Protección pulmonar intraoperatoria: estrategias y su impacto en los resultados

Sesión de formación continuada

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Residente: Ignacio Ledesma

Valencia, 27 de mayo 2025

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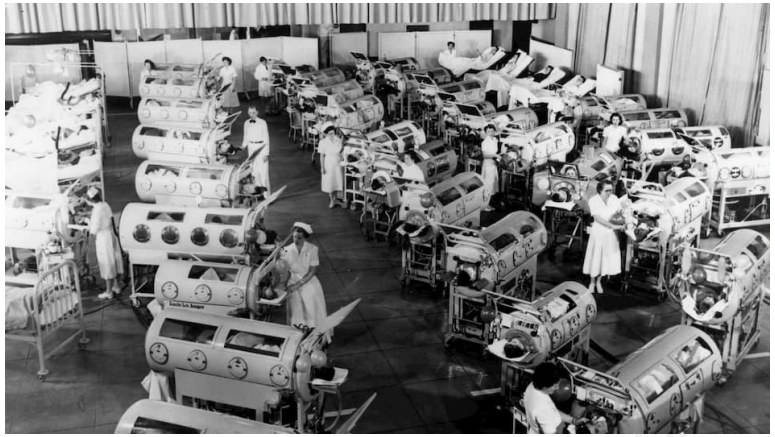
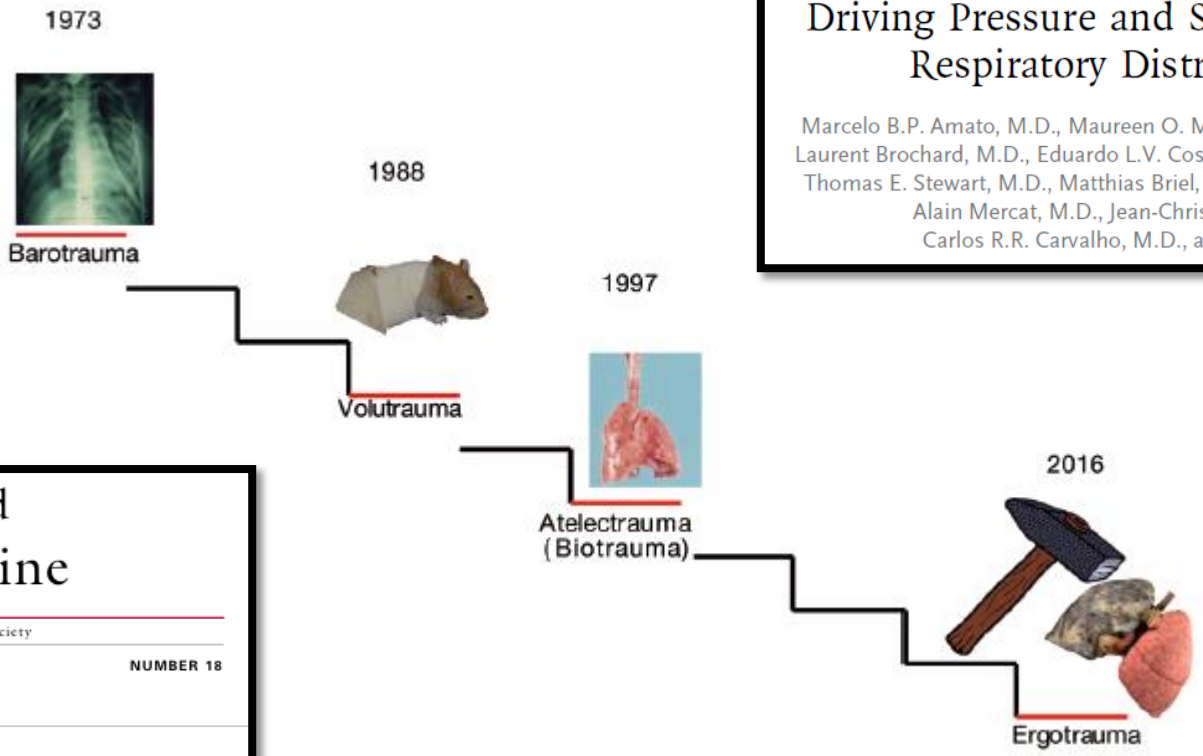
- Evolución de concepto de protección pulmonar
- Ventilación protectiva
  - VILI
  - Parámetros ventilatorios
- Maniobras de reclutamiento
- Ventilación unipulmonar
- Ventilacion en pacientes obesos
- Perspectivas futuras
- Conclusiones

Evolución de concepto de protección pulmonar





SPECIAL ARTICLE

Driving Pressure and Survival in the Acute Respiratory Distress Syndrome

Marcelo B.P. Amato, M.D., Maureen O. Meade, M.D., Arthur S. Slutsky, M.D., Laurent Brochard, M.D., Eduardo L.V. Costa, M.D., David A. Schoenfeld, Ph.D., Thomas E. Stewart, M.D., Matthias Briel, M.D., Daniel Talmor, M.D., M.P.H., Alain Mercat, M.D., Jean-Christophe M. Richard, M.D., Carlos R.R. Carvalho, M.D., and Roy G. Brower, M.D.

The New England Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

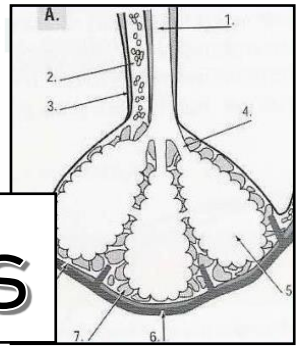
Ventilación protectiva

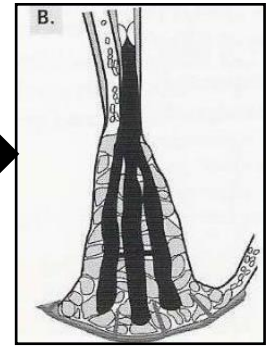
- Ventilación mecánica es un proceso anti fisiologico
- Injuria generada por ventilación mecánica - VILI
  - Volutrauma
  - Barotrauma

