JAVA
CRETEIL

Fonction diaphragmatique au cours de la ventilation mécanique

Martin Dres

Unité de Réanimation Médicale
Service de Pneumologie et Réanimation
Groupe hospitalier Pitié-Salpêtrière Charles Foix
Université Pierre et Marie Curie

UMR-S 1158
Inserm UPMC

ASSISTANCE PUBLIQUE HÔPITAUX DE PARIS

Liens d'intérêt

- **Lungpacer Inc.**
- **Pulsion Medical System - Maquet**

Points abordés au cours de la présentation

- **Le diaphragme, fonction(s) et méthodes d'évaluation**
- **Dysfonction diaphragmatique : Prévalence et facteurs de risque**
- **Impact pronostique**

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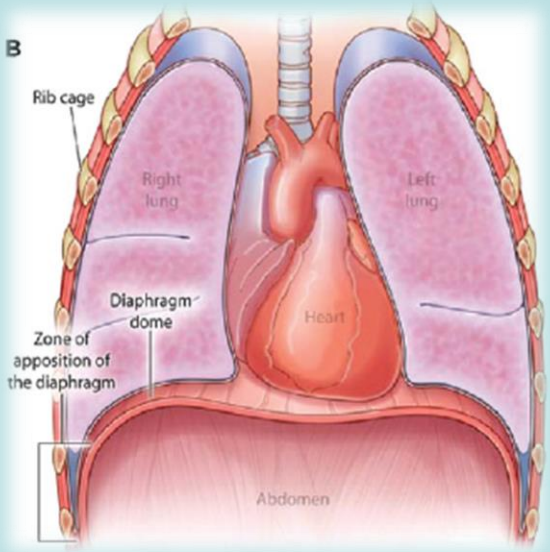
Le diaphragme en réanimation

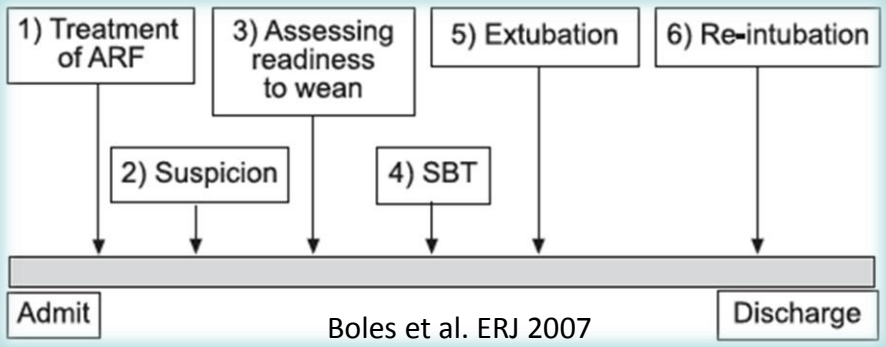


McCool and Tzelepis N Engl J Med 2012

insuffisance respiratoire aiguë

Perren et al. Intensive Care Med 2013

le sevrage



Boles et al. ERJ 2007

résolution IRA

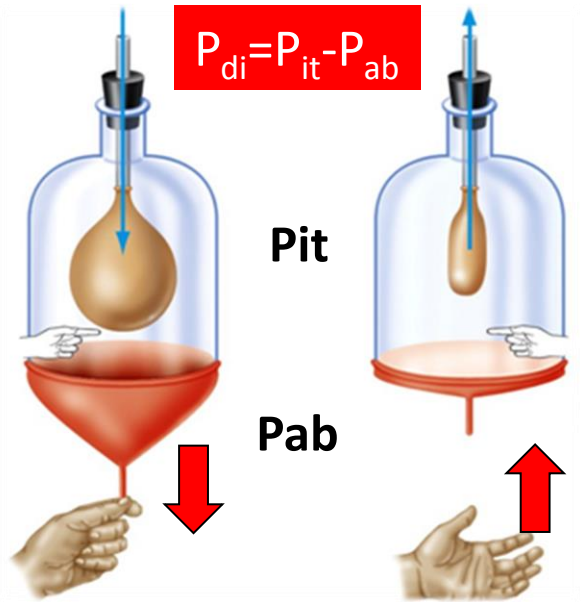
Le diaphragme: fonction(s)

- extra-ventilation (parturition, défécation, posture)
- **ventilation**

raccourcissement
production d'une ***force***

capacité à générer une pression

$P_{di}=P_{it}-P_{ab}$



pression transdiaphragmatique

- *avantage*:
contribution propre diaphragme

- *inconvénient*:
nécessite ballonnets oes/gas

autres approches

- *pression trachéale (stimulation phrénique)*
- *activité électrique diaphragmatique (EMG)*
- *mesure épaississement (échographie)*

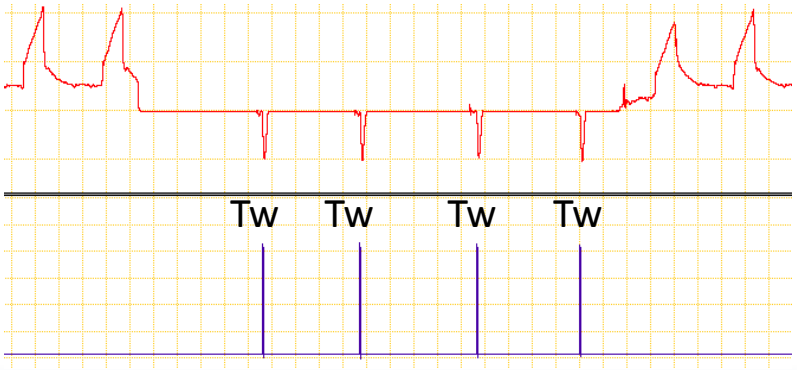
Le diaphragme: stimulation phrénique

Pressure generated by the diaphragm = Twitch pressure during magnetic stimulation

Independent of the patient's cooperation

Magnetic stimulators
Supramaximal intensity

cervical portion of
the phrenic nerves



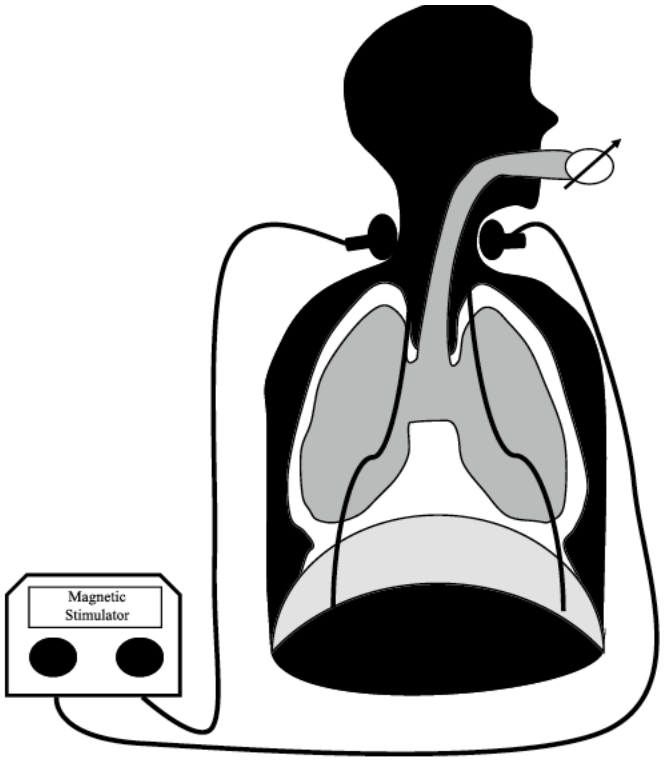
Airways Pressure
(surrogate of pleural pressure)
Watson et al. CCM 2001

