réanimation 2023
PARIS 14-16 JUIN

Prévention de la Dysfonction Diaphragmatique durant la Ventilation Mécanique

Martin Dres

Sorbonne Université, INSERM, UMRS1158
Neurophysiologie Respiratoire Expérimentale et Clinique

AP-HP. Sorbonne Université
Groupe Hospitalier Universitaire Pitié-Salpêtrière
Médecine intensive Réanimation
Paris - France

MÉDECINE SORBONNE UNIVERSITÉ

Inserm
La science pour la santé
From science to health

UMR-S 1158
Inserm

ReVA

AP-HP. Sorbonne Université

Liens d'intérêt (depuis Mars 2020)

- Lungpacer Med Inc. (Board, travel fees, research)

Contribution au trafic aérien (depuis Mars 2022)

- Distance parcourue : 33 000 Km
- Equivalent 5 Tonnes de CO_2

Dysfonction diaphragmatique: causes et conséquences

Si l'histoire était simple….

En réanimation

Ventilation Mécanique

Repos forcé
Décharge excessive

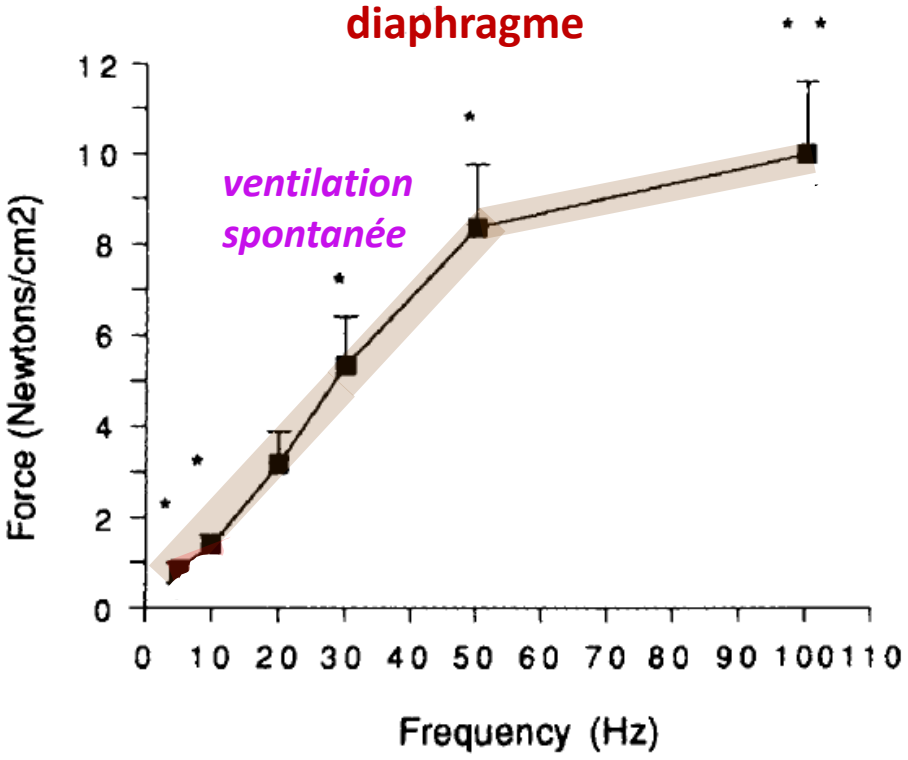
Dysfonction diaphragmatique

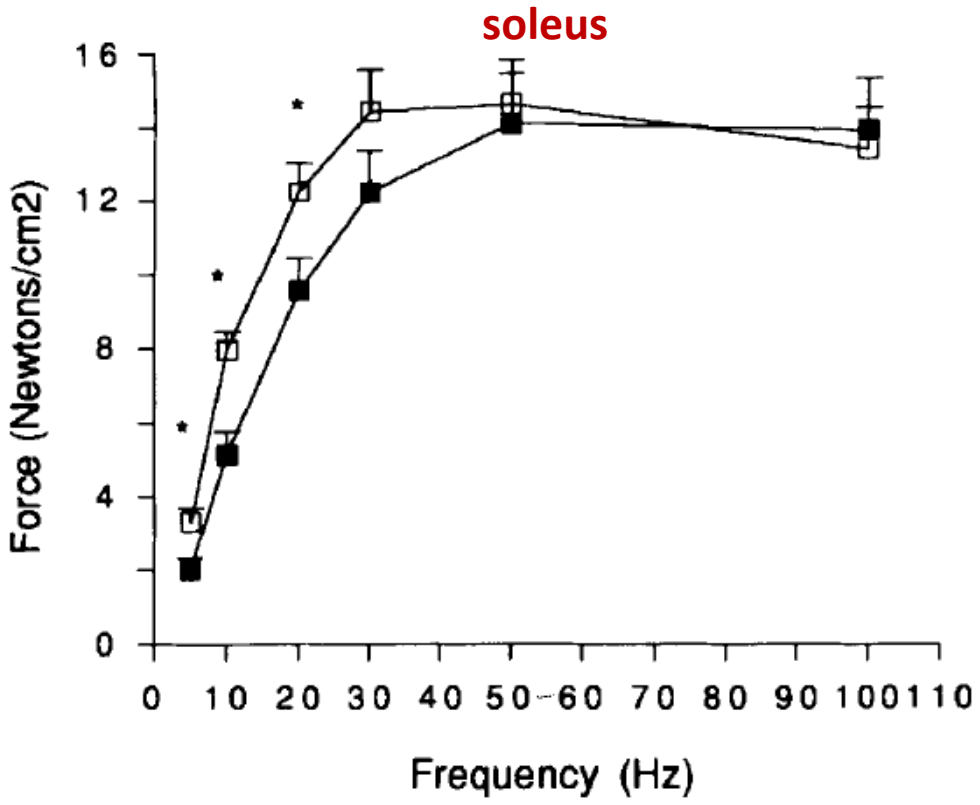
Thomas Pesquet "va vraiment bien"

Le médecin de l'astronaute français juge spectaculaire la vitesse à laquelle il récupère de ses 6 mois dans l'espace. Interview.
Source AFP