➡ Biotrauma

Pulmón enfermo ≠ pulmón sano

Producción de citoquinas



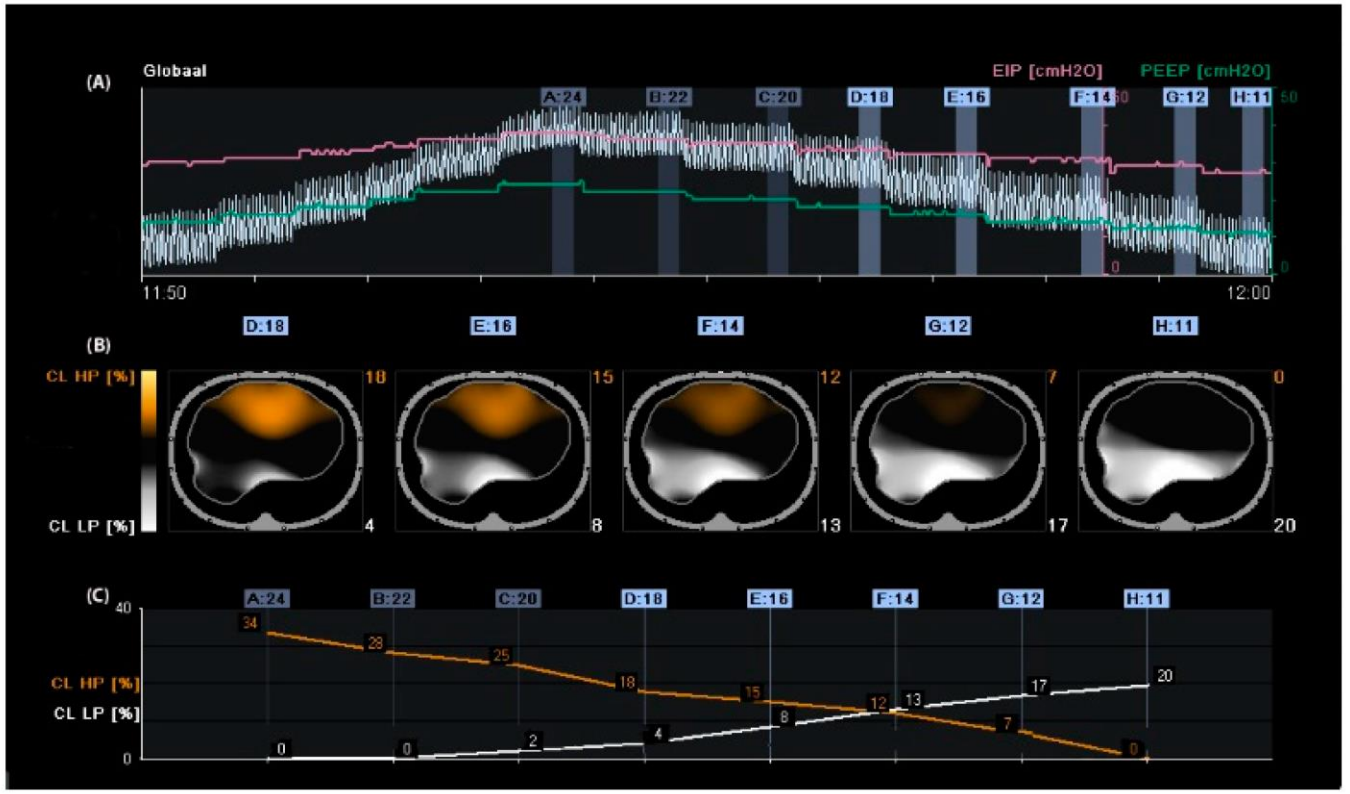


Volutrauma

- Volutrauma = strain = deformación
- Directamen
- Inversamen

Vol Corriente

CRF



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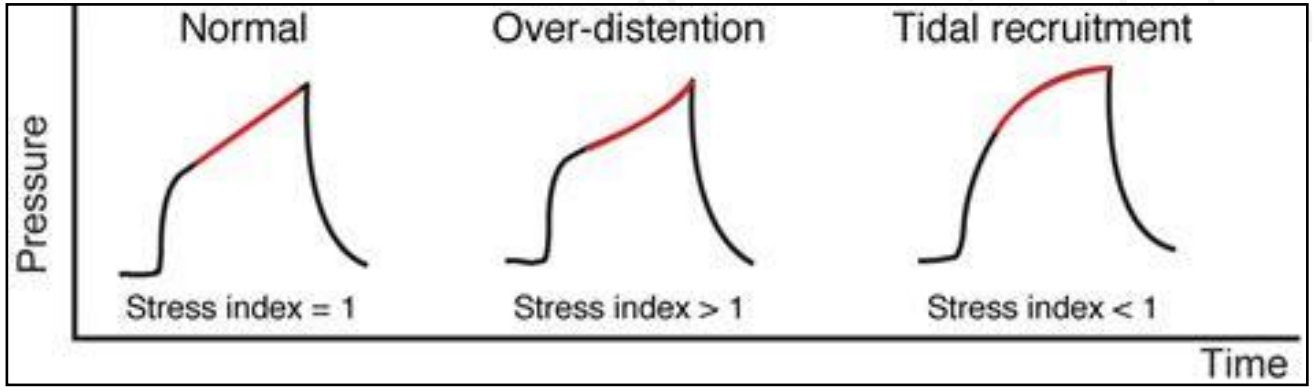
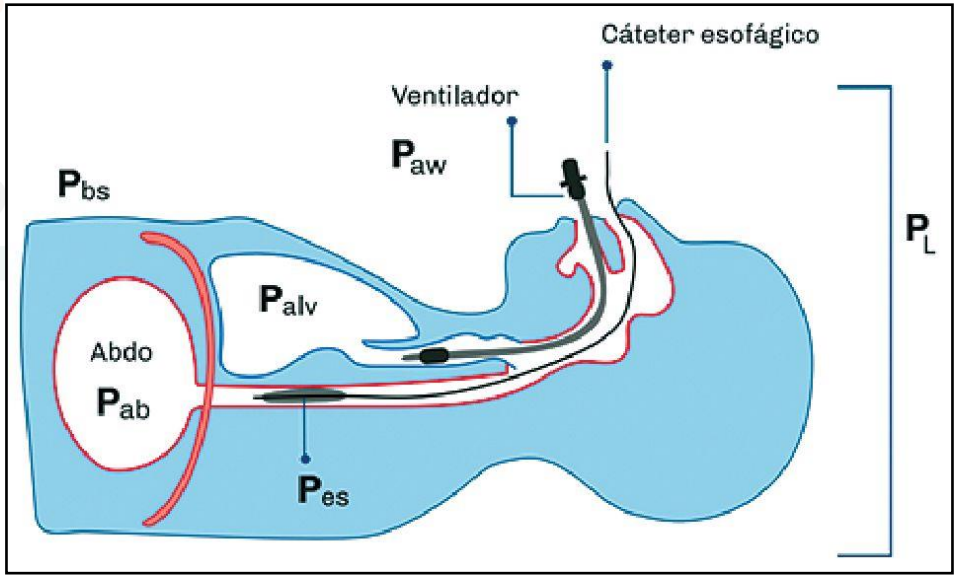
Barotrauma

