RICS
Rotterdam, The Netherlands
April 5, 2023; 13:30–14:00 HH

Future of Automated Ventilation

patient *vs.* healthcare provider

Disclosures

- Xenios/Fresenius, Germany
- Hamilton Medical AG, Switzerland

Agenda

- history of ventilation
- history of automated ventilation
- benefits of automated ventilation
- need for automated ventilation?
- wrap–up

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