Effects of Mechanical Ventilation on Diaphragmatic Contractile Properties in Rats

GENEVIEVE LE BOURDELLES, NAÏMA VIIRES, JORGE BOCZKOWSKI, NATHALIE SETA, DRAGAN PAVLOVIC, and MICHEL AUBIER



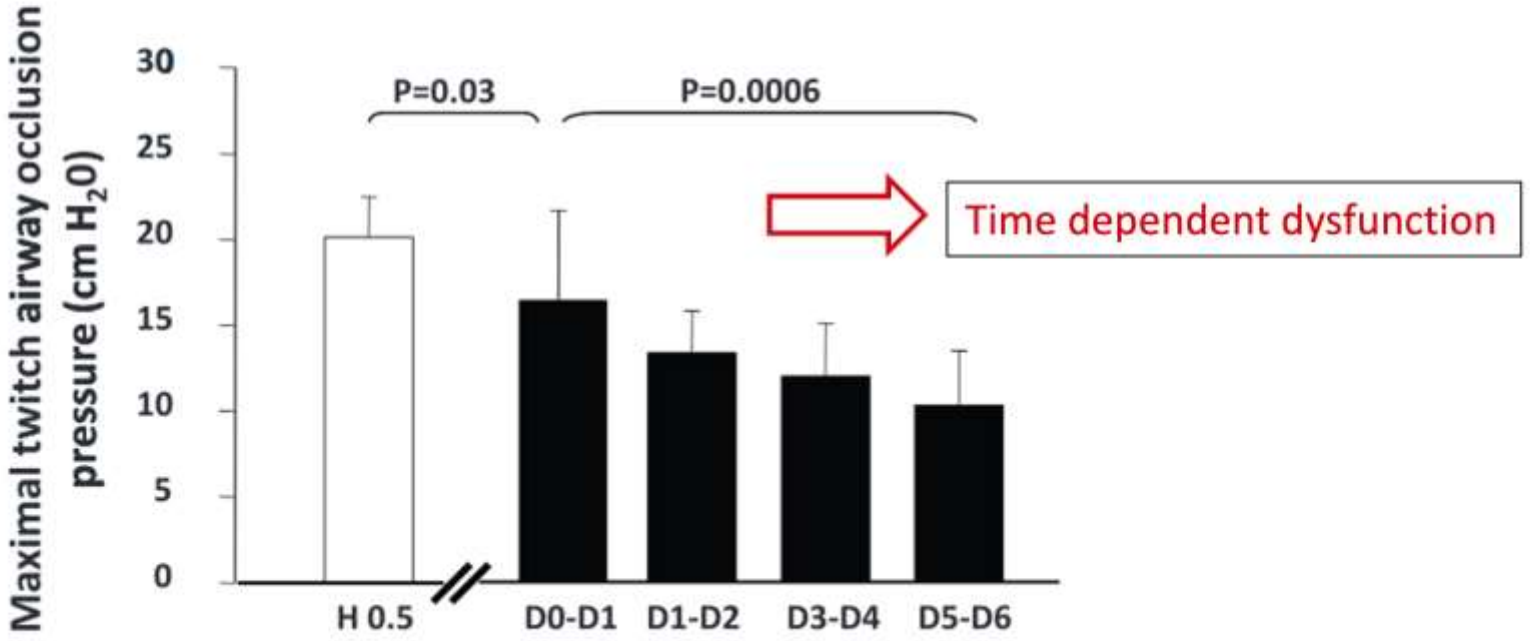


AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 149 1994

Dysfonction diaphragmatique: causes et conséquences

Rapidly Progressive Diaphragmatic Weakness and Injury during Mechanical Ventilation in Humans

Samir Jaber[1,2,6], Basil J. Petrof[3], Boris Jung[1,2], Gérald Chanques[1,2], Jean-Philippe Berthet[4], Christophe Rabuel[5], Hassan Bouyabrine[6], Patricia Courouble[1,2], Christelle Koechlin-Ramonatxo[7], Mustapha Sebbane[1,2], Thomas Similowski[8], Valérie Scheuermann[9], Alexandre Mebazaa[5], Xavier Capdevila[1,2], Dominique Mornet[2], Jacques Mercier[2,10], Alain Lacampagne[9], Alexandre Philips[2], and Stefan Matecki[2,10]



Am J Respir Crit Care Med Vol 183. pp 364–371, 2011

Dysfonction diaphragmatique: causes et conséquences

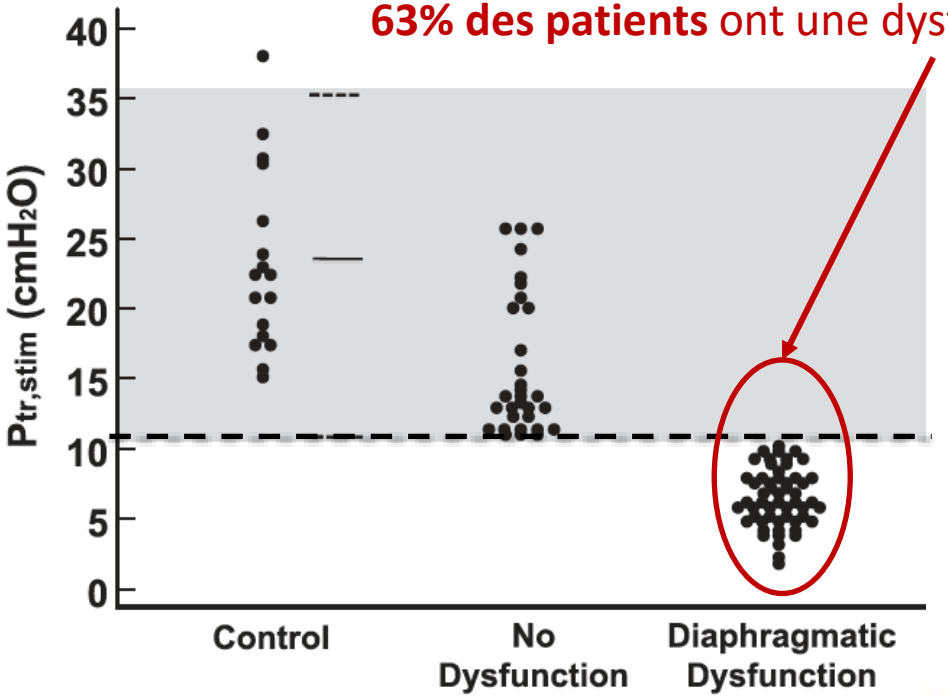
En vrai, l'histoire n'est pas si simple....

