UNIVERSITÉ CÔTE D'AZUR

Centre Hospitalier Universitaire de Nice

Ventilation des insuffisances respiratoires aigues

J Dellamonica

Médecine Intensive Réanimation

Archet 1

RIRE

Réseau Inter Réanimation sud-Est

Pourquoi ventiler ?

- Protéger les voies aériennes → Intubation
- Indications respiratoires:
  - Hypoxémie
  - Hypercapnie
  - Défaillance multiple, choc septique,

    → « protéger les poumons »

Mise en sécurité avant le transfert vers un service de soins intensifs ou réanimation

2 questions

Diagnostic

Thérapeutique

Efficacité

Tolérance

Cas clinique 1

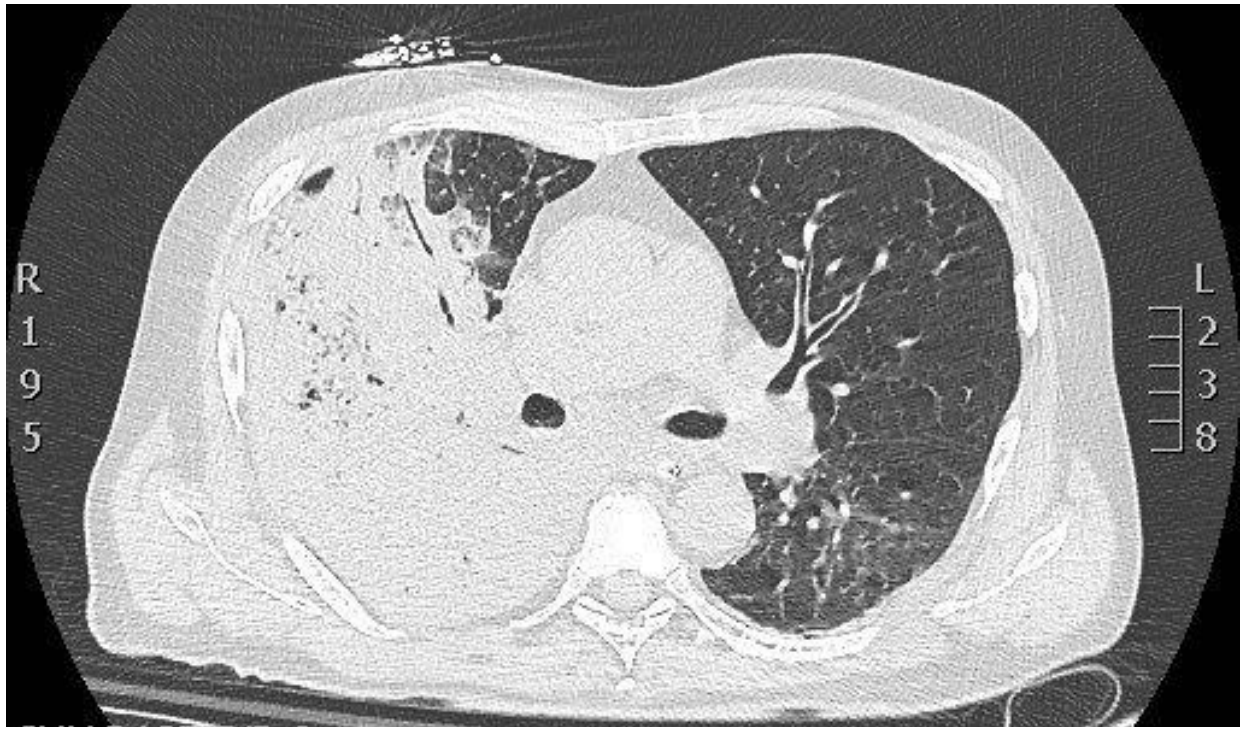
Mr B

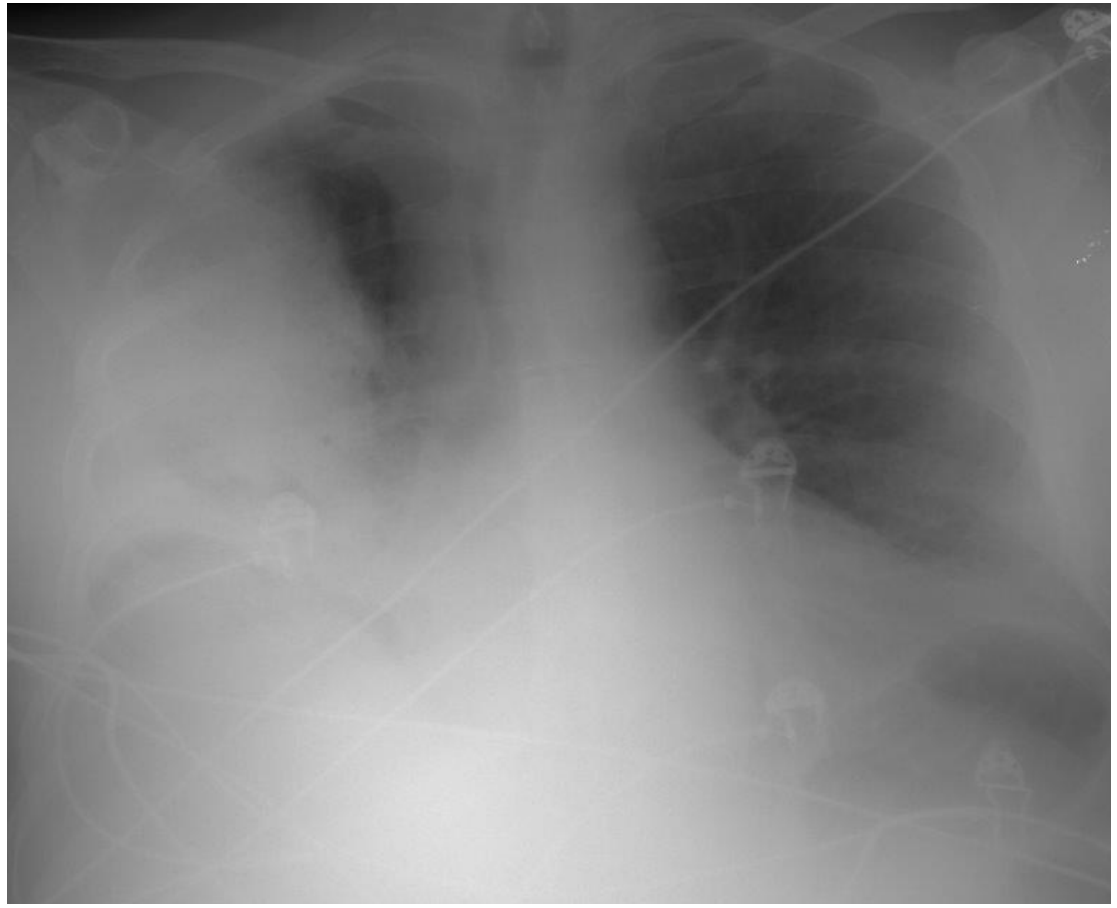
- 67 ans novembre 2017
- Antécédents:
  - Tabagisme sevré 15 PA
  - Alcool occasionnel
- Histoire de la maladie:
  - « moins bien depuis 4-5 jours »
  - T° 39°
  - Non vacciné grippe
  - Toux grasse
  - Glasgow 14
  - SpO_2=91 % sous oxygénothérapie à débit croissant
  - PA= 90/65 Pouls =110/min

pH	7,47
PaO_2	61 mmHg
$PaCO_2$	34 mmHg
SaO_2	91%

Radio initiale

- Oxygène 15L/min





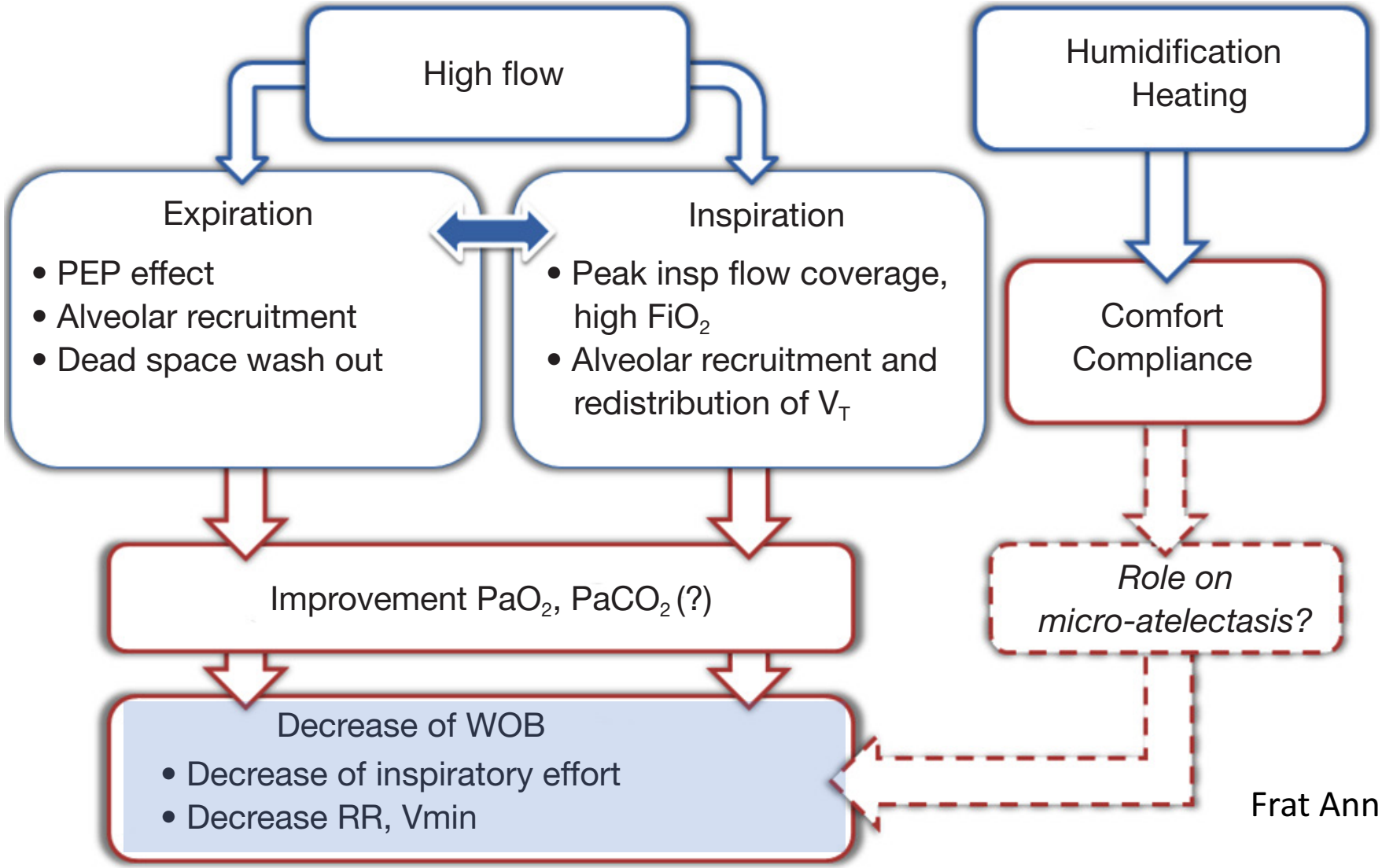
Quel est votre diagnostic ?
Que proposez vous ?

1. Oxygénothérapie à haut débit humidifié

2. Ventilation non invasive

3. Ventilation invasive

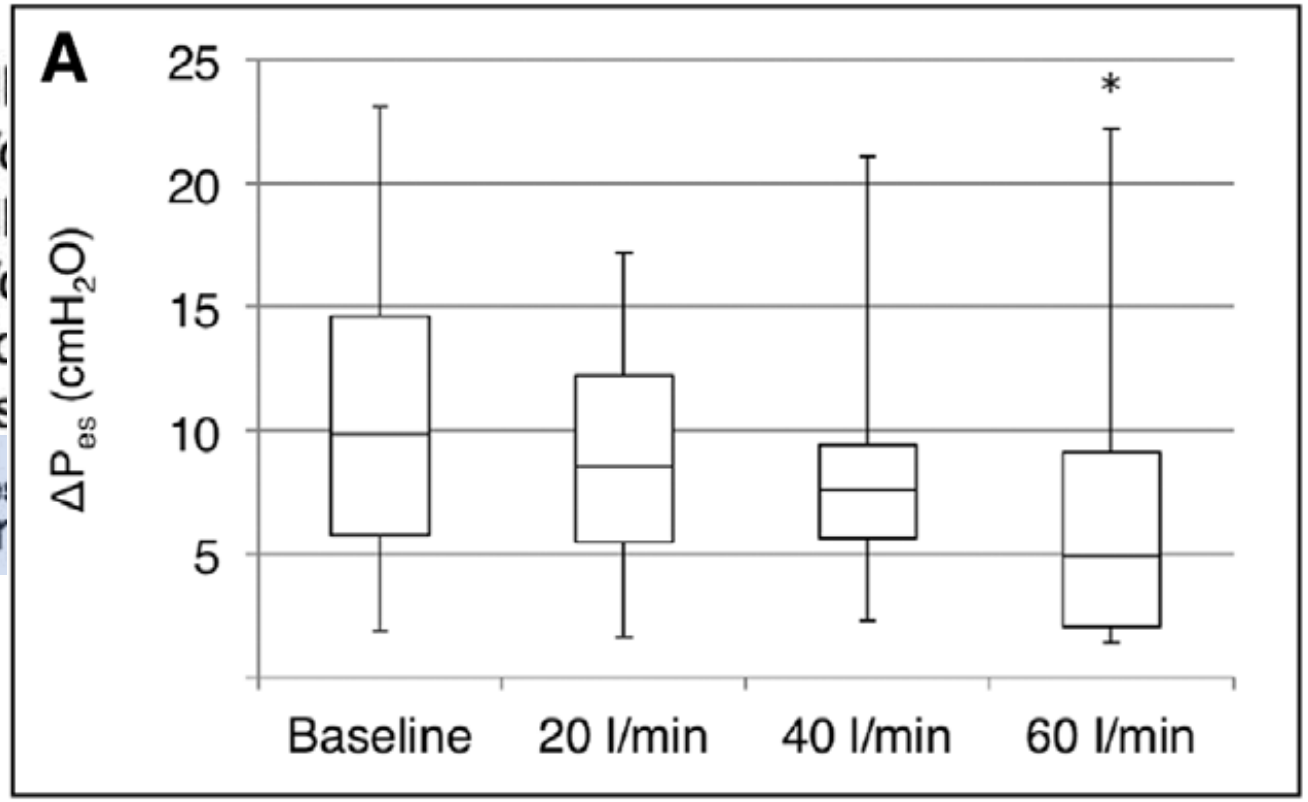
Faire de l'OHDH

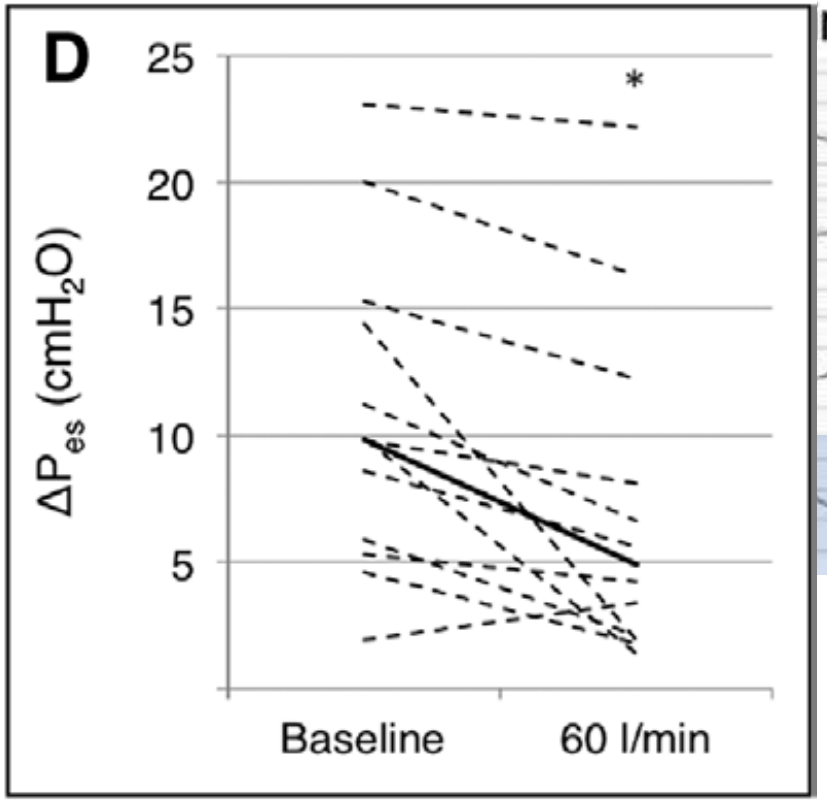


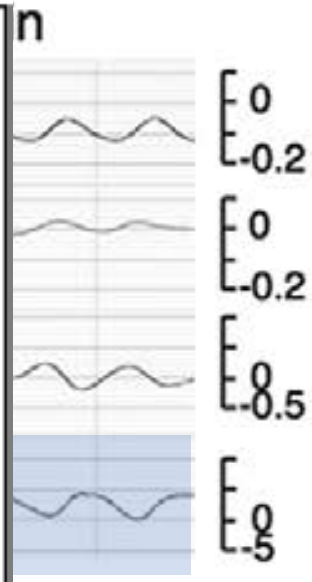
Frat Ann Transl Med 2017

Effects of High-Flow Nasal Cannula on the Work of Breathing in Patients Recovering From Acute Respiratory Failure*

Mathieu Delorme, PT, MSc[1,2]; Pierre-Alexandre Bouchard, RT[2]; Mathieu Simon, MD, FRCPC[2]; Serge Simard, MSc[2]; François Lellouche, MD, PhD[2]







CCM 2017

Humidified High Flow Nasal Oxygen During Respiratory Failure in the Emergency Department: Feasibility and Efficacy

RESPIRATORY CARE

Hugo Lenglet MD, Benjamin Sztrymf MD, Christophe Leroy MD, Patrick Brun MD, Didier Dreyfuss MD, and Jean-Damien Ricard MD PhD