Palv - Ppleural

- Barotrauma = Stress = Tensión
- Recordar que las mediciones evalúan el sistema respiratorio
  - Obesidad, escoliosis, neumoperitoneo



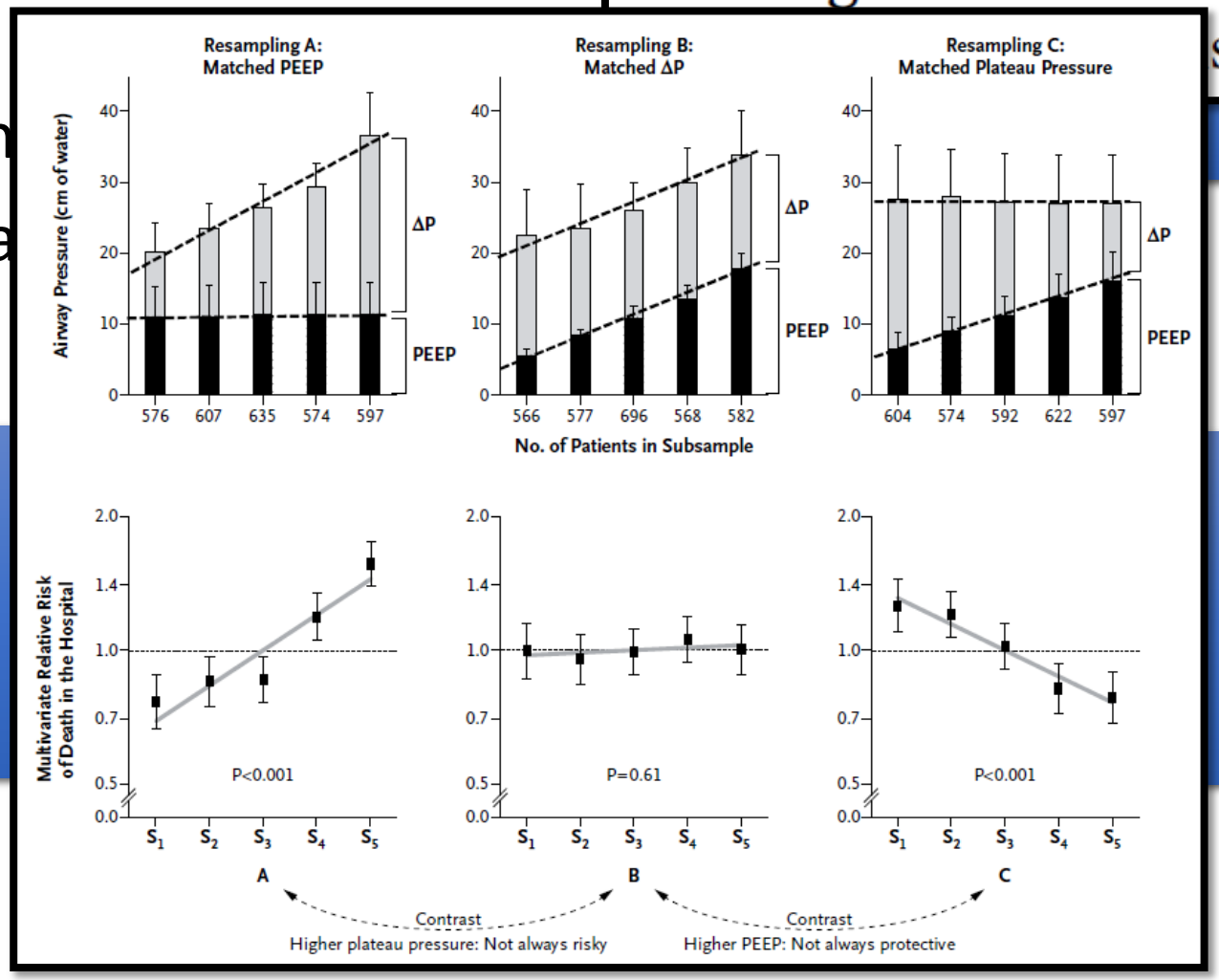


Driving Pressure

- Relación en
- Valor desea

SPECIAL ARTICLE

Driving Pressure and Survival in the Acute
stress Syndrome

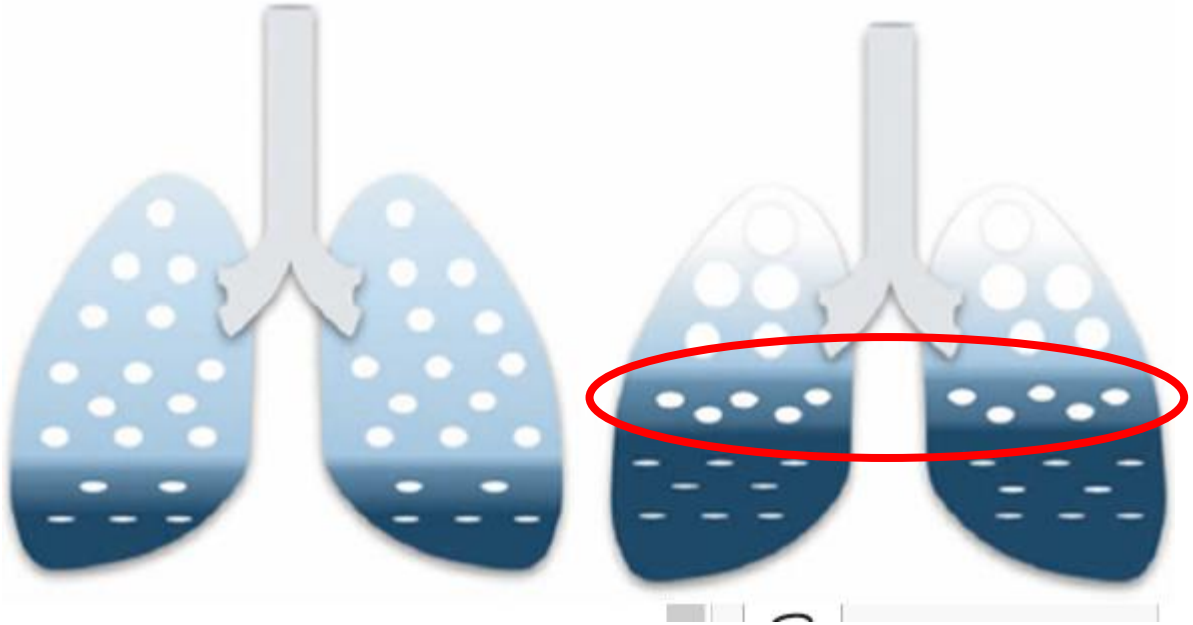


Cest =

Volumen / Cest

Atelectrauma

- Lesión ocasionada por apertura y colapso cíclico alveolar
- Se evitaría con PEEP ideal -> mejor complacencia
  - Menor colapso, menor sobredistension