Diaphragm Dysfunction on Admission to the Intensive Care Unit

Prevalence, Risk Factors, and Prognostic Impact—A Prospective Study

Alexandre Demoule[1,2,3], Boris Jung[4,5], Hélène Prodanovic[2], Nicolas Molinari[6], Gerald Chanques[4,5], Catherine Coirault[3], Stefan Matecki[5,7], Alexandre Duguet[1,2], Thomas Similowski[1,2*], and Samir Jaber[4,5*]

63% des patients ont une dysfonction diaphragmatique!



dysfonction diaphragmatique

pas de dysfonction diaphragmatique

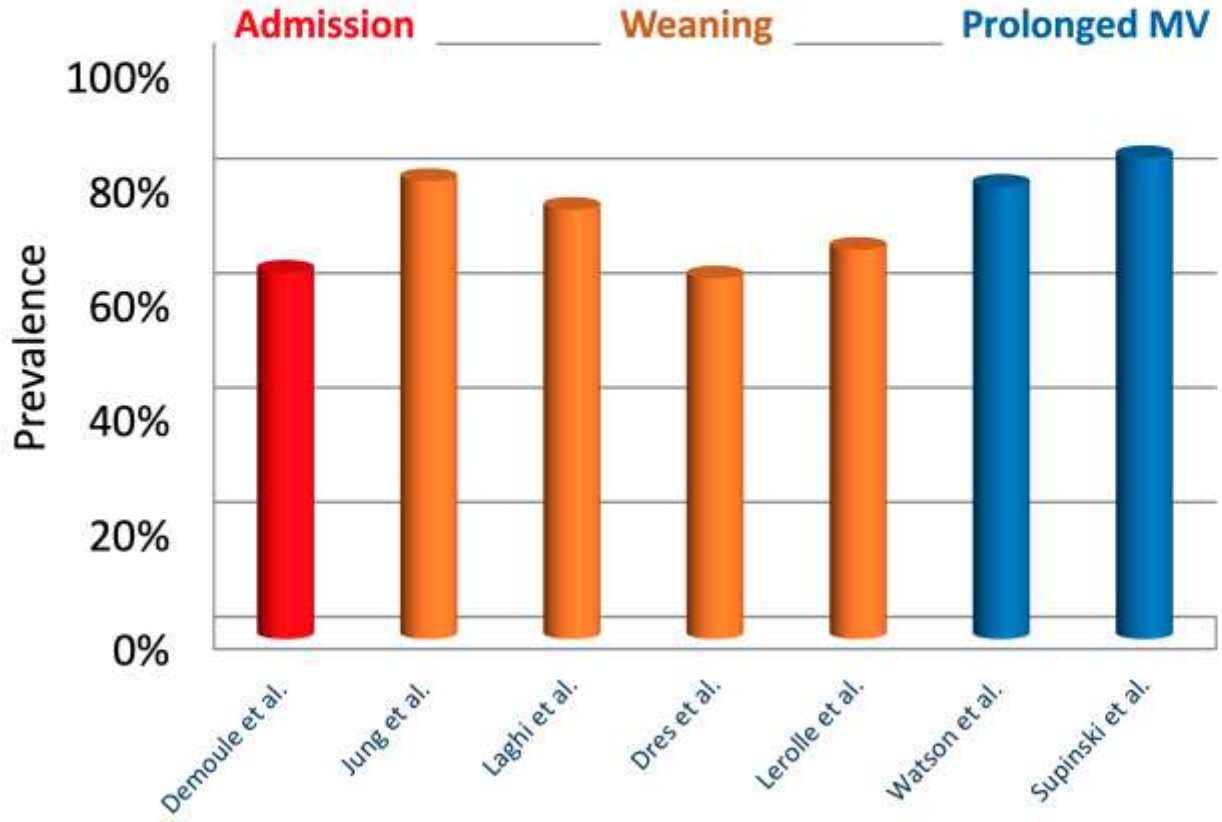
Am J Respir Crit Care Med Vol 188, Iss. 2, pp 213–219, Jul 15, 2013

Dysfonction diaphragmatique: au moment du sevrage

REVIEW

Critical illness-associated diaphragm weakness

Martin Dres[1,2,3*], Ewan C. Goligher[4,5], Leo M. A. Heunks[6] and Laurent J. Brochard[3,5]



Diaphragm dysfunction

> 60% of the patients

Dysfonction diaphragmatique: au moment du sevrage

Coexistence and Impact of Limb Muscle and Diaphragm Weakness at Time of Liberation from Mechanical Ventilation in Medical Intensive Care Unit Patients

Martin Dres[1,2*], Bruno-Pierre Dubé[1,3*], Julien Mayaux[2], Julie Delemazure[2], Danielle Reuter[2], Laurent Brochard[4,5], Thomas Similowski[1,2], and Alexandre Demoule[1,2]

	Overall Population (*n* = 76)	Diaphragm Dysfunction		
		Yes (*n* = 48)	No (*n* = 28)	*P* Value
Difficult weaning, n (%)	25 (33)	23 (48)	2 (7)	<0.001
Prolonged weaning, n (%)	8 (10)	8 (17)	0 (0)	0.02
Total duration of MV, d	5 (2–10)	7 (4–12)	4 (1–6)	0.04
Length of ICU stay, d	8 (4–15)	10 (5–16)	6 (3–10)	0.05
Length of hospital stay, d	21 (9–30)	23 (15–32)	18 (6–29)	0.09
ICU mortality, n (%)	8 (10)	8 (17)	0 (0)	0.02
Hospital mortality, n (%)	12 (16)	11 (23)	1 (4)	0.04

Am J Respir Crit Care Med Vol 195, Iss 1, pp 57–66, Jan 1, 2017

Dysfonction diaphragmatique

1. atteinte *fréquente* (2/3 des patients)
2. *inactivité* des muscles respiratoires
3. facteur de risque associés: *sepsis, état de choc*
4. association avec les *difficultés de sevrage*

quel(s) traitement(s)?

préventif *curatif*

Dysfonction diaphragmatique: quelle prévention?