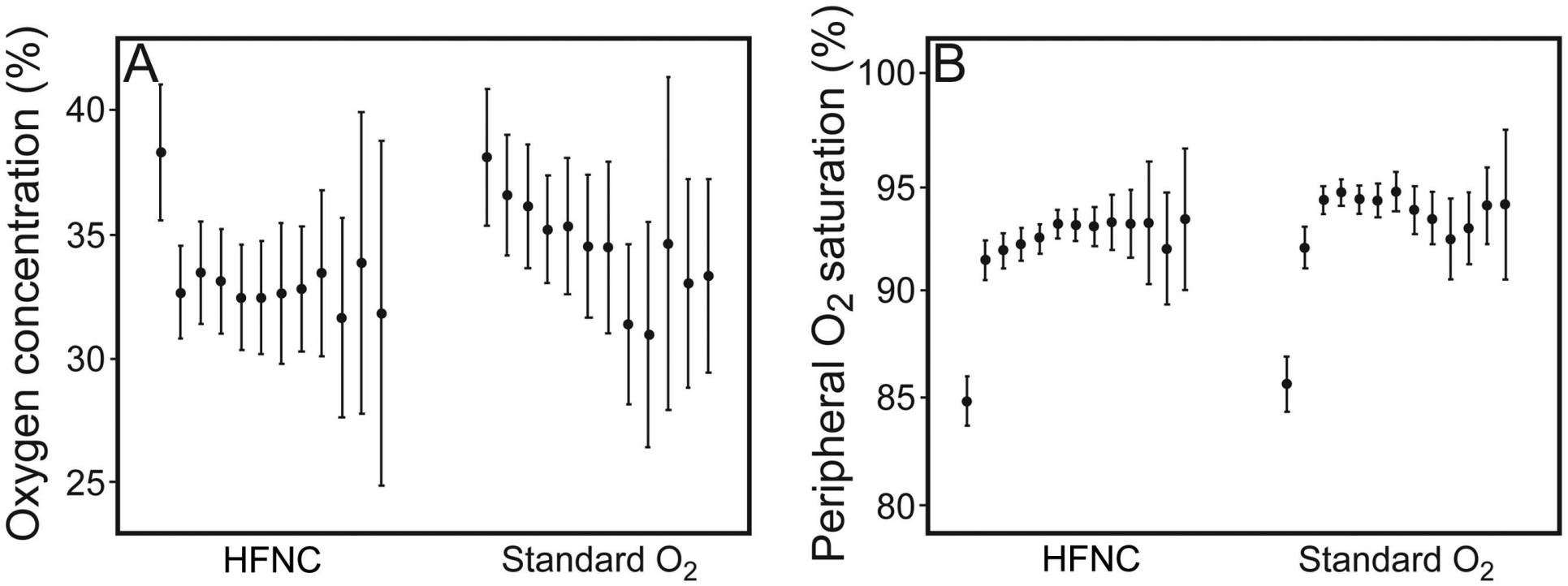
Inclusion
Dyspnée malgré 9-15L/min

	H0	H + 15 min	H + 30 min	H + 60 min
Borg scale ($n = 9$)	6 (5–7)	4 (3–4)*	4 (2–4)†	3 (2–4)†
Visual analog scale ($n = 9$)	7 (5–8)	5 (2–6)*	4 (2–6)†	3 (1–5)‡
Respiratory rate, breaths/min ($n = 17$)	28 (25–32)	25 (23–30)*	25 (21–30)‡	25 (21–28)†
S_{pO_2}, % ($n = 17$)	90 (88.5–94)	96 (90–99)‡	95 (90–100)†	97 (92.5–100)†

Randomized Controlled Trial of Humidified High-Flow Nasal Oxygen for Acute Respiratory Distress in the Emergency Department: The HOT-ER Study

RESPIRATORY CARE
2016

Peter G Jones MSc MBChB, Sinan Kamona MBChB, Owen Doran MBChB, Frann Sawtell RN, and Margaret Wilsher MD MBChB



Inclusion
SpO2 <92% +
FR > 22/min
Objectif 93%

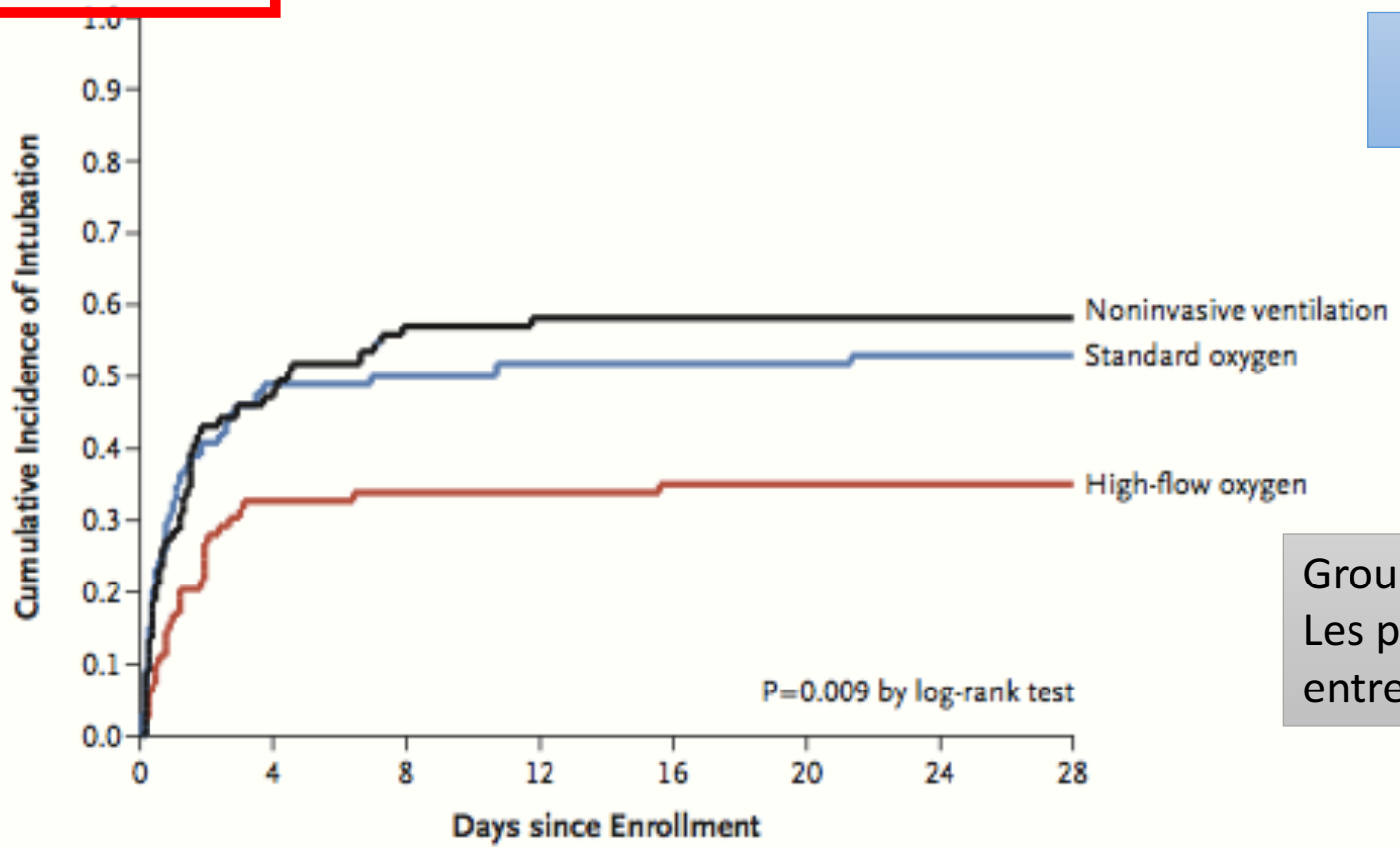
165 *vs* 138

Étude négative: 13 transferts en réanimation - 4 intubations…

The NEW ENGLAND JOURNAL of MEDICINE

IRA Hypoxémique NON hypercapnique

B Patients with a PaO_2:FIO_2 ≤200 mm Hg



No. at Risk

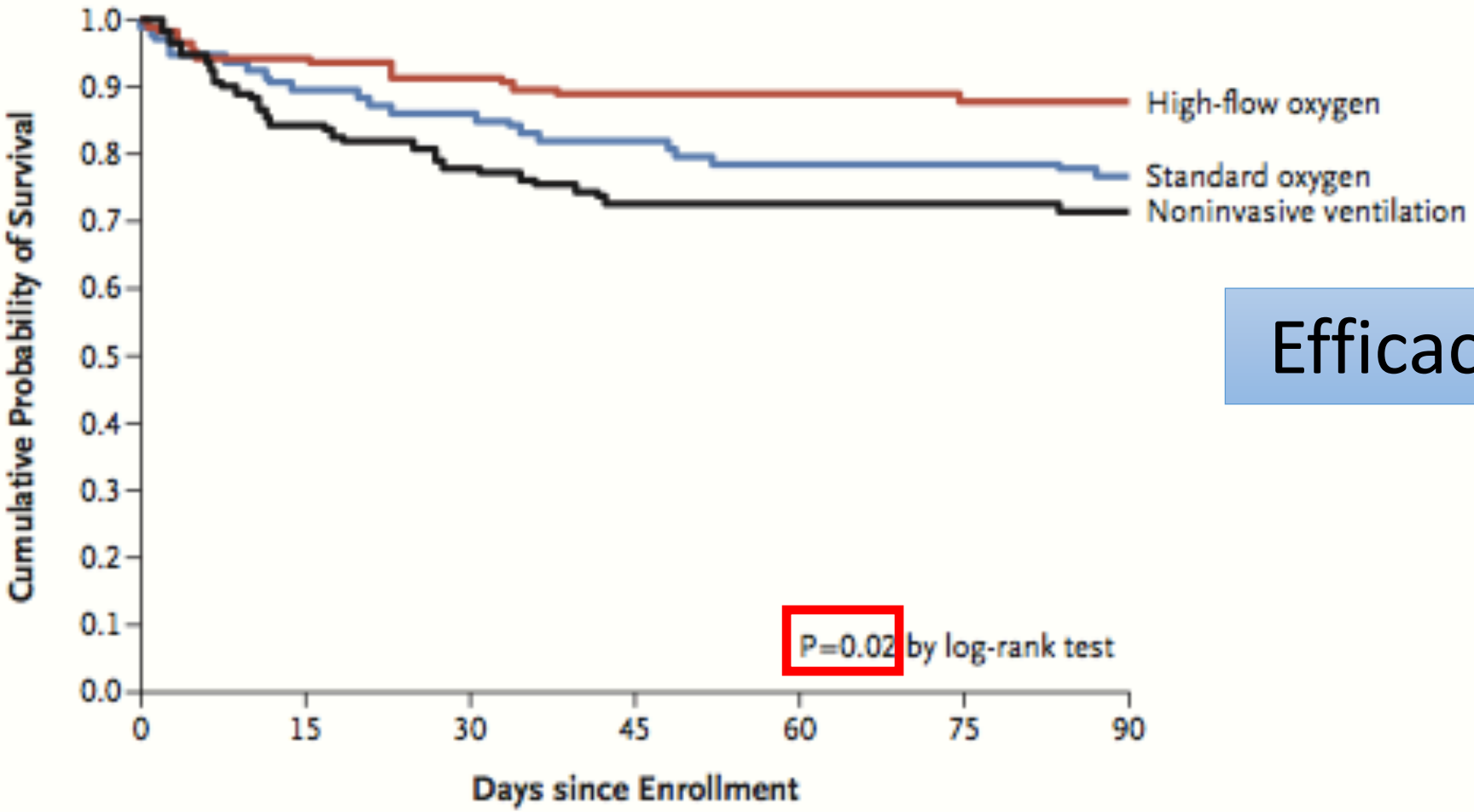
High-flow oxygen	83	55	54	54	53	53	53	53
Standard oxygen	74	37	35	34	34	34	33	33
Noninvasive ventilation	81	41	34	32	32	32	32	32

Figure 2. Kaplan–Meier Plots of the Cumulative Incidence of Intubation from Randomization to Day 28.

Efficacité

Groupe VNI:
Les patients ont eu de l'OHD entre les séances de VNI

Frat Nejm 2015

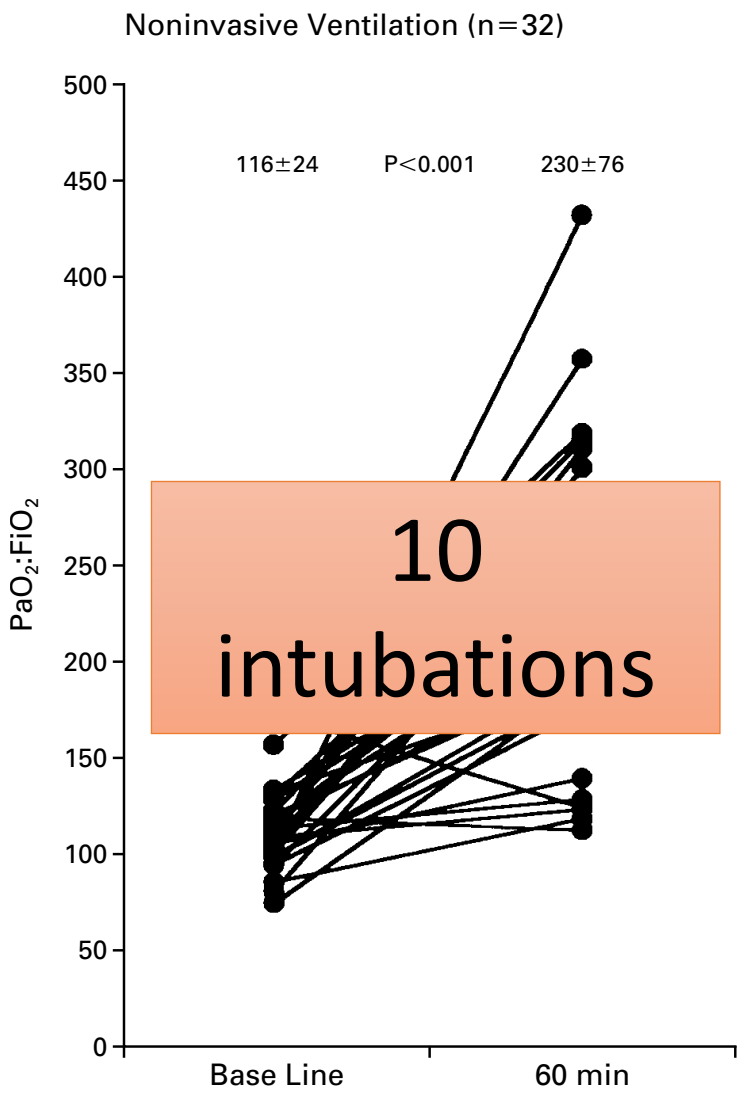


Efficacité

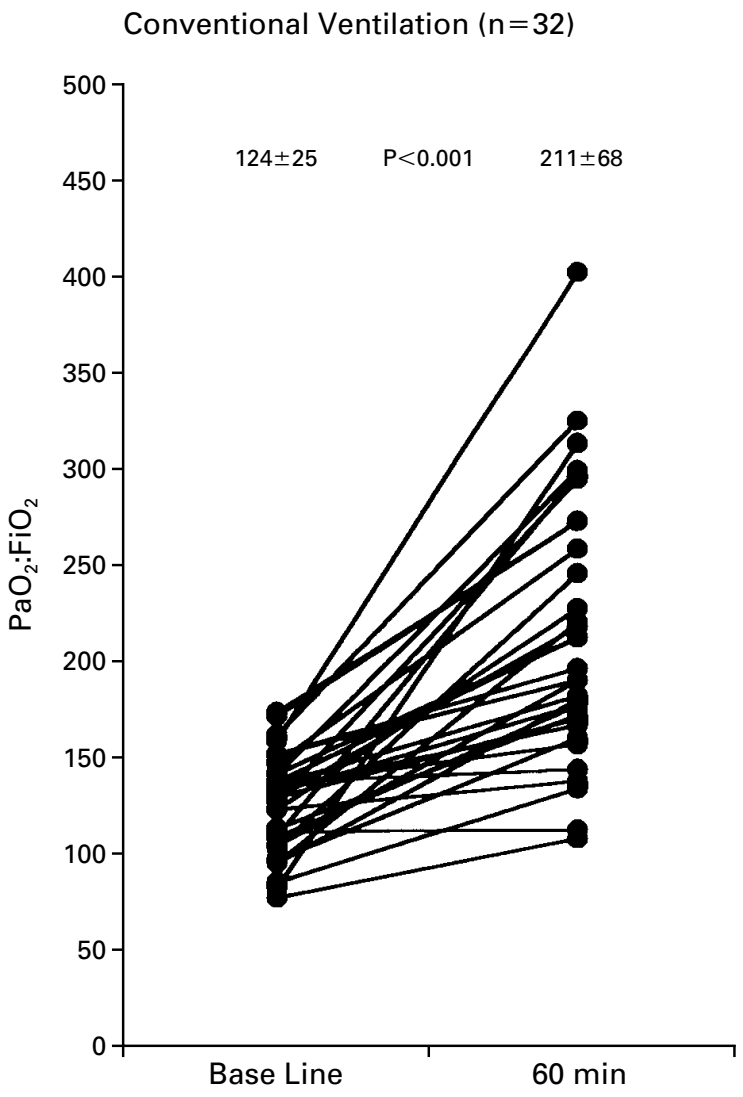
No. at Risk							
High-flow oxygen	106	100	97	94	94	93	93
Standard oxygen	94	84	81	77	74	73	72
Noninvasive ventilation	110	93	86	80	79	78	77

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

Peut on faire de la VNI ?



10 intubations



Efficacité

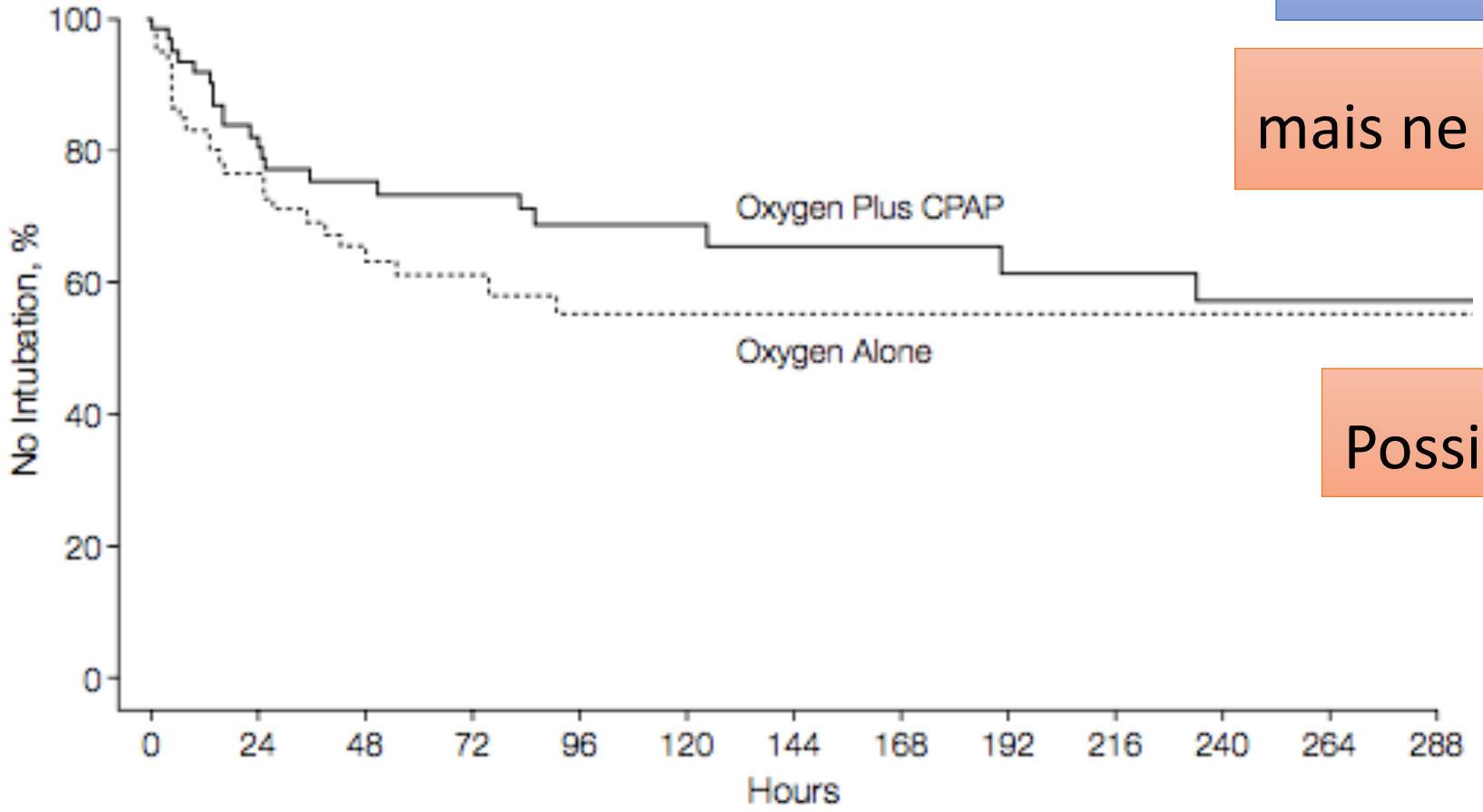
Sur l'oxygénation

Antonelli Nejm 1998

Pneumonies >50%

Treatment of Acute Hypoxemic Nonhypercapnic Respiratory Insufficiency With Continuous Positive Airway Pressure Delivered by a Face Mask