Configuración de parámetros

European Society of

of sts™

Volumen

Tidal Volume and Positive End-expiratory Pressure and Postoperative Hypoxemia during General Anesthesia: A Single-center Multiple Crossover Factorial Cluster Trial

N= 727 received	N= 635 received	N= 799 received	N= 699 received
TV=6ml/kg	TV=6ml/kg	TV=10ml/kg	TV=10ml/kg
PEEP=5cmH_2O	PEEP=8cmH_2O	PEEP=5cmH_2O	PEEP=8cmH_2O

- Cirugía traumatológica
- 2860 pacientes
- Sin diferencias en SaFi o complicaciones

September 1, 2020

Effect of Intraoperative Low Tidal Volume vs Conventional Tidal Volume on Postoperative Pulmonary Complications in Patients Undergoing Major Surgery

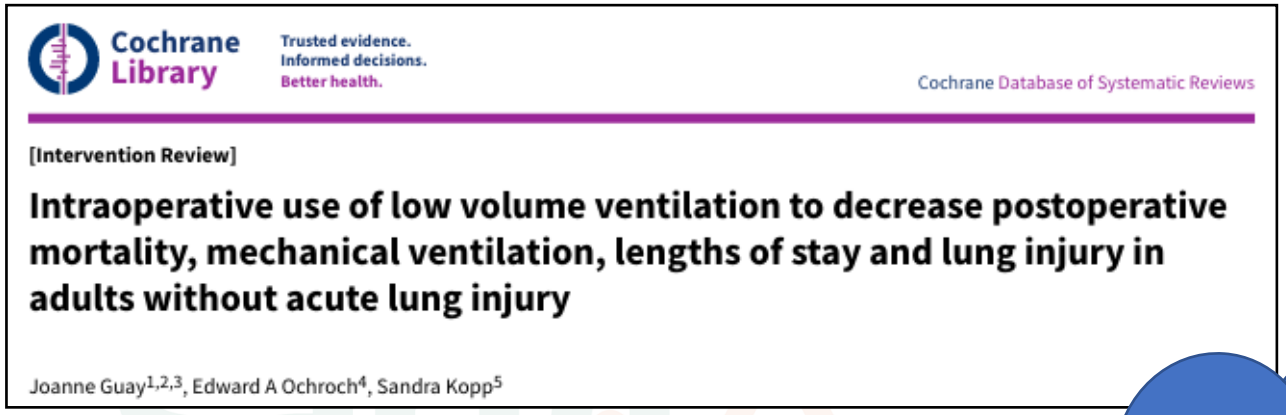
A Randomized Clinical Trial

- Cirugía abdominal
- 1200 pacientes
- 6 ml/kg vs 10 ml/kg
- PEEP 5 cm H2O
- Sin diferencias en aparición de complicaciones

ORIGINAL ARTICLE

A Trial of Intraoperative Low-Tidal-Volume Ventilation in Abdominal Surgery

- Cirugía abdominal (20% laparoscópica)
- 400 pacientes
- Protectivo (6 – 8 ml/kg + 5 – 6 PEEP) vs no protectivo (10 – 12 ml/kg + 0 PEEP)
- Aumento de complicaciones respiratorias en el grupo no protectivo

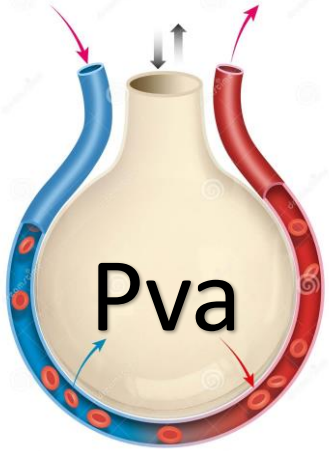


- Metaanálisis 19 estudios
- 6 – 8 ml/kg vs 10 – 12 ml/kg
- Calidad de evidencia moderada
- Menor incidencia de complicaciones respiratorios en grupo 6 – 8 ml/kg

Peso teórico

PEEP

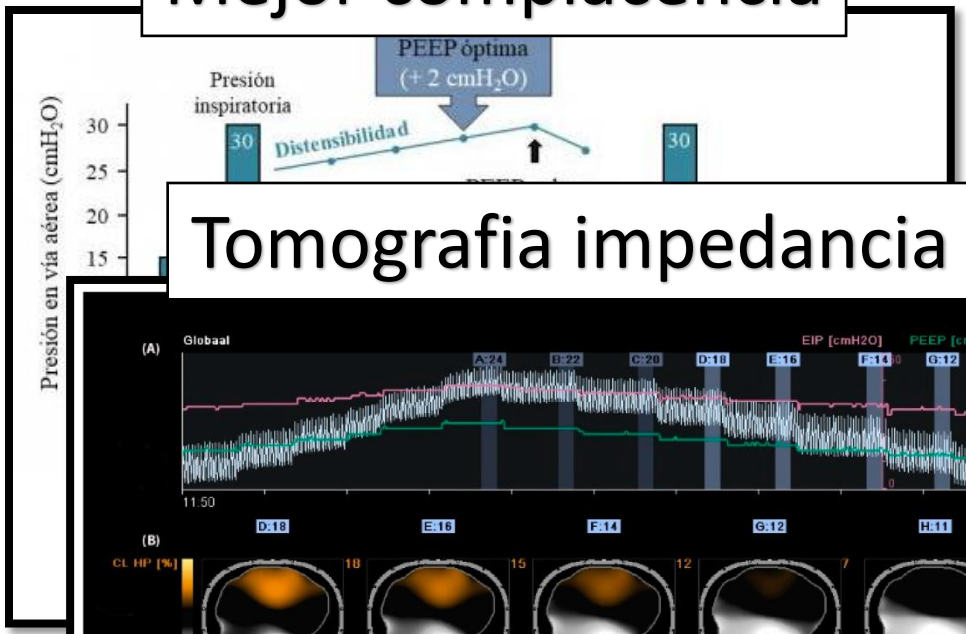
- Presión alveolar al final de la inspiración
- Anestesia general genera perdida de tono diafragmático
- Gradiente positivo respecto a presión pleural