Managing respiratory muscle weakness during weaning from invasive ventilation

Côme Bureau [1,2], Marine Van Hollebeke[3,4] and Martin Dres [1,2]

EUROPEAN RESPIRATORY REVIEW
SERIES
C. BUREAU ET AL.

Preventive strategy

Prevention of atrophy: lung and diaphragm protective ventilation

Limit duration and degree of respiratory muscle inactivity: maintaining inspiratory efforts with spontaneous breathing

Optimising diaphragm effort and synchrony:

- Injurious efforts: insufficient assists, high effort, high drive
- Eccentric injury: expiratory dysynchrony
- Longitudinal atrophy: excessive positive expiratory pressure
- Disuse atrophy: excessive assist, low effort, low drive

Utilisation of proportional modes

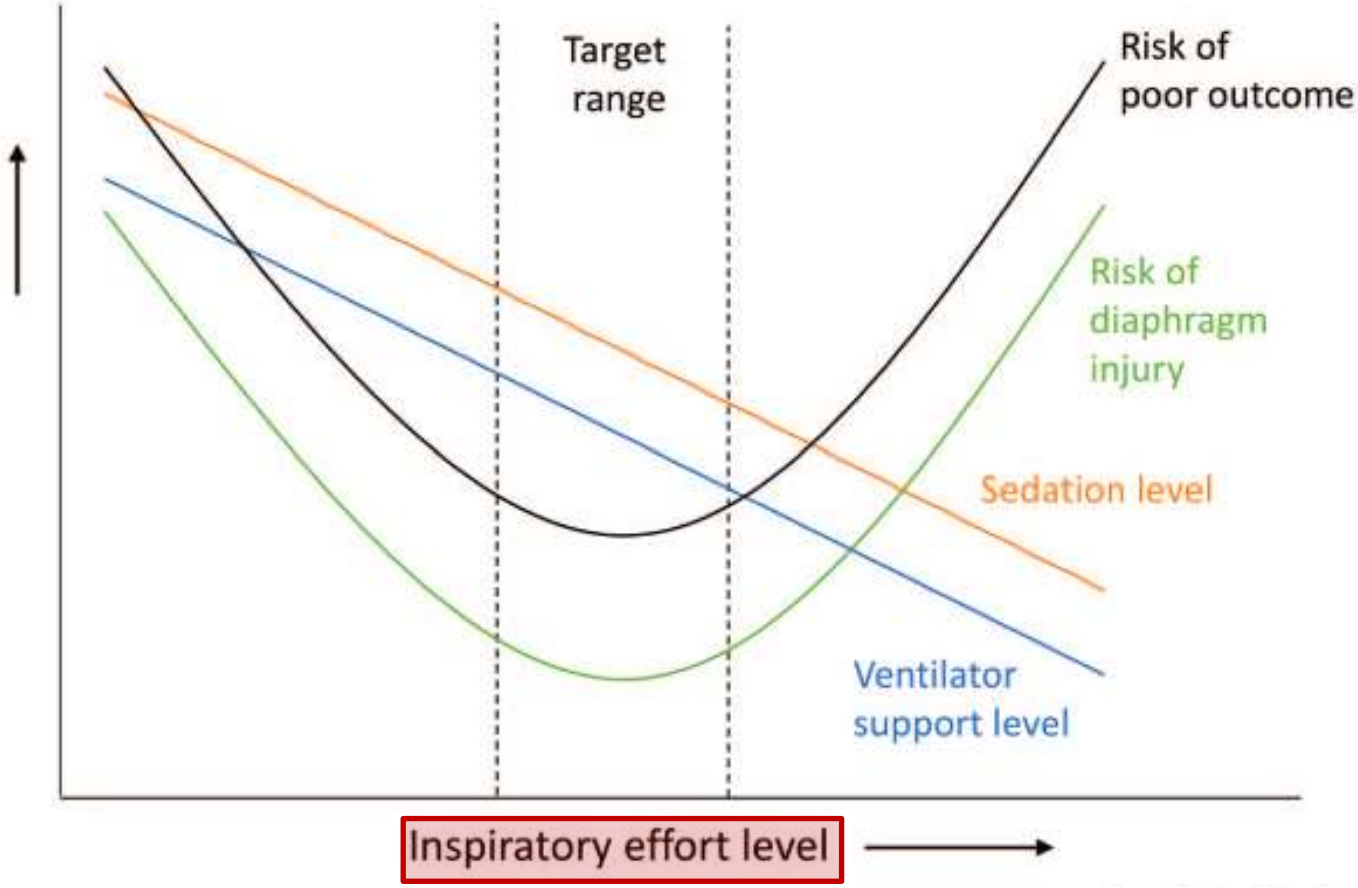
Prevent myotoxic drugs

Phrenic nerve pacing (experimental and clinical data; not in routine)

Dysfonction diaphragmatique: quelle prévention?

Diaphragm-protective mechanical ventilation

Tom Schepens[a], Martin Dres[b,c], Leo Heunks[d], and Ewan C. Goligher[e,f,g]



Curr Opin Crit Care 2019, 25:77–85

Dysfonction diaphragmatique: recherche d'un compromis

Lung- and Diaphragm-Protective Ventilation

Ewan C. Goligher[1,2,3], Martin Dres[4,5], Bhakti K. Patel[6], Sarina K. Sahetya[7], Jeremy R. Beitler[8], Irene Telias[1,2,9], Takeshi Yoshida[10], Katerina Vaporidi[11], Domenico Luca Grieco[12,13], Tom Schepens[14], Giacomo Grasselli[15,16], Savino Spadaro[17], Jose Dianti[1,2,18], Marcelo Amato[19], Giacomo Bellani[20], Alexandre Demoule[4,5], Eddy Fan[1,2,3,21], Niall D. Ferguson[1,2,3,21,22], Dimitrios Georgopoulos[11], Claude Guérin[23], Robinder G. Khemani[24,25], Franco Laghi[26,27], Alain Mercat[28], Francesco Mojoli[29], Coen A. C. Ottenheijm[30], Samir Jaber[31], Leo Heunks[32*], Jordi Mancebo[33*], Tommaso Mauri[13,14], Antonio Pesenti[13,14], and Laurent Brochard[1,9*]; for the Pleural Pressure Working Group, Acute Respiratory Failure Section of the European Society of Intensive Care Medicine