A Randomized Controlled Trial



CPAP Améliore l'oxygénation

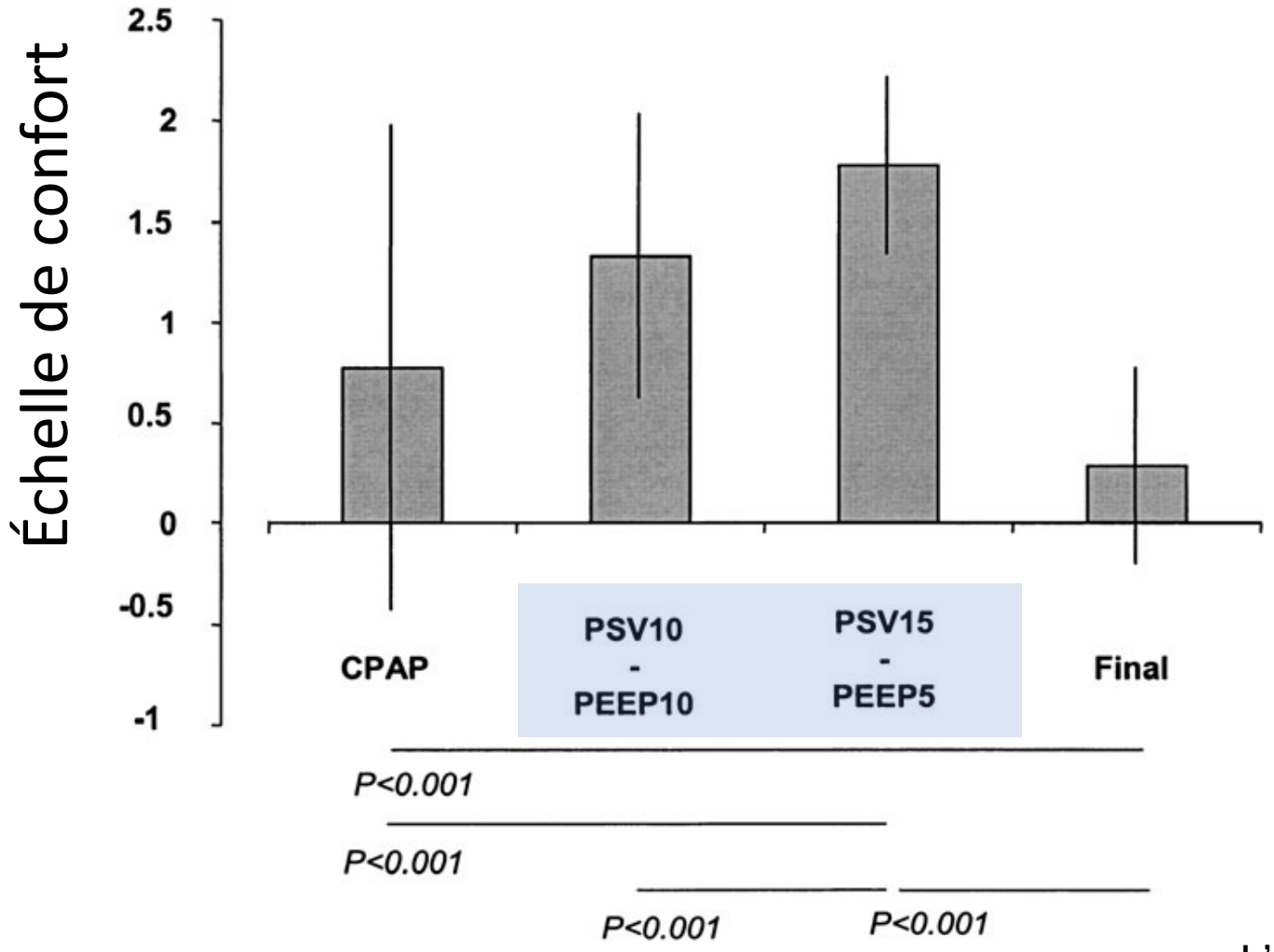
mais ne diminue pas les intubations

Possible retard d'intubation…

Delclaux JAMA 2000

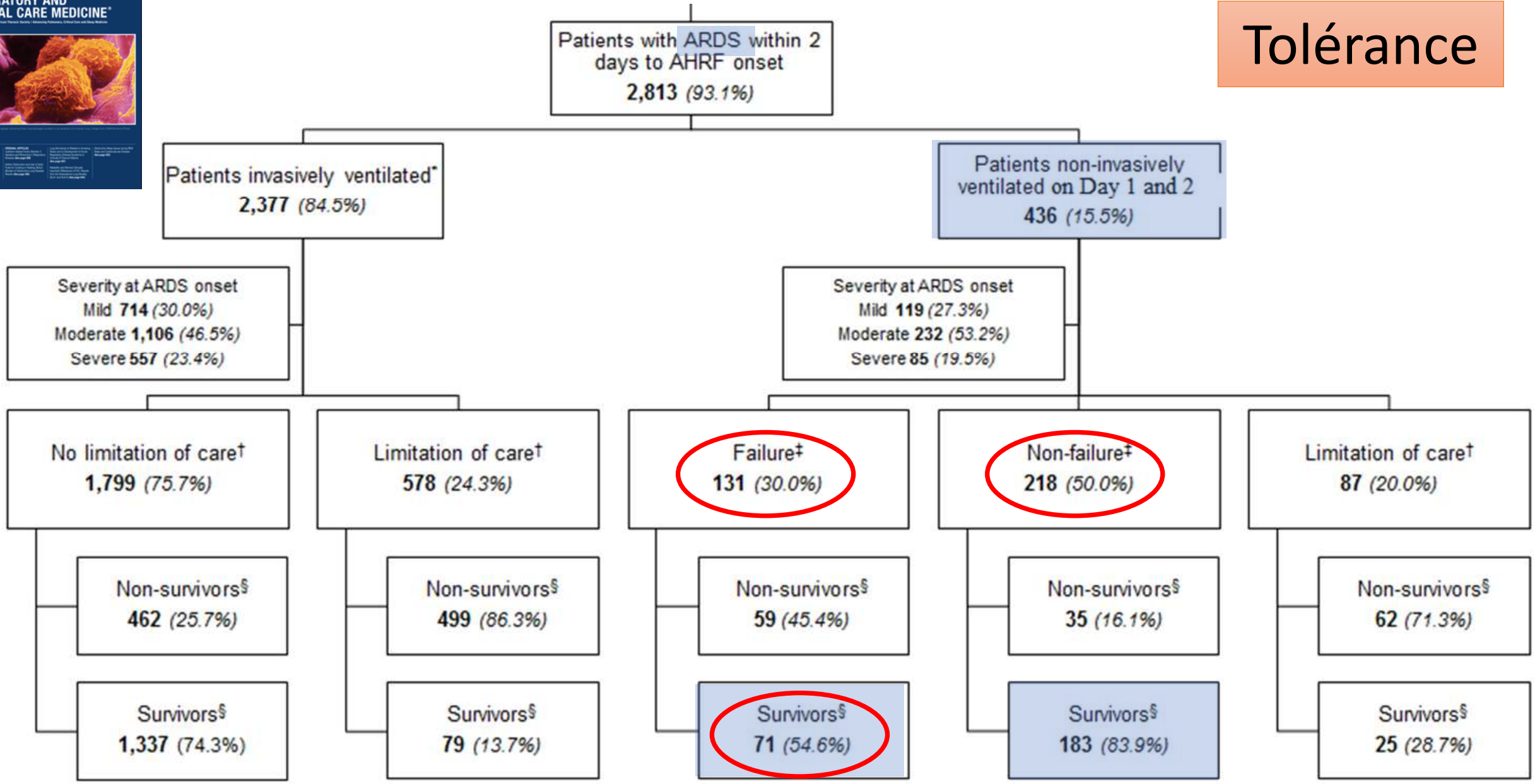
Niveau d'AI: Objectif de confort

Efficacité

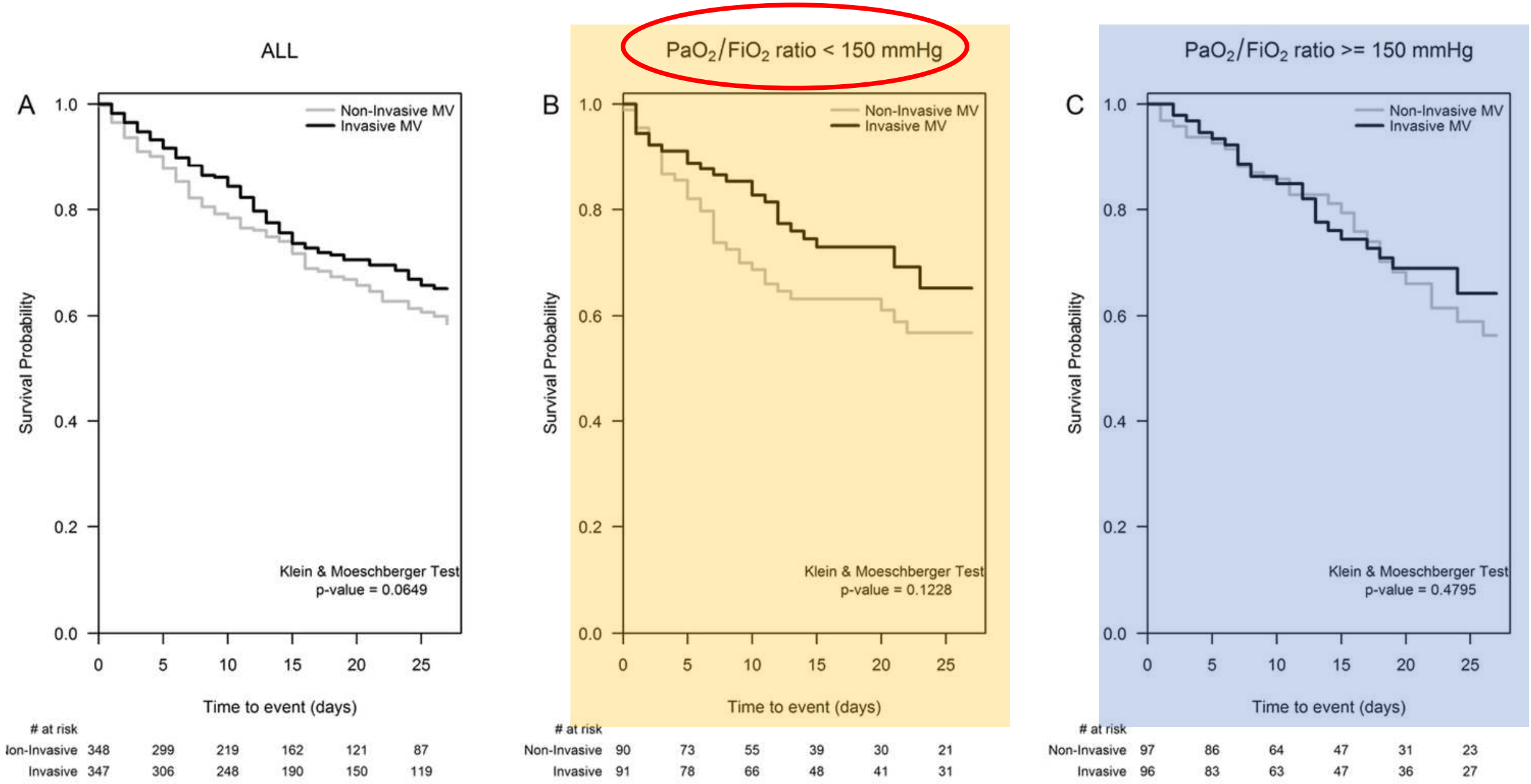


L'Her AJRCCM 2005

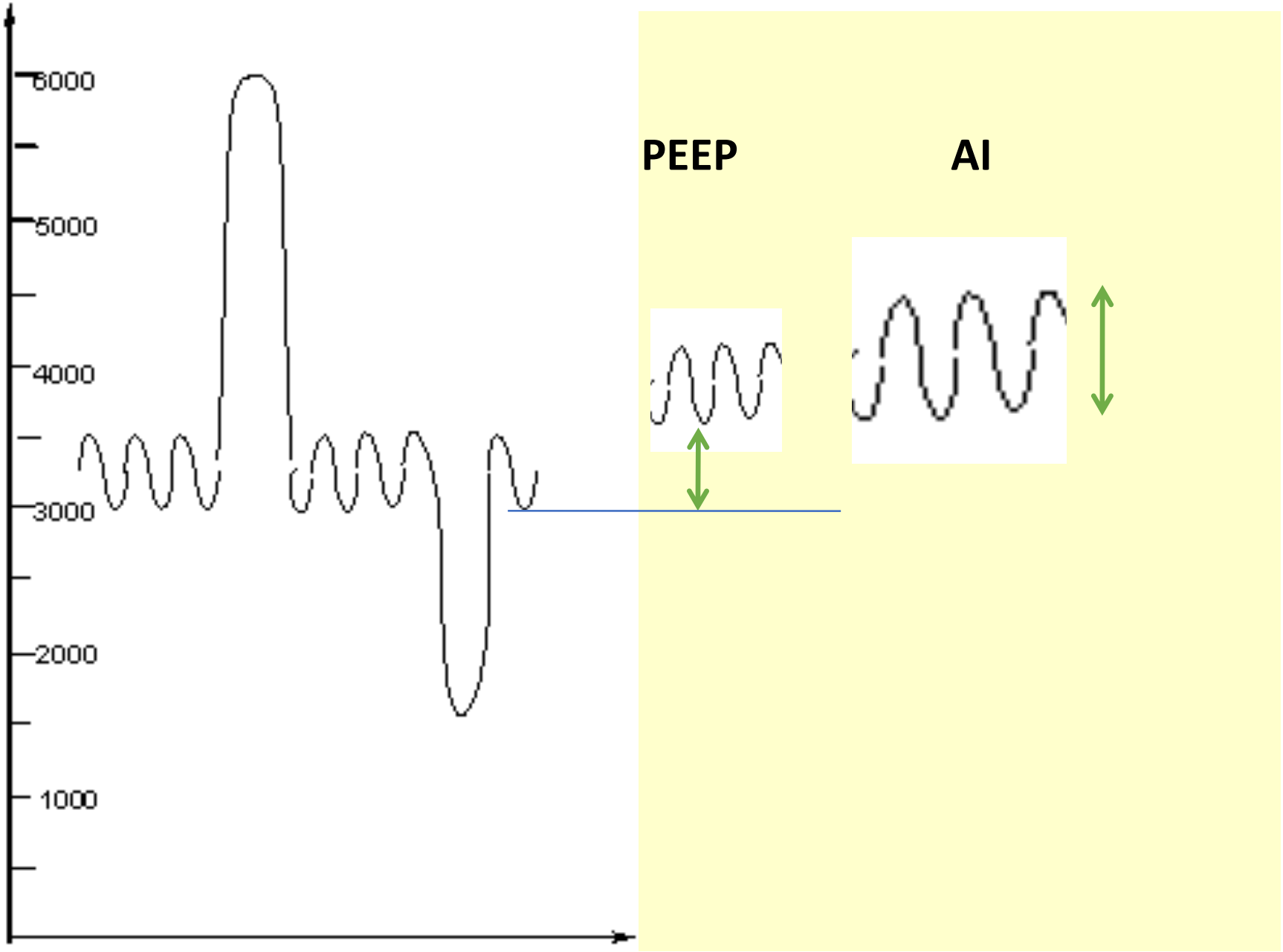
Tolérance



Laffey LungSAFE AJRCCM 2016



Laffey LungSAFE AJRCCM 2016

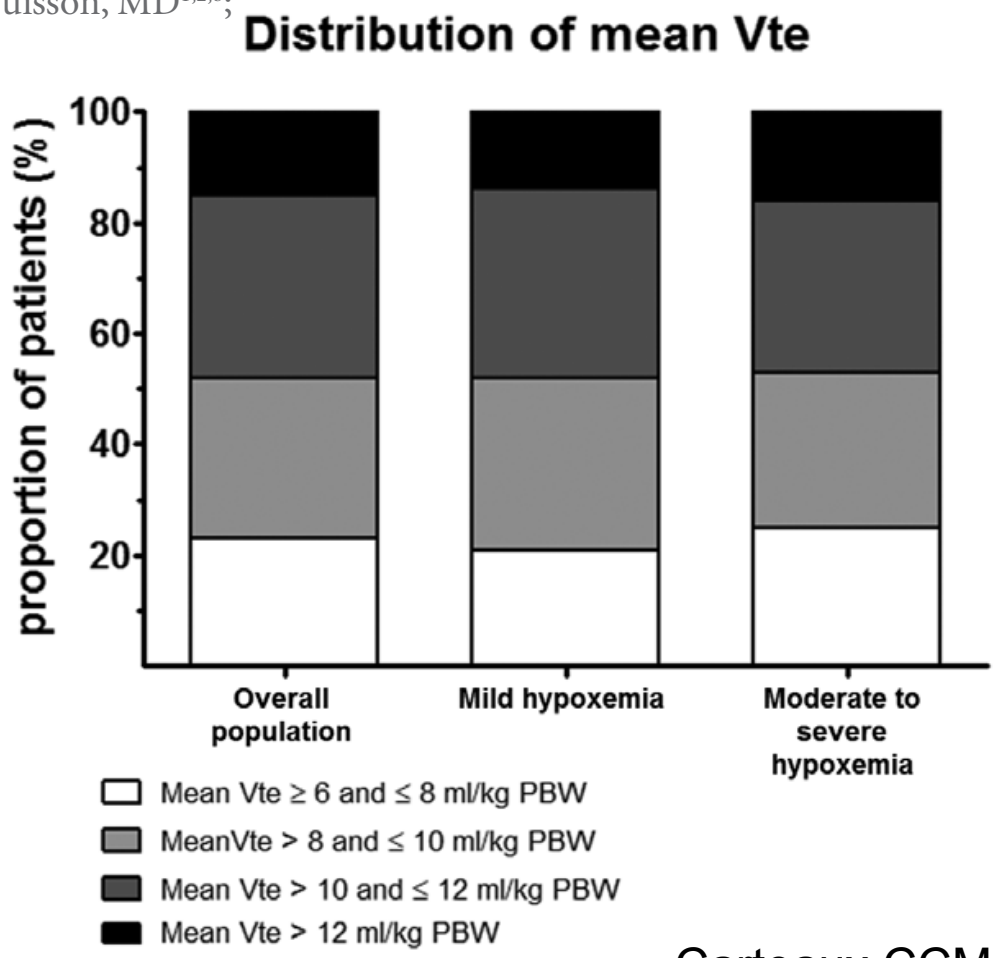

6000
5000
4000
3000
2000
1000
PEEP
AI

Failure of Noninvasive Ventilation for De Novo Acute Hypoxemic Respiratory Failure: Role of Tidal Volume*

Tolérance

Guillaume Carteaux, MD[1,2,3]; Teresa Millán-Guilarte, MD[4]; Nicolas De Prost, MD, PhD[1,2,3]; Keyvan Razazi, MD[1,2,3]; Shariq Abid, MD, PhD[3]; Arnaud W. Thille, MD, PhD[5]; Frédérique Schortgen, MD, PhD[1,3]; Laurent Brochard, MD[3,6,7]; Christian Brun-Buisson, MD[1,2,8]; Armand Mekontso Dessap, MD, PhD[1,2,3]

- **VNI** objectif Vte 6-8mL/kg
- AI_{mini} =**7** cmH_2O $PEEP_{max}$=**10** cmH_2O
- Patients hypoxémiques