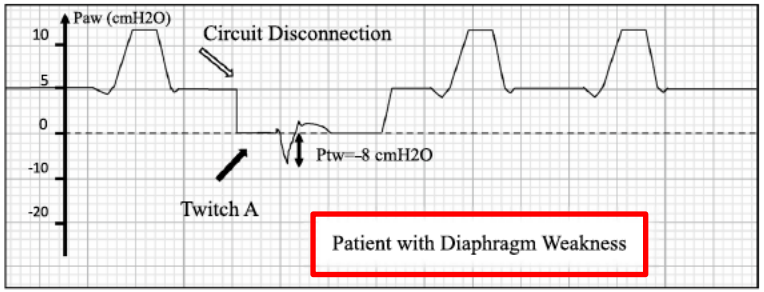
Le diaphragme: stimulation phrénique

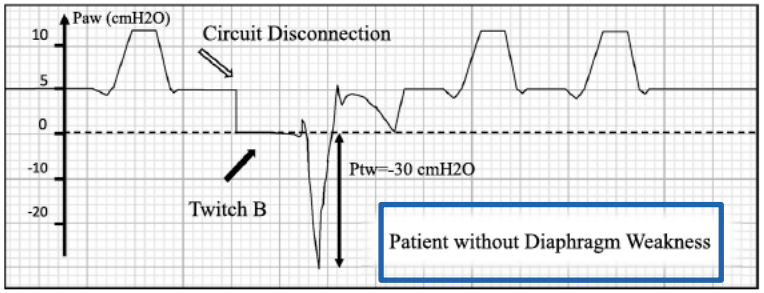
REVIEW

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]