Goal	Potential Therapeutic Target*
Prevent overassistance myotrauma	Any 1 of: Pmus $\geq$ 3 to 5 cm H_2O ΔPdi $\geq$ 3 to 5 cm H_2O ΔPes $\leq$ −3 to −2 cm H_2O $P_{0.1}$ > 1 to 1.5 cm H_2O TFdi $\geq$ 15% EAdi $\geq$ target value selected on the basis of Pocc-EAdi index and above targets
Prevent underassistance myotrauma	Any 1 of: Pmus $\leq$ 10 to 15 cm H_2O ΔPdi $\leq$ 10 to 15 cm H_2O ΔPes $\geq$ −12 to −8 cm H_2O Pocc $\geq$ −20 to −15 cm H_2O $P_{0.1}$ < 3.5 to 5 cm H_2O TFdi $\leq$ 30% to 40% EAdi $\leq$ limit value selected on the basis of Pocc-EAdi index and above targets

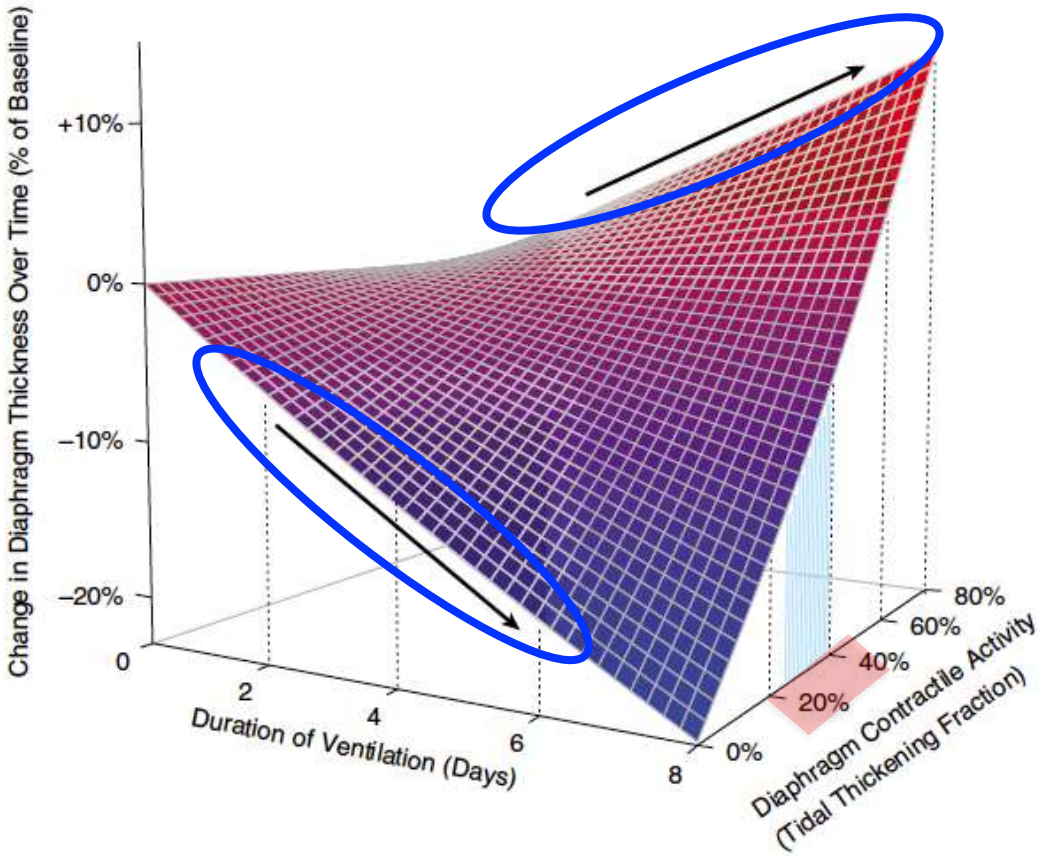
American Journal of Respiratory and Critical Care Medicine Volume 202 Number 7 | October 1 2020

Dysfonction diaphragmatique: recherche d'un compromis

Evolution of Diaphragm Thickness during Mechanical Ventilation

Impact of Inspiratory Effort

Ewan C. Goligher[1,2,3,4], Eddy Fan[1,2,4,5], Margaret S. Herridge[1,2,4,6], Alistair Murray[1,4], Stefannie Vorona[1,4], Debbie Brace[1,4], Nuttapol Rittayamai[1,7], Ashley Lanys[1,4,7], George Tomlinson[2], Jeffrey M. Singh[1,2,4], Steffen-Sebastian Bolz[3], Gordon D. Rubenfeld[1,2,5,8], Brian P. Kavanagh[1,3,9,10], Laurent J. Brochard[1,2,7], and Niall D. Ferguson[1,2,3,4,5,6]



Dysfonction diaphragmatique: causes et conséquences

Mechanical Ventilation–induced Diaphragm Atrophy Strongly Impacts Clinical Outcomes