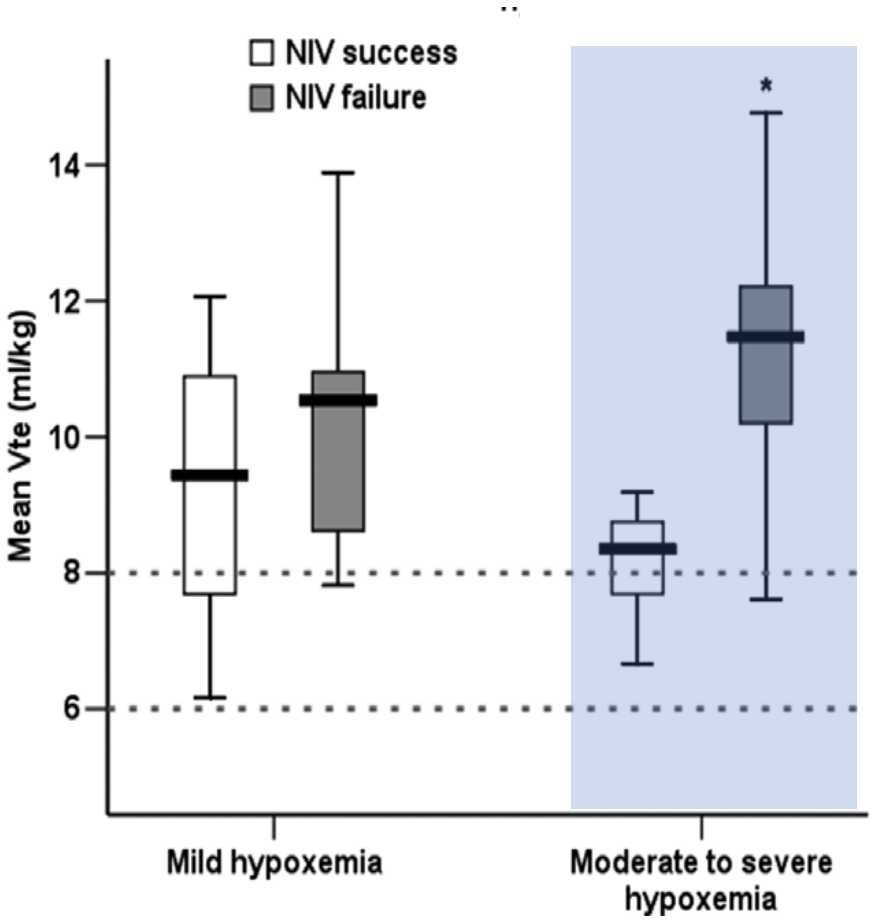


Carteaux CCM 2016

Effet délétère des Vte élevés

Tolérance

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
Pa_{O_2}/Fi_{O_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



Carteaux CCM 2016

Plus de confort…

Efficacité

Tolérance

Variable	Initial*	CPAP	PSV10/PEEP10	PSV15/PEEP5
pH	7.37 ± 0.10	7.36 ± 0.12	7.39 ± 0.08	7.40 ± 0.08[†§]
Pa_{O_2}/FI_{O_2} mm Hg	131 ± 61	184 ± 74[†]	206 ± 120[‡]	153 ± 41[‖]
Pa_{CO_2}, mm Hg	42.0 ± 11.3	44.4 ± 17.8	40.2 ± 14.3	38.6 ± 12.3[§]

Variable	Initial*	CPAP	PSV10/PEEP10	PSV15/PEEP5	Final[‖]
V_{TE}, Ml	524 ± 212	394 ± 224[†]	483 ± 247	591 ± 279[‡§]	535 ± 229
RR, breaths/min	29 ± 10	28 ± 11	28 ± 11	26 ± 9[†]	30 ± 12
$\dot{V}_E$, L/min	15.7 ± 4.4	12.3 ± 3.4	14.6 ± 3.8	17.6 ± 5.4[‡]	15.6 ± 5.3
Leaks, %	25 ± 13	39 ± 18[†]	36 ± 18	37 ± 22[†]	24 ± 15
MAP, mm Hg	77 ± 13	79 ± 16[†]	77 ± 16	75 ± 16	84 ± 17[†]
HR, beats/min	100 ± 13	100 ± 9	95 ± 14	96 ± 16	99 ± 14

L'Her AJRCCM 2005

Preliminary Communication | CARING FOR THE CRITICALLY ILL PATIENT

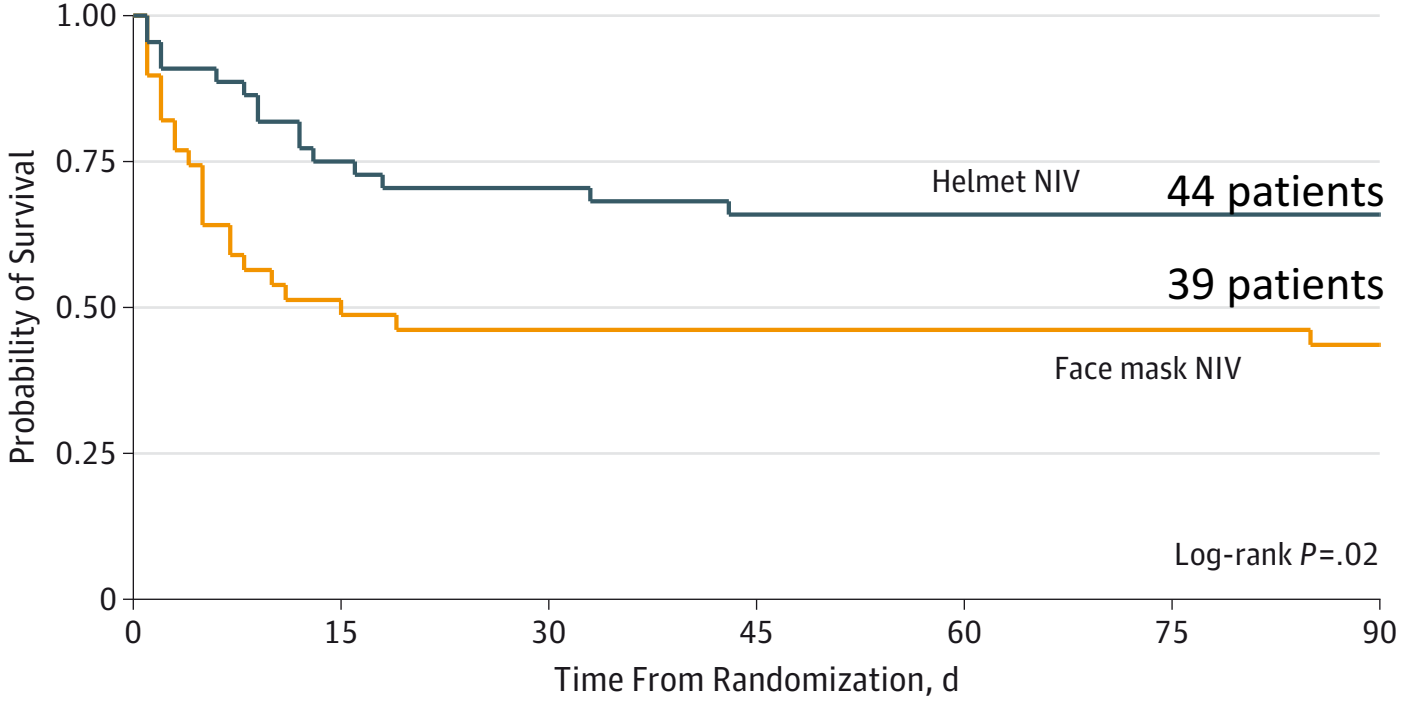
Effect of Noninvasive Ventilation Delivered by Helmet vs Face Mask on the Rate of Endotracheal Intubation in Patients With Acute Respiratory Distress Syndrome

A Randomized Clinical Trial

JAMA®

Patel 2016

Bhakti K. Patel, MD; Krysta S. Wolfe, MD; Anne S. Pohlman, MSN; Jesse B. Hall, MD; John P. Kress, MD



No. at risk							
Face mask	39	20	18	18	18	18	17
Helmet	44	33	31	29	29	29	29

À confirmer

VNI et IRA hypoxémique **OUI mais…**

- Si succès…
- Plutôt pour $PaO_2/FiO_2 > 150$
- Ne pas retarder l'intubation
- Surveiller les Vte
- Surveiller le patient

Predictors of Intubation in Patients With Acute Hypoxemic Respiratory Failure Treated With a Noninvasive Oxygenation Strategy

Jean-Pierre Frat, Critical Care Medicine 2018

TABLE 3. Multivariate Logistic Regression Analyses of Factors Associated With Intubation

Risk Factors	OR (95% CI)	*p*
In patients treated with conventional O_2 therapy by nonrebreathing mask[a]		
Respiratory rate ≥ 30 breaths/min at H1	2.76 (1.13–6.75)	0.03
In patients treated with high-flow nasal cannula oxygen therapy[a]		
Heart rate at H1 (per beat/min)	1.03 (1.01–1.06)	< 0.01
In patients treated with noninvasive ventilation[ab]		
Tidal volume > 9 mL/kg of predicted body weight at H1	3.14 (1.22–8.06)	0.02
Pa_{O_2}/F_{IO_2} ≤ 200 mm Hg at H1	4.26 (1.62–11.16)	0.003

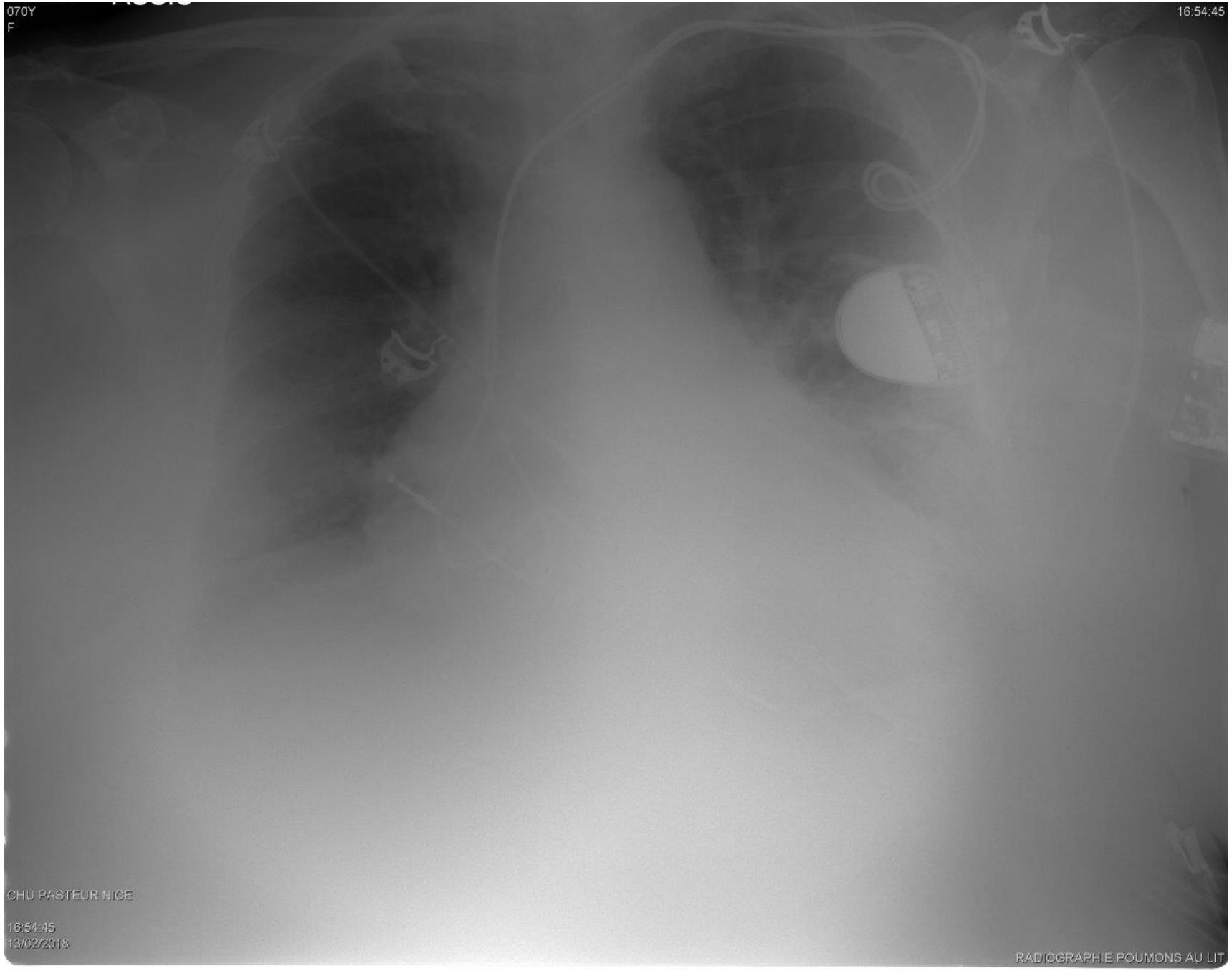
Cas clinique 2

Mme G.

- 70 ans
- BPCO post-tabagique
- Cardiopathie ischémique stentée
- Pace maker

pH	7,13
PaO_2	83 mmHg
$PaCO_2$	91 mmHg
SaO_2	90,6%

- Désaturation SpO2= 86% en AA
- Glasgow 12
- ETT: FeVG 35%, pressions de remplissage augmentées
- BNP 1300pg/mL troponine US 450ng/mL


070Y
F
16:54:45
CHU PASTEUR NICE
16:54:45
13/02/2018
RADIOGRAPHIE POUMONS AU LIT

Quel est votre diagnostic ?
Que proposez vous ?

1. Ventilation invasive

2. Oxygénothérapie à haut débit humidifié

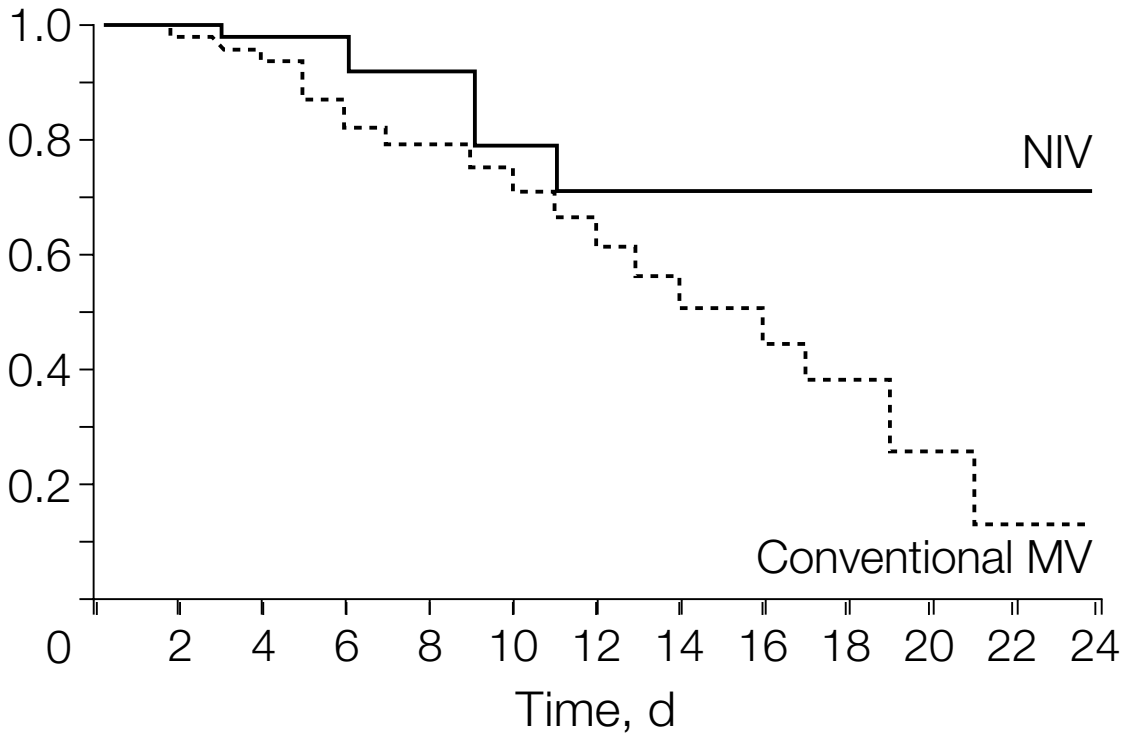
3. Ventilation non invasive

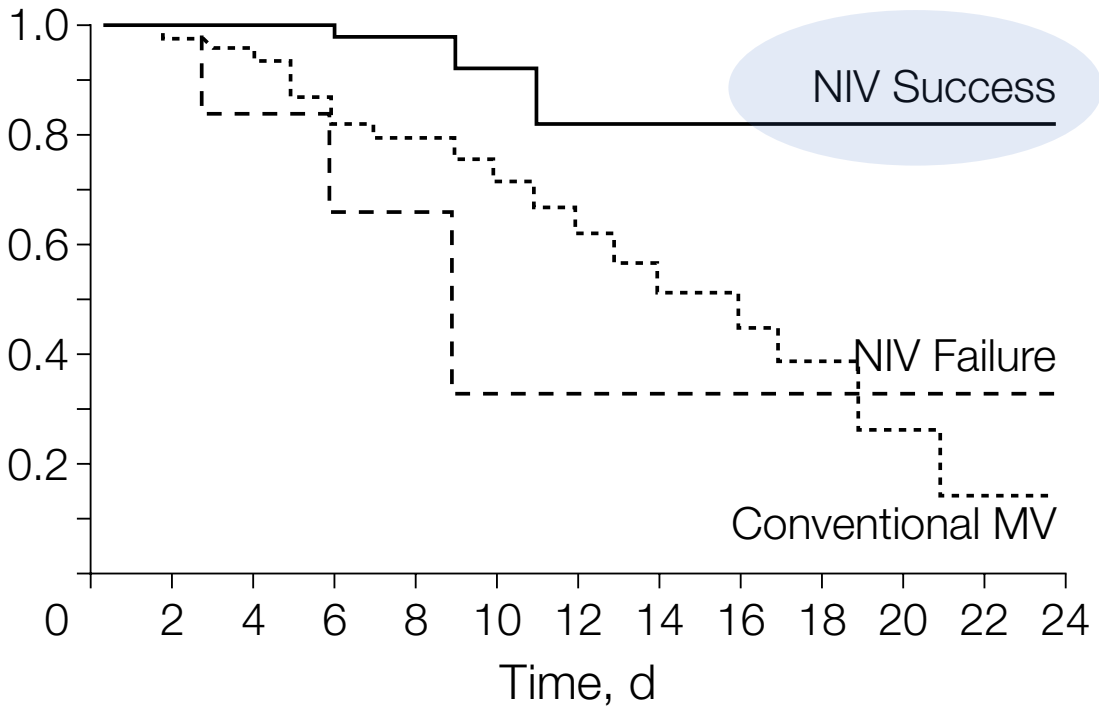
Association of Noninvasive Ventilation With Nosocomial Infections and Survival in Critically Ill Patients