↓ retorno venoso
↑ postcarga ventrículo derecho
Hipotensión

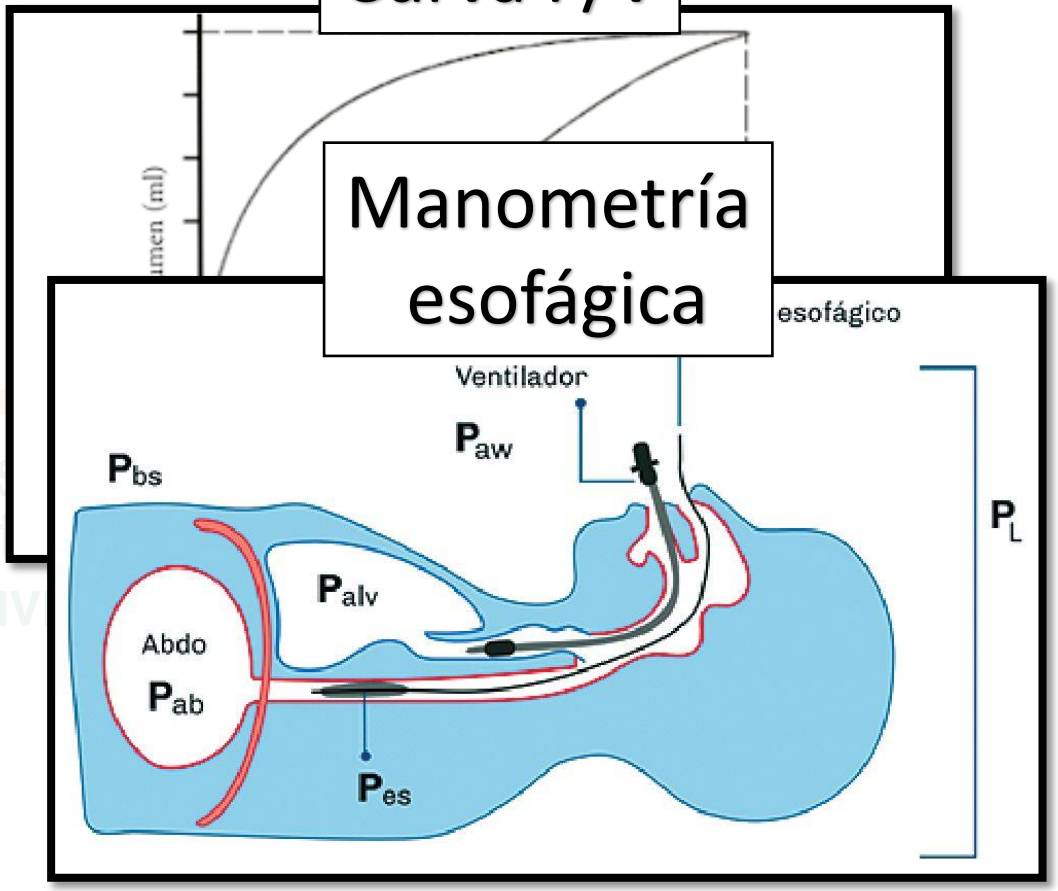
PEEP ideal

Mejor complacencia



Tomografia impedancia

Curva P/V



Manometría esofágica

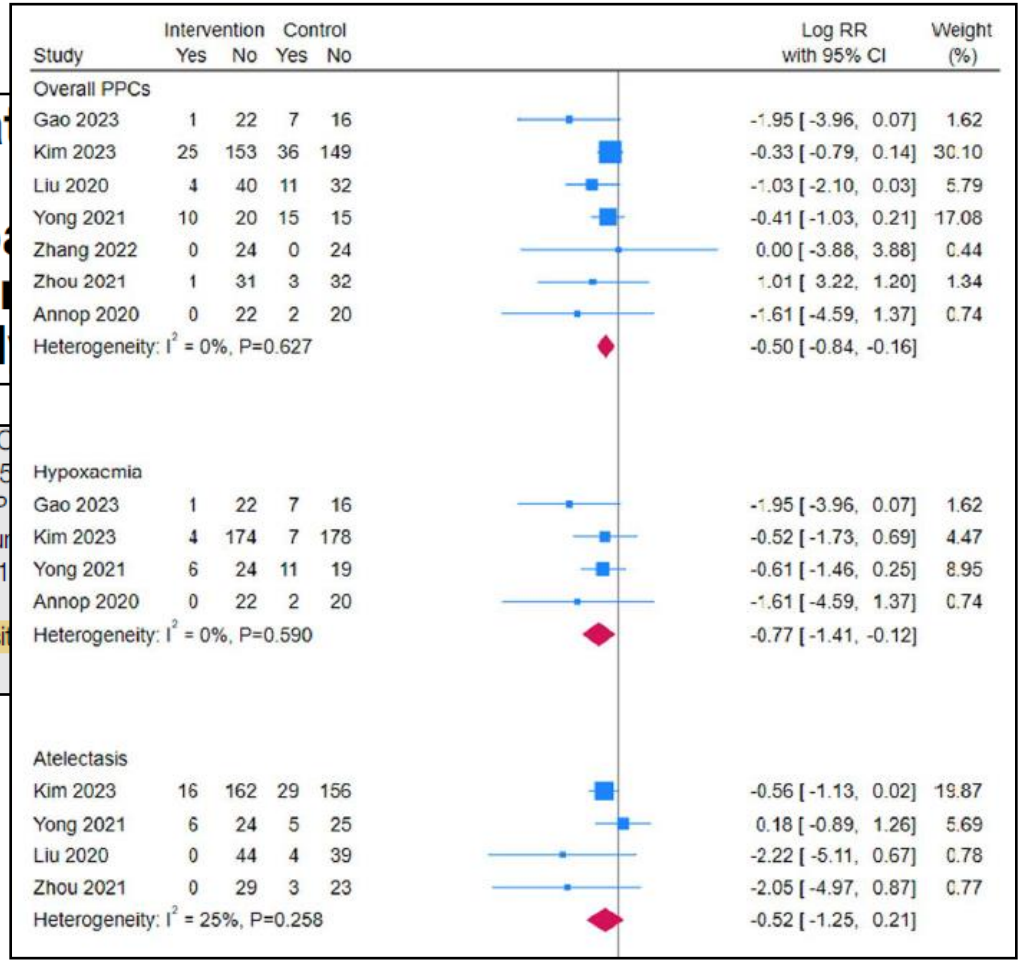
High versus low positive end-expiratory pressure during general anaesthesia for open abdominal surgery (PROVHILO trial): a multicentre randomised controlled trial

- Cirugía abdominal (20% laparoscópica)
- 900 pacientes
- 8 ml/kg
- PEEP 2 sin MR vs 12 cmH20 + MR
- Sin diferencias en aparición de complicaciones pulmonares. Mayor hipotesion intraoperatoria con PEEP alta

Effects of individualized positive end-expirat pressure on intraoperative oxygenation and postoperative pulmonary complications in pa requiring pneumoperitoneum with Trendelen position: a systematic review and meta-anal

Results: We included 14 studies (1121 patients) that employed different individualized PEEP strategies. C groups, individualized PEEP groups exhibited a significantly improved intraoperative PaO_2/FiO_2 (MD = 56.5 [33.98–79.06], $P < 0.001$) and reduced incidence of PPCs (log RR = −0.50, 95% CI: [−0.84 to −0.16], P PEEP reduced driving pressure while improving respiratory compliance. Intraoperative vasopressor consur between both groups. The weighted mean PEEP in the individual PEEP groups was 13.2 cmH_2O [95% CI, 1 indicated that one individualized PEEP strategy is superior to others.