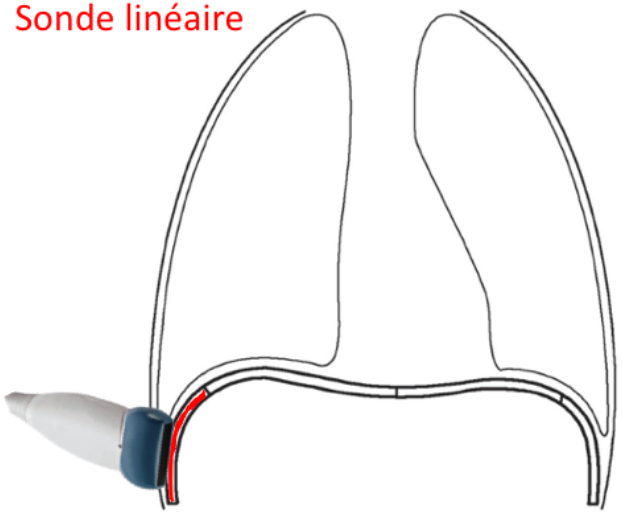




Dysfonction diaphragmatique
Ptw<-11 cmH_2O

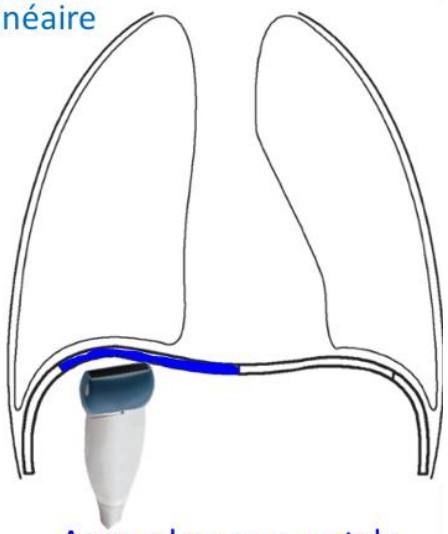
Le diaphragme: échographie

Sonde linéaire

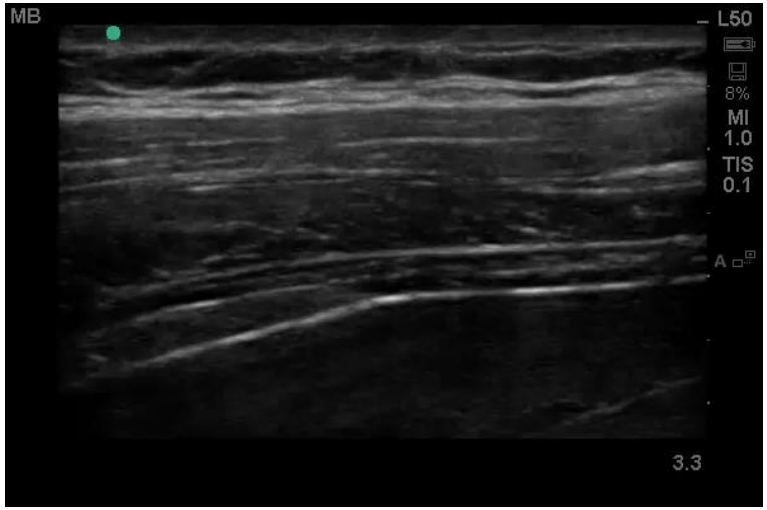


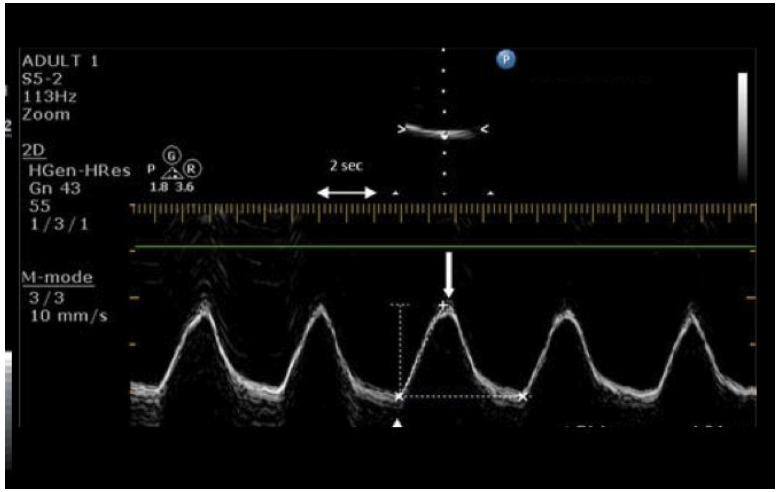
Approche intercostale
zone d'apposition

Sonde curvilinéaire



Approche sous-costale
dôme



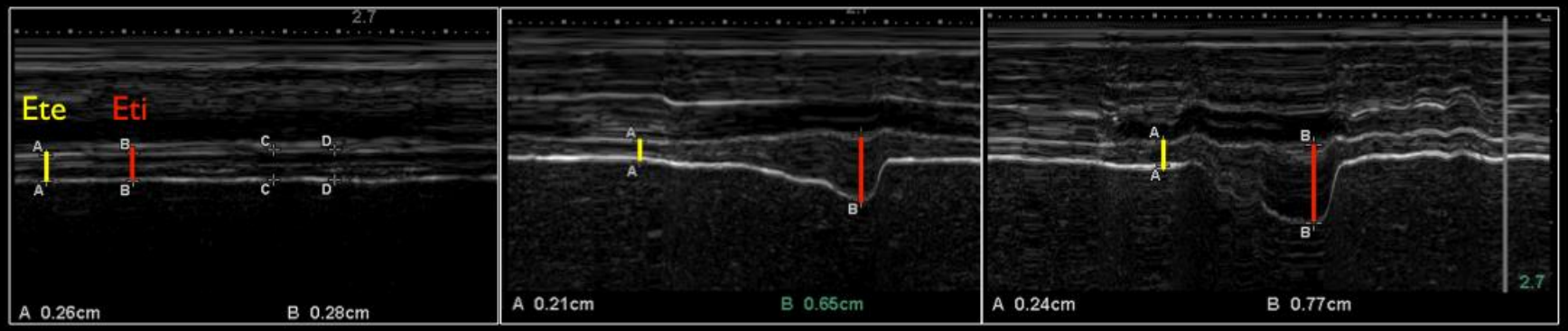


Le diaphragme: échographie

Approche intercostale

Mode Temps Mouvement (TM)

Mesure de l'épaisseur diaphragmatique **en fin d'expiration (E_{te})** et **en fin d'inspiration (E_{ti})**



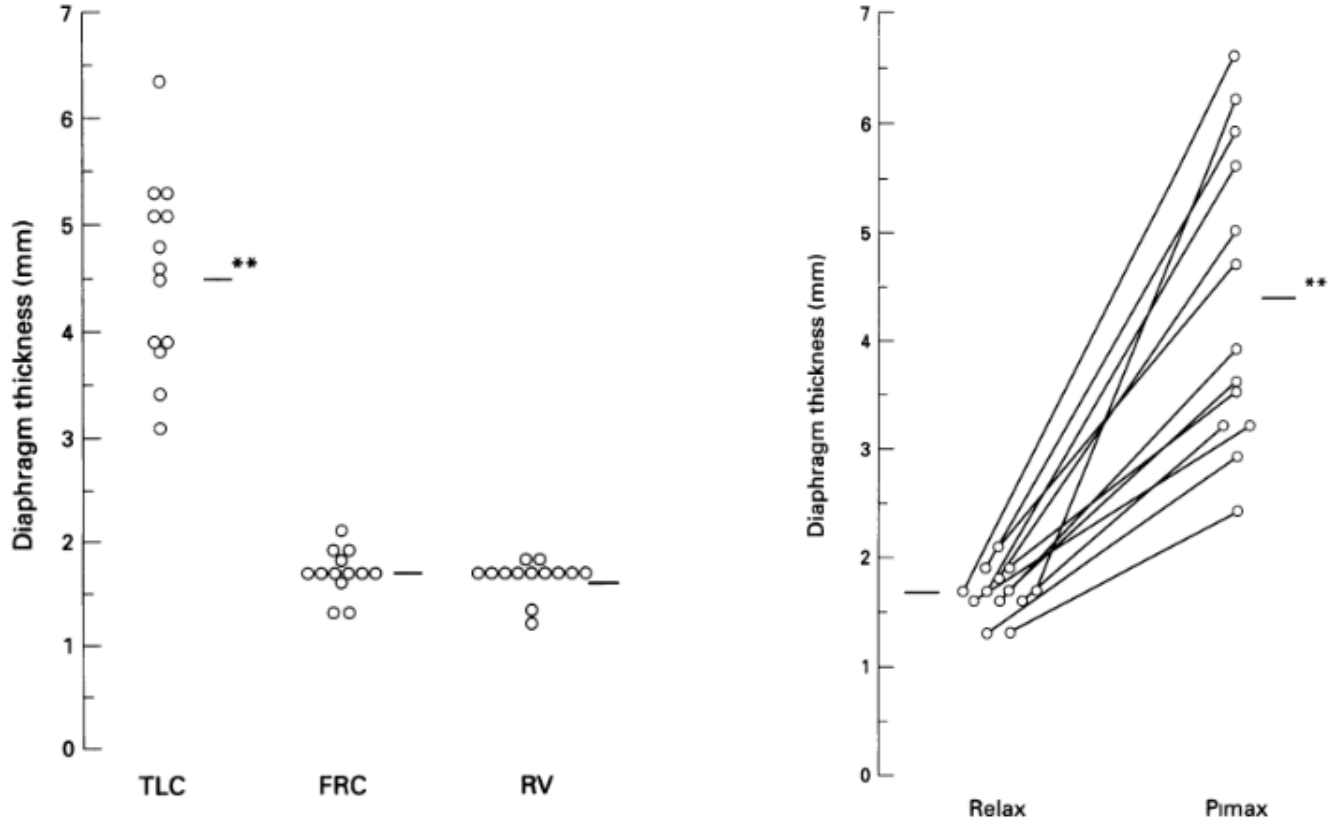
Ventilation courante | Effort inspiratoire modéré | Effort inspiratoire intense

Fraction d'épaississement = $\dfrac{\text{épaisseur inspiratoire} - \text{épaisseur expiratoire}}{\text{épaisseur expiratoire}}$ **(%)**

Le diaphragme: échographie

In vivo assessment of diaphragm contraction by ultrasound in normal subjects

J Ueki, P F De Bruin, N B Pride



Thorax 1995;**50**:1157–1161

Le diaphragme: échographie

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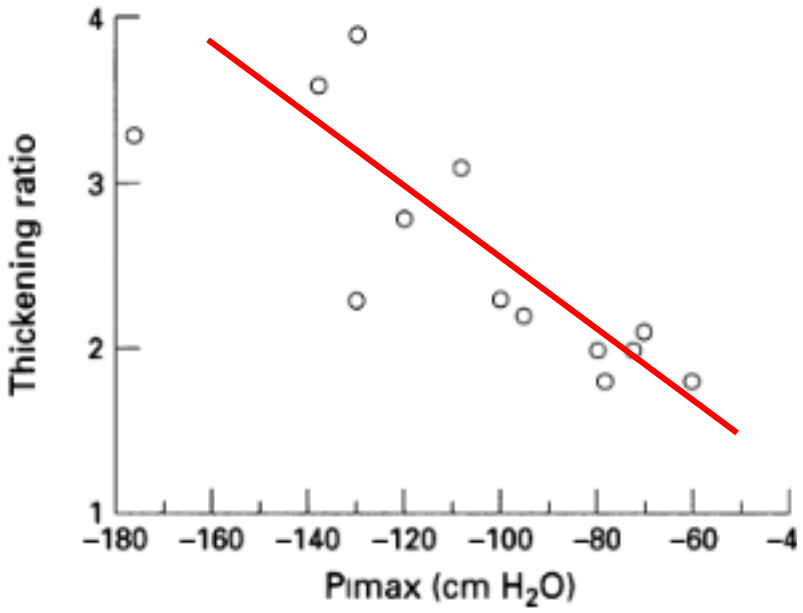
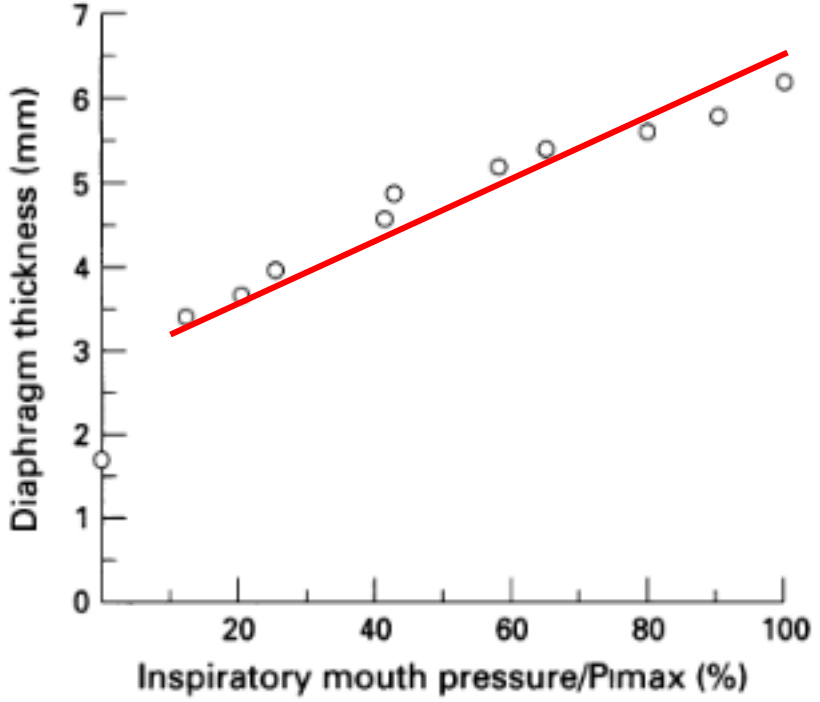