JAMA®

E Girou 2000

Emmanuelle Girou, PharmD

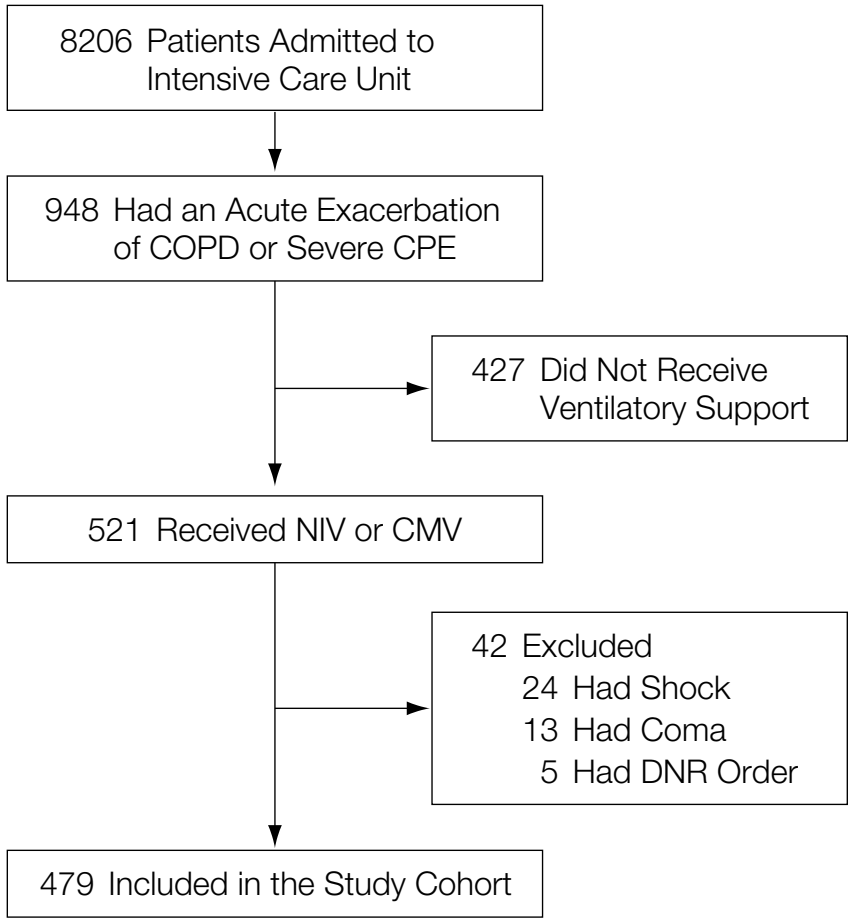


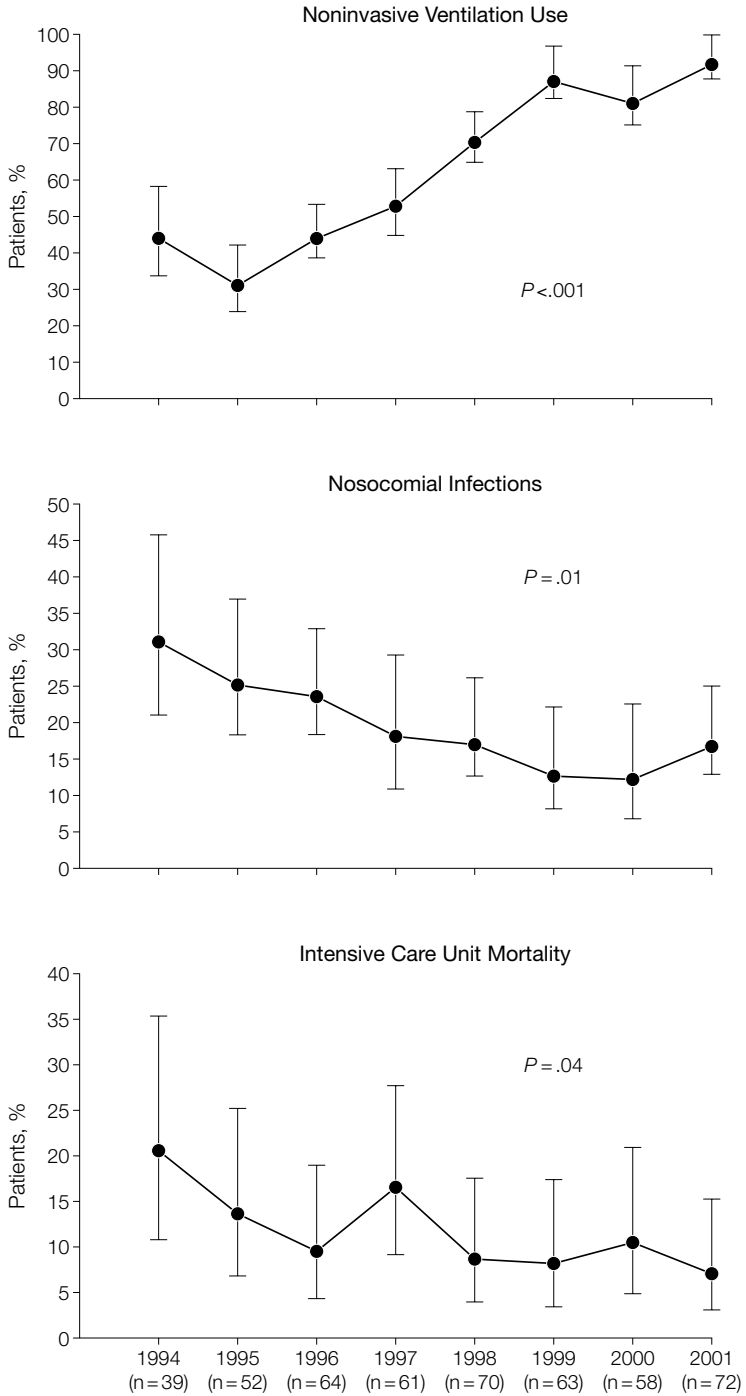


Secular Trends in Nosocomial Infections and Mortality Associated With Noninvasive Ventilation in Patients With Exacerbation of COPD and Pulmonary Edema

E Girou 2003

JAMA®

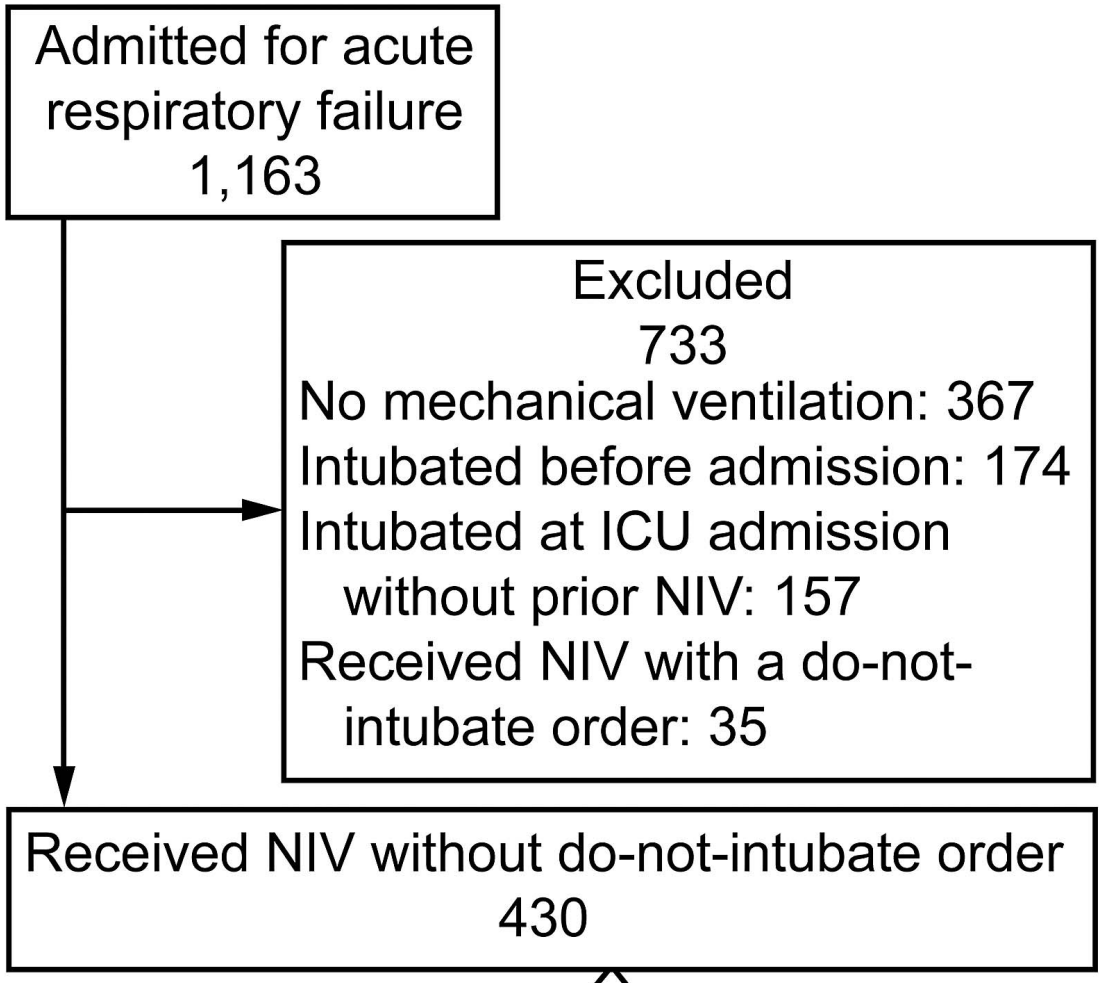




Noninvasive Ventilation for Acute Hypercapnic Respiratory Failure: Intubation Rate in an Experienced Unit

RESPIRATORY CARE
2012

Damien Contou MD, Chiara Fragnoli MD, Ana Córdoba-Izquierdo MD, Florence Boissier MD, Christian Brun-Buisson MD, and Arnaud W Thille MD PhD



331 patients

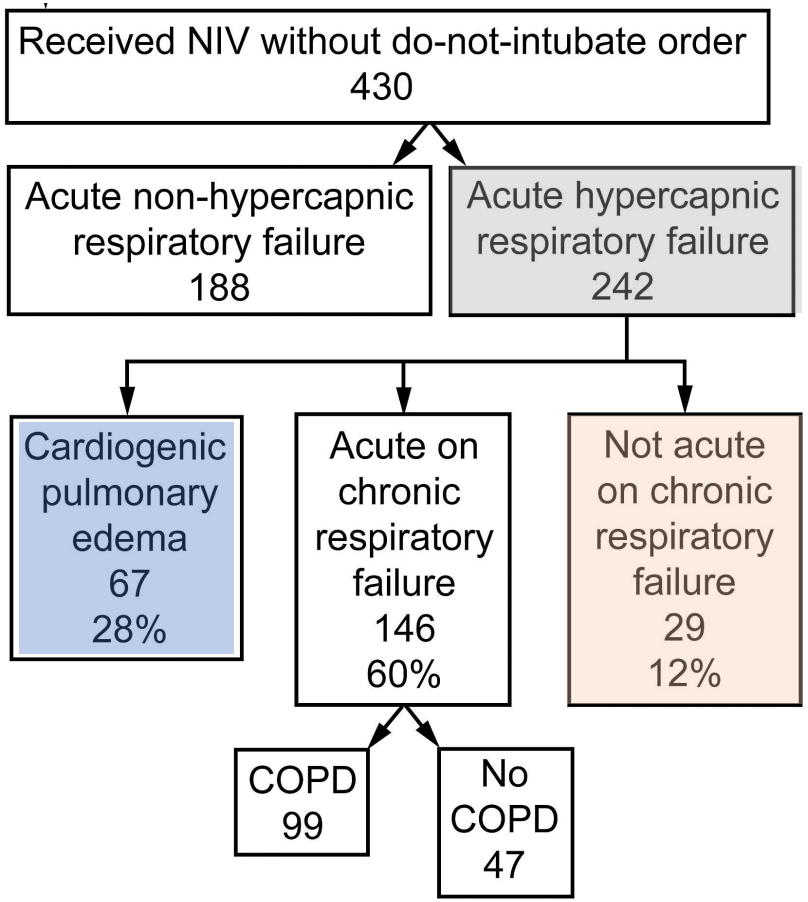
28 % intubés

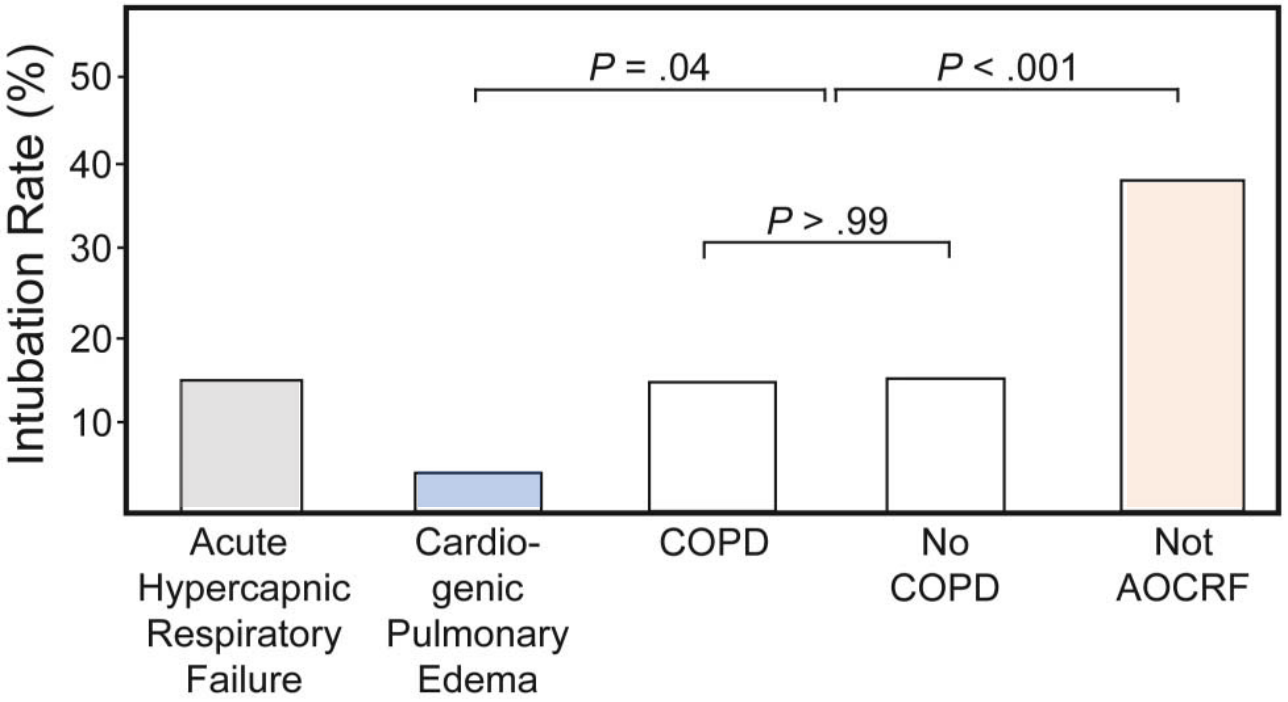
IRA nécessitant une Ventilation: **VNI 54 %**

Noninvasive Ventilation for Acute Hypercapnic Respiratory Failure: Intubation Rate in an Experienced Unit

RESPIRATORY CARE
2012

Damien Contou MD, Chiara Fragnoli MD, Ana Córdoba-Izquierdo MD, Florence Boissier MD, Christian Brun-Buisson MD, and Arnaud W Thille MD PhD



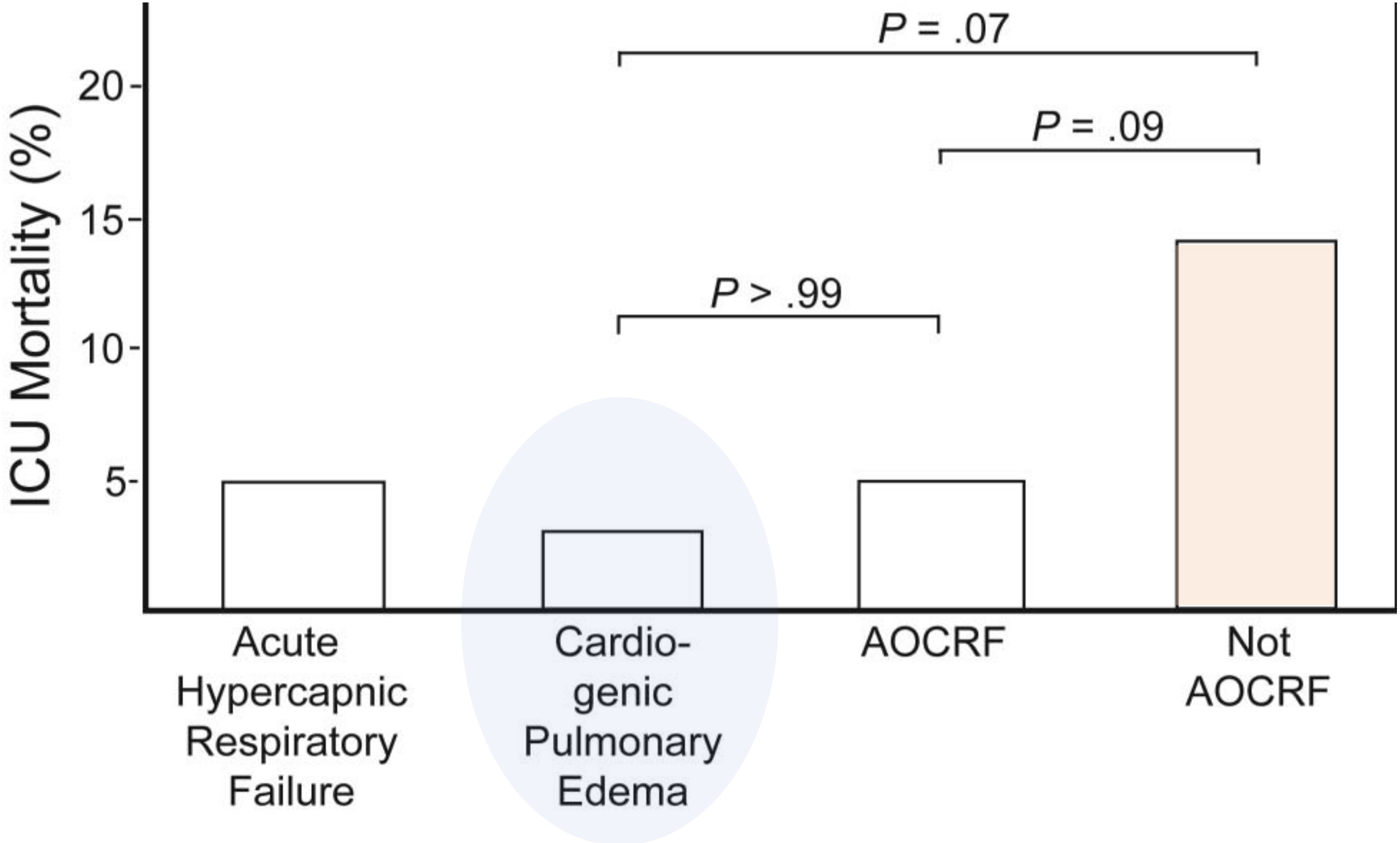


Noninvasive Ventilation for Acute Hypercapnic Respiratory Failure: Intubation Rate in an Experienced Unit