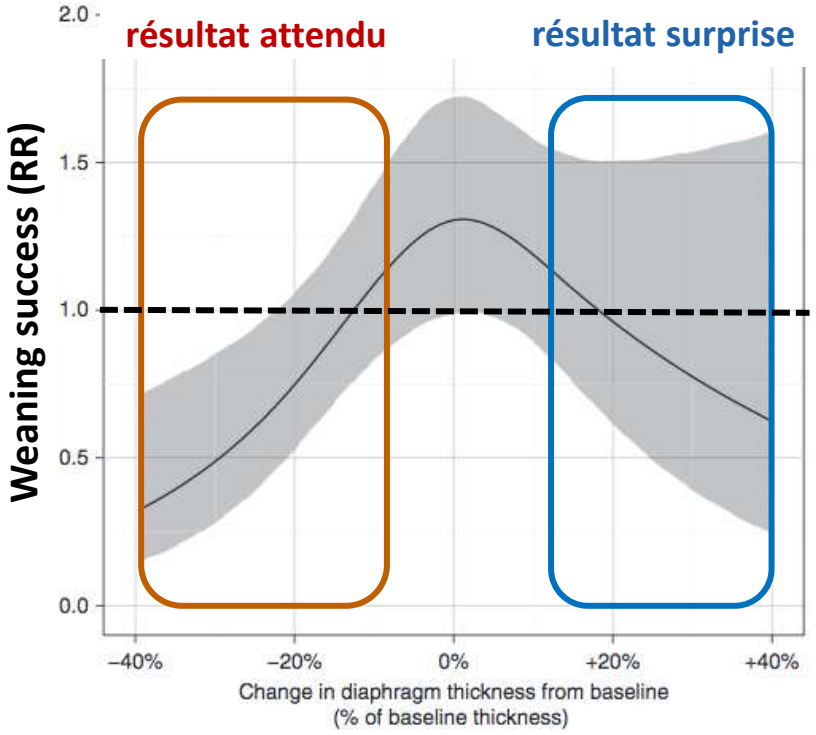
Ewan C. Goligher[1,2,3,4], Martin Dres[5,6], Eddy Fan[1,2,4,7], Gordon D. Rubenfeld[1,4,7,8], Damon C. Scales[1,4,7,8], Margaret S. Herridge[1,2,4,9], Stefannie Vorona[2], Michael C. Sklar[5,10], Nuttapol Rittayamai[5], Ashley Lanys[5], Alistair Murray[2], Deborah Brace[2], Cristian Urrea[2], W. Darlene Reid[11], George Tomlinson[2], Arthur S. Slutsky[1,4,5], Brian P. Kavanagh[1,3,10,12], Laurent J. Brochard[1,4,5*], and Niall D. Ferguson[1,2,3,4,7,9*]

191 patients under MV

↘ **épaisseur (atrophie)**
n=78 (41%)

⇆ **épaisseur**
n=66 (35%)

↗ **épaisseur**
n=47 (24%)



American Journal of Respiratory and Critical Care Medicine Volume 197 Number 2 | January 15 2018

Dysfonction diaphragmatique: recherche d'un compromis

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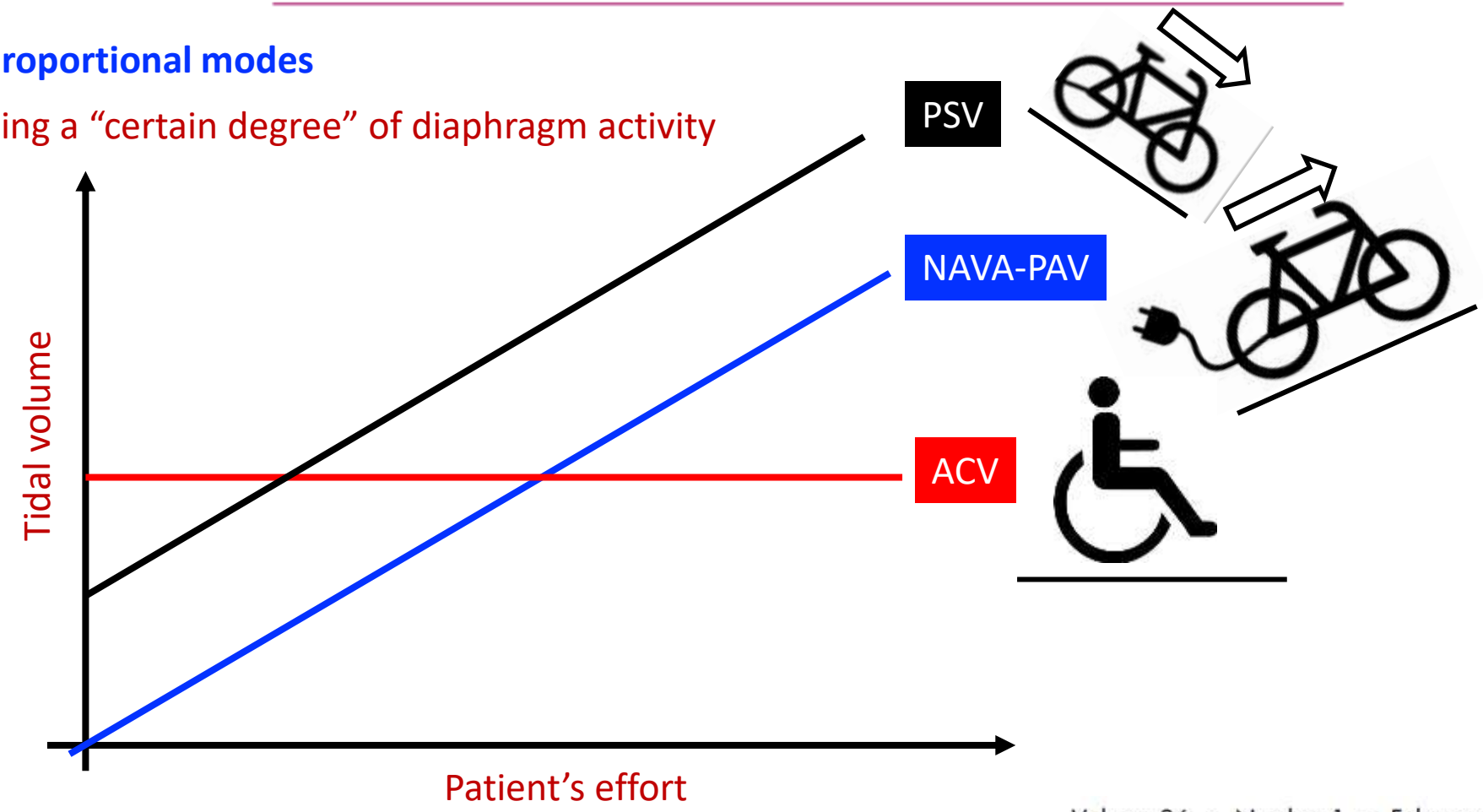
CURRENT OPINION