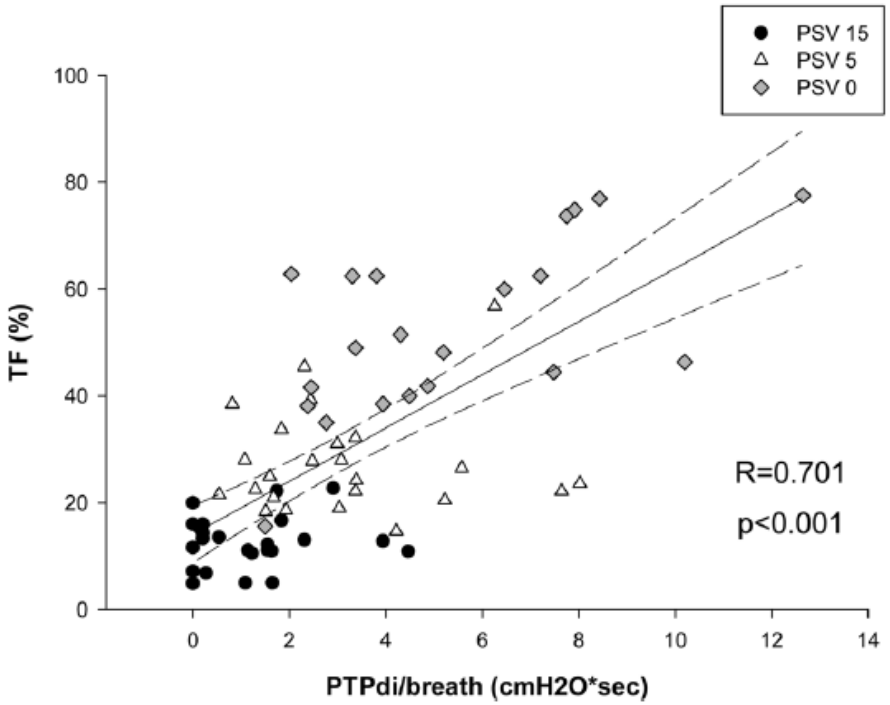
Thorax 1995;**50**:1157–1161

Le diaphragme: échographie

Thickening fraction vs. PTPdi

Diaphragm ultrasound as indicator of respiratory effort in critically ill patients undergoing assisted mechanical ventilation: a pilot clinical study

Michele Umbrello[1,2*], Paolo Formenti[1], Daniela Longhi[2], Andrea Galimberti[2], Ilaria Piva[2], Angelo Pezzi[1], Giovanni Mistraletti[1,2], John J Marini[3] and Gaetano Iapichino[1,2]



Le diaphragme: échographie

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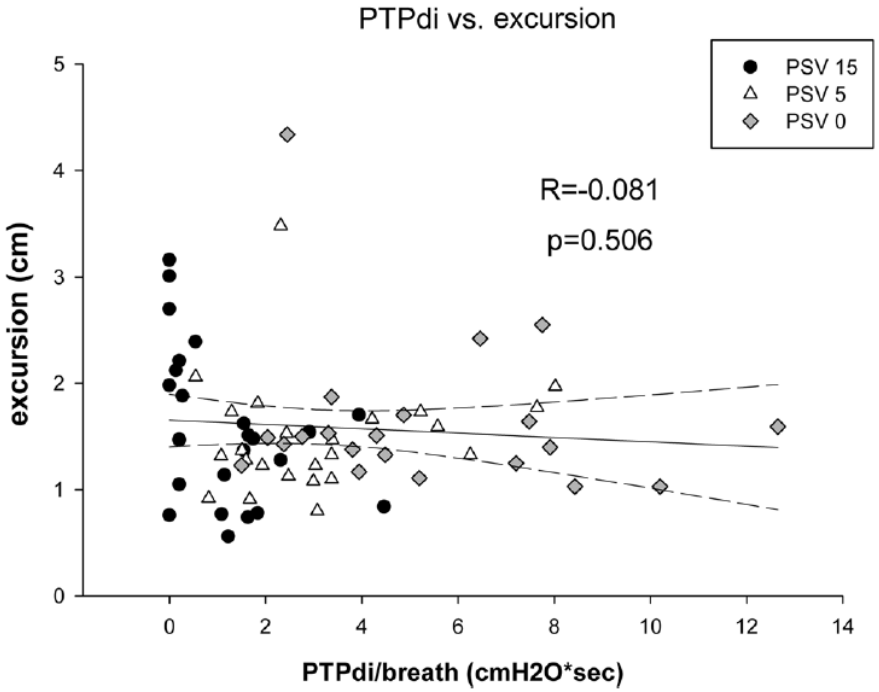
CRITICAL CARE