RESPIRATORY CARE
2012

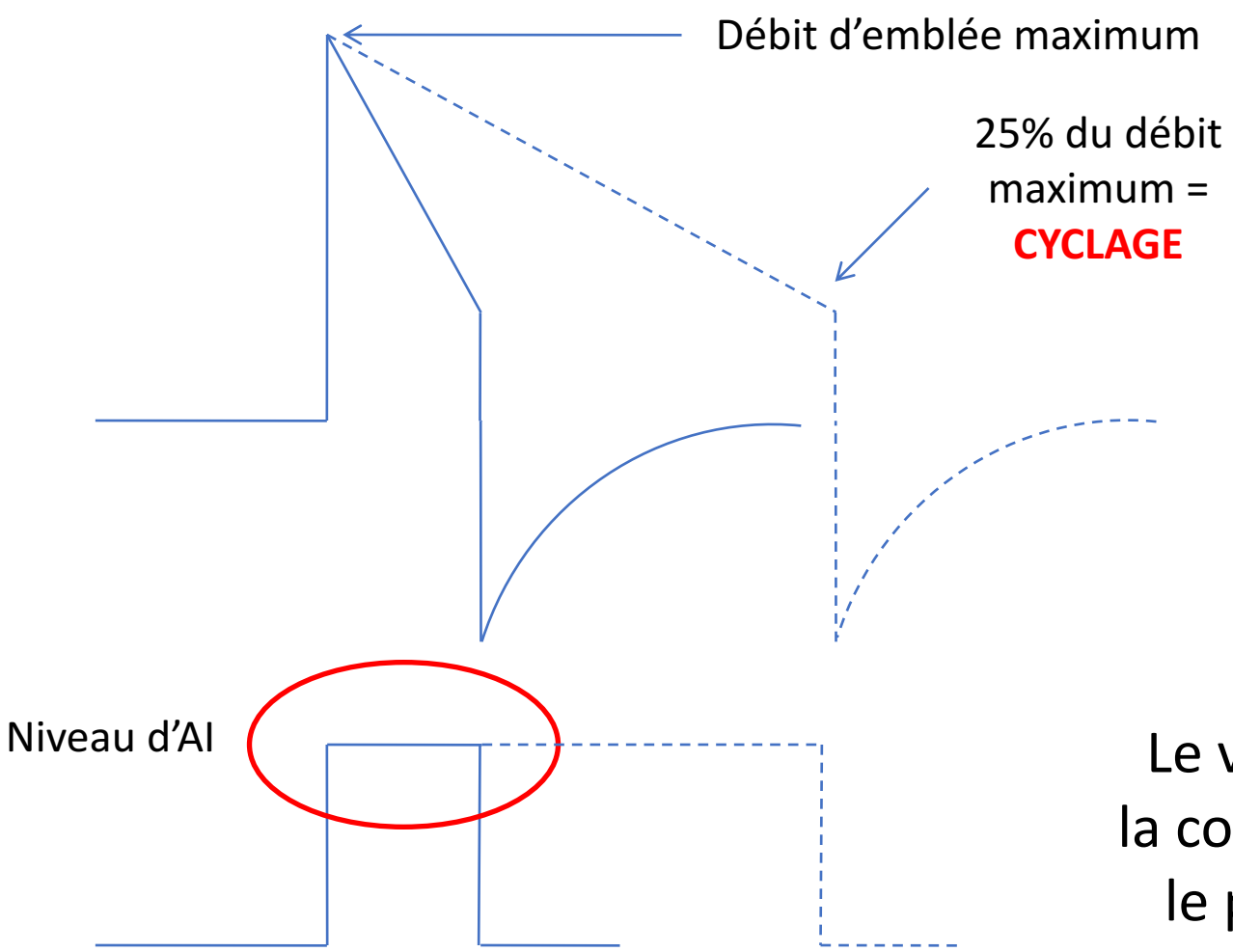
Damien Contou MD, Chiara Fragnoli MD, Ana Córdoba-Izquierdo MD, Florence Boissier MD, Christian Brun-Buisson MD, and Arnaud W Thille MD PhD

	All AHRF $n = 242$	CPE $n = 67$	AOCRF $n = 146$	Non-AOCRF $n = 29$	P
Total duration of NIV, median (IQR) d	2 (1–4)	2 (1–3)*	3 (1–5)*	1 (1–3)	< .001
Rate of NIV failure, no. (%)	36 (14)	3 (4)*	22 (15)	11 (38)*	< .001
ICU stay, median (IQR) d	6 (4–9)	4 (3–6)*	7 (5–9)	8 (6–14)†	< .001
ICU mortality, no. (%)	13 (5)	2 (3)	7 (5)	4 (14)	.09


ICU Mortality (%)
20
15
10
5
P = .07
P = .09
P > .99
Acute Hypercapnic Respiratory Failure
Cardio-genic Pulmonary Edema
AOCRF
Not AOCRF

On décide de faire de la VNI…

Aide Inspiratoire en VNI : risque de **fuites**



1. Consigne de pression
2. **Tous** les cycles sont déclenchés par le patient
3. Cyclage expiratoire sur le débit max

Le ventilateur atteint la consigne de pression le plus vite possible

Quels réglages pour commencer ?

- AI= 12 cmH2O
- PEP= 4 cmH2O
- Pente= maximum tolérée
- Trigger Inspi = 3 L/min
- Trigger Expi = 50%

- Dr + IDE bedside pendant au moins 20 min

Di Marco Crit care 2011

Optimiser la VNI en Limitant les asynchronies

Asynchronies en VNI

- 60 patients en VNI

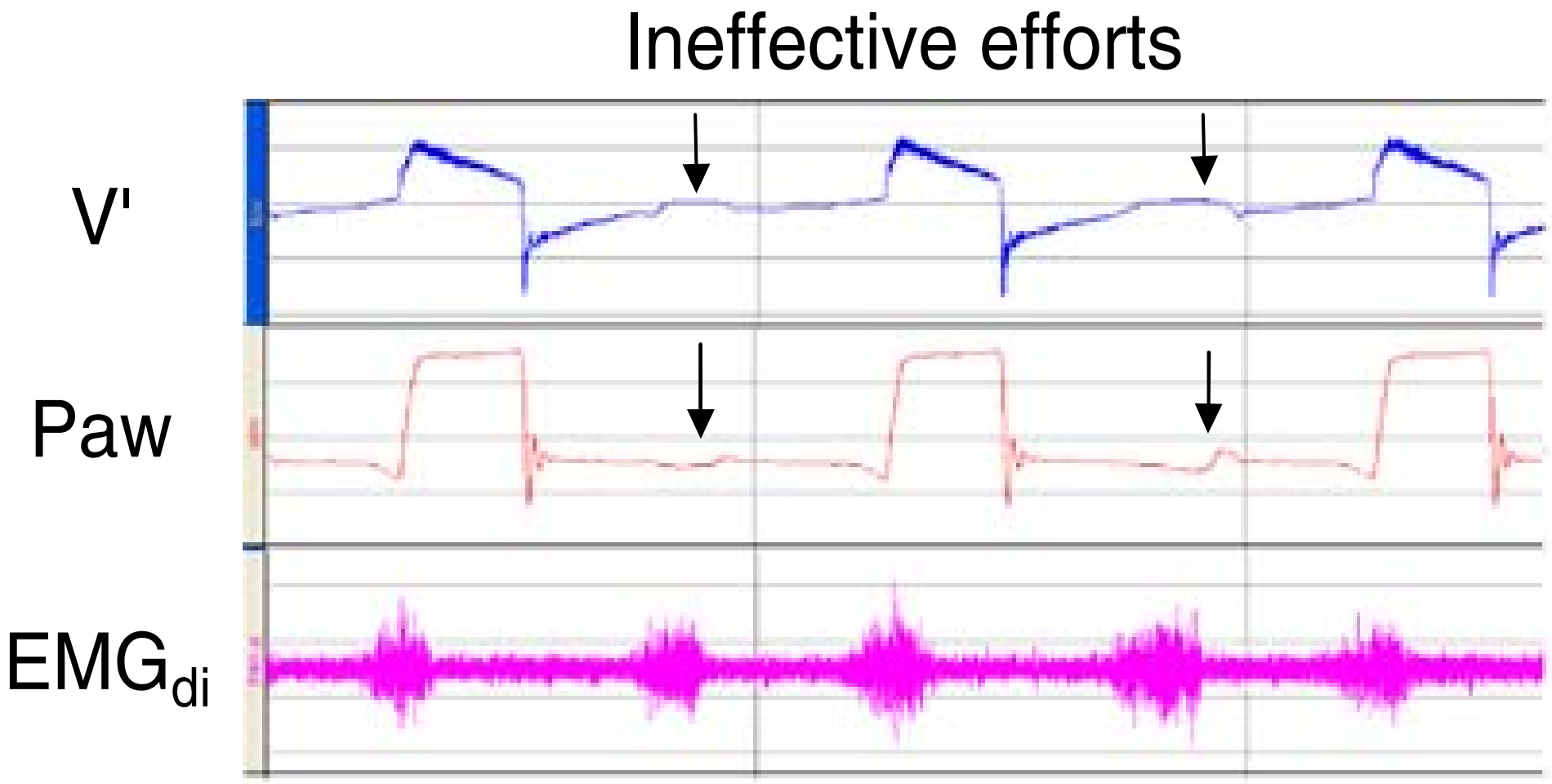
	Ineffective efforts		Auto- triggering		Double-triggering		Premature cycling		Late cycling		AI > 10%	
	Absent ($n = 52$)	Present ($n = 8$)	Absent ($n = 48$)	Present ($n = 12$)	Absent ($n = 51$)	Present ($n = 9$)	Absent ($n = 53$)	Present ($n = 7$)	Absent ($n = 46$)	Present ($n = 14$)	Absent ($n = 34$)	Present ($n = 26$)
VTe												
(ml)	516 (22)	346 (52)*	504 (23)	452 (55)	489 (22)	523 (44)	483 (21)	570 (91)	517 (25)	419 (27)	508 (25)	475 (37)
(ml/kg)	7.6 (2.8)	3.9 (1.9)*	7.2 (3.3)	6.6 (3.1)	6.9 (2.8)	8.2 (4.1)	6.7 (2.5)	10.4 (4.3)*	7.6 (3.1)	5.7 (3.1)*	7.8 (2.5)	7.2 (3.6)
MVe (l/min)	12.8 (0.6)	8.3 (1.2)*	12.4 (0.7)	11.1 (1.5)	12.1 (0.7)	12.9 (1.7)	12.2 (0.6)	12.1 (1.7)	13.0 (0.7)	9.5 (0.48)*	13.1 (0.8)	10.9 (0.8)*
RR (*n*/min)	25 (0.9)	25 (1)	25 (0.8)	25 (2)	25 (0.8)	26 (3)	25 (0.8)	22 (3)	25 (1)	23 (1)	26 (1)	24 (1)
Leak												
(l/min)	3.5 (0.4)	4.5 (1.2)*	3.4 (0.4)	6.1 (1.7)*	4.2 (0.6)	3.9 (0.9)	4.3 (0.6)	3.7 (0.9)	3.4 (0.4)	5.2 (1.5)*	3.1 (0.5)	5.7 (0.9)*
(%)	27.3	54.2	47.2	54.9	34.7	30.2	35.2	30.5	26.1	54.7	23.6	52.3
ti_p (ms)	796 (45)	773 (47)	786 (47)	820 (63)	758 (22)	992 (23)*	752 (23)	1,100 (28)*	791 (50)	800 (39)	730 (27)	874 (82)*
ti_{excess} (ms)	32 (3)	61 (5)*	37 (5)	30 (3)	40 (4)	15 (4)*	40 (4)	1 (7)	28 (3)	62 (9)*	34 (4)	38 (8)
PSL (cmH_2O)	11 (0.5)	12 (1.1)	11 (0.6)	11 (1.3)	12 (0.5)	8 (1.4)*	11 (1.5)	12 (1.1)	11 (0.6)	12 (1.1)	10 (0.6)	12 (0.8)