Conclusions: Individualized PEEP seems to work positively for lung protection in the Trendelenburg posit pneumoperitoneum in patients undergoing general anesthesia.



Resultados post operatorios

RESPIRATION AND THE AIRWAY

Impact of ventilation strategies on pulmonary and cardiovascular complications in patients undergoing general anaesthesia for elective surgery: a systematic review and meta-analysis

Intraoperative protective mechanical ventilation and risk of postoperative respiratory complications: hospital based registry study

Karim Ladha,[1] Marcos F Vidal Melo,[1] Duncan J McLean,[1] Jonathan P Wanderer,[2] Stephanie D Grabitz,[1] Tobias Kurth,[3,4,5] Matthias Eikermann[1,6]

complications rarely analyse their consequences on the quality of life of patients, which is a fundamental outcome in anaesthesia and intensive care research.[45]

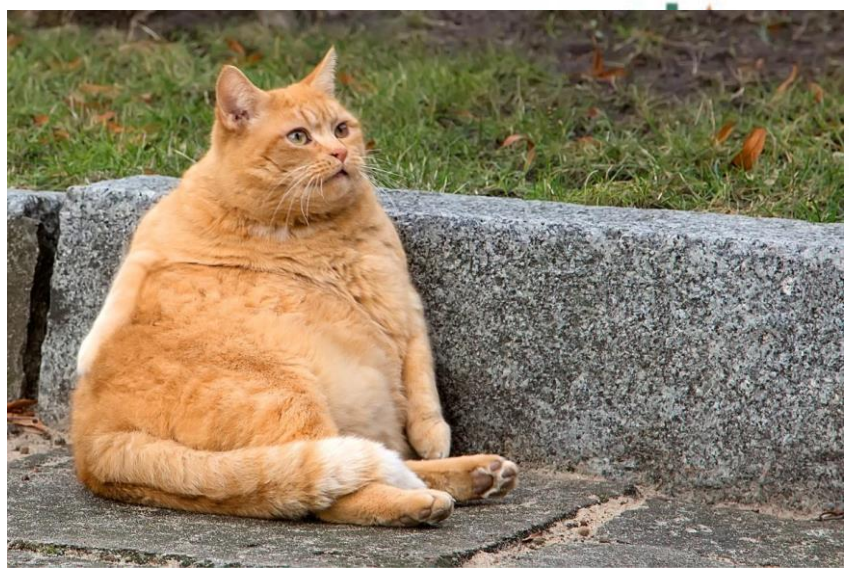
In conclusion, our meta-analysis suggests that low tidal volume and low driving pressure-guided PEEP ventilation strategies could help reduce the incidence of postoperative pulmonary complications. Optimal intraoperative mechanical ventilation is not fully elucidated, and further studies are needed to investigate the influence of different ventilation strategies on postoperative pulmonary complications, cardiovascular complications, and mortality.

69000 pacientes

CONCLUSIONS

Intraoperative protective ventilation was associated with a decreased risk of postoperative respiratory complications. A PEEP of 5 cmH_2O and a plateau pressure of 16 cmH_2O or less were identified as protective mechanical ventilator settings. These findings suggest that protective thresholds differ for intraoperative ventilation in patients with normal lungs compared with those used for patients with acute lung injury.

Ventilación mecánica en obesos



- Aumento de presión pleural
  - Mayor colapso
  - ↓ CRF

Optimized ventilation strategy for surgery on patients with obesity from the perspective of lung protection: A network meta-analysis

Conclusions: This research suggests that VCV+PEEPind+RM is the optimal ventilation strategy for patients with obesity and is more effective in increasing PaO_2/FiO_2, improving lung compliance, and among the five ventilation strategies for postoperative atelectasis, VCV+highPEEP+RM had the greatest potential to reduce atelectasis caused by inflammation.

Although the results of the present study have shown that VCV+highPEEP+RM has the greatest potential to reduce postoperative atelectasis, no statistically significant differences were found in the incidence of postoperative atelectasis between VCV+highPEEP+RM and VCV+lowPEEP. This result may be

Maniobras de reclutamiento

- Episodios cortos de elevación de presión en vía aérea para superar presión critica de apertura
- Se recomiendan maniobras de ascenso gradual, no muy prolongadas

Alveolar Recruitment Maneuvers Under General Anesthesia: A Systematic Review of the Literature

Benjamin L Hartland RN, Timothy J Newell RN, and Nicole Damico MSNA CRNA

Primary Outcome Measures

Overall, subjects in the alveolar recruitment maneuver groups experienced a higher intraoperative P_{aO_2}, greater lung compliance, and higher P_{aO_2}/F_{IO_2}.

Secondary Outcome Measures

Overall, there were no significant differences in the rate of postoperative pulmonary complications, postoperative

PERIOPERATIVE MEDICINE: CLINICAL SCIENCE

High Positive End-expiratory Pressure (PEEP) with Recruitment Maneuvers *versus* Low PEEP during General Anesthesia for Surgery: A Bayesian Individual Patient Data Meta-analysis of Three Randomized Clinical Trials

Conclusions:

