pulmonary oedema as its application in **the pre-hospital setting has been shown to prevent clinical deterioration and to lower intubation risk**

NIV in de novo acute respiratory failure ARDS -pneumonia

Brambilla, ICM 2014, mRCT in Italy, CPAP vs. O2, 80 pts with Pneumonia
Zhan, CCM 2012, mRCT in China, PS vs O2, 40 pts with Pneumonia or ARDS
Ferrer 2003, mRCT in Spain, PS vs. O2, 49 pts with Pneumonia or ARDS



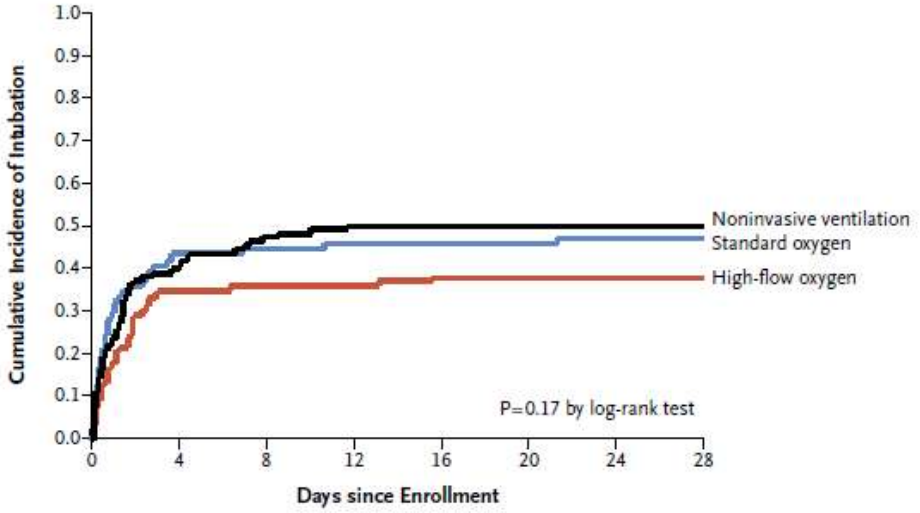
The NEW ENGLAND JOURNAL of MEDICINE

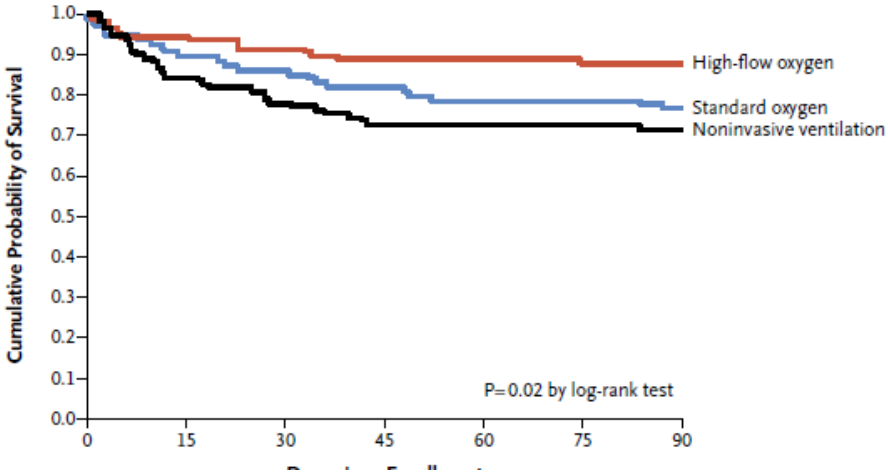
ORIGINAL ARTICLE

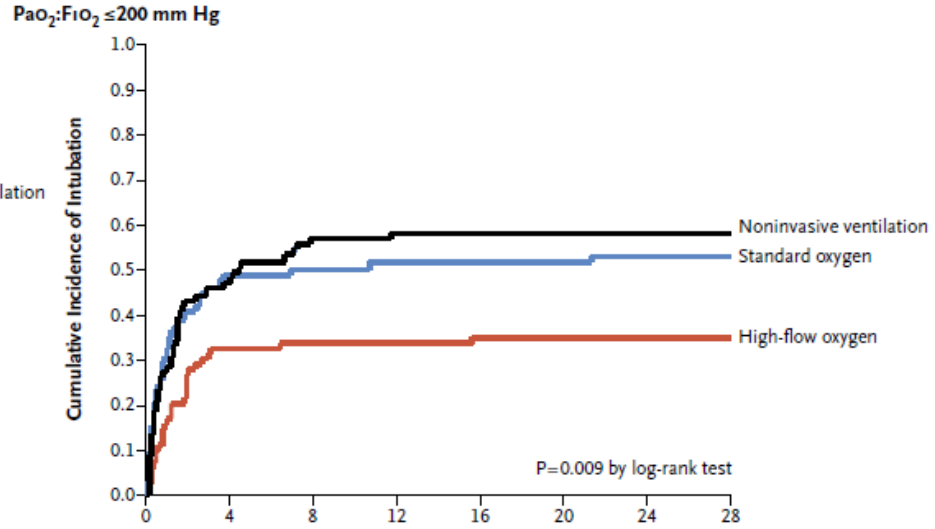
High-Flow Oxygen through Nasal Cannula in Acute Hypoxemic Respiratory Failure

Jean-Pierre Frat, M.D., Arnaud W. Thille, M.D., Ph.D., Alain Mercat, M.D., Ph.D.,

23 ICUs in France and Belgium
310 patients
106 HF-O2, 111 NIMV, 94 O2
Age 60, pneumonia 75%
Po2/FiO2 = 160







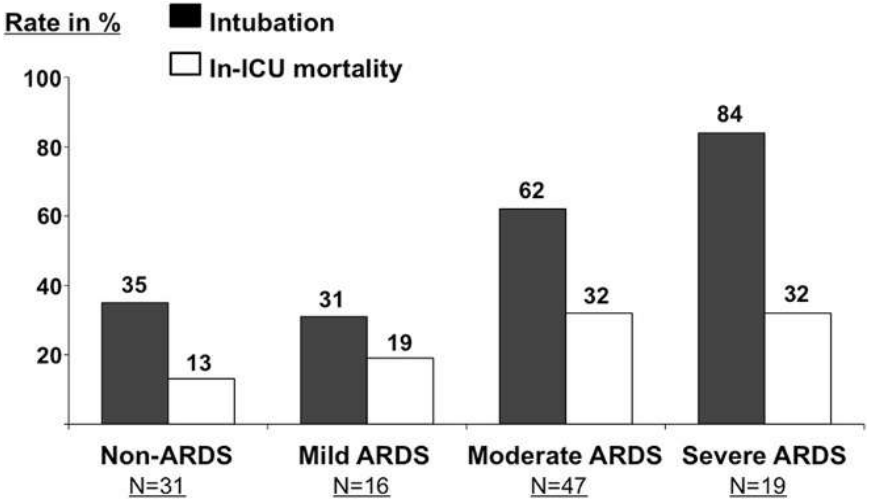
Noninvasive Ventilation of Patients with ARDS -Insights from the LUNG SAFE

Am J Respir Crit Care Med. 2017 Jan

- NIMV in 15% of 2813 ARDS pts
- NIMV failure
  - 22.2% mild ARDS
  - 42.3% moderate ARDS
  - 47.1% severe ARDS.
- Hospital mortality
  - NIMV success 16%
  - NIMV failure 45%,
- ICU mortality NIMV >IMV PaO_2/FiO_2 <150 mm Hg.

NIV Failure in ARDS

Thille et al. CrCare 2013, observational study 113 pts



Carteaux et al. CrCare 2016, observational study 62 pts

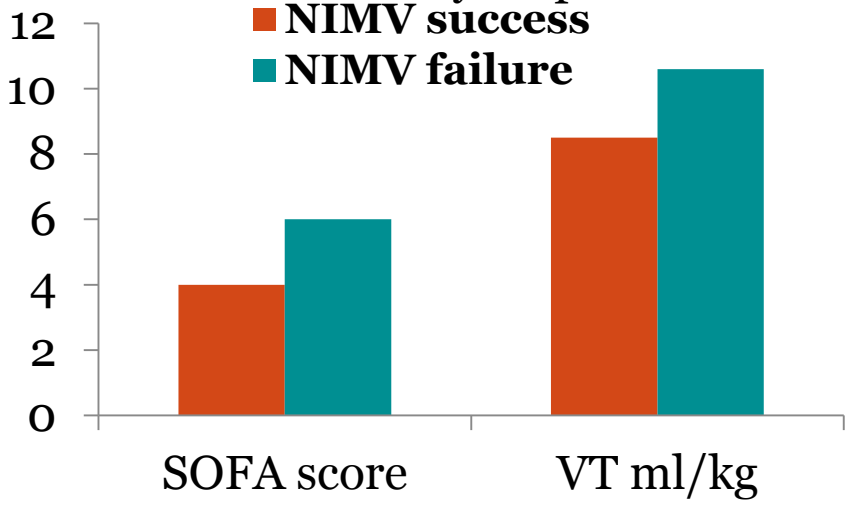


TABLE 3. Multivariate Analysis of Risk Factors for Noninvasive Ventilation Failure in Patients With De Novo Acute Hypoxemic Respiratory Failure

Risk Factors	Unadjusted Hazard Ratio (95% CI)	p	Adjusted Hazard Ratio (95% CI)[a]	p
Simplified Acute Physiology Score II (30)	1.026 (1.008–1.043)	0.011	1.024 (1.007–1.041)	0.013
Immunosuppression	2.207 (1.054–4.622)	0.045	1.351 (0.598–3.056)	0.476
Pao_2/Fio_2 before NIV	0.995 (0.990–1.001)	0.114	0.995 (0.989–1.001)	0.109
Mean expired tidal volume during NIV, per mL/kg predicted body weight	1.318 (1.109–1.567)	0.002	1.286 (1.069–1.547)	0.008

Early predictors of NIV failure in de novo ARF

- Higher severity score
- Older age
- ARDS or pneumonia as the etiology for respiratory failure,
- Failure to improve after 1 h of treatment

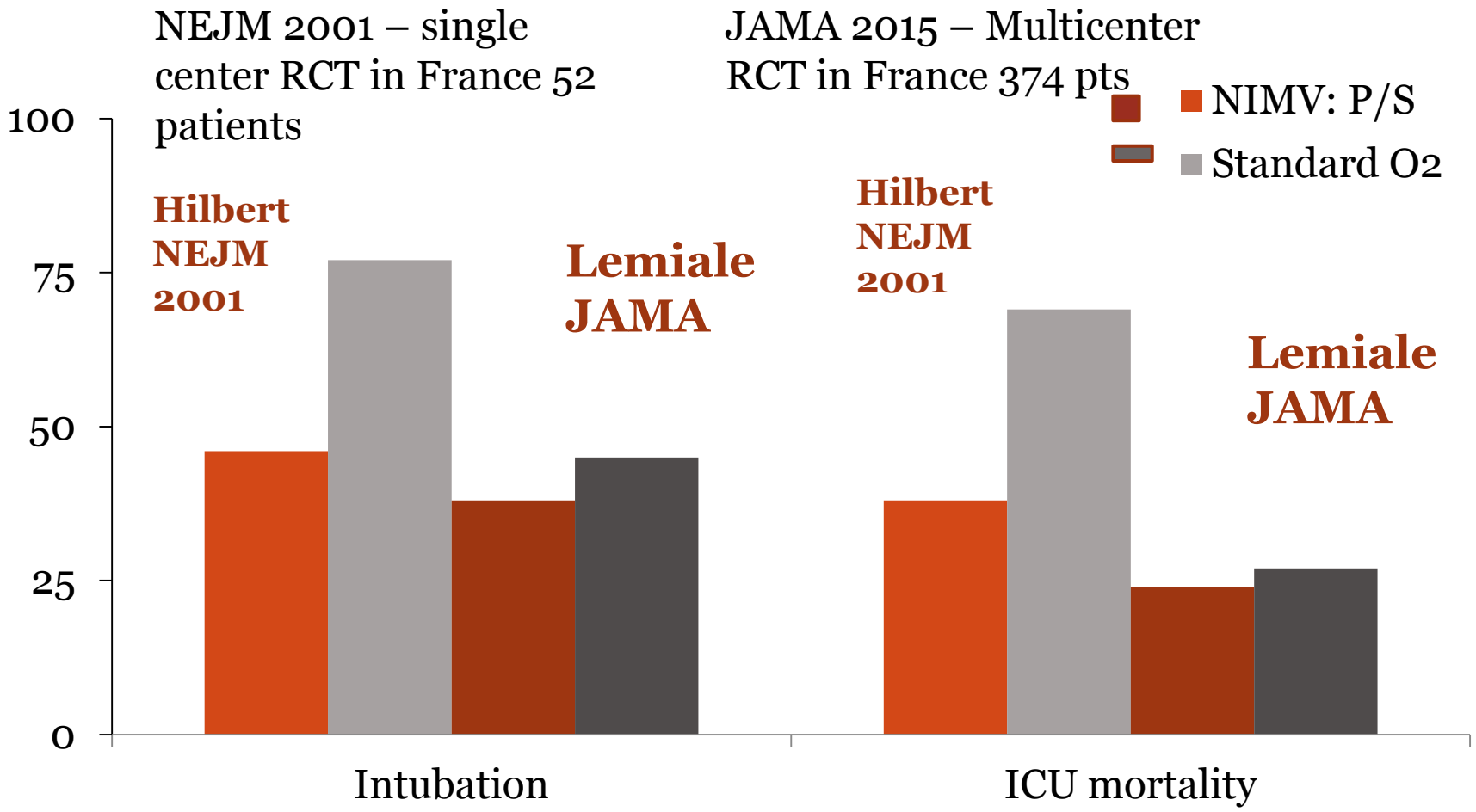
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

? Should NIV be used in de novo ARF?

- Given the uncertainty of evidence we are unable to offer a recommendation

The main risk of NIV for the indication of de novo ARF **is to delay a needed intubation**

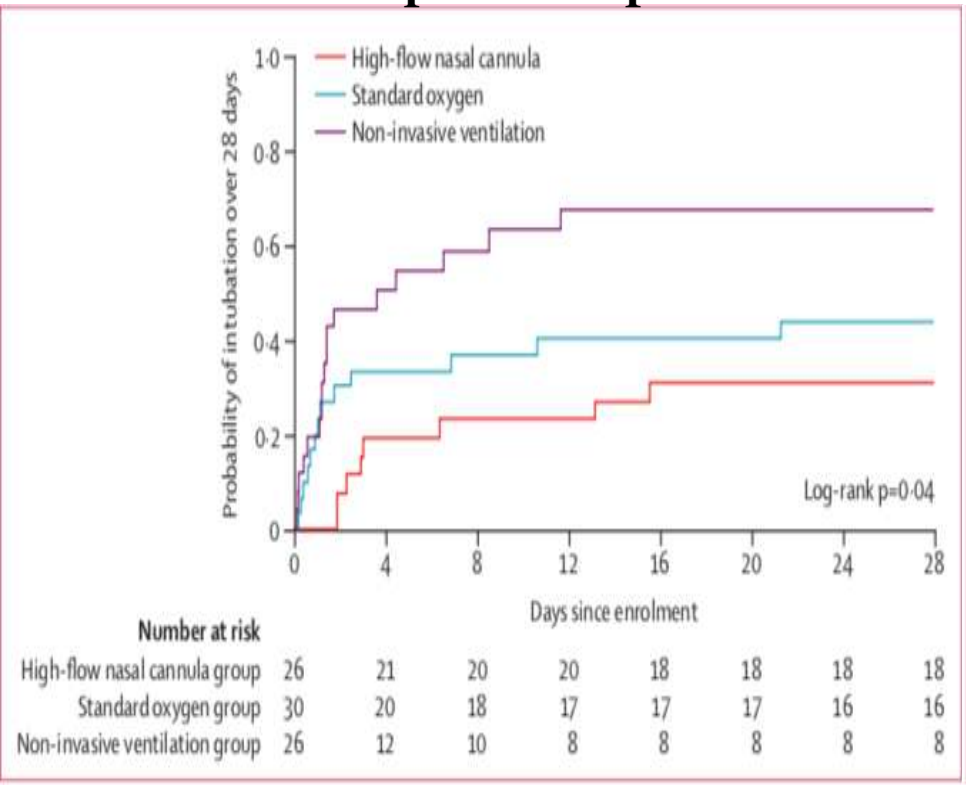
NIV in Immuno-compromised patients

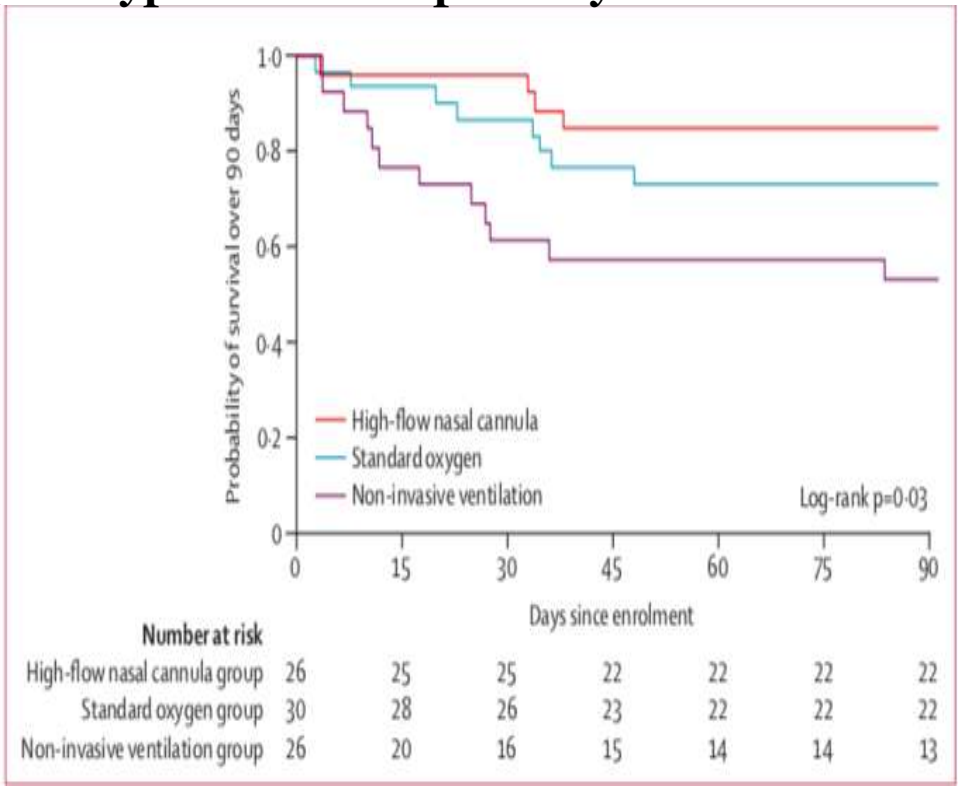


Effect of non-invasive oxygenation strategies in immunocompromised patients with severe acute respiratory failure: a post-hoc analysis of a randomised trial

Jean-Pierre Frat, Stéphanie Ragot, Christophe Girault, Sébastien Perbet, Gwénael Prat, Thierry Boulain, Alexandre Demoule, Jean-Damien Ricard, Rémi Coudroy, René Robert, Alain Mercat, Laurent Brochard, Arnaud W Thille, for the REVA network

Non-invasive ventilation might be associated with an increased risk of intubation and mortality and should be used cautiously in immunocompromised patients with acute hypoxaemic respiratory failure.



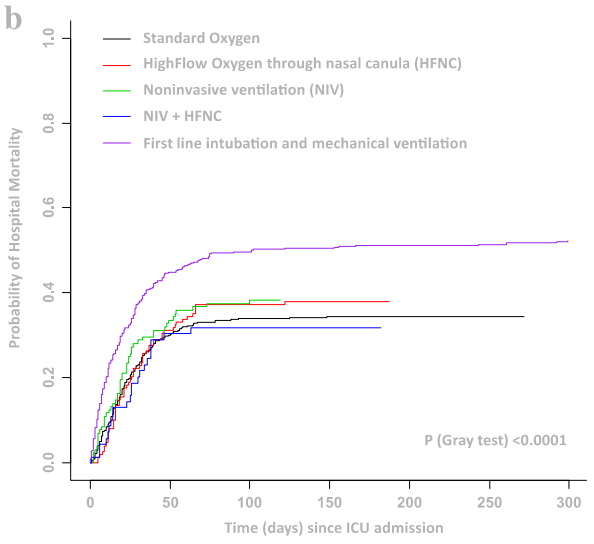


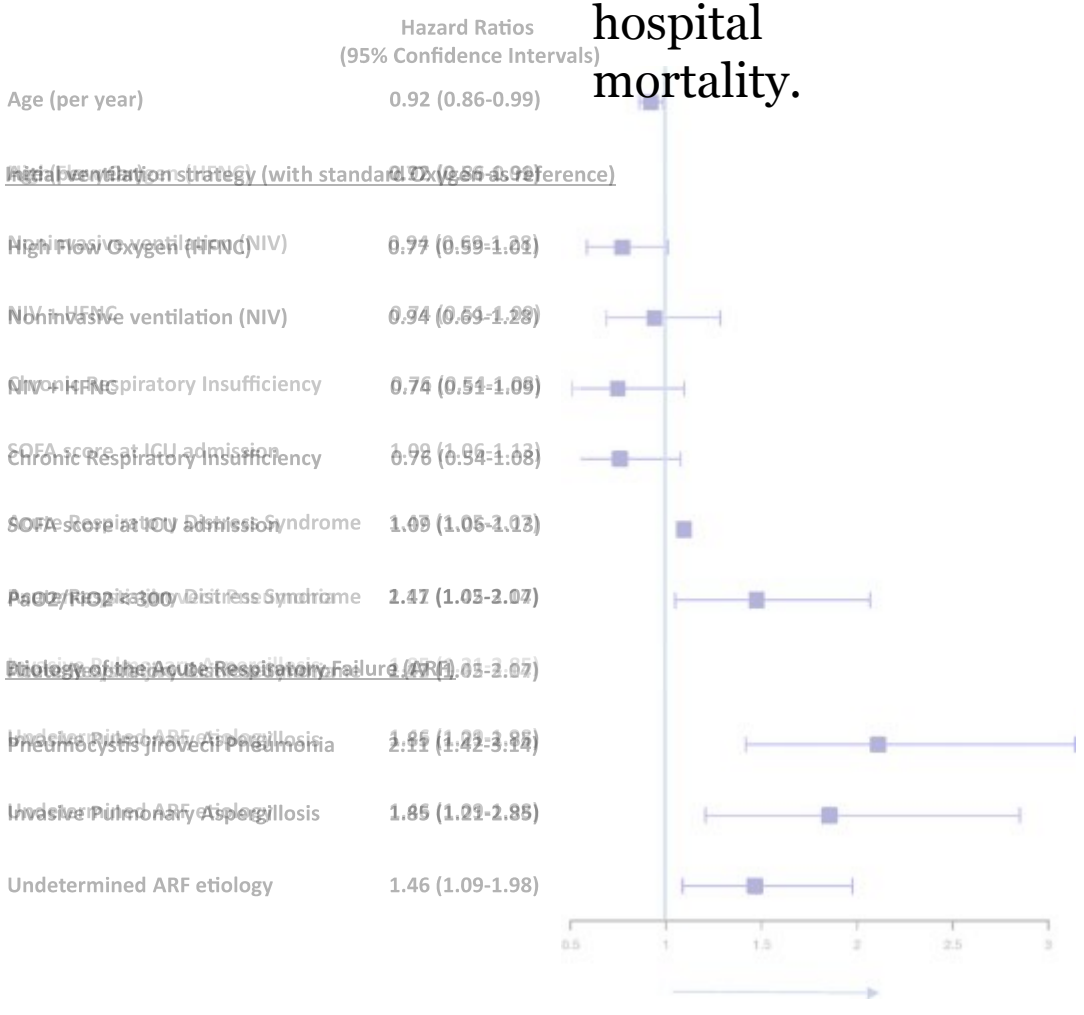
Acute hypoxemic respiratory failure in immunocompromised patients: the Efraim multinational prospective cohort study

Intensive Care Med
DOI 10.1007/s00134-017-4947-1

Over the 8-month study period, 1611, age 63 years old (IQR 54–71)] were enrolled in the 68 participating ICUs. Immunosuppression was related to malignancy in 87%

?whether initial management affects the need for MV or hospital mortality.





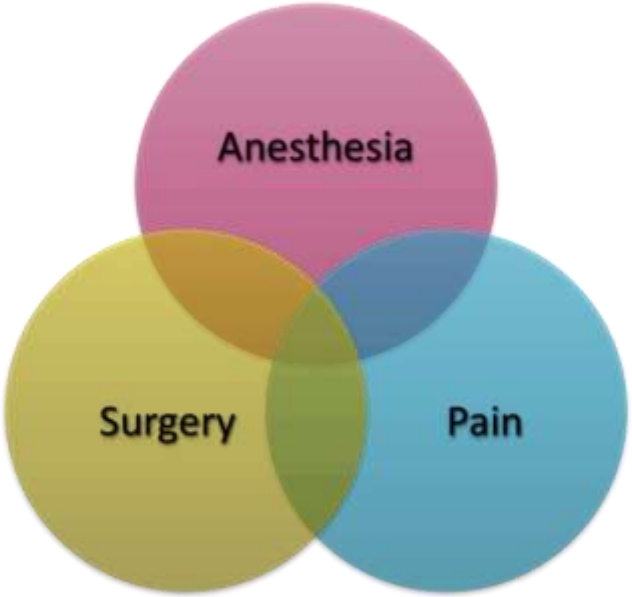
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

? Should NIV be used for ARF in immunocompromised patients?

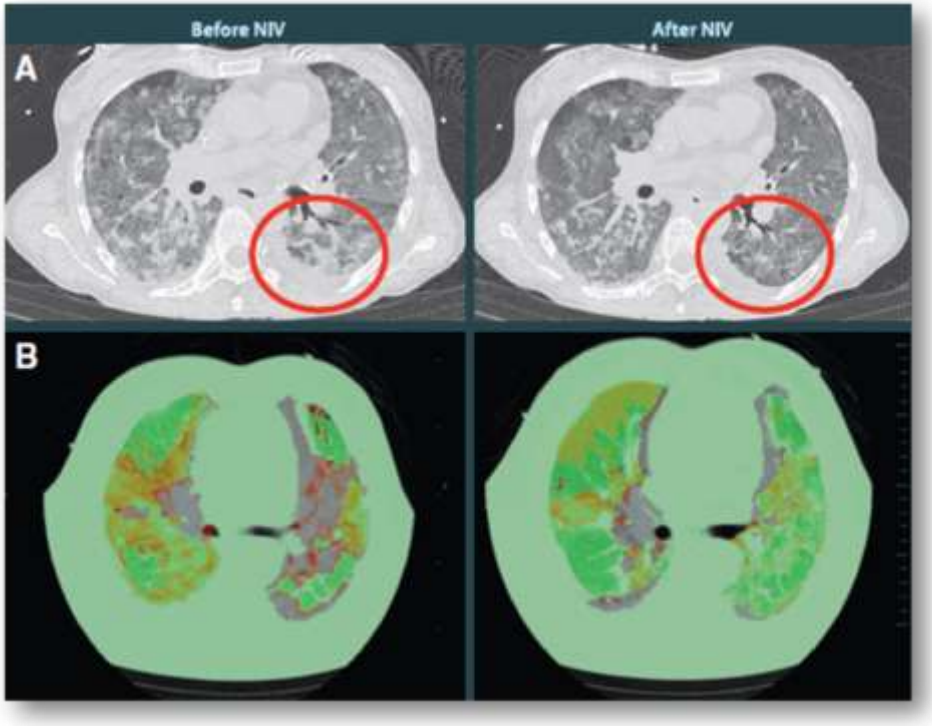
- **We suggest early NIV for immunocompromised patients with ARF - Conditional recommendation, moderate certainty of evidence**

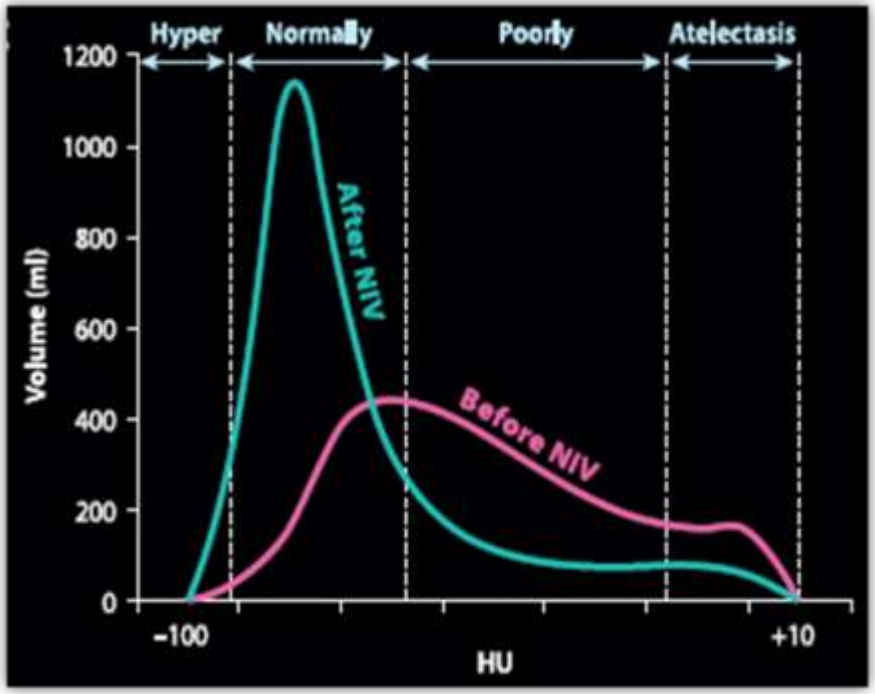
NIV in post-operative ARF

- ↓Pulmonary Volume
- Atelectasis associated with a Restrictive Syndrome
- Ventilation-Perfusion Mismatch
- Diaphragm Dysfunction
  - early after surgery
  - may last up to 7 days
  - could lead to ARF

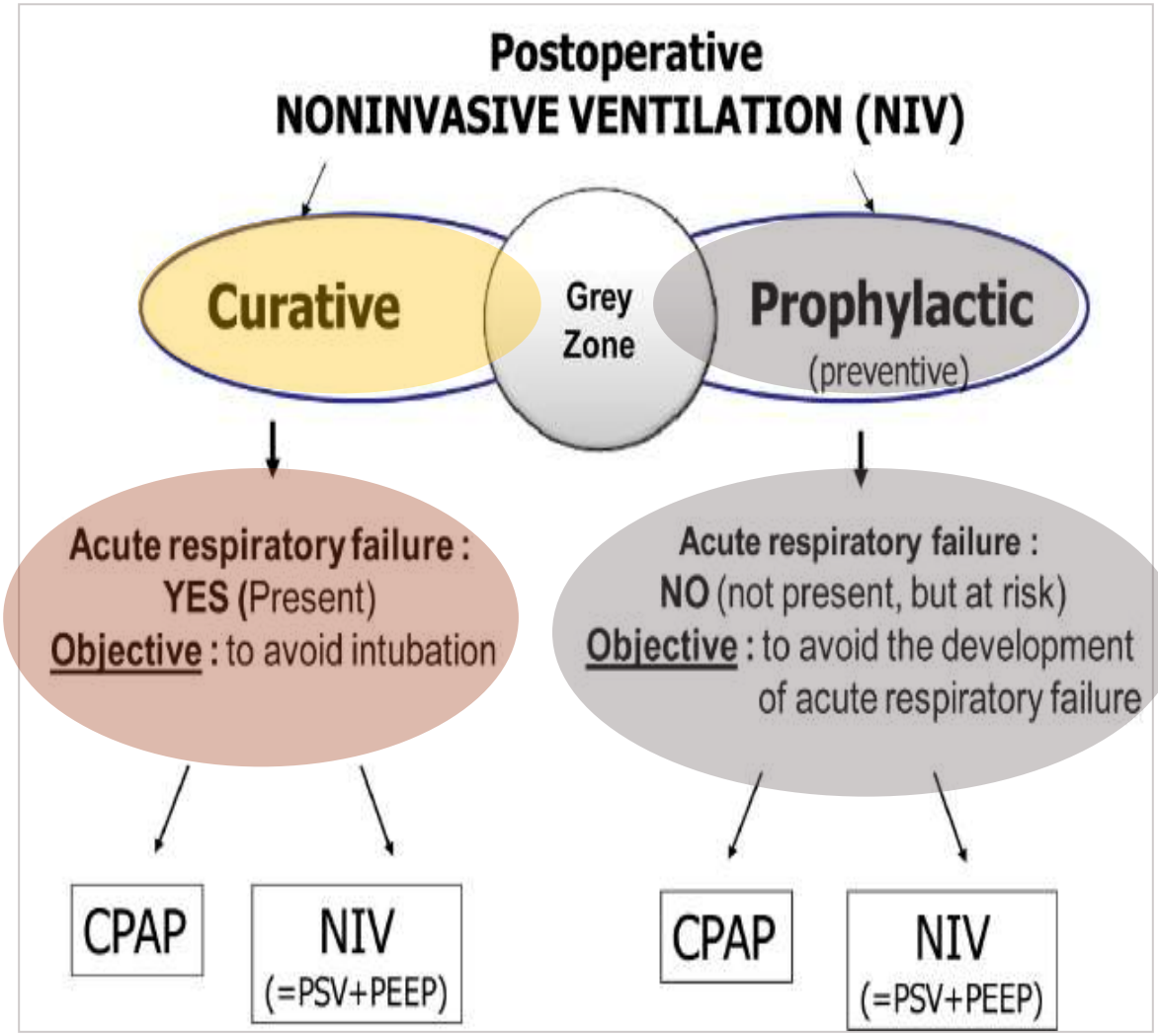


Physiologic Effects of NIV on Post-op. Respiratory Function





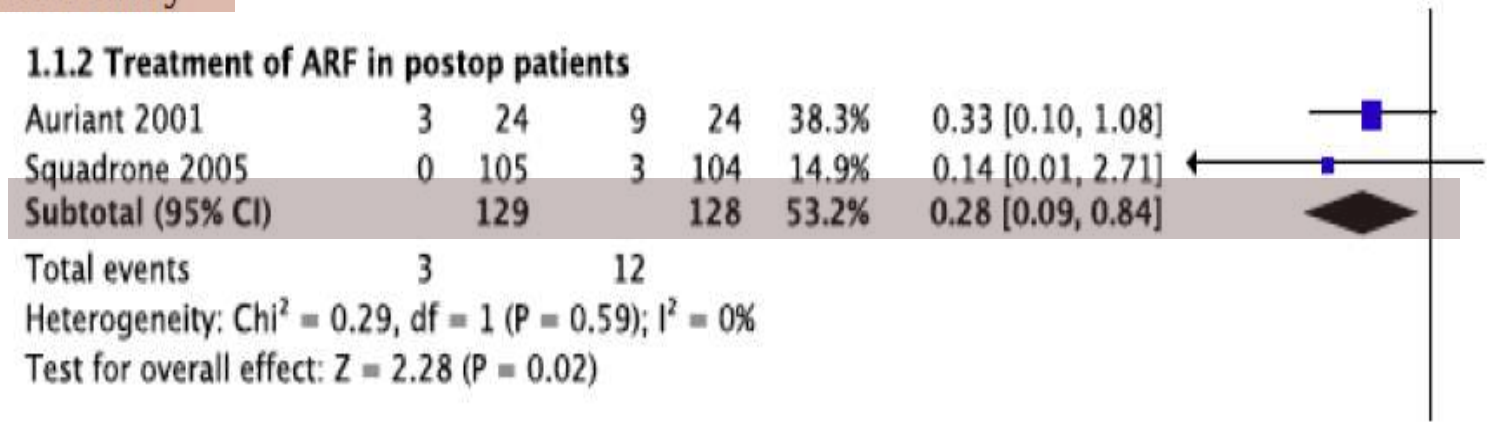
Jaber S ,Anesthesiology 2010; 112



Jaber S Ann Françaises d' Anesthésié et de Réanimation 2014;33

NIV in post-operative ARF-Curative

Mortality



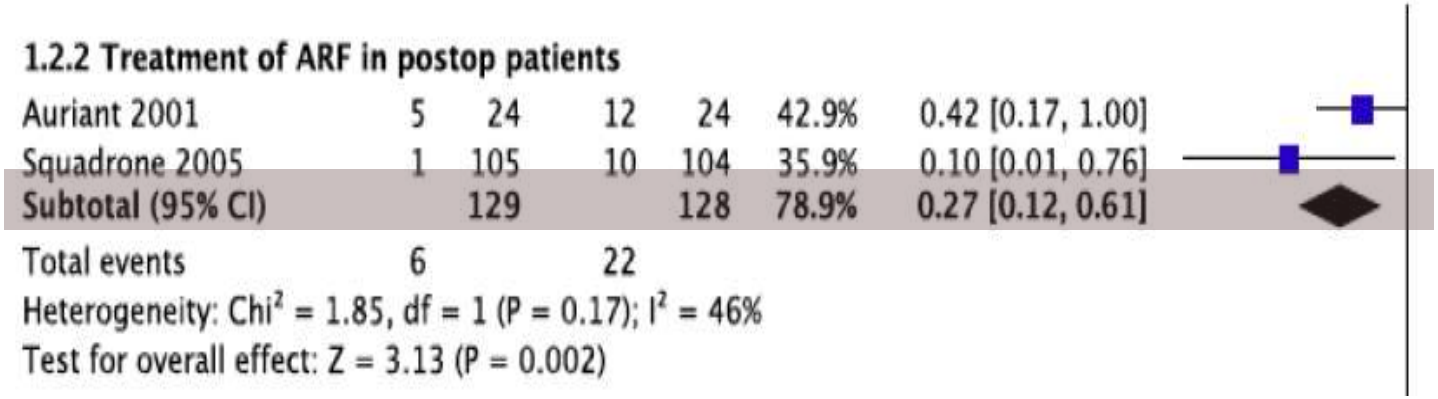
1.1.2 Treatment of ARF in postop patients

Auriant 2001	3	24	9	24	38.3%	0.33 [0.10, 1.08]
Squadrone 2005	0	105	3	104	14.9%	0.14 [0.01, 2.71]
Subtotal (95% CI)		**129**		**128**	**53.2%**	**0.28 [0.09, 0.84]**
Total events	3		12			

Heterogeneity: $Chi^2 = 0.29$, $df = 1$ ($P = 0.59$); $I^2 = 0\%$

Test for overall effect: $Z = 2.28$ ($P = 0.02$)

Intubation



1.2.2 Treatment of ARF in postop patients

Auriant 2001	5	24	12	24	42.9%	0.42 [0.17, 1.00]
Squadrone 2005	1	105	10	104	35.9%	0.10 [0.01, 0.76]
Subtotal (95% CI)		**129**		**128**	**78.9%**	**0.27 [0.12, 0.61]**
Total events	6		22			

Heterogeneity: $Chi^2 = 1.85$, $df = 1$ ($P = 0.17$); $I^2 = 46\%$

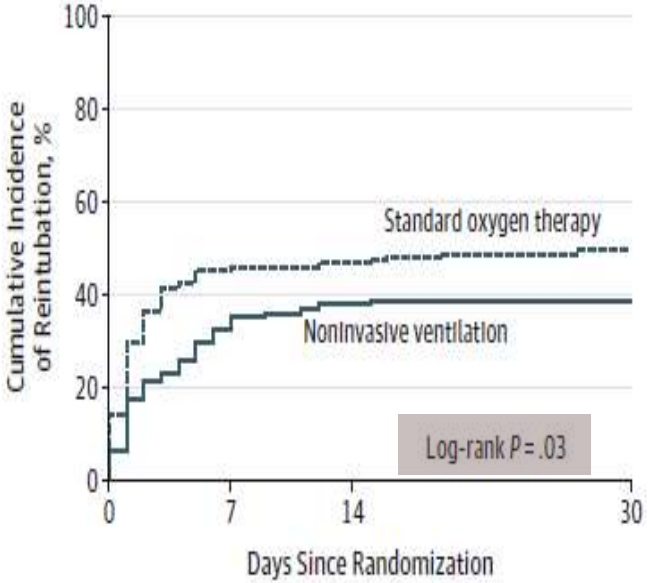
Test for overall effect: $Z = 3.13$ ($P = 0.002$)

Rochwerg B Eur Respir J 2017;50

Effect of Noninvasive Ventilation on Tracheal Reintubation Among Patients With Hypoxemic Respiratory Failure Following Abdominal Surgery

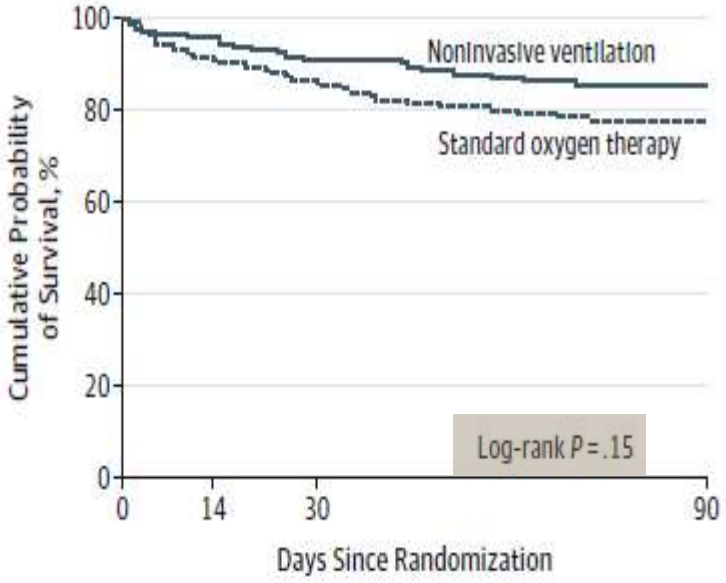
A Randomized Clinical Trial

Figure 2. Cumulative Incidence of Reintubation Between Randomization and Day 30 According to Study Group



No. at risk				
Standard oxygen therapy	145	79	76	71
Noninvasive ventilation	148	99	90	87

Figure 3. Probability of Survival Between Randomization and Day 90 According to Study Group



No. at risk				
Standard oxygen therapy	145	132	125	102
Noninvasive ventilation	148	141	131	109

Jaber S JAMA 2016;315

Noninvasive positive pressure ventilation for acute respiratory failure following oesophagectomy: Is it safe? A systematic review of the literature

	Study Methodology and Results			Outcomes Extracted			
Study	Design	Patient Groups	Main findings reported	Re-intubation	Anastomotic Leak	ICU length of stay	Post-operative death
Jaber et al.[8]	Prospective observational single centre	463 patients post abdominal surgery96 developed ARF72 NPPV48/72 not intubated10 oesophagectomies	No main findings reported for the oesophagectomy patients	NR	Of the 10 cases receiving NPPV following oesophagectomy – no complications including anastomotic leak	NR	NR
Michelet et al.[32]	Single centre case-control study	243 admissions 84 with ARF met inclusion criteria 36 NPPV matched with 36 controls managed medically	1) Reduced intubation rate with NPPV 2) Reduced incidence of ARDS with NPPV 3) Reduced ICU LOS with NPPV 4) Reduced incidence of anastomotic leak with NPPV 5) Improved gas exchange with NPPV	Lower in NPPV group (9 vs. 23 $p = 0.008$)	Lower in NPPV group (2 vs. 10 $p = 0.027$)	Lower in NPPV group (14 vs. 22 days $p = 0.034$)	Lower in NPPV group (4 vs. 7 $p = 0.512$)
Yu et al.[33]	Retrospective single centre case note analysis	Post-oesophagectomy NPPV (32) vs. IPPV (32) 48 NPPV initially – 16 re-intubated	1) NPPV avoided intubation in 30/64 patients 2) PaO_2/FiO_2 after 2/24 hr of NPPV significantly better 3) NPPV significantly reduces surgical complications	16/48 patients were re-intubated following NPPV No data for re-intubation following extubation in IPPV group	NR	Lower in NPPV vs IPPV (11.5 vs. 33.1 days $p < 0.05$)	28 day – no difference ICU mortality NPPV lower vs. IPPV (6.25% vs. 25% $p < 0.05$)
Pawley et al.[34]	Retrospective case note audit	72 oesophagectomies 23.1% received NPPV	1) NPPV not associated with anastomotic breakdown 2) Low PaO_2/FiO_2 associated with prolonged ICU/hospital stay	NR	6 anastomotic leaks across NPPV and IPPV groups Reports not associated with NPPV use	NR	NR

Charlesworth M Journal of the Intensive Care Society 2015;16

Continuous positive airway pressure (CPAP) during the postoperative period for prevention of postoperative morbidity and mortality following major abdominal surgery

- Very low-quality evidence from this review suggests that CPAP initiated during the postoperative period might reduce:
  - Atelectasis
  - Pneumonia
  - Re-intubation
- Uncertain Effects on:
  - Mortality
- *Evidence is not sufficiently strong to confirm the benefits or harms of CPAP during the postoperative period in those undergoing major abdominal surgery.*

Cochrane Database of Systematic Reviews 2014;8

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

- ?Should NIV be used in ARF in the post-operative setting?

- We suggest NIV for patients with post-operative ARF. (Conditional recommendation, moderate certainty of evidence.)

Conclusion

When to start NIV

- Respiratory distress
- Respiratory failure (not corrected by oxygen therapy alone)
  - $PO_2/FiO_2<300$
  - $PCO_2>45$
  - $pH<7.35$
- Disease in which NIMV proven helpful
- Absence of Contraindications

When to stop NIV

- NIMV failure – need for intubation
- Avoid pt exhaustion – respiratory or cardiac arrest
- Markers of NIMV failure
- Disease-specific criteria COPD/HypoxemicRF

Protocol for NIV on the ward

1° στάδιο – απόφαση για την εφαρμογή Μη-ΕΜΑ

Ένδειξη Μη-ΕΜΑ	Αντένδειξη Μη-ΕΜΑ
ΧΑΠ	Σοκ
ΟΠΟ	Κώμα
Άσθμα	Αδυναμία προστασίας αεραγωγού
ΑΑΙ	Έμετο
ΑΑΙΙ	Αδυναμία εφαρμογής μάσκας

2° στάδιο – πριν την εφαρμογή Μη-ΕΜΑ

Σε περίπτωση αποτυχίας του Μη-ΕΜΑ θα διασωληνωθεί ο ασθενής ΝΑΙ ΟΧΙ

Αν ΝΑΙ &

Ο ασθενής έχει…	ΝΑΙ	ΟΧΙ
Υποξυγοναιμία με ανάγκη θετικών πιέσεων		
Πολλές εκκρίσεις		
Επηρεασμένο επίπεδο συνείδησης		
Αιμοδυναμική αστάθεια		

Αν ΝΑΙ εξετάστε το ενδεχόμενο μεταφοράς σε ΜΕΘ

3° στάδιο – άμεσα μετά την εφαρμογή Μη-ΕΜΑ

Ο ασθενής έχει…	ΝΑΙ	ΟΧΙ
Εμμένουσα υποξυγοναιμία		
Διέγερση ή δυσανεξία στο Μη-ΕΜΑ		
Διαφυγές από τη μάσκα		

Αν ΝΑΙ εξετάστε το ενδεχόμενο μεταφοράς σε ΜΕΘ

4° στάδιο 1-2 ώρες μετά την εφαρμογή Μη-ΕΜΑ

Ο ασθενής έχει…	ΝΑΙ	ΟΧΙ
Βελτίωση της δύσπνοιας		
Βελτίωση της ανταλλαγής αερίων		
Καλή ανοχή και συνεργασία με το Μη-ΕΜΑ		
Φυσιολογικό – βελτιωμένο επίπεδο συνείδησης		
Σταθεροποιηθεί αιμοδυναμικά		
Δυνατότητα προσωρινής διακοπής του Μη-ΕΜΑ		

Αν ΟΧΙ εξετάστε το ενδεχόμενο μεταφοράς σε ΜΕΘ

Modified from: Huddle form and checklist, as used at the Massachusetts General Hospital @ Noninvasive Ventilation for Acute Respiratory Failure, D. Hess RESPIRATORY CARE • JUNE 2013