13% 20% 15% 12% 23%

43% des patients ont > 10% d'asynchronies

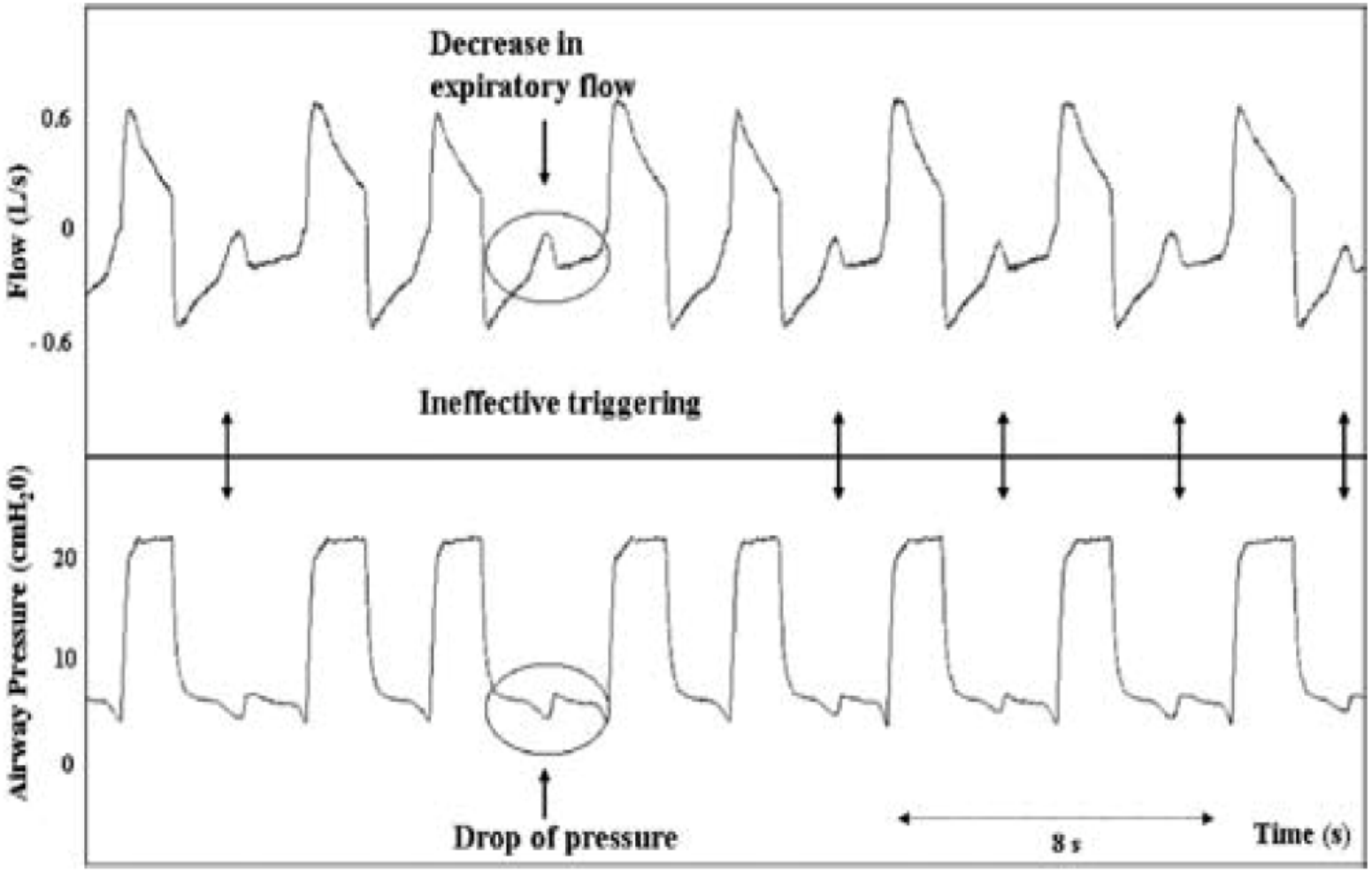
Vignaux ICM 2009

Asynchronies



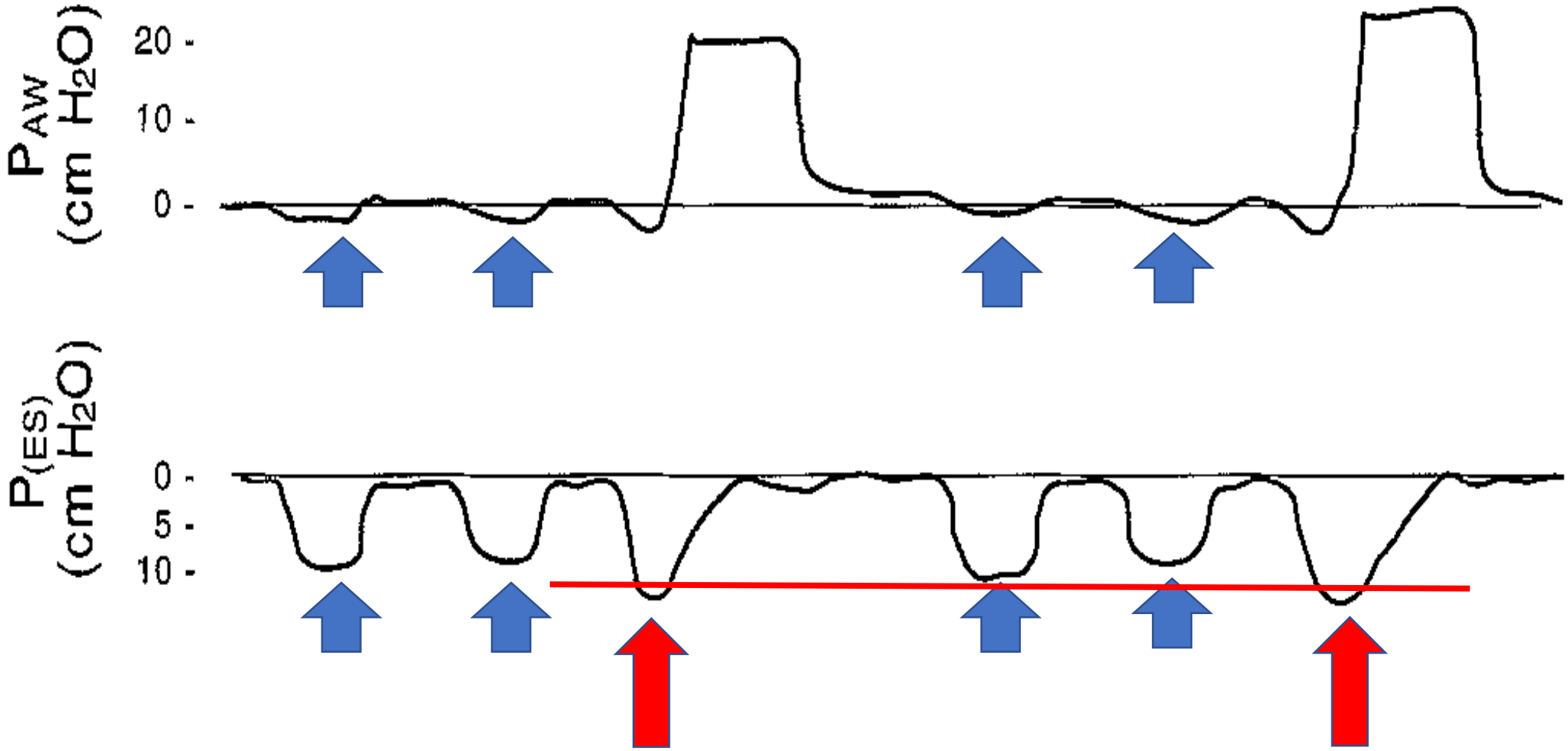
Vignaux ICM 2009

Efforts inefficaces

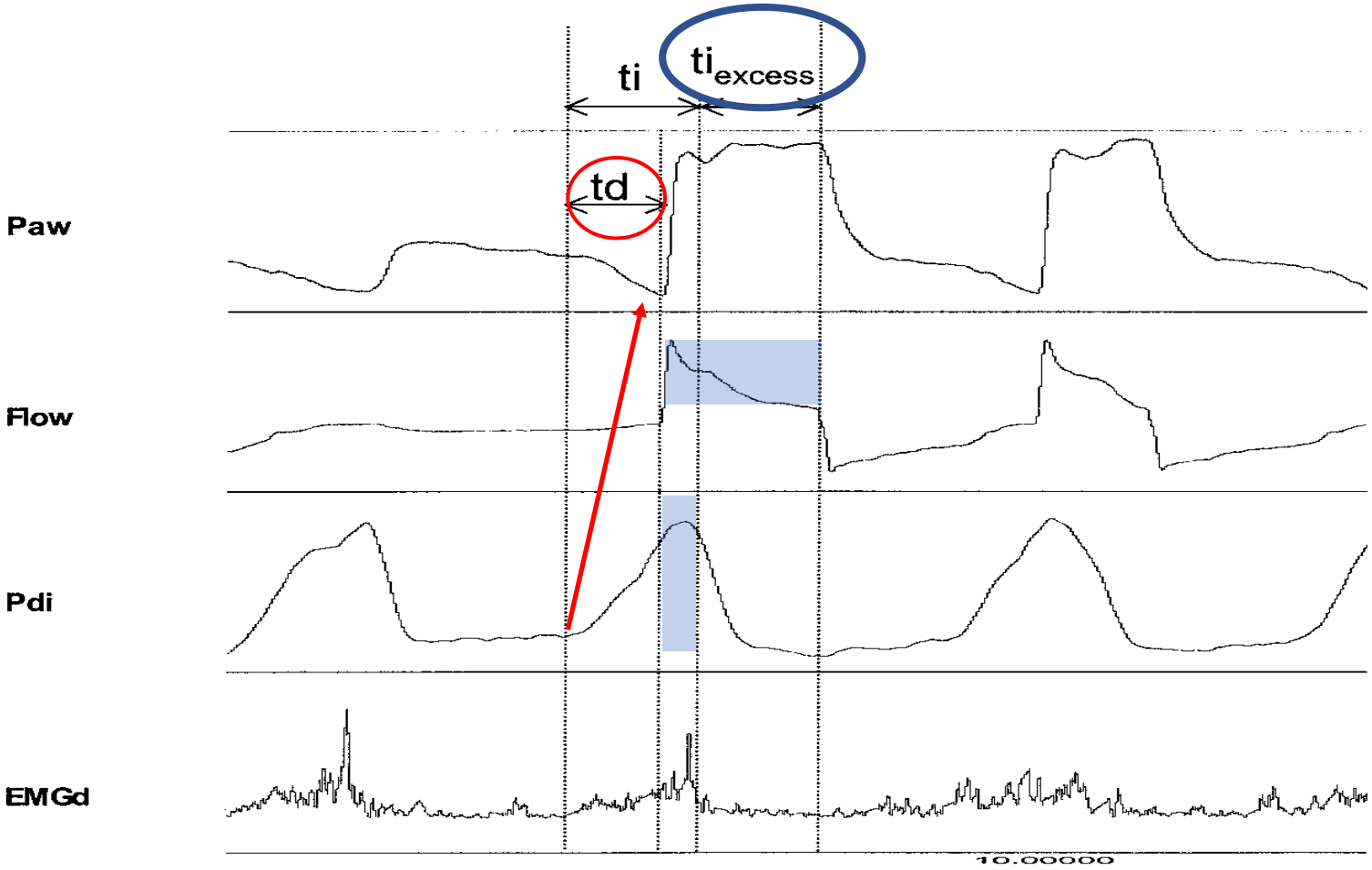


Thille ICM 2006

Réglage du trigger inspiratoire



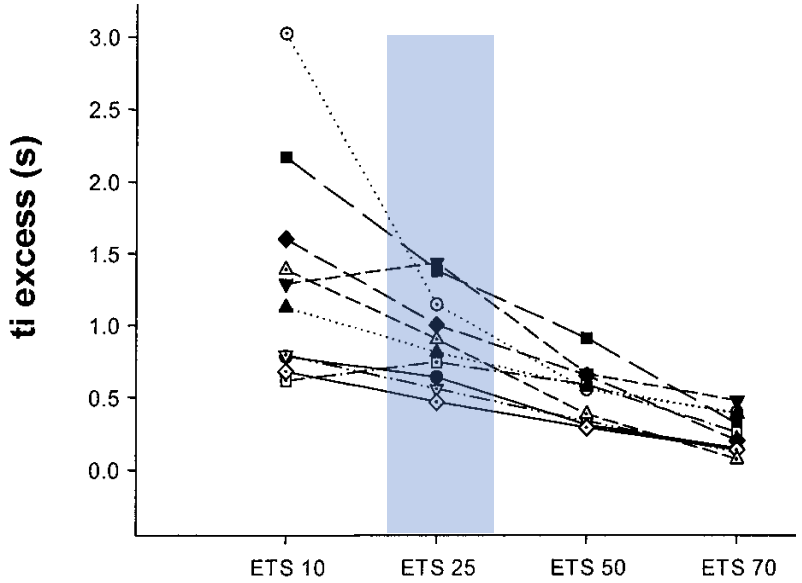
Limiter les efforts inefficaces: **réglage du trigger expi**

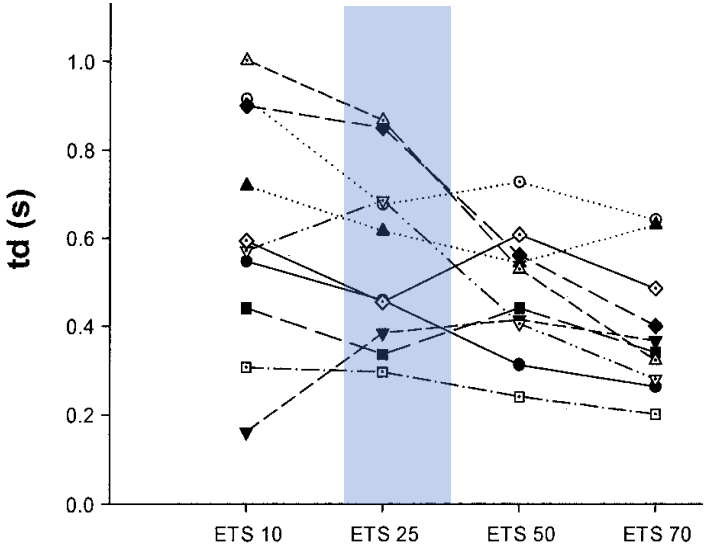


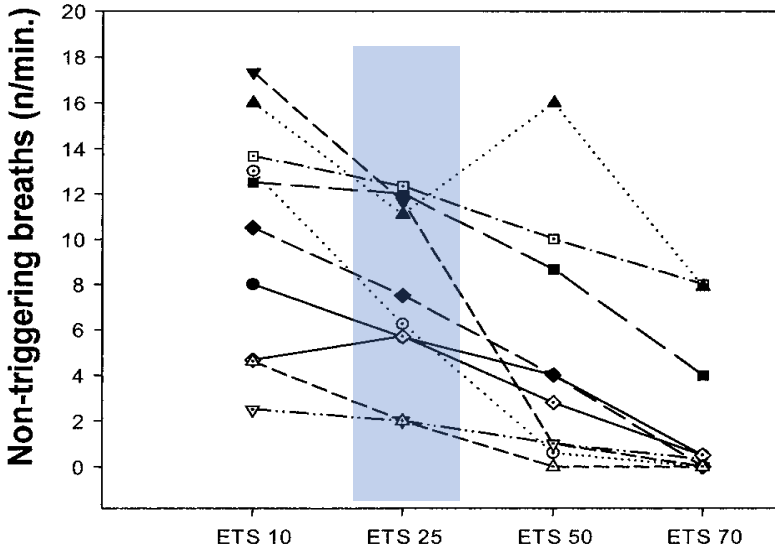
Durée de l'effort

Tassaux AJRCCM 2005

Variation du trigger Expi







- ↘ durée pressurisation
- Favorise cyclage
- ↘ PEEPi
- Amélioration trigger
- < 25% désynchronisation

Tassaux AJRCCM 2005

Résumé: Efforts Inefficaces

- Optimiser le Trigger inspiratoire
  - Trigger en Débit +++
  - Adapter le seuil
- Optimiser le cyclage
  - Augmenter le trigger expiratoire (40%)
  - Utiliser un Ti_{max}
- Lutter contre l'autoPEEP
  - Éviter sur-assistance → surdistension
  - $PEEP_{ext}$ proche de l'autoPEEP

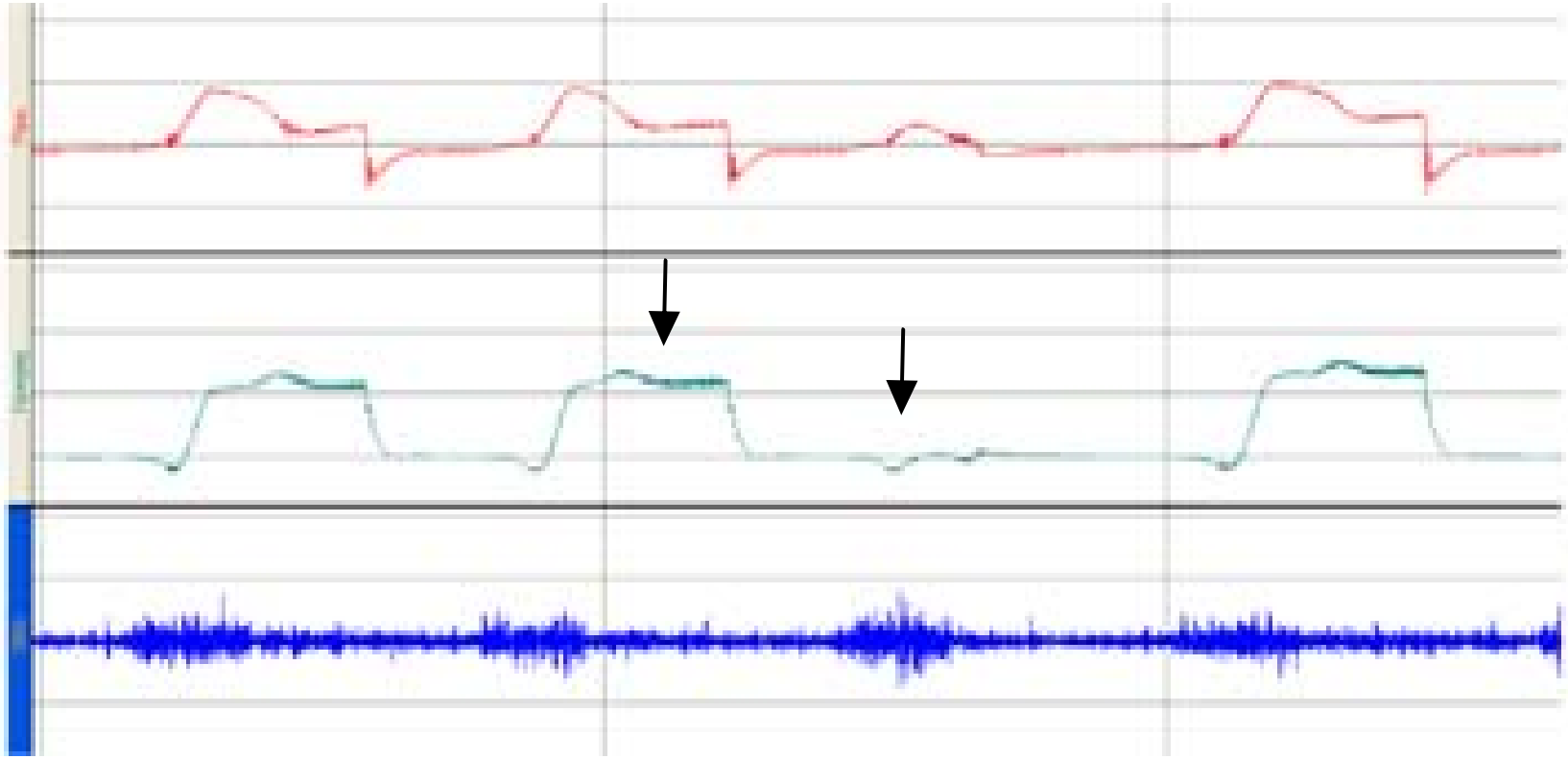
Cycle trop long

Late cycling and in effective triggering

V'

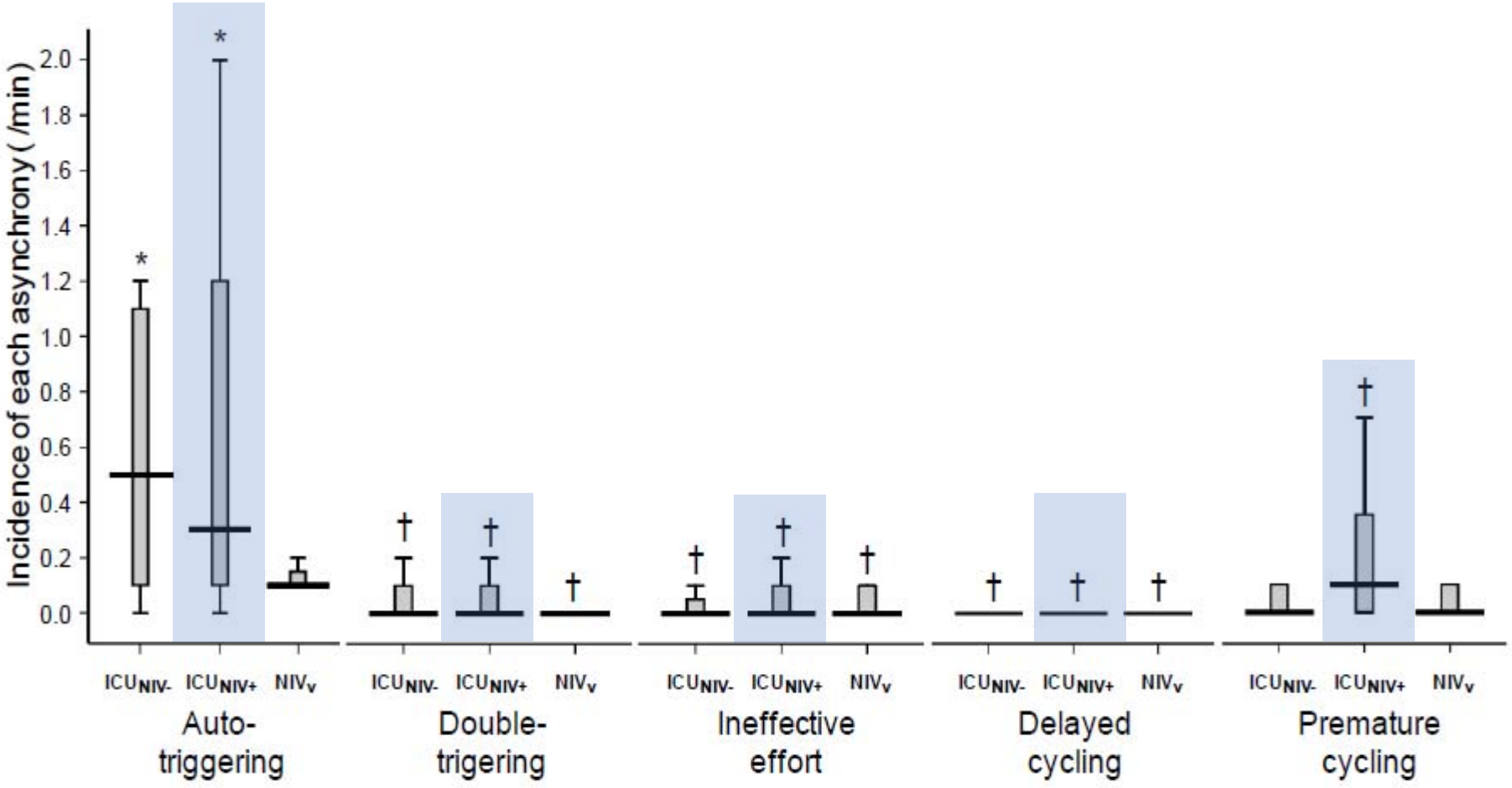
Paw

EMG_{di}



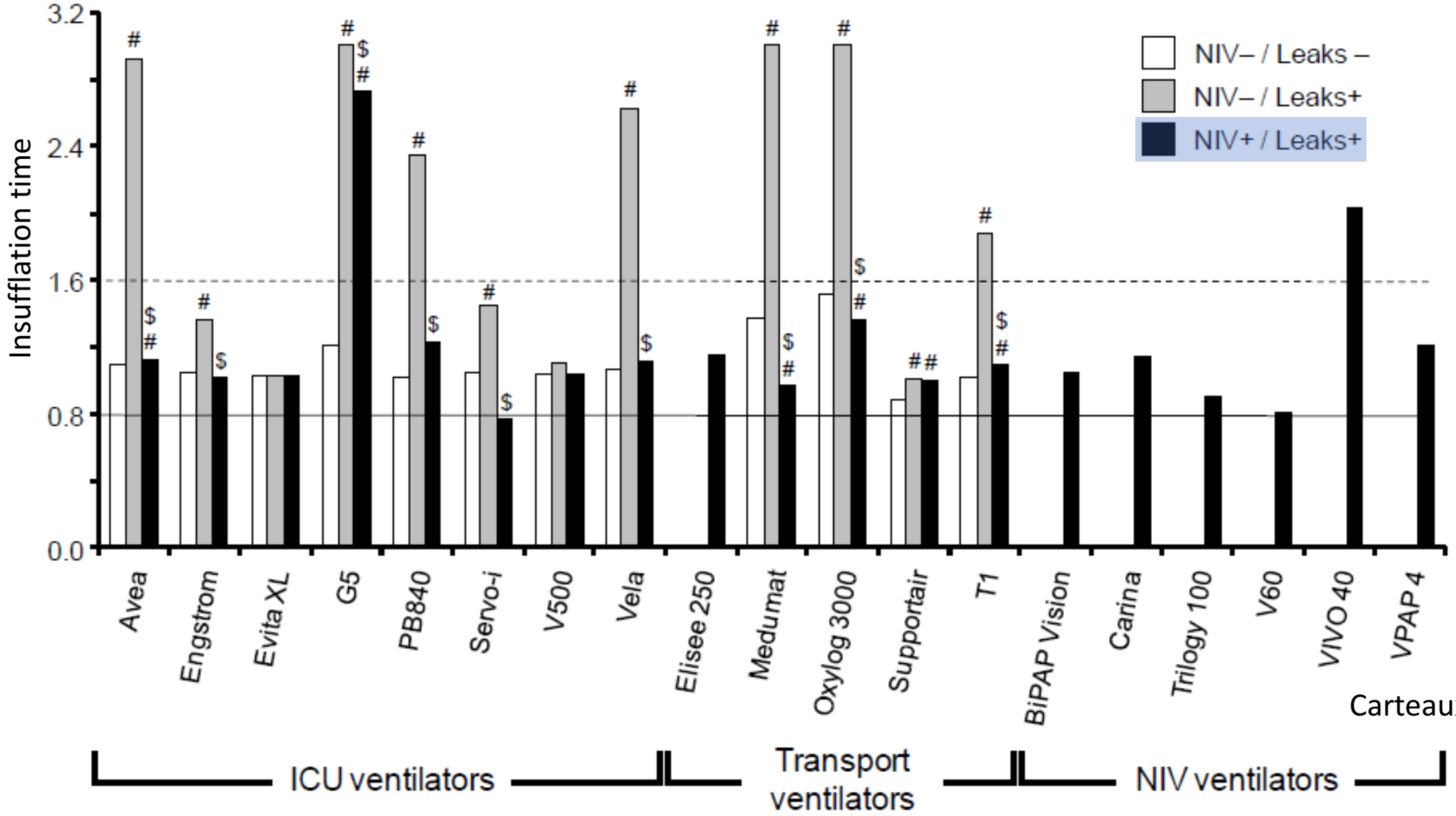
Vignaux ICM 2009

Utiliser le mode VNI du ventilateur !