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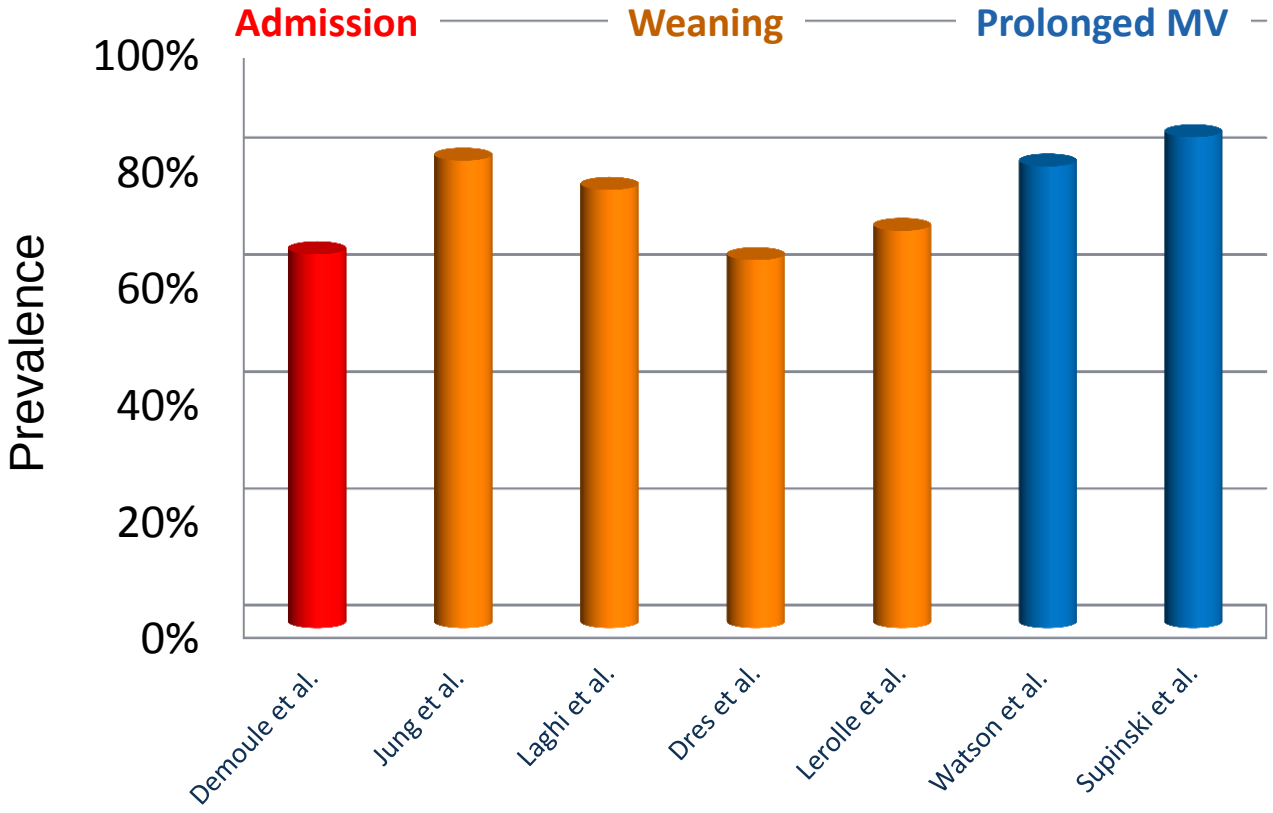
- **Dysfonction diaphragmatique : Prévalence et facteurs de risque**
- Impact pronostique

Le diaphragme: prévalence en réanimation

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]



Le diaphragme: prévalence en réanimation

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Studies	Settings	Prevalence
Ultrasound studies		
Kim et al. [17]	Weaning	24/82 (29%)
Jiang et al. [20]	Weaning	20/55 (36%)
DiNino et al. [99]	Weaning	15/66 (23%)
Pressure studies		
Demoule et al. [2]	On admission	54/85 (64%)
Watson et al. [9]	Stable ICU patients	26/33 (79%)
Supinski and Callahan [19]	Stable ICU patients	48/57 (84%)
Jung et al. [3]	Weaning	32/40 (80%)
Laghi et al. [1]	Weaning	12/16 (75%)
Dres et al. [5]	Weaning	48/76 (63%)
Lerolle et al. [50]	Post cardiac surgery	19/28 (68%)

Le diaphragme: facteurs de risque de dysfonction

ventilation mécanique

Critical Care Perspective

Ventilator-induced Diaphragmatic Dysfunction

Theodoros Vassilakopoulos and Basil J. Petrof

dysfunction. For the purposes of this Critical Care Perspective, we define this phenomenon, henceforth referred to as ventilator-induced diaphragmatic dysfunction (VIDD), as a loss of diaphragmatic force-generating capacity that is specifically related to the use of mechanical ventilation.

- études animales: impact isolé de la ventilation; en réanimation difficulté d'isoler la ventilation des autres facteurs de risques
- en réanimation: exploration du diaphragme difficile

Am J Respir Crit Care Med Vol 169. pp 336–341, 2004

Le diaphragme: facteurs de risque de dysfonction

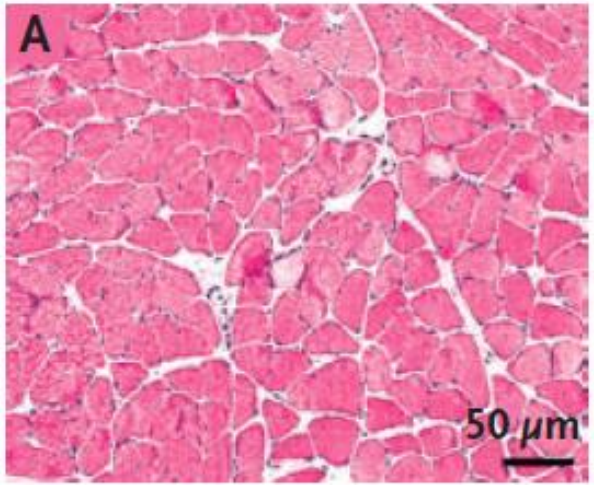
ventilation mécanique

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MARCH 27, 2008 VOL. 358 NO. 13

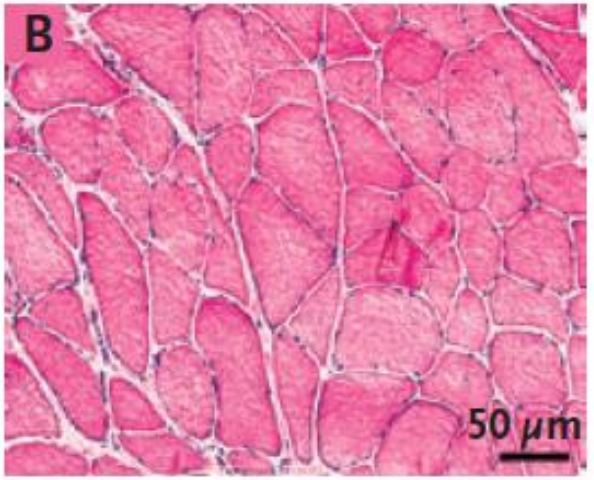
Rapid Disuse Atrophy of Diaphragm Fibers in Mechanically Ventilated Humans

Sanford Levine, M.D., Taitan Nguyen, B.S.E., Nyali Taylor, M.D., M.P.H., Michael E. Friscia, M.D., Murat T. Budak, M.D., Ph.D., Pamela Rothenberg, B.A., Jianliang Zhu, M.D., Rajeev Sachdeva, M.D., Seema Sonnad, Ph.D., Larry R. Kaiser, M.D., Neal A. Rubinstein, M.D., Ph.D., Scott K. Powers, Ph.D., Ed.D., and Joseph B. Shrager, M.D



