NIV as a strategy to treat post-extubation ARF or to prevent re-intubation

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COI

Received fees for pesentations from:

- Philips
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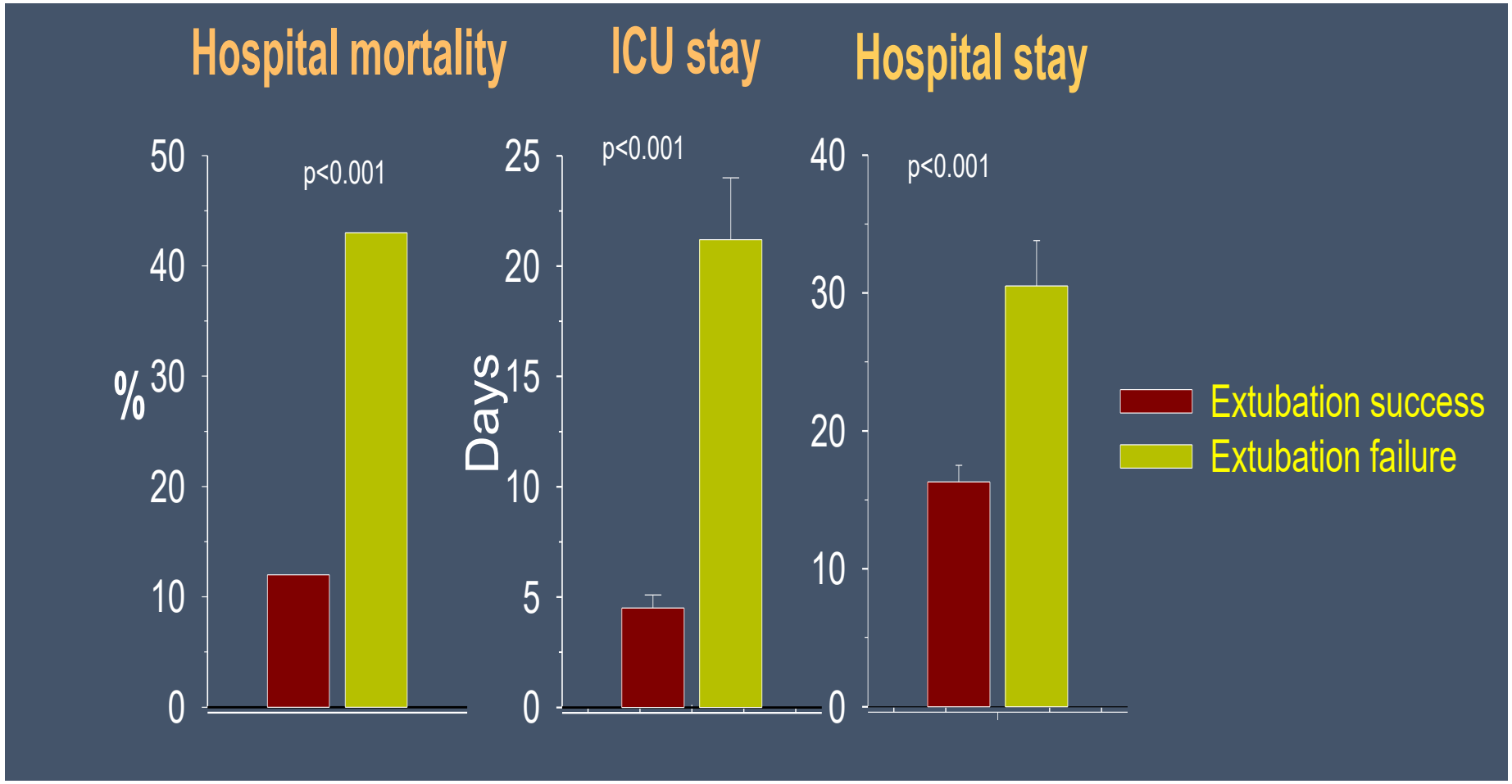
Ann Am Thorac Soc. 2018

Physiologic Basis of Mechanical Ventilation

Martin J Tobin [1]

Although mechanical ventilation saves lives, it is also responsible for many deaths. Accordingly, it is critical to get patients off the ventilator at the earliest possible time. This task demands greater wisdom and cognitive skill than that required for adjusting settings on the ventilator.