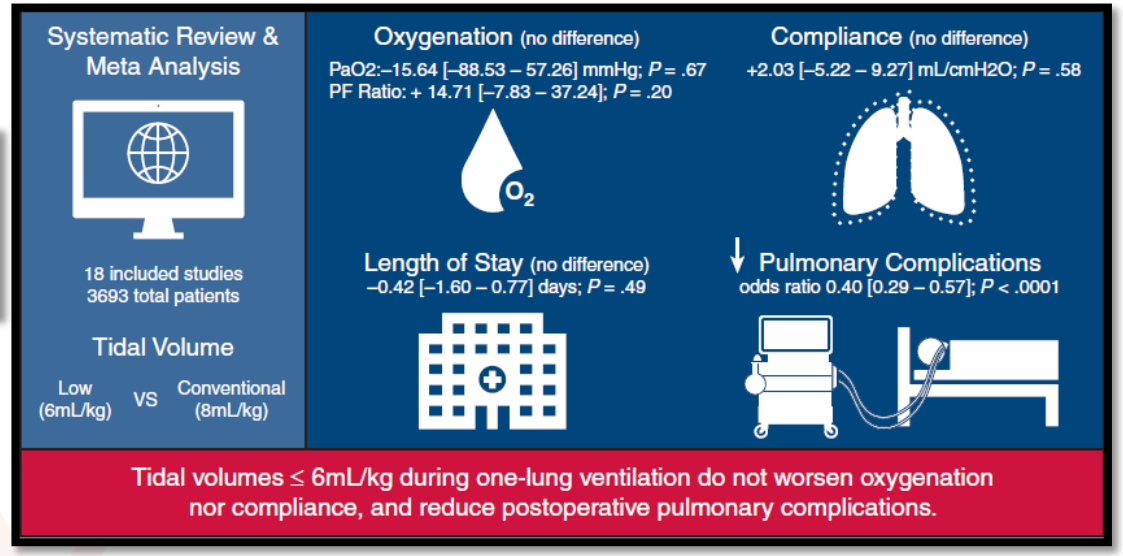
High PEEP with recruitment maneuvers demonstrated a moderate reduction in the probability of postoperative pulmonary complication occurrence, with a high posterior probability of benefit observed consistently across various prior beliefs, particularly among patients who underwent laparoscopy.

Cirugía torácica

- Suelen requerir ventilación unipulmonar
- Pacientes con patología respiratoria previa
- Importante cantidad de complicaciones respiratorias post operatorias

Morbilidad respiratoria previa
Morbilidad anestésica
Morbilidad post quirúrgica

Tidal volume during 1-lung ventilation: A systematic review and meta-analysis



Individualized positive end-expiratory pressure (PEEP) during one-lung ventilation for prevention of postoperative pulmonary complications in patients undergoing thoracic surgery

A meta-analysis

Result: Eight studies examining 849 patients were included in this review. The rate of postoperative pulmonary complications was reduced in the individualized PEEP group with a risk ratio of 0.52 (95% CI:0.37–0.73; *P*=.0001). The partial pressure of arterial oxygen during the OLV in the individualized PEEP group was higher with a mean difference 34.20mm Hg (95% CI: 8.92–59.48; *P*=.0004). Similarly, the individualized PEEP group had a higher oxygenation index, MD: 49.07mmHg, (95% CI: 27.21–70.92; *P*<.0001).

Conclusions: Individualized PEEP setting during one-lung ventilation in patients undergoing thoracic surgery was associated with fewer postoperative pulmonary complications and better perioperative oxygenation.

Fracción inspirada de oxigeno

Original contribution

Comparison of low and high inspiratory oxygen fraction added to lung-protective ventilation on postoperative pulmonary complications after abdominal surgery: A randomized controlled trial

Conclusions

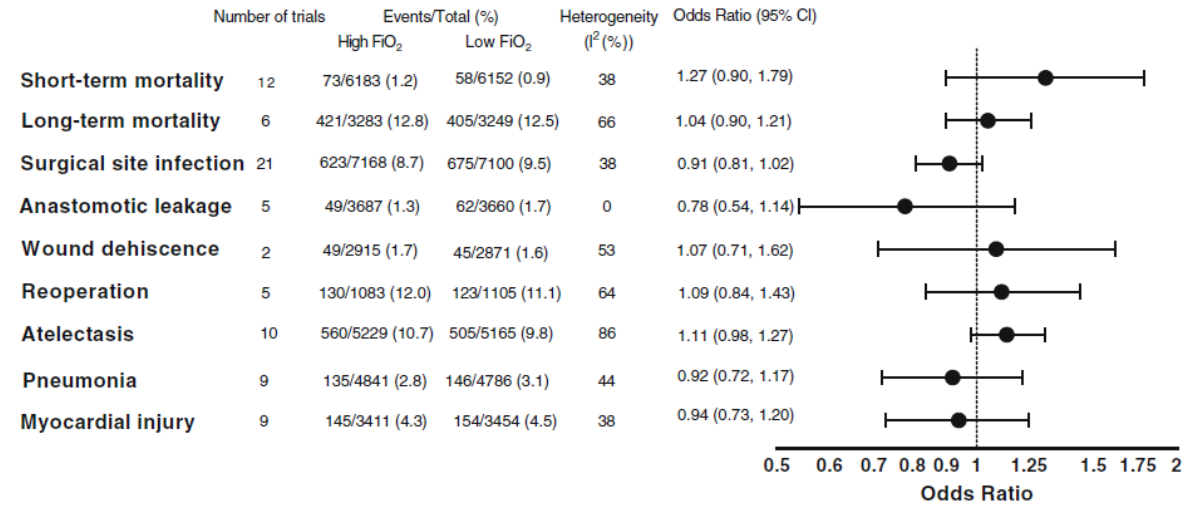
Among patients undergoing abdominal surgery under general anesthesia, an intraoperative lung-protective ventilation strategy with 30% FiO_2 compared with 80% FiO_2 did not reduce the incidence of PPCs. And the use of 30% FiO_2 resulted in less severe

REVIEW ARTICLE

acta Anaesthesiologica Scandinavica

Fraction of inspired oxygen during general anesthesia for non-cardiac surgery: Systematic review and meta-analysis

Conclusions: In adults undergoing general anesthesia for non-cardiac surgery, a high FiO_2 did not improve outcomes including surgical site infections, length of stay, or mortality. However, the certainty of the evidence was assessed as low.