NAVA and PAV+ for lung and diaphragm protection

Katerina Vaporidi

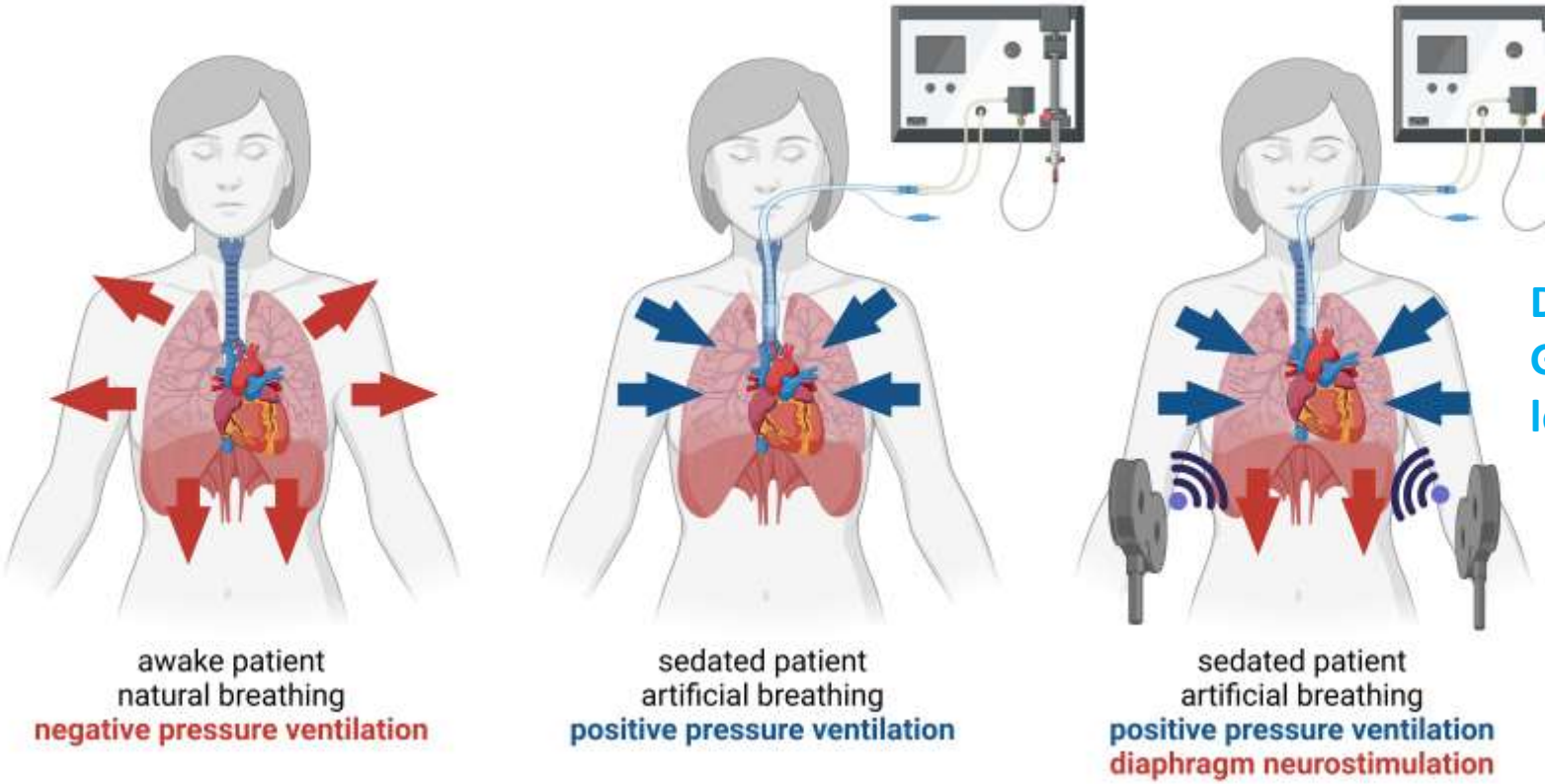
Role of proportional modes

Maintaining a "certain degree" of diaphragm activity



Volume 26 • Number 1 • February 2020

Dysfonction diaphragmatique: stimulation phrénique



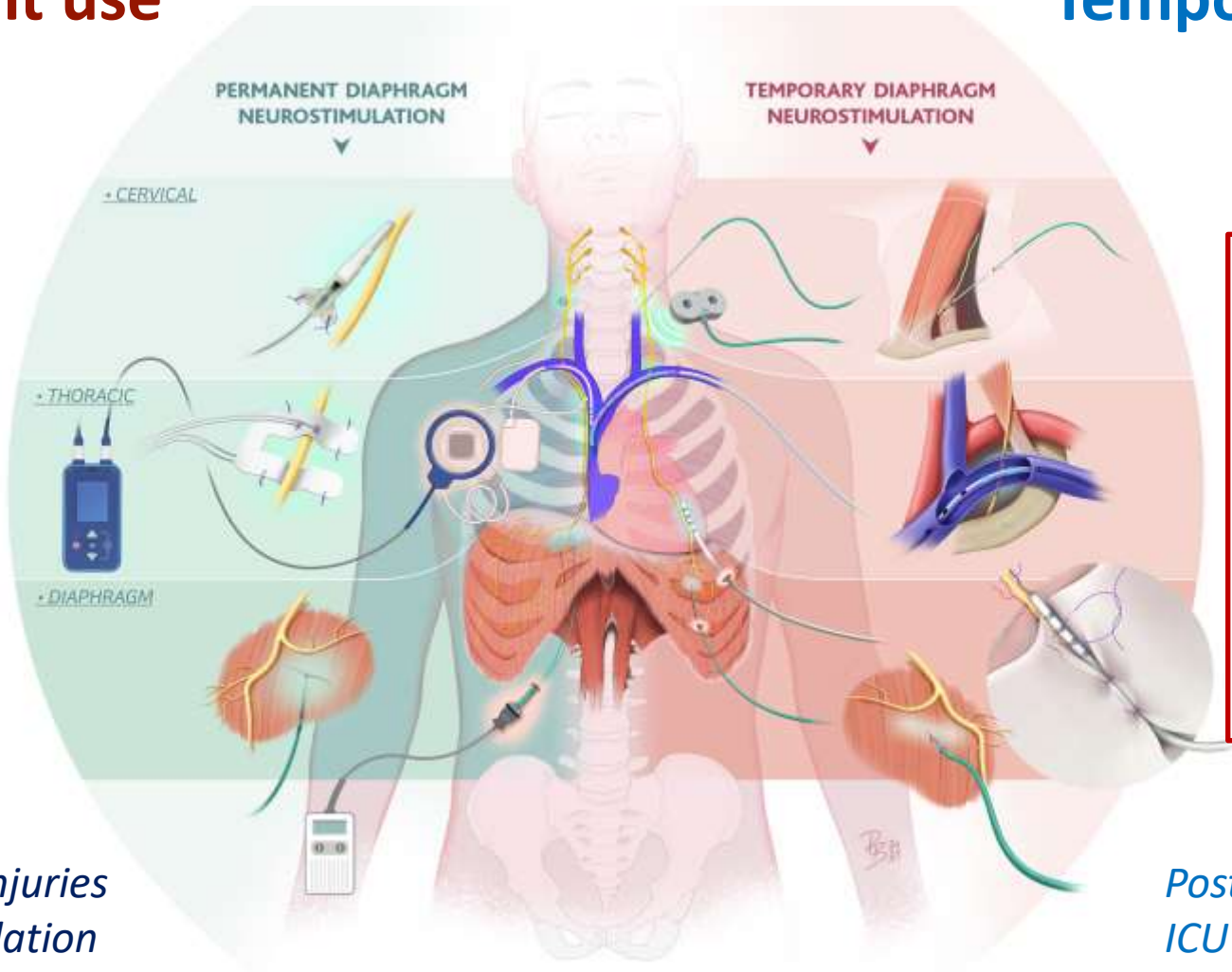
Diminuer la pression Générée par le ventilateur

Etienne et al. AJRCCM 2023

Dysfonction diaphragmatique: stimulation phrénique

Permanent use

Temporary use



Percutaneous

Transvenous

Per-operative

High spinal cord injuries
Central hypoventilation

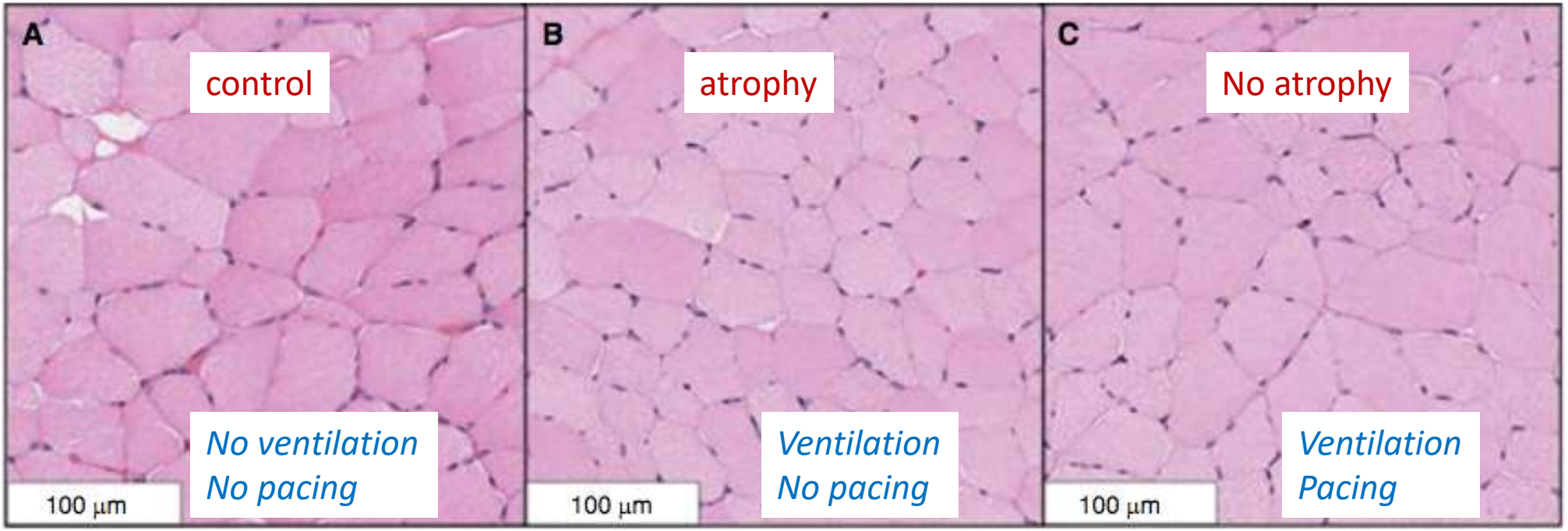
Post operative
ICU

Etienne et al. AJRCCM 2023

Dysfonction diaphragmatique: stimulation phrénique

Mitigation of Ventilator-induced Diaphragm Atrophy by Transvenous Phrenic Nerve Stimulation

Steven C. Reynolds[1,2,3], Ramasamy Meyyappan[4], Viral Thakkar[4], Bao D. Tran[4], Marc-André Nolette[4], Gautam Sadarangani[4], Rodrigo A. Sandoval[4], Laura Bruulsema[4,5], Brett Hannigan[4,5], Jason W. Li[5], Elizabeth Rohrs[2], Jason Zurba[2], and Joaquín Andrés Hoffer[4,5]



Am J Respir Crit Care Med Vol 195, Iss 3, pp 339–348, Feb 1, 2017

Dysfonction diaphragmatique: stimulation phrénique

Méd. Intensive Réa. 29(2020)(in press)
DOI : 10.37051/mir-00014

Médecine Intensive Réanimation

MISE AU POINT / *UPDATE*

Dysfonction diaphragmatique en réanimation : physiopathologie, diagnostic et prise en charge

Diaphragmatic dysfunction in Intensive Care Unit: physiopathology, diagnosis and treatment

Q. Fossé[1,2] • M. Dres[1,2*]