Effect of post-extubation failure on the outcome of mechanical ventilation



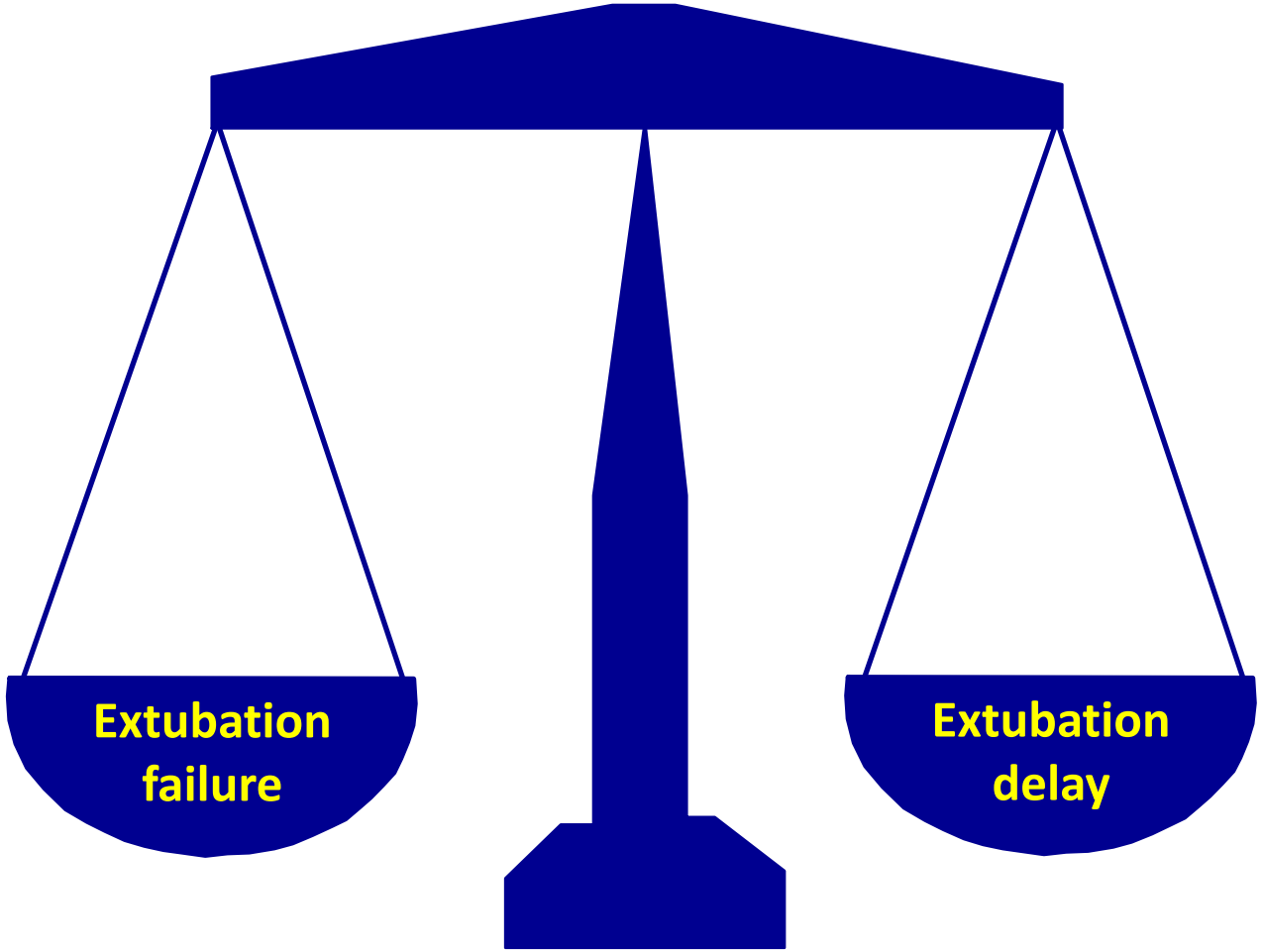
Epstein SK. Chest 1997;112:186

clinical investigations in critical care

Cough Peak Flows and Extubation Outcomes*

Mihai Smina, MD; Adil Salam, MD; Mohammad Khamiees, MD; Pritee Gada, MD; Yaw Amoateng-Adjepong, MD, PhD; and Constantine A. Manthous, MD, FCCP

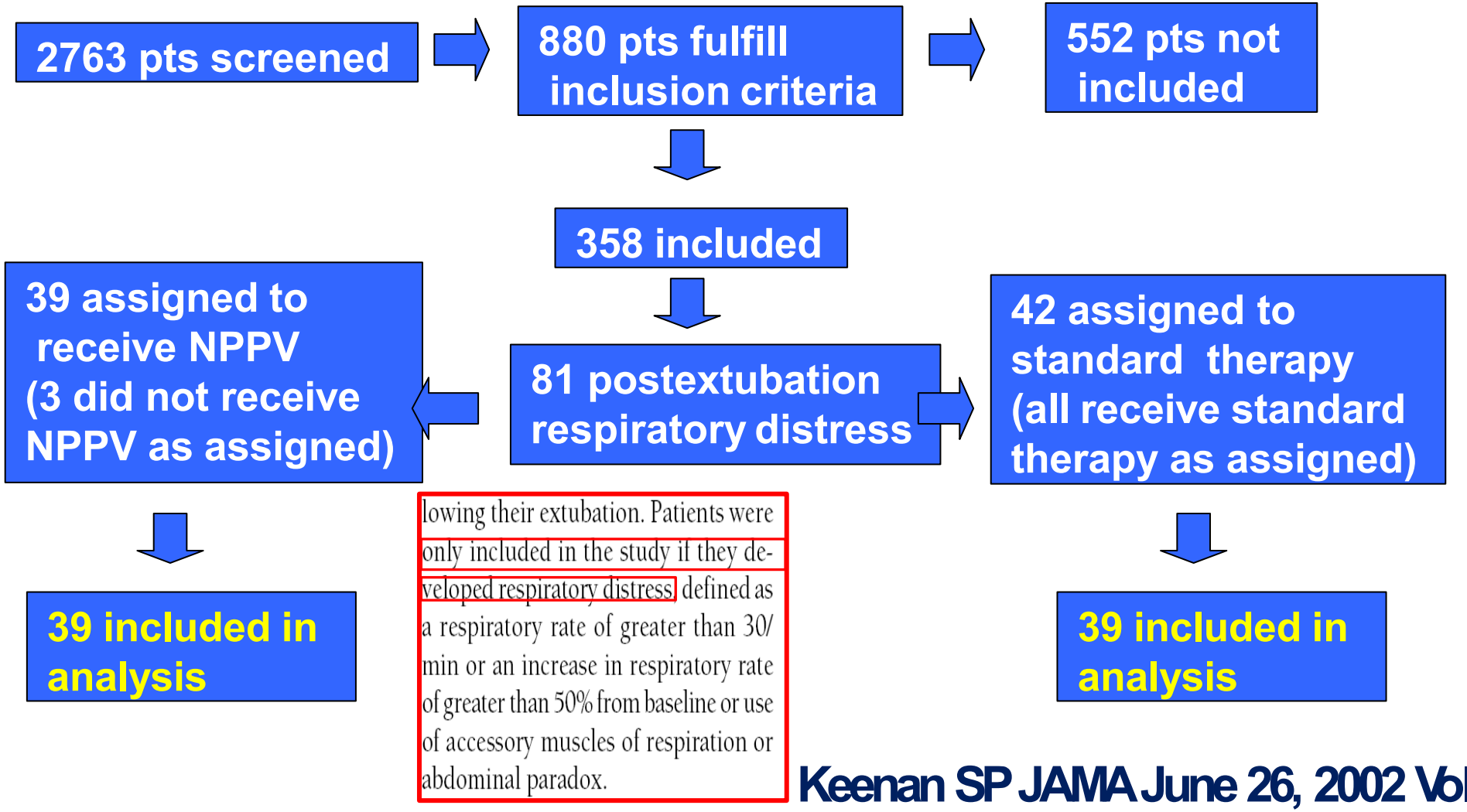
Background: **Semiobjective methods of quantifying cough strength and endotracheal secretions have been demonstrated to predict extubation outcomes of patients who have passed a spontaneous breathing trial (SBT).**
Hypothesis: **Cough strength, measured by voluntary cough peak expiratory flow (PEF), and endotracheal secretions, measured volumetrically, predict extubation outcomes of patients who have passed an SBT.**
Patient population: **Critically ill patients admitted to the medical ICU of a 300-bed community teaching hospital.**
Methods: **All patients who passed an SBT and were about to be extubated were studied. The best of three cough attempts, measured with an in-line spirometer, and the average hourly rate of suctioned secretions prior to extubation were recorded with other weaning parameters and demographic data.**
Results: **Ninety-five patients were studied before and after 115 extubations. There were 13 unsuccessful extubations. There were no differences in age, gender, duration of intubation, or APACHE (acute physiology and chronic health evaluation) II scores between successful and unsuccessful extubations. The magnitude of endotracheal secretions was not associated with outcomes. The PEF of patients with unsuccessful extubations was significantly lower than that of those with successful extubations (64.2 ± 6.8 L/min vs 81.9 ± 2.7 L/min, $p = 0.03$). Patients with unsuccessful extubations stayed longer in the ICU than those with successful extubations (11.7 ± 2.1 days vs 5.3 ± 0.4 days, $p = 0.009$). Those with PEF ≤ 60 L/min were five times as likely to have unsuccessful extubations and were 19 times as likely to die on that hospital stay. PEF and the rapid shallow breathing index were independently associated with extubation outcomes, while only the PEF (≤ 60 L/min) was independently associated with in-hospital mortality.**
Conclusion: **These data suggest that cough strength, measured objectively, is a predictor of extubation outcome, morbidity, and mortality.** *(CHEST 2003; 124:262–268)*