Case – VM - 18-69h

atrophie
induite
par l'inactivité
diaphragmatique



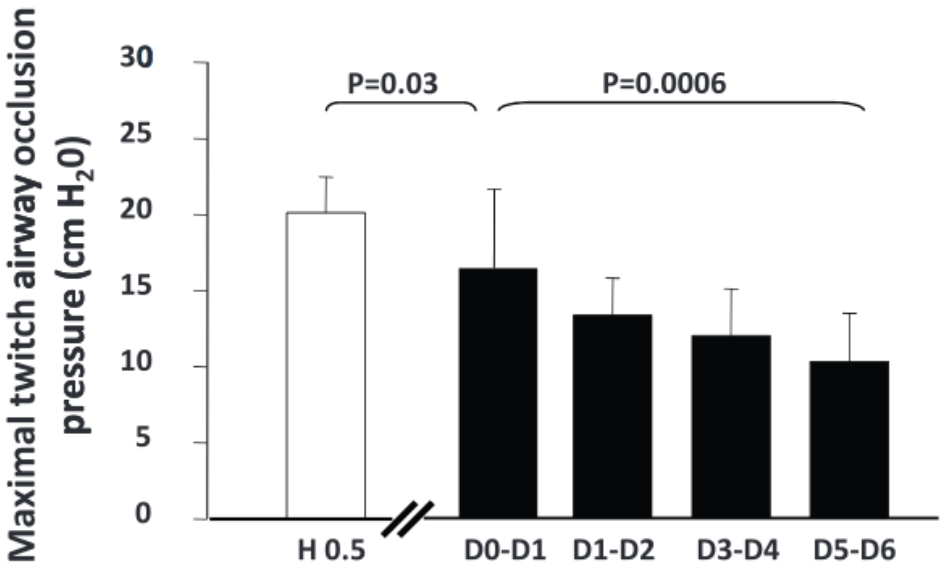
Control – VM - 2-3h

Le diaphragme: facteurs de risque de dysfonction

ventilation mécanique

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]



dysfonction « temps dépendante »

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

Le diaphragme: facteurs de risque de dysfonction

inactivité diaphragmatique – **sur**activité diaphragmatique

Evolution of Diaphragm Thickness during Mechanical Ventilation

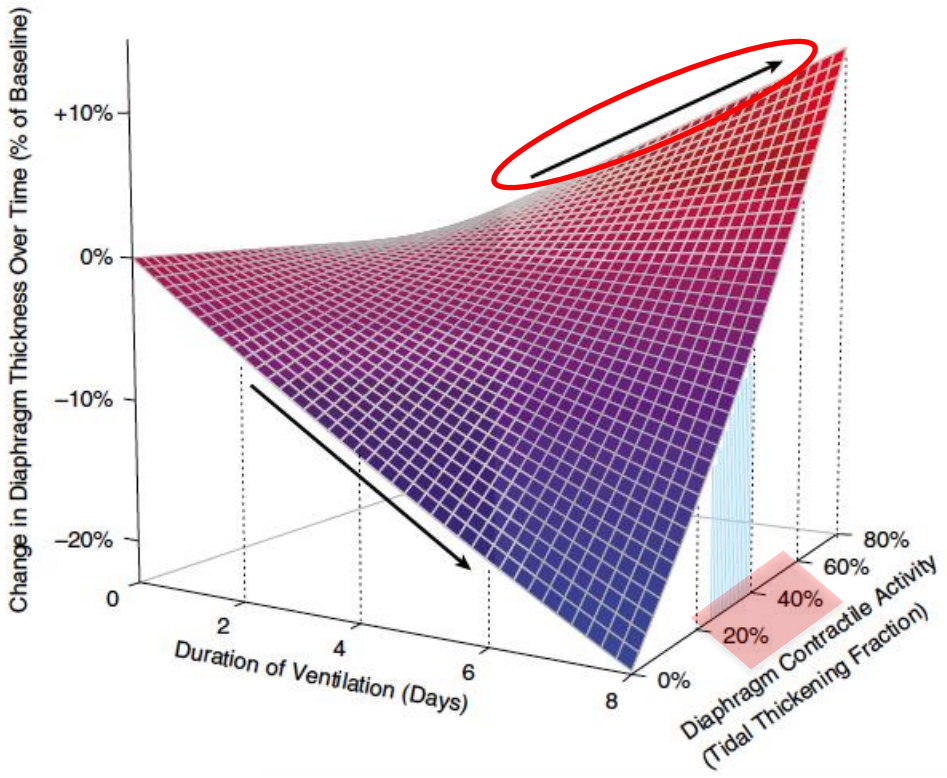
Impact of Inspiratory Effort

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]

low TFdi

↓

higher rate of atrophy



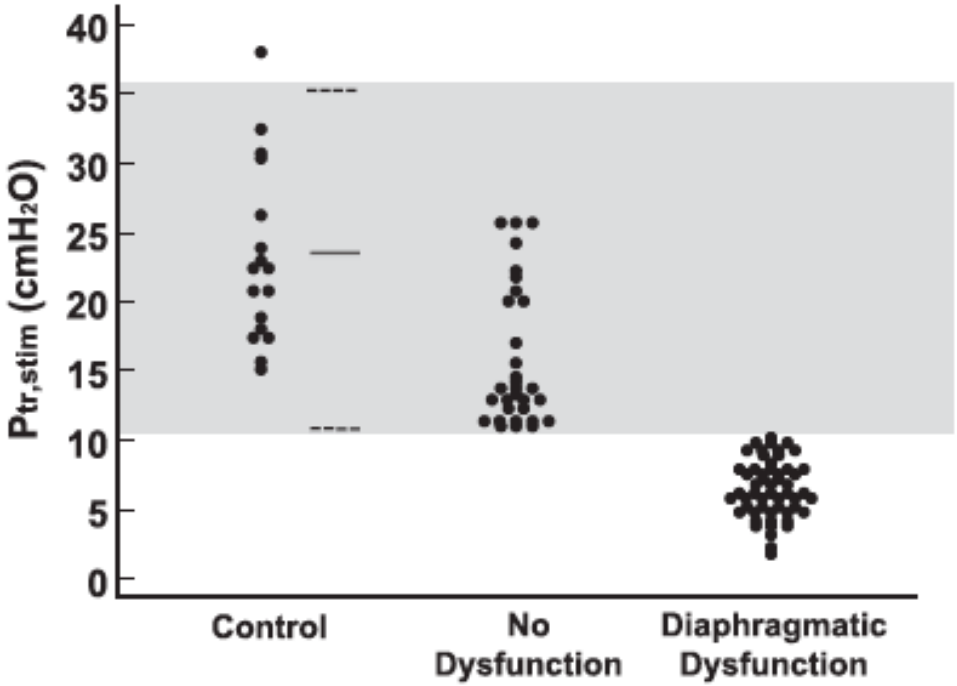
Le diaphragme: facteurs de risque de dysfonction

sepsis, sévérité

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*]