Non-intubated spontaneous ventilation in video-assisted thoracoscopic surgery: a meta-analysis

mulative meta-analysis. Subgroup analyses of different thoracic diseases and study types were examined. Twenty-seven studies including 2537 patients were included in the analysis. A total of 1283 patients underwent non-intubated VATS; intubated VATS was performed on the other 1254 patients. Overall, the non-intubated VATS group had fewer postoperative overall complications [odds ratios (OR) 0.505; $P < 0.001$]; shorter postoperative fasting times [standardized mean difference (SMD) -2.653; $P < 0.001$]; shorter hospital stays (SMD -0.581; $P < 0.001$); shorter operative times (SMD -0.174; $P = 0.041$); shorter anaesthesia times (SMD -0.710; $P < 0.001$) and a lower mortality rate (OR 0.123; $P = 0.020$). Non-intubated VATS may be a safe and feasible alternative to intubated VATS and provide a more rapid postopera-

Mayor dificultad para anestesista
- Manejo de hipoxemia
- Nivel adecuado de sedación
- Requerimiento de epidural

Mayor dificultad para cirujano
- Adherencias, enfisema
- Pulmón moviéndose
- Reflejo tusígeno (Opción bloqueo X)

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Perspectivas futuras: mechanical power

$$Power_{rs} = 0.098 \cdot RR \cdot \{\Delta V^2 \cdot \left[\frac{1}{2} \cdot E_{rs} + RR \cdot \frac{(1 + I:E)}{60 \cdot I:E} \cdot R_{aw}\right] + \Delta V \cdot PEEP\}$$

$$\text{MP (J/min)} = 0.098 \times (V_T) \times (RR) \times (\text{PIP} - \Delta P \times 0.5)$$

PERIOPERATIVE MEDICINE: CLINICAL SCIENCE

Mechanical Power during General Anesthesia and Postoperative Respiratory Failure: A Multicenter Retrospective Cohort Study

Santer, Peter M.D., D.Phil.; Wachtendorf, Luca J. cand.med.; Suleiman, Aiman M.D., M.Sc.; Houle, Timothy T. Ph.D.; Fassbender, Philipp M.D.; Costa, Eduardo L. M.D.; Talmor, Daniel M.D., M.P.H.; Eikermann, Matthias M.D., Ph.D.; Baedorf-Kassis, Elias M.D.; Schaefer, Maximilian S. M.D.

- Patients experiencing reintubation within 7 days after surgery had a higher median mechanical power (7.67 [5.64 to 10.11] *vs.* 6.62 [4.62 to 9.10] J/min; $P < 0.001$)
- For each 5-J/min rise in intraoperative mechanical power, the adjusted risk of reintubation was 31% higher

Inteligencia artificial

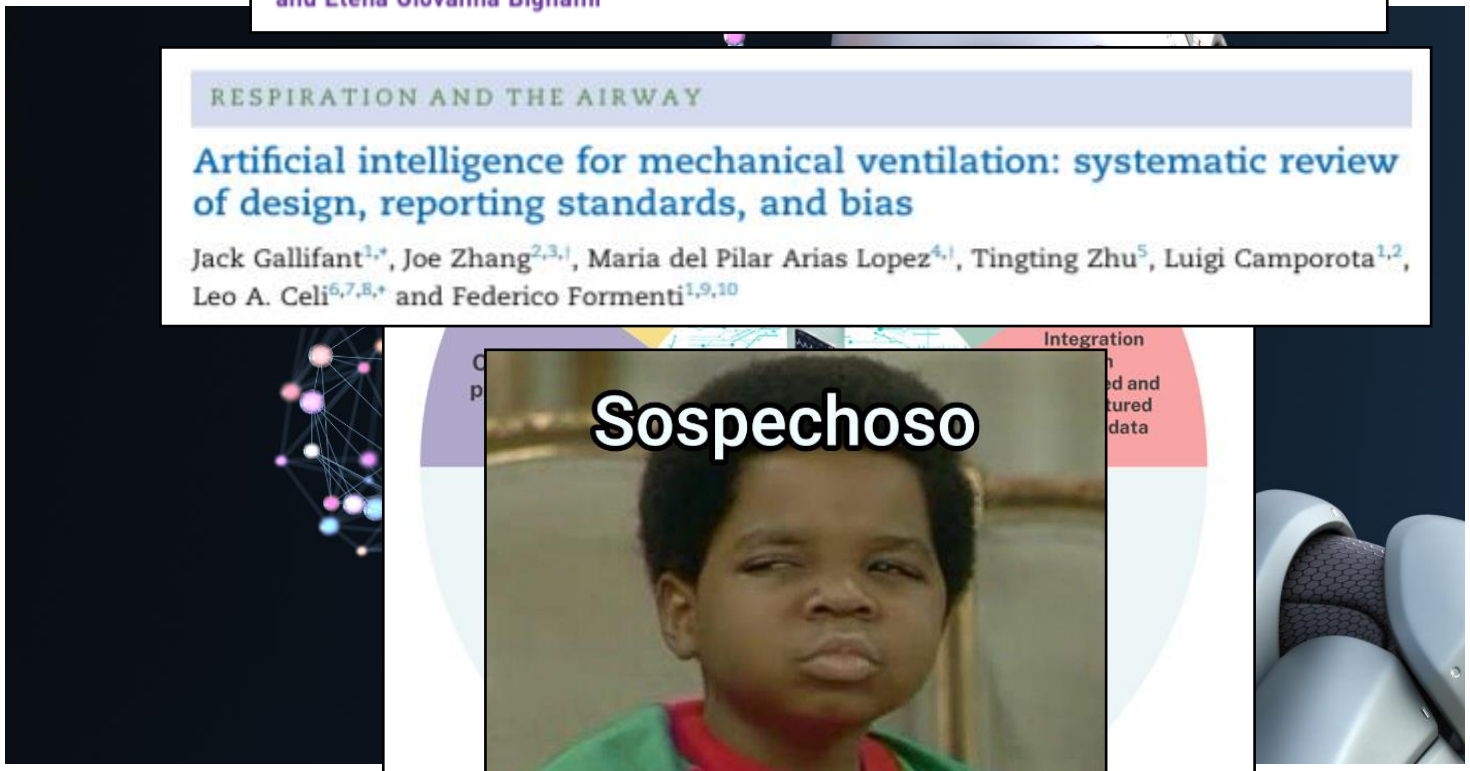
Artificial Intelligence for Mechanical Ventilation: A Transformative Shift in Critical Care

Giovanni Misseri, Matteo Piattoli, Giuseppe Cuttone, Cesare Gregoretti and Elena Giovanna Bignami

RESPIRATION AND THE AIRWAY

Artificial intelligence for mechanical ventilation: systematic review of design, reporting standards, and bias

Jack Gallifant[1,*], Joe Zhang[2,3,†], Maria del Pilar Arias Lopez[4,†], Tingting Zhu[5], Luigi Camporota[1,2], Leo A. Celi[6,7,8,*] and Federico Formenti[1,9,10]



SA

Valencia, 27 de mayo de 2025

Conclusiones

- Las intervenciones ventilatorias tienen un fundamento fisiológico con impacto a nivel cardio pulmonar
- Extrapolar datos de pacientes con patología pulmonar aguda a pacientes en quirófano no es adecuado
- Configuración personalizada al paciente, no solo al pulmón
- No existe un consenso definido de configuración de ventilación mecánica intraoperatoria

VT < 10 ml/kg | PEEP ≥5 cmH20 | DP < 13 cmH20 | ¿FiO2?

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