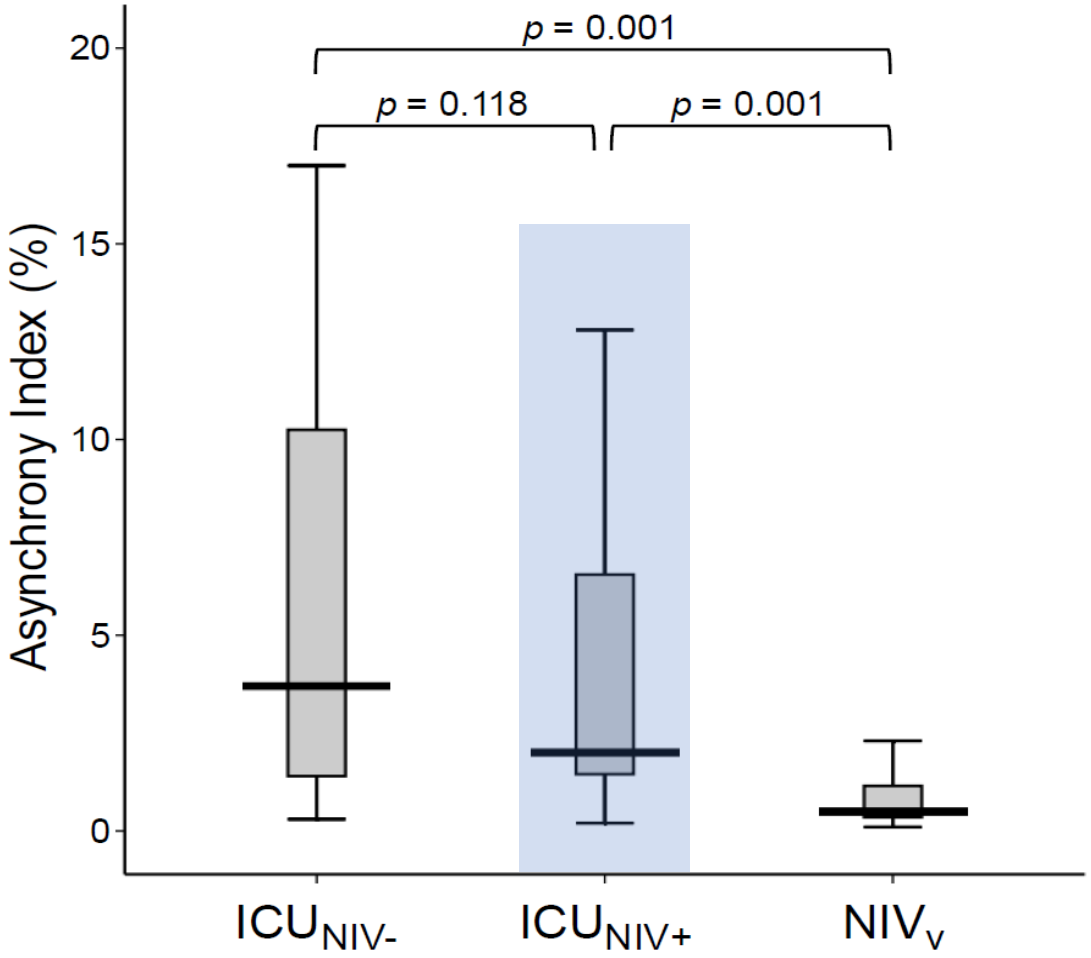
Carteaux Chest 2013

Activer le mode VNI & Limiter les fuites



Carteaux Chest 2012

Utiliser le mode VNI du ventilateur !



	NIV0 *n* (%)	NIV+ *n* (%)
Auto triggering	14 (22)	10 (15)
Ineffective efforts	15 (23)	5 (8)*
Late cycling	11 (17)	5 (8)*
Premature cycling	22 (34)	21 (32)
Double triggering	3 (5)	6 (9)
Asynchrony index (AI)	30 (46)	25 (38)
AIleaks	18 (28)	8 (12)*

Vignaux ICM 2010

Sédation et VNI

Intensive Care Med (2015) 41:1586–1600
DOI 10.1007/s00134-015-3854-6

ORIGINAL

CrossMark

Alfonso Muriel
Oscar Peñuelas
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Alejandro C. Arroliga
Victor Abraira
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Laurent Brochard
Nicolás Nin

Impact of sedation and analgesia during noninvasive positive pressure ventilation on outcome: a marginal structural model causal analysis

À partir d'Esteban et al. AJRCCM 2013

Non-invasive positive pressureventilation as firstsupport
N = 1169

	Failure NPPV (%)	Crude (GEE model)		Adjusted by age, SAPS II, interface for NPPV, reason for NPPV, RASS, pH and $PaCO_2$	
		Odds ratio (95 % CI)	*p* value	Odds ratio (95 % CI)	*p* value
Non-sedoanalgesia	31	1		1	
Analgesia	36	1.5 (1.0–2.3)	0.063	1.8 (0.6–5.4)	0.266
Sedation	47	2.3 (1.3–3.9)	0.003	2.8 (0.8–9.4)	0.095
Sedation and Analgesia	51	6.6 (3.3–12.8)	<0.001	5.7 (1.8–18.4)	0.004

Non-sedoanalgesia	Analgesia	Sedation	Analgesia &Sedation
N = 677 (80%)	N = 88 (10%)	N = 44 (5%)	N = 33 (4%)
Failure NPPV: 31%	*Failure NPPV: 36%*	*Failure NPPV: 47%*	*Failure NPPV: 51%*
28-day Mortality: 23%	*28-day Mortality: 35%*	*28-day Mortality: 27%*	*28-day Mortality: 47%*

Muriel Intensive Care Med 2015

Intensive Care Med (2015) 41:1688–1691
DOI 10.1007/s00134-015-3935-6

EDITORIAL

Gilles Hilbert
Paolo Navalesi
Christophe Girault

Is sedation safe and beneficial in patients receiving NIV? Yes

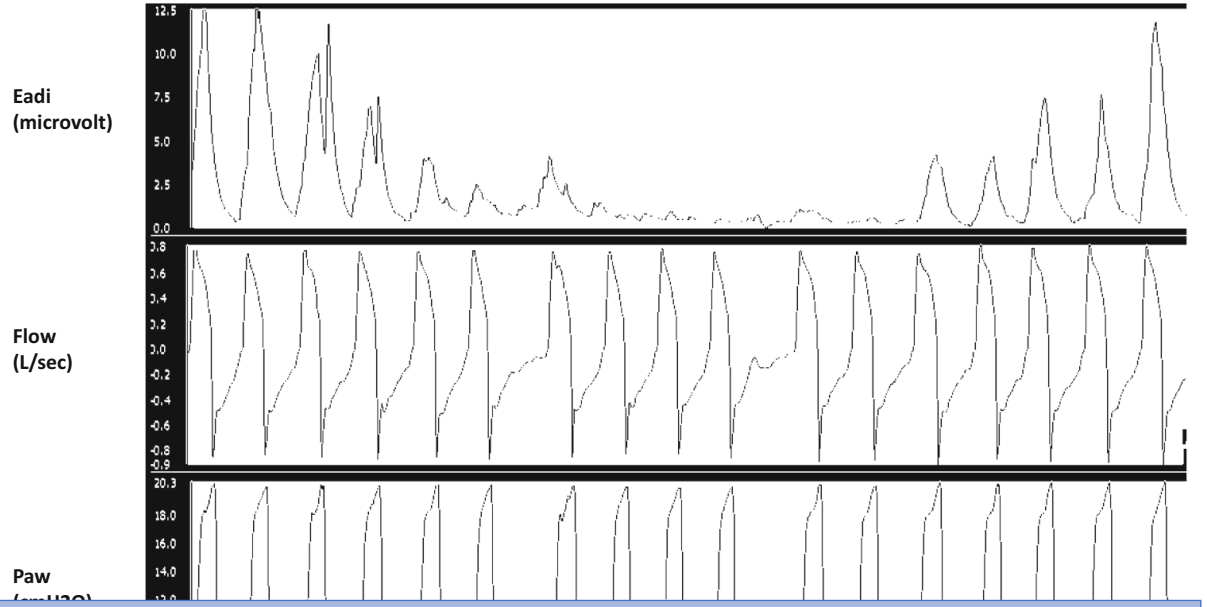
Intensive Care Med (2015) 41:1692–1695
DOI 10.1007/s00134-015-3915-x

EDITORIAL

Giorgio Conti
Nicholas S. Hill
Stefano Nava

Is sedation safe and beneficial in patients receiving NIV? No

- Choix de la drogue
- Choix de la dose
- Choix du timing d'administration



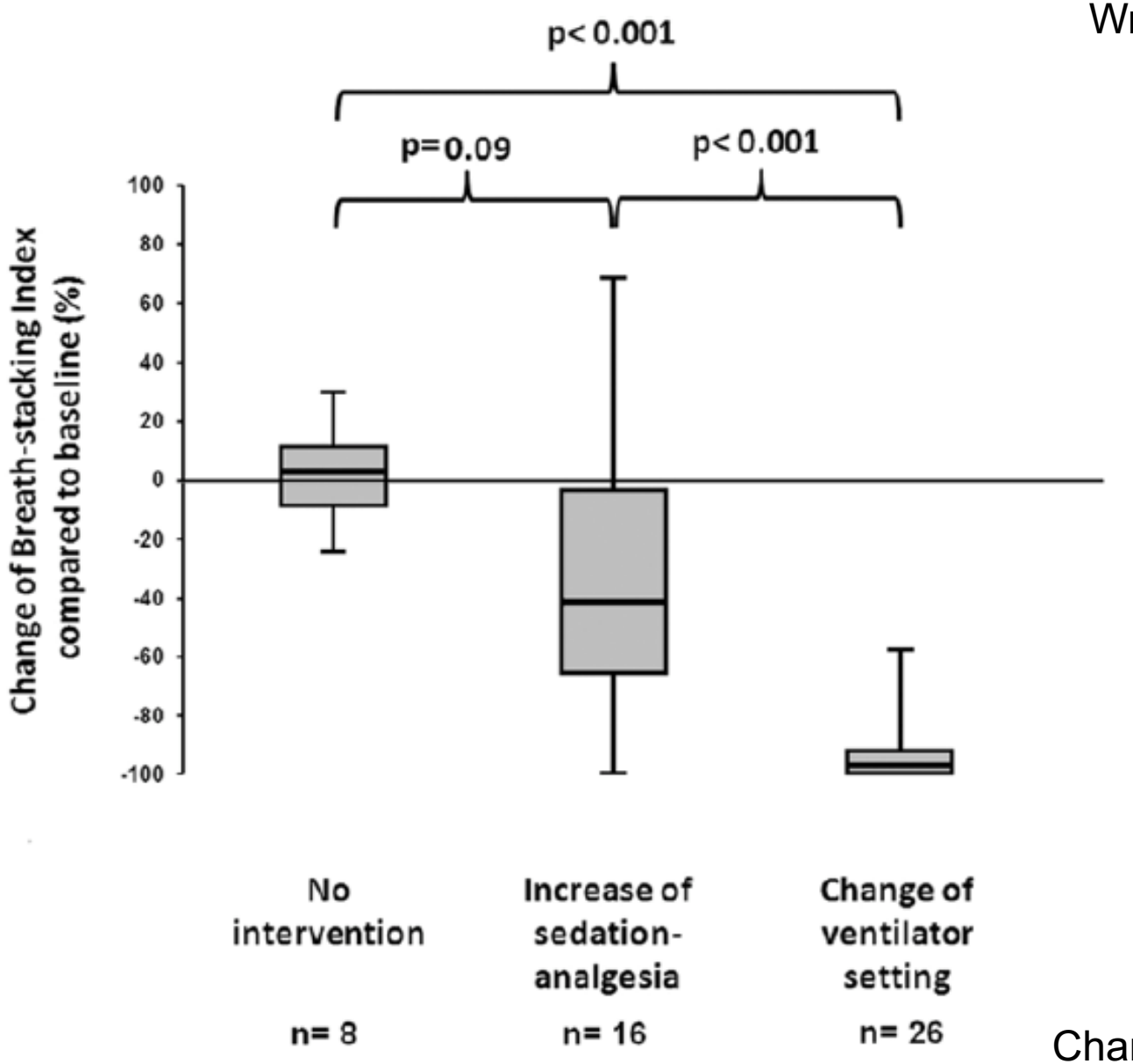
<u>Proposition</u>: intolérance du masque +/- manque de coopération

À discuter selon la capacité de surveillance

→ Objectif: Eviter l'intubation

« Adapt the ventilator not the patient »

Wrigge CCM 2013



Chanques CCM 2013

Optimization of ventilator setting by flow and pressure waveforms analysis during noninvasive ventilation for acute exacerbations of COPD: a multicentric randomized controlled trial

CRITICAL CARE

Di Marco 2011

DIAGNOSTIC	ACTION PROPOSÉE
• Auto-triggering	➢ ↘ fuites ou ↘ Se du TR_{inspi}
• Effort inefficace	➢ titrer PSV, TR_{inspi} et TR_{expi}, PEP
• Cycle long	➢ ↘ fuites, TR_{expi}, Ti_{max}
• Cycle court	➢ TR_{expi}
• PEPi	➢ PEPext

OHDH et IRA hypercapnique

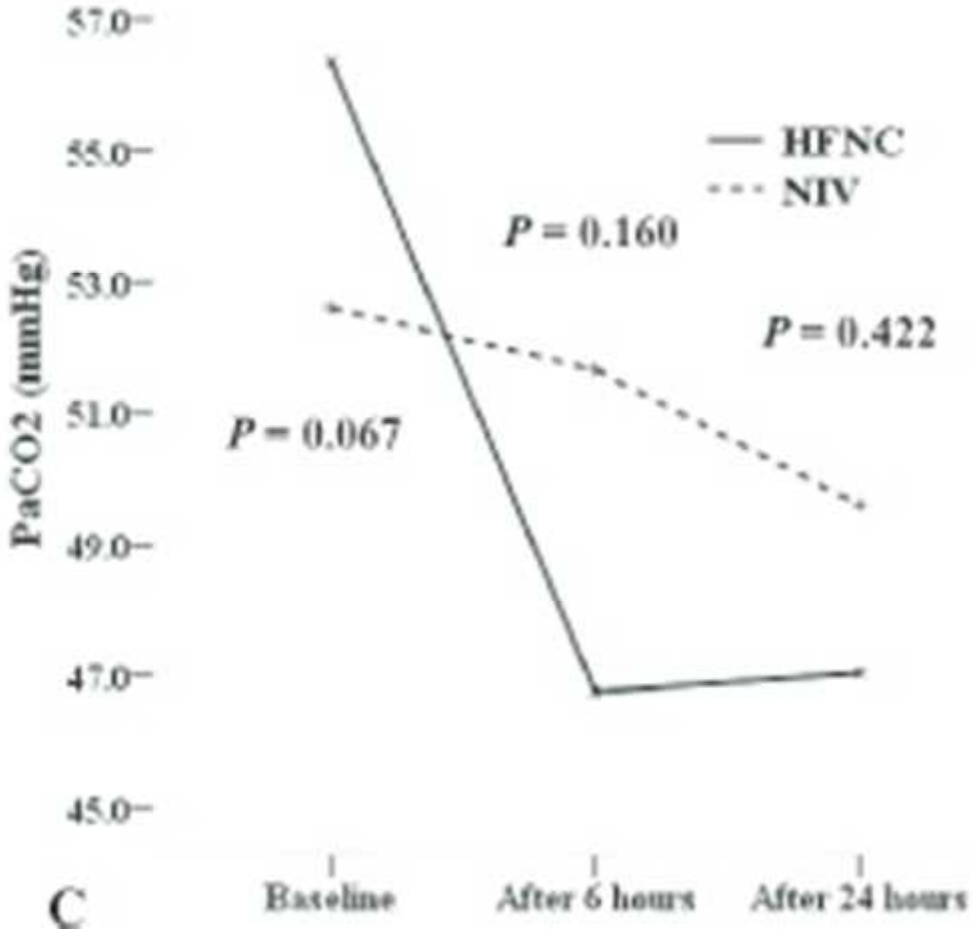
High flow nasal cannulae oxygen therapy in acute-moderate hypercapnic respiratory failure

Lee MK Clin respir J 2018

- Étude prospective observationnelle

Variables	Total (n=88)	HFNC (n=44)	NIV (n=44)	*P*-value
Clinical, median (IQR)				
Mean BP, mm Hg	92.3 (79.5-108.7)	90.5 (79.2-101.0)	99.5 (81.7-113.7)	0.242
PR, beats/min	106.5 (93.25-120)	106 (89.5-119.5)	106.5 (94.5-120)	0.277
RR, /min	24 (20.5-28)	24 (20-28)	24 (22-29)	0.235
Laboratory, mean ± SD*				
Oxygen saturation, %	89.1 ± 3.1	88.9 ± 3.0	88.2 ± 3.2	0.660
pH	7.32 ± 0.03	7.32 ± 0.28	7.31 ± 0.29	0.595
PaO2/FiO2, mm Hg	134.6 ± 7.4	134.8 ± 7.3	134.5 ± 7.5	0.877
$paCO_2$, mmHg	54.5 ± 9.6	56.4 ± 10.1	52.6 ± 8.8	0.067
Hb, g/dL	12.7 ± 2.2	12.5 ± 2.5	12.9 ± 1.7	0.342
Albumin, g/dL	3.4 ± 0.5	3.4 ± 0.5	3.4 ± 0.5	0.983
hs-CRP, mg/dL	8.6 ± 8.5	8.9 ± 8.0	8.2 ± 9.0	0.678

Outcomes, n (%)	HFNC (n=44)	NIV (n=44)	*P*-value	HR (or OR) (95% CI)
Intubation rate at day 30*	11 (25.0)	12 (27.3)	0.857	0.927 (0.409 – 2.102)
30-day mortality*	7 (15.9)	8 (18.2)	0.845	0.904 (0.328 – 2.493)
Duration of device application, days, median (IQR)	7.0 (5 – 10)	8.0 (6 – 10)	0.978	0.822 (-1.657 – 1.611)



Lee MK Clin respir J 2018

Mme G.

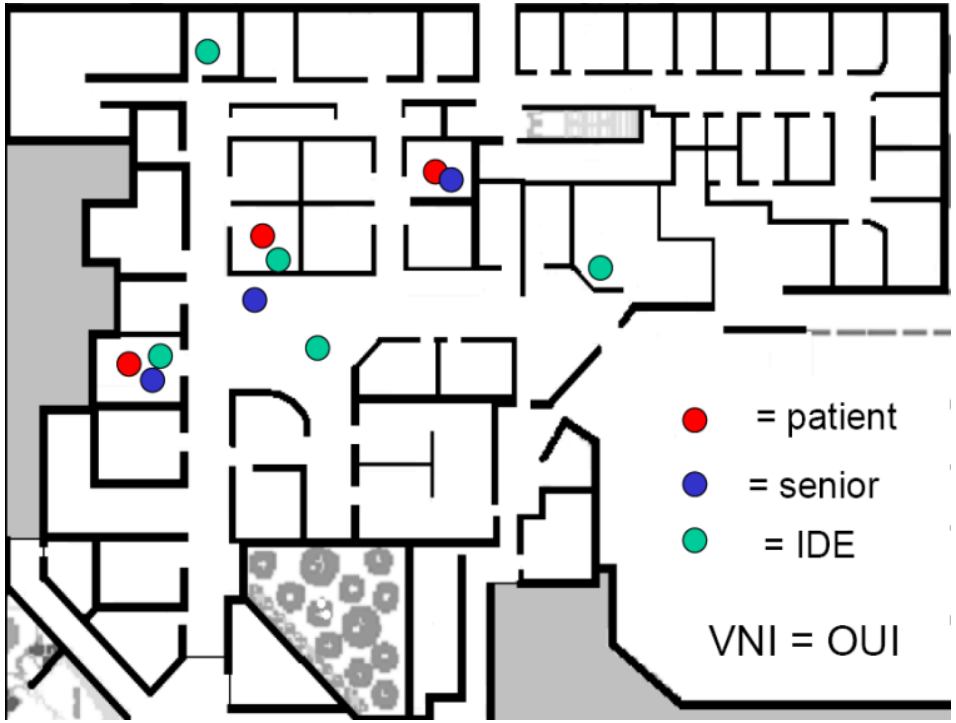
- 70 ans
- BPCO post-tabagique
- Cardiopathie ischémique stentée
- Pace maker

	GDS 1
pH	7,20
PaO_2	96 mmHg
$PaCO_2$	74 mmHg
SaO_2	93,6 %

- Désaturation SpO2= 86% en AA
- Glasgow 12
- ETT: FeVG 35%, pressions de remplissage augmentées
- BNP 1300pg/mL troponine US 450ng/mL

Conclusion

- Technique maitrisée
- Compromis EFFICACITÉ TOLÉRANCE
- Surveillance
- Réévaluation



Selon E L'her