Am J Respir Crit Care Med 2013

Le diaphragme: une dysfonction multifactorielle

REVIEW

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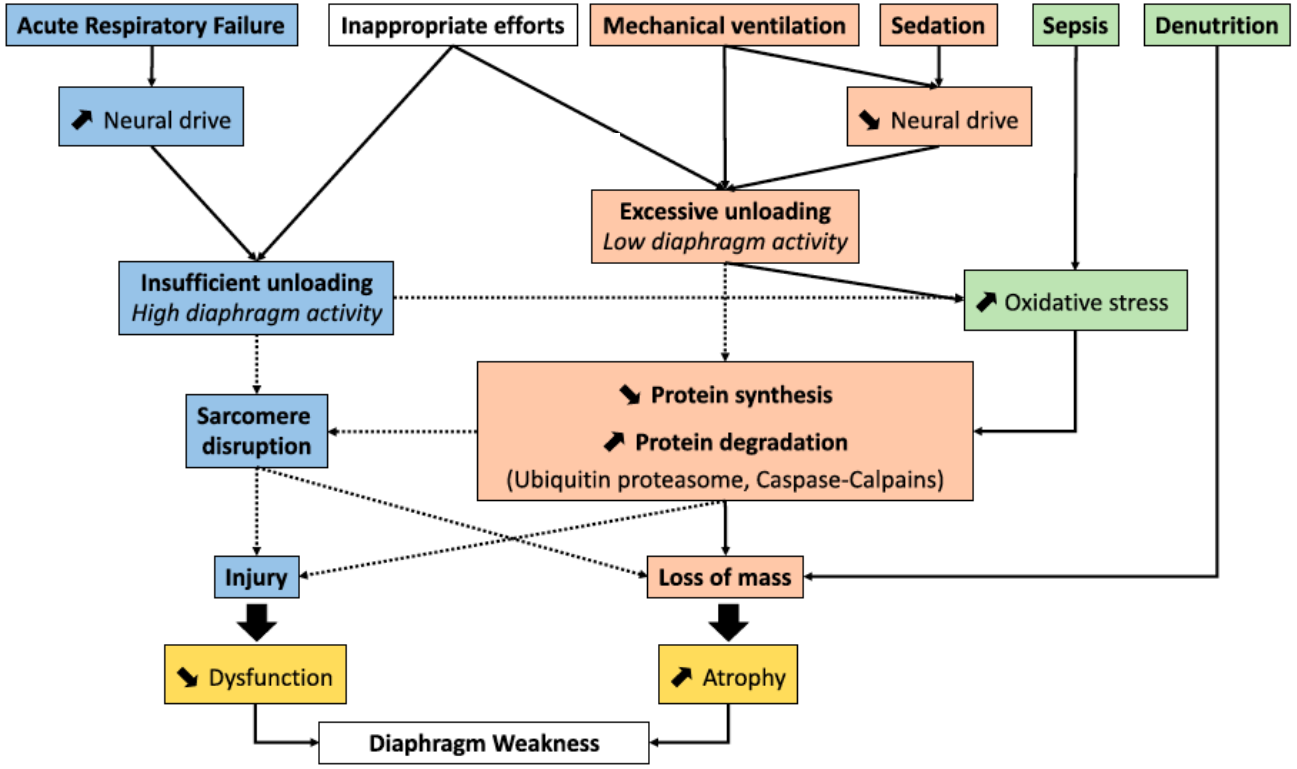

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Le diaphragme: impact pronostique

Diaphragm dysfunction assessed by ultrasonography: Influence on weaning from mechanical ventilation*

Won Young Kim, MD; Hee Jung Suh, RT; Sang-Bum Hong, MD, PhD; Younsuck Koh, MD, PhD, FCCM; Chae-Man Lim, MD, PhD, FCCM

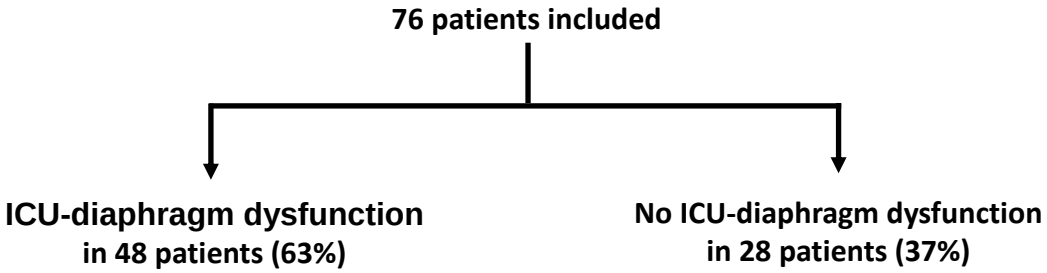
Variables	Diaphragm dysfunction	No diaphragm dysfunction	*p*
Total ventilation time, hrs (IQR)	576 (374–850)	203 (109–408)	<.01
Weaning time, hrs (IQR)	401 (226–612)	90 (24–309)	<.01
Time to the spontaneous breathing trial, day (IQR)	4 (2.5–7.5)	4 (3.0–6.0)	.55
Primary weaning failure, no. (%)	20/24 (83)	34/58 (59)	<.01
Secondary weaning failure, no. (%)	10/20 (50)	10/46 (22)	.01
Died before weaning, no. (%)	4/24 (17)	12/58 (21)	.79