Extubation
failure
Extubation
delay

NIV

- **Treatment of respiratory distress after extubation**
- **Prevention of post-extubation respiratory failure**

Noninvasive Positive-Pressure ventilation for postextubation respiratory distress: A randomized controlled trial



lowing their extubation. Patients were only included in the study if they developed respiratory distress, defined as a respiratory rate of greater than 30/min or an increase in respiratory rate of greater than 50% from baseline or use of accessory muscles of respiration or abdominal paradox.

Keenan SP JAMA June 26, 2002 Vol. 287, 24

Table 2. Outcomes for the Study Groups*

Outcomes	NPPV (n = 39)	Standard Therapy (n = 42)	*P* Value
Reintubation, No. (%)	28 (72)	29 (69)	.79
Pneumonia, No. (%)	16 (41)	17 (40)	.61
Duration of ventilation†			
Mean (SD)	8.4 (7.4)	17.5 (28.0)	.11
Median (range)	6.7 (0.5-28.6)	8.9 (2.0-146.7)	.12
ICU length of stay			
Mean (SD)	15.1 (10.9)	19.4 (25.0)	.32
Median (range)	11.9 (3.6-41.7)	10.8 (2.3-152.7)	.72
Hospital length of stay			
Mean (SD)	32.2 (25.4)	29.8 (28.4)	.69
Median (range)	19 (6-111)	22 (4-162)	.51
ICU survival, No. (%)	33 (85)	32 (76)	.34
Hospital survival, No. (%)	27 (69)	29 (69)	.99

Conclusions The addition of NPPV to standard medical therapy does not improve outcome in heterogeneous groups of patients who develop respiratory distress during the first 48 hours after extubation.

JAMA. 2002;287:3238-3244 www.jama.com

Keenan SP JAMA June 26, 2002 Vol. 287, 24

Noninvasive Positive-Pressure ventilation for postextubation respiratory distress: A randomized controlled trial

lowing their extubation. Patients were only included in the study if they developed respiratory distress, defined as a respiratory rate of greater than 30/min or an increase in respiratory rate of greater than 50% from baseline or use of accessory muscles of respiration or abdominal paradox.

After the first year, patients with an acute exacerbation of COPD were excluded because the randomized trial evidence strongly supported the use of NPPV for these patients[9-11] and because NPPV was

Keenan SP JAMA June 26, 2002 Vol. 287, 24

Noninvasive Positive-Pressure Ventilation for Respiratory Failure after Extubation

Andrés Esteban, M.D., Ph.D., Fernando Frutos-Vivar, M.D.,
Niall D. Ferguson, M.D., M.Sc., Yaseen Arabi, M.D.,
Carlos Apezteguía, M.D., Marco González, M.D., Scott K. Epstein, M.D.,
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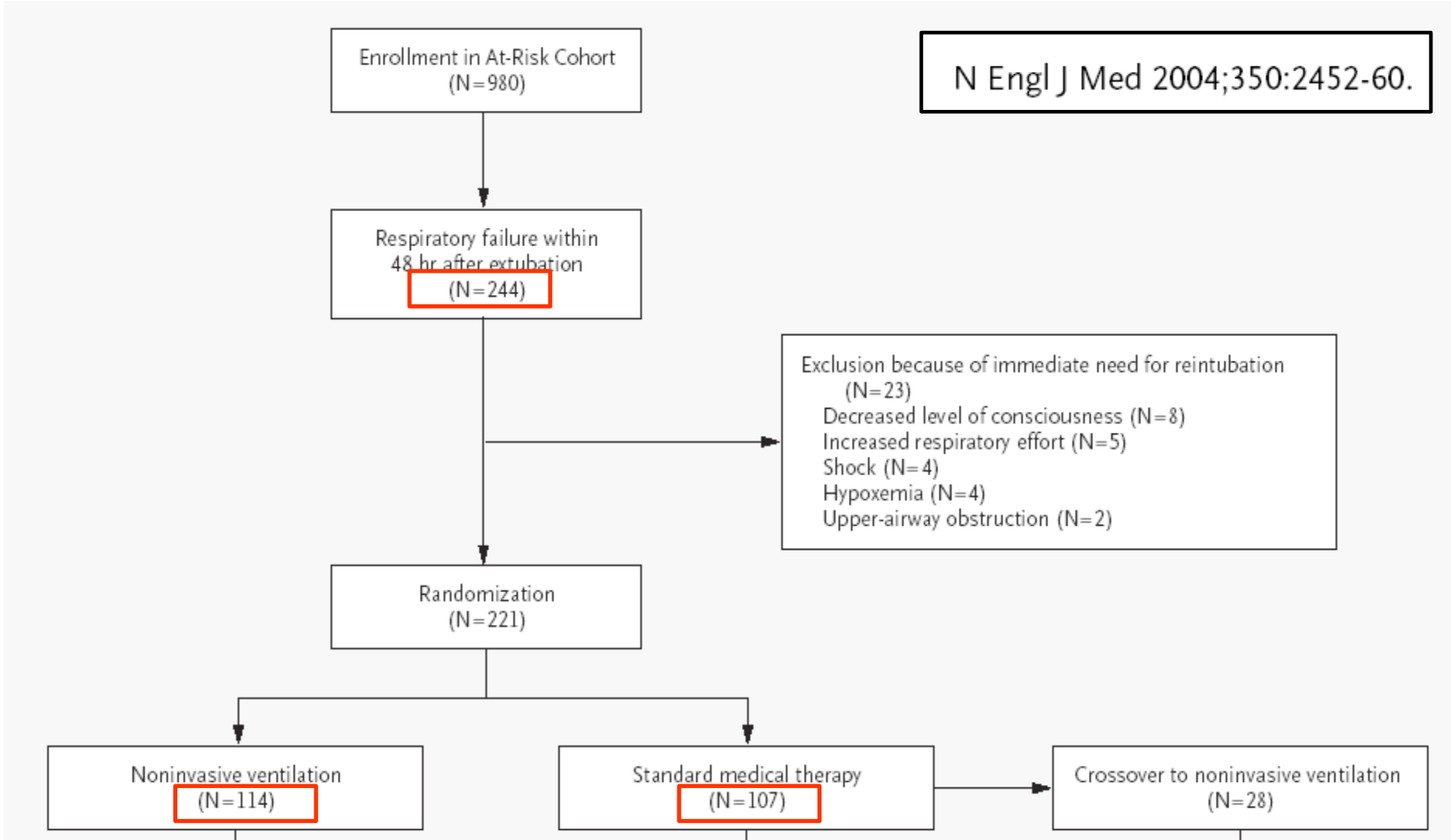
Gabriel D'Empaire, M.D., Inmaculada Alía, M.D., and Antonio Anzueto, M.D.*



N Engl J Med 2004;350:2452-60.

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	Mortality	Reintubation
Non-Invasive Ventilation (n.114)	**25%**	49%
Conventional Therapy (n.107)	**14%**	**49%**
		0%
Absolute Risk Difference	**11.4% (0.85-21.63)**	
Relative Risk (95% CI)	**1.75 (0.99-3.09)**	**0.99 (0.76-1.30)**
p-value	**0.05**	**ns**

Noninvasive Positive-Pressure Ventilation for Respiratory Failure after Extubation

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After extubation, patients were observed for 48 hours for the onset of respiratory failure, as defined by the presence of two or more of the following: respiratory acidosis (defined as an arterial pH below 7.35 with a partial pressure of arterial carbon dioxide greater than 45 mm Hg), clinical signs suggestive of respiratory-muscle fatigue or increased respiratory effort (i.e., use of accessory muscles, intercostal indrawing, or paradoxical motion of the abdomen), a respiratory rate greater than 25 breaths per minute for two consecutive hours, and hypoxemia (defined as an arterial oxygen saturation of less than 90 percent or a partial pressure of arterial oxygen of less than 80 mm Hg with a fraction of inspired oxygen greater than 0.50).

N Engl J Med 2004;350:2452-60.

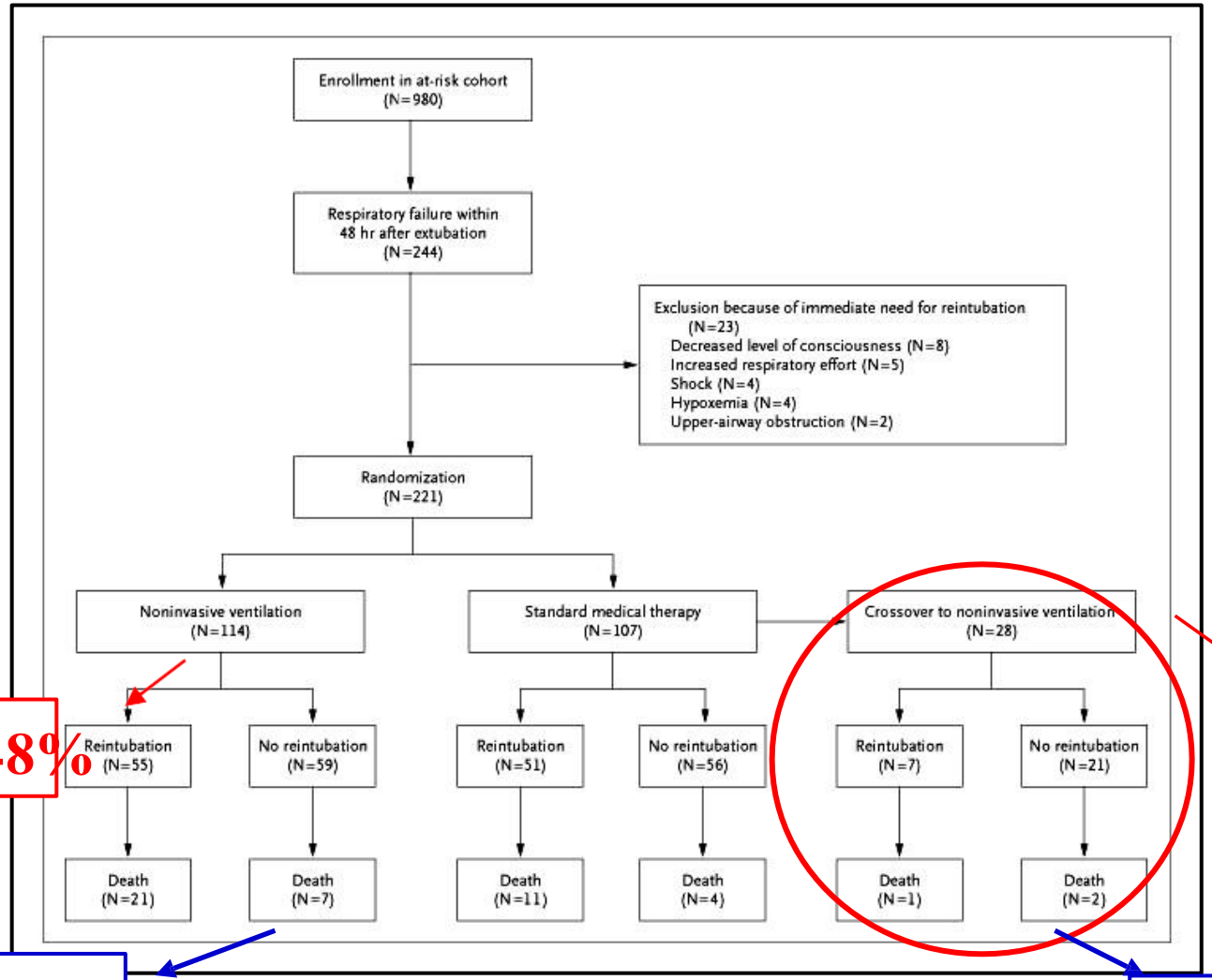
Esteban, A. et al. N Engl J Med 2004;350:2452-2460

VNI

12 hr [2-28]

TMS

2 hr [45'-16]



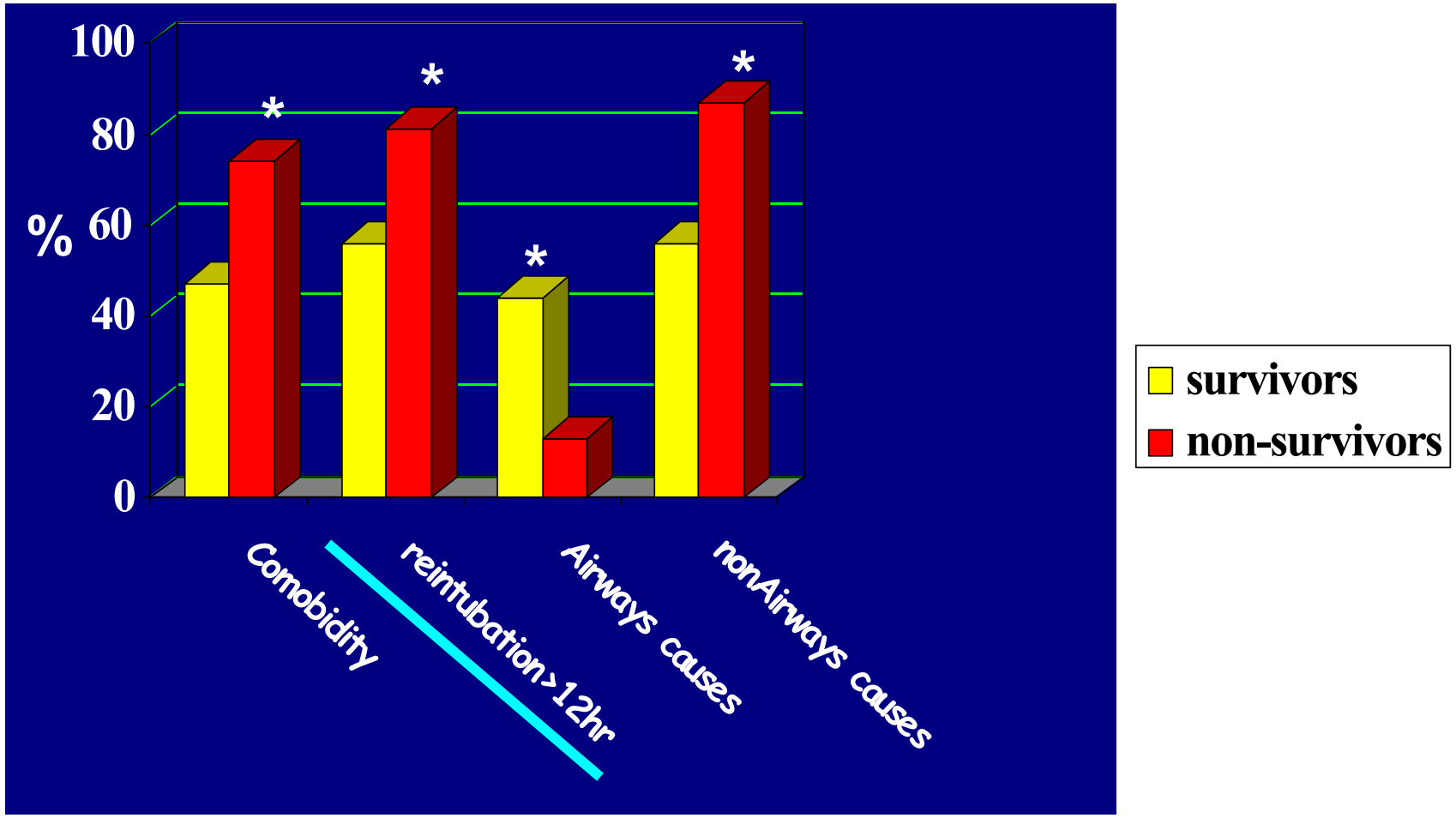
IET: 48%

IET: 25%

Mortalité:25%

10%

Survivors vs Nonsurvivors



Epstein and Ciubotaru AJRCCM 1998;158:489-93

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

Bram Rochwerg[1], Laurent Brochard[2,3], Mark W. Elliott[4], Dean Hess[5], Nicholas S. Hill[6], Stefano Nava[7] and Paolo Navalesi[8] (members of the steering committee); Massimo Antonelli[9], Jan Brozek[1], Giorgio Conti[9], Miquel Ferrer[10], Kalpalatha Guntupalli[11], Samir Jaber[12], Sean Keenan[13,14], Jordi Mancebo[15], Sangeeta Mehta[16] and Suhail Raoof[17,18] (members of the task force)

Recommendation

We suggest that NIV should not be used in the treatment of patients with established post-extubation respiratory failure. (Conditional recommendation, low certainty of evidence.)

https://doi.org/10.1183/13993003.02426-2016

Eur Respir J 2017; 50: 1602426

NIV

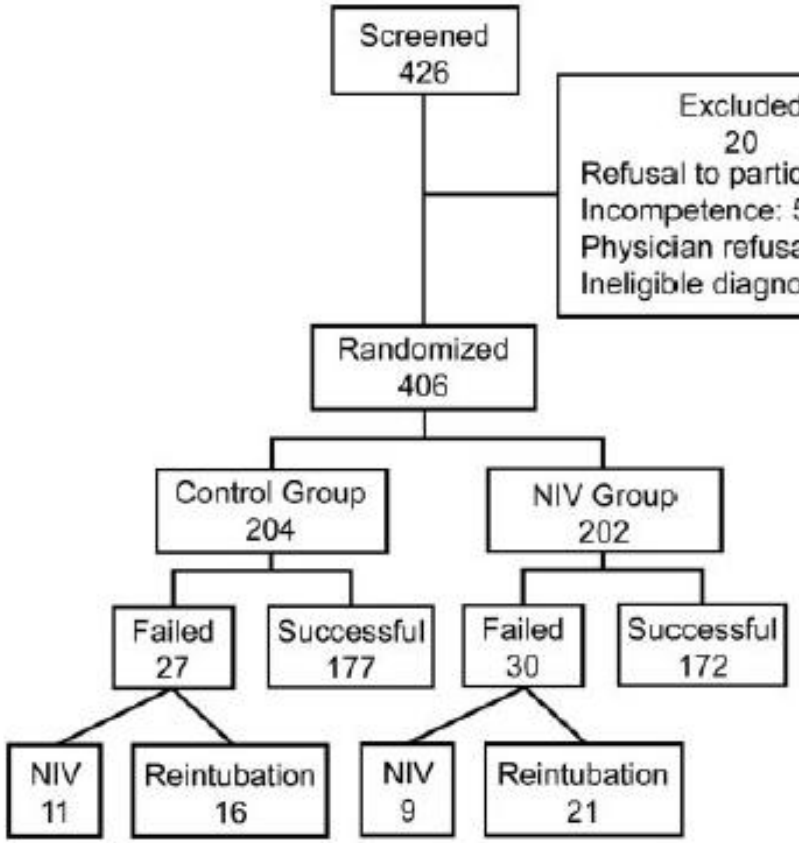
- Treatment of respiratory distress after extubation
- **Prevention of post-extubation respiratory failure**

RESPIRATORY CARE • FEBRUARY 2012 VOL 57 NO 2

Preventive Use of Noninvasive Ventilation After Extubation: A Prospective, Multicenter Randomized Controlled Trial

Chien-Ling Su MSc RT, Ling-Ling Chiang MSc RT, Shih-Hsing Yang MSc RT, Hen-I Lin MD, Kuo-Chen Cheng MD, Yuh-Chin T Huang MD MHS, and Chin-Pyng Wu MD PhD

NIV applied in all pts after extubation (no patient selection)



Study Patients	Control (no. = 204)	NIV (no. = 202)	*P*
Failure groups	27 (13.2)	30 (14.9)	.62
Re-intubation	16 (7.7)	21 (10.4)	.37
ICU mortality	2 (0.98)	3 (1.49)	.64

* Values are number and percent.
NIV = noninvasive ventilation
ICU = intensive care unit

Noninvasive ventilation to prevent respiratory failure after extubation in high-risk patients*

Stefano Nava; Cesare Gregoretti; Francesco Fanfulla; Enzo Squadrone; Mario Grassi; Annalisa Carlucci; Fabio Beltrame; Paolo Navalesi

Crit Care Med 2005 Vol. 33, No. 11

Table 5. Risk difference of univariate and multivariate equations calculated with the generalized linear models

Response Variable Y	Predictor Variable X, n (%)		Risk Difference, %	95% CI	*p* Value
Univariate	NIV	No NIV	−16	(−2, −31)	.027
Reintubation	4/48 (8)	12/49 (24)			
	NIV	No NIV	−12	(−25, +0.7)	.064
ICU mortality	3/48 (6)	9/49 (18)			
	Reintubation	No reintubation	+60	(+36, +84)	<.001
ICU mortality	10/16 (63)	2/81 (3)			
Multivariate	NIV	No NIV	−16	(−2, −31)	.027
Reintubation	4/48 (8)	12/49 (24)			
	NIV	No NIV	−1	(−8, +6)	.845
ICU mortality	6/48 (12)	6/49 (13)			
	Reintubation	No reintubation	+60	(+37, +83)	<.001
ICU mortality	10/16 (62)	2/81 (3)			

CI, confidence interval; NIV, noninvasive ventilation; ICU, intensive care unit.

Noninvasive ventilation to prevent respiratory failure after extubation in high-risk patients*

Stefano Nava; Cesare Gregoretti; Francesco Fanfulla; Enzo Squadrone; Mario Grassi; Annalisa Carlucci; Fabio Beltrame; Paolo Navalesi

Crit Care Med 2005 Vol. 33, No. 11

Table 1. Criteria for enrollment

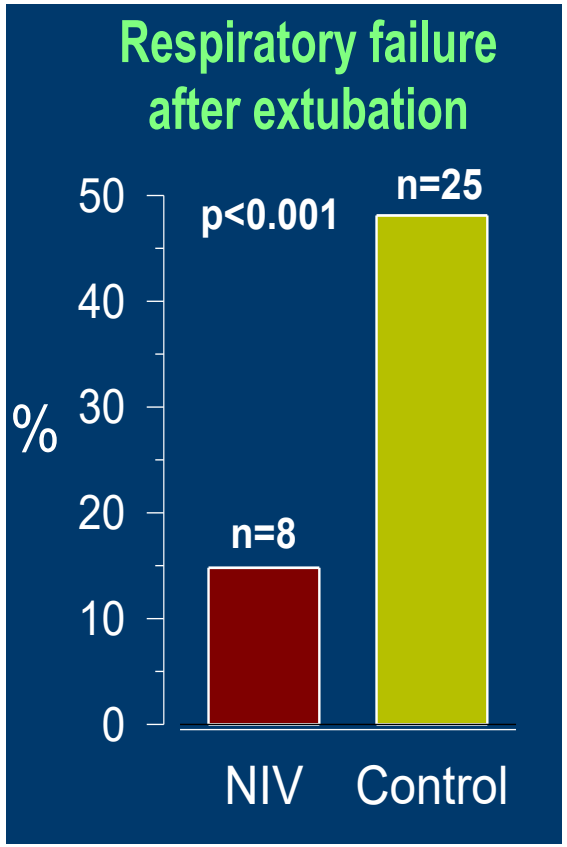
Mechanical ventilation >48 hrs
Successful weaning trial
Plus one or more of the following high-risk scenarios for reintubation features:
1. More than one consecutive failure of weaning trial
2. Chronic heart failure
3. $Paco_2$ >45 mm Hg after extubation
4. More than one comorbidity (excluding chronic heart failure)
5. Weak cough defined as Airway Care Score (10) values ≥8 and <12
6. Upper airways stridor at extubation not requiring immediate reintubation

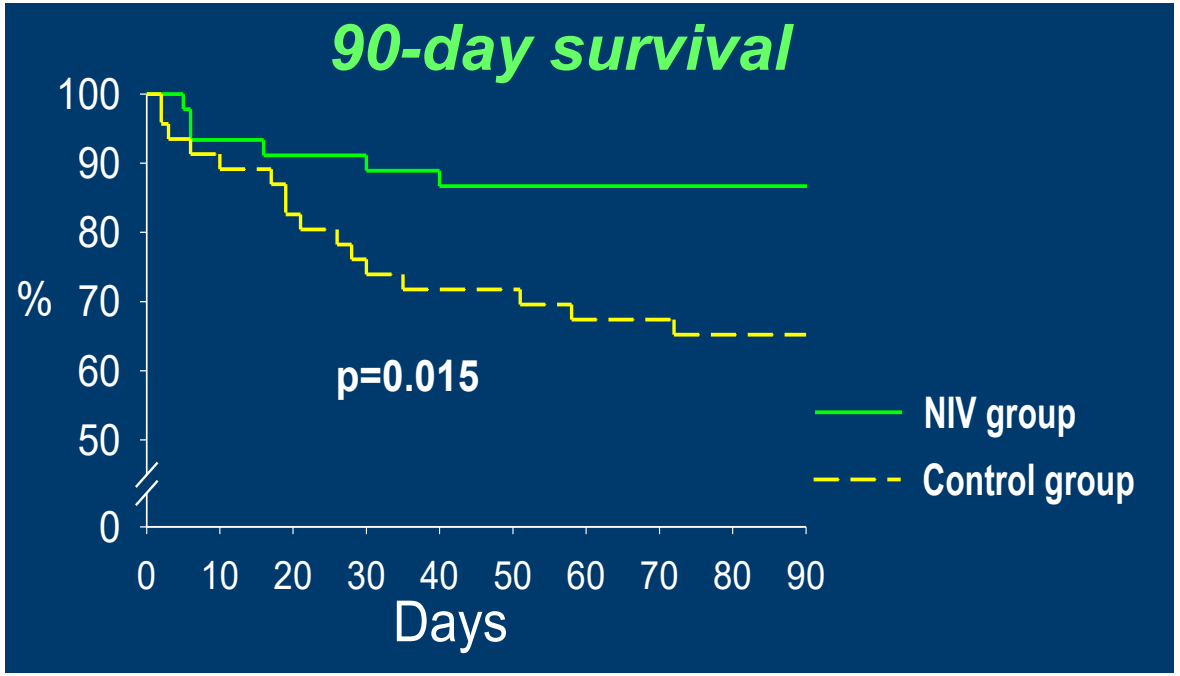
NIV after extubation in hypercapnic patients

- ***Patients MV >48 h., chronic respiratory diseases (70% COPD or chronic bronchitis)***
- ***Successful weaning trial, hypercapnia while on spontaneous breathing***

Extubation and randomisation:

NIV 24 hours vs. Venturi mask





Ferrer M et al. Lancet 2009

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Recommendations

We suggest that NIV be used to prevent post-extubation respiratory failure in high-risk patients post-extubation. (Conditional recommendation, low certainty of evidence.)

We suggest that NIV should not be used to prevent post-extubation respiratory failure in non-high-risk patients. (Conditional recommendation, very low certainty of evidence.)

https://doi.org/10.1183/13993003.02426-2016

Effect of Postextubation High-Flow Nasal Oxygen With Noninvasive Ventilation vs High-Flow Nasal Oxygen Alone on Reintubation Among Patients at High Risk of Extubation Failure
A Randomized Clinical Trial

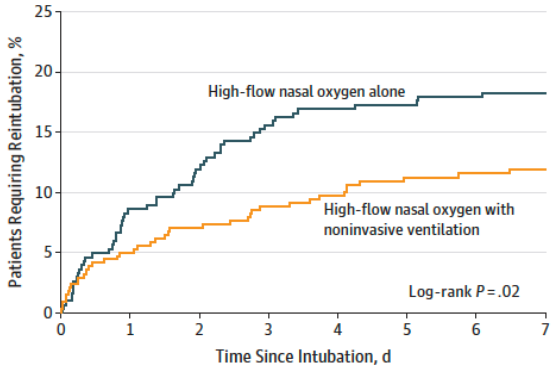
Arnaud W. Thille, MD, PhD; Grégoire Muller, MD; Arnaud Gacouin, MD; Rémi Coudroy, MD; Maxens Decavèle, MD; Romain Sonneville, MD, PhD;

JAMA. doi:10.1001/jama.2019.14901
Published online October 2, 2019.

Conclusions

In mechanically ventilated patients at high risk of extubation failure, the use of high-flow nasal oxygen with noninvasive ventilation immediately after extubation significantly decreased the risk of reintubation compared with high-flow nasal oxygen alone.

Figure 2. Kaplan-Meier Analysis of Time From Extubation to Reintubation for the Overall Study Population

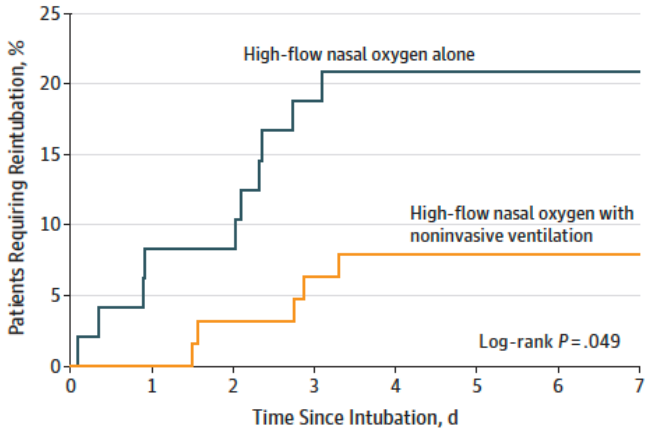


No. at risk								
High-flow nasal oxygen								
Alone	302	276	265	253	248	246	244	243
With noninvasive ventilation	339	321	314	308	305	294	292	291

The median observation time was 7 days (interquartile range, 7-7) in both treatment groups.

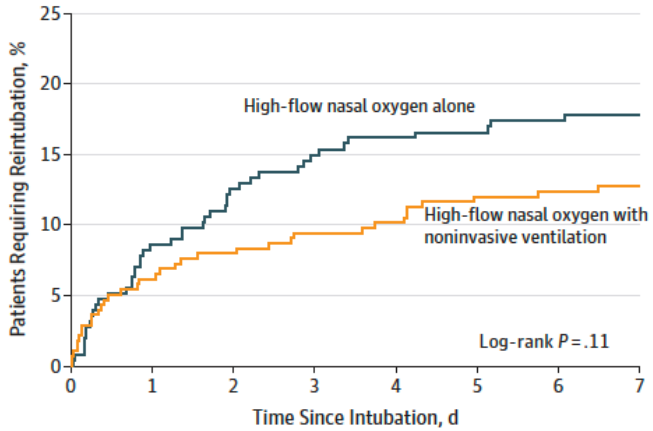
Figure 3. Kaplan-Meier Analysis of Time From Extubation to Reintubation According to Predefined Strata

A Hypercapnic patients ($PaCO_2$ >45 mm Hg)



No. at risk								
High-flow nasal oxygen								
Alone	48	44	44	39	38	37	37	37
With noninvasive ventilation	63	63	61	59	58	58	58	58

B Nonhypercapnic patients ($PaCO_2$ ≤45 mm Hg)



No. at risk								
High-flow nasal oxygen								
Alone	254	232	221	214	210	209	207	206
With noninvasive ventilation	276	258	253	249	247	236	234	233

Noninvasive respiratory support after extubation: a systematic review and network meta-analysis

Annalisa Boscolo [1,2,4], Tommaso Pettenuzzo [2,4], Nicolò Sella[2], Matteo Zatta[1], Michele Salvagno[1], Martina Tassone[1], Chiara Pretto[1], Arianna Peralta[2], Luisa Muraro[2], Francesco Zarantonello [2], Andrea Bruni[3], Federico Geraldini[2], Alessandro De Cassai[2] and Paolo Navalesi [1,2]

Number 3 in the Series "Respiratory Failure and Mechanical Ventilation Conference reviews"
Edited by Leo Heunks and Marieke L. Duiverman

[1]Department of Medicine (DIMED), University of Padua, Padova, Italy. [2]Institute of Anaesthesia and Intensive Care, Padua University Hospital, Padova, Italy. [3]Intensive Care Unit, Department of Medical and Surgical Sciences, University Hospital Mater Domini, Magna Graecia University, Catanzaro, Italy. [4]These authors contributed equally to this work.

Corresponding author: Paolo Navalesi (paolo.navalesi@unipd.it)

Points for clinical practice

- NRS may be useful for preventing, but not for treating, post-extubation respiratory failure in ICU patients.
- Prophylactic NIV decreased the rate of extubation failure in ICU high-risk patients; prophylactic HFNO decreased the rate of extubation failure in ICU post-surgical patients.

Eur Respir Rev 2023; 32: 220196

Pettenuzzo et al. Critical Care (2024) 28:152
https://doi.org/10.1186/s13054-024-04924-0

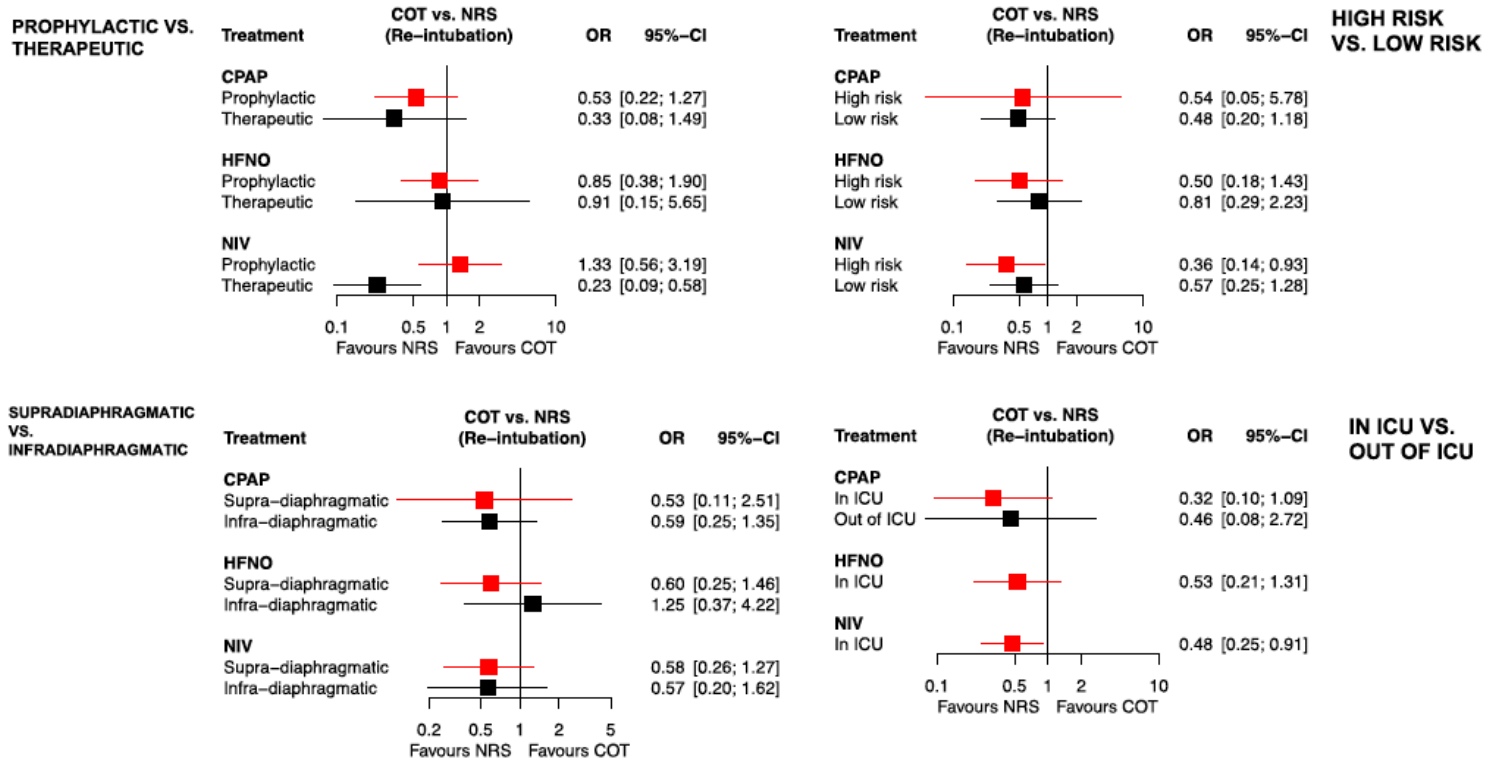
RESEARCH Open Access

Effects of non-invasive respiratory support in post-operative patients: a systematic review and network meta-analysis

Tommaso Pettenuzzo[1†], Annalisa Boscolo[1,2,3†], Elisa Pistollato[2], Chiara Pretto[2], Tommaso Antonio Giacon[2], Sara Frasson[2], Francesco Maria Carbotti[2], Francesca Medici[2], Giovanni Pettenon[2], Giuliana Carofiglio[2], Marco Nardelli[2], Nicolas Cucci[2], Clara Letizia Tuccio[2], Veronica Gagliardi[2], Chiara Schiavolin[2], Caterina Simoni[2], Sabrina Congedi[2], Francesco Monteleone[2], Francesco Zarantonello[1], Nicolò Sella[1], Alessandro De Cassai[1] and Paolo Navalesi[1,2*]

Supplementary Figure 3. Forest plots of the effect of NRS on re-intubation in patient subgroups.

Abbreviations: COT, conventional oxygen therapy; NRS, non-invasive respiratory support; OR, odds ratio; CI, confidence interval; CPAP, continuous positive airway pressure; HFNO, high-flow nasal oxygen; NIV, non-invasive ventilation; ICU, intensive care unit.



In post-operative patients receiving NRS after extubation, NIV reduced the rate of re-intubation, compared to COT, when used for treatment of post-extubation respiratory failure and in patients at high risk of post- extubation respiratory failure.