Crit Care Med 2011 Vol. 39, No. 12

Le diaphragme: impact pronostique

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

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

Le diaphragme: impact pronostique

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

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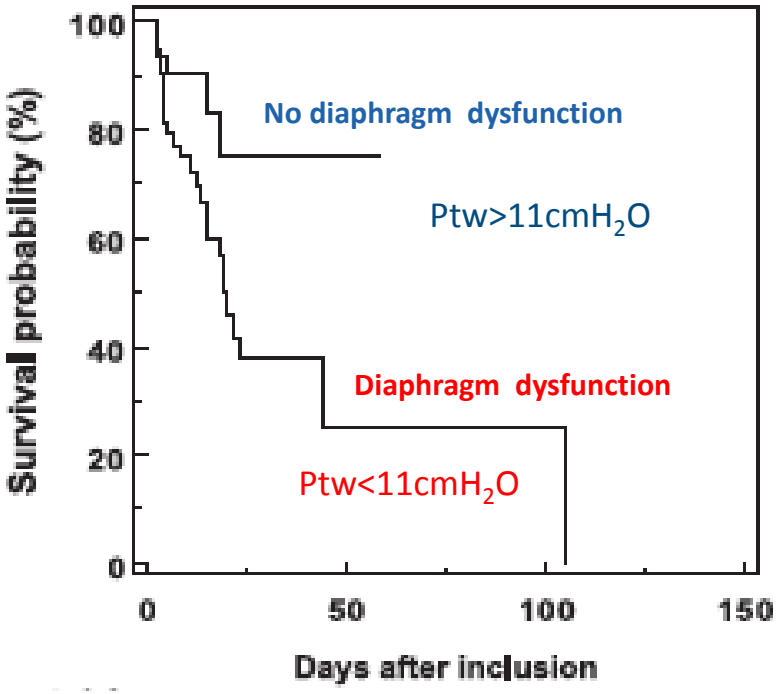
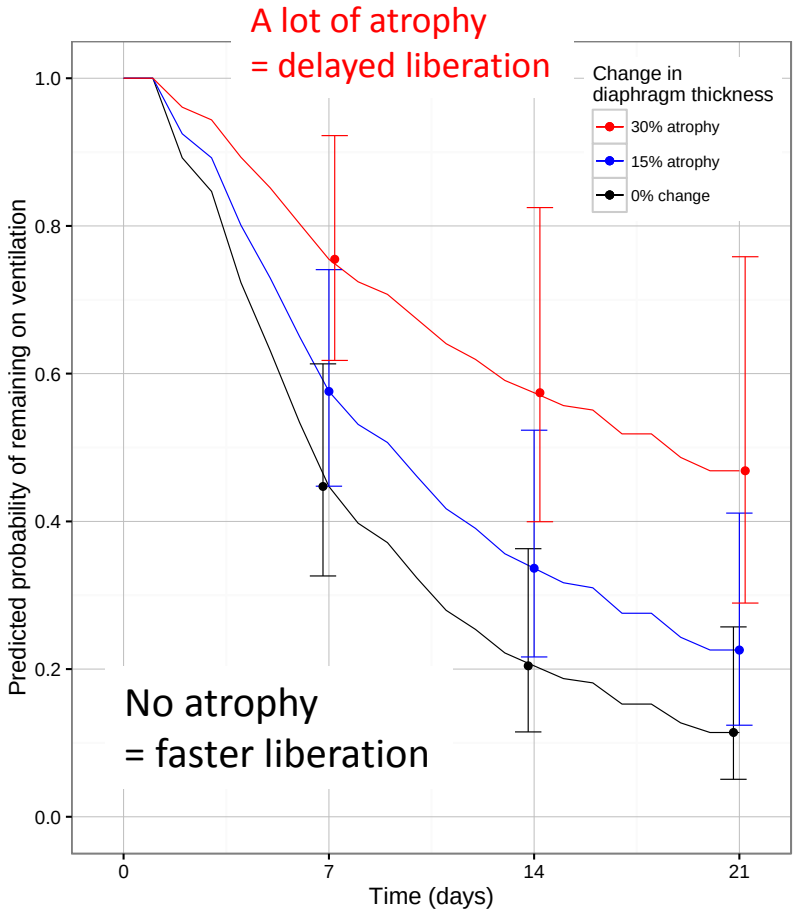
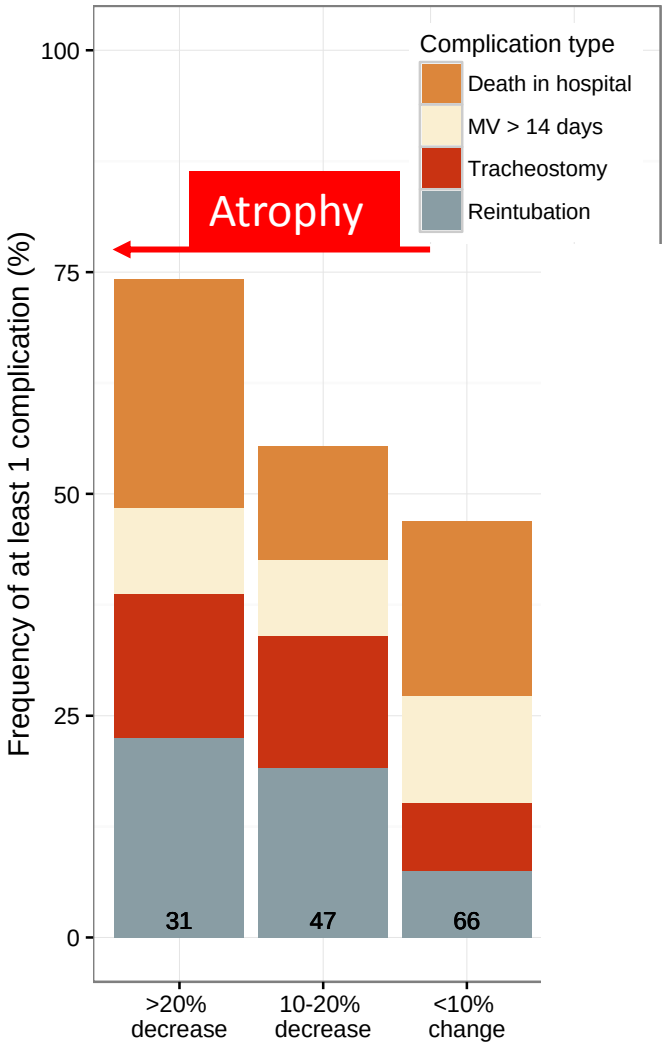


Am J Respir Crit Care Med Vol 188, Iss. 2, pp 213–219, Jul 15, 2013

Le diaphragme: impact pronostique

Diaphragm atrophy as a surrogate of diaphragm dysfunction



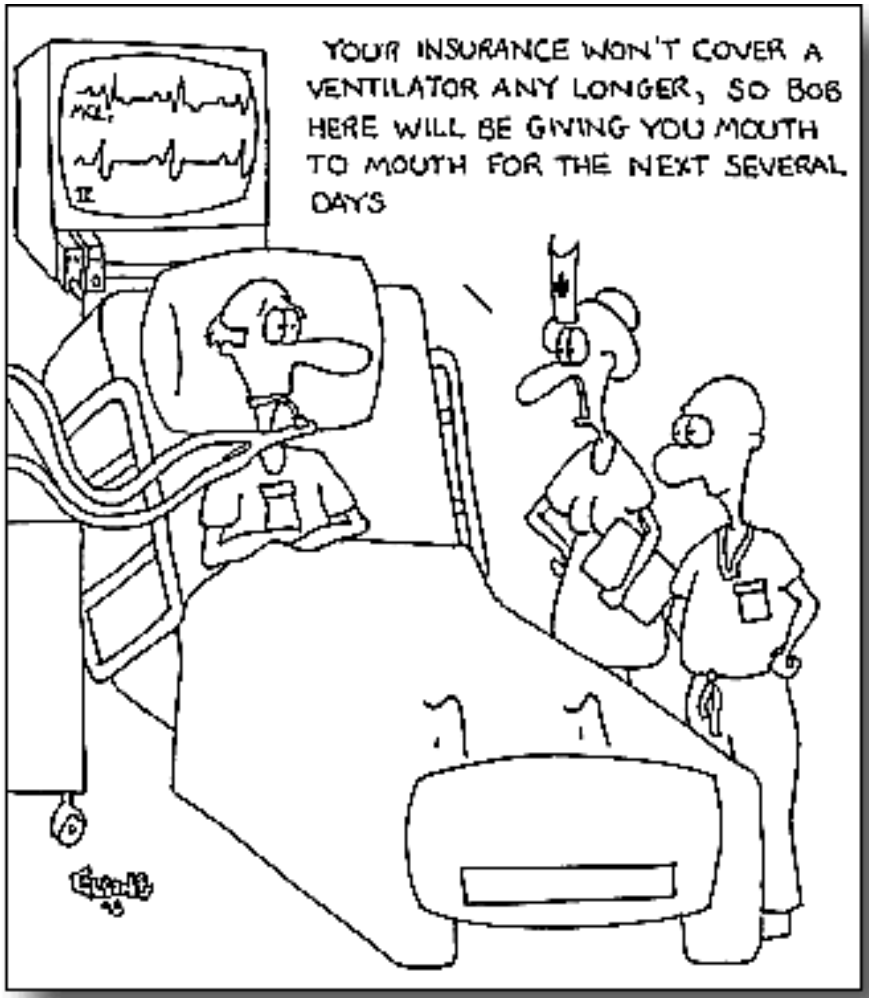


Goligher et al. AJRCCM 2017

Le diaphragme: conclusions

- dysfonction diaphragmatique:
  phénomène **sous estimé,** implication **pronostique** notable
- « sensibilité » aux **agressions rencontrées en réanimation**
- **ventilation mécanique**: une agression parmi d'autres
- **inactivité diaphragmatique** > ventilation mécanique
- intérêt diagnostique de **l'échographie** à confirmer

Merci pour votre attention



martin.dres@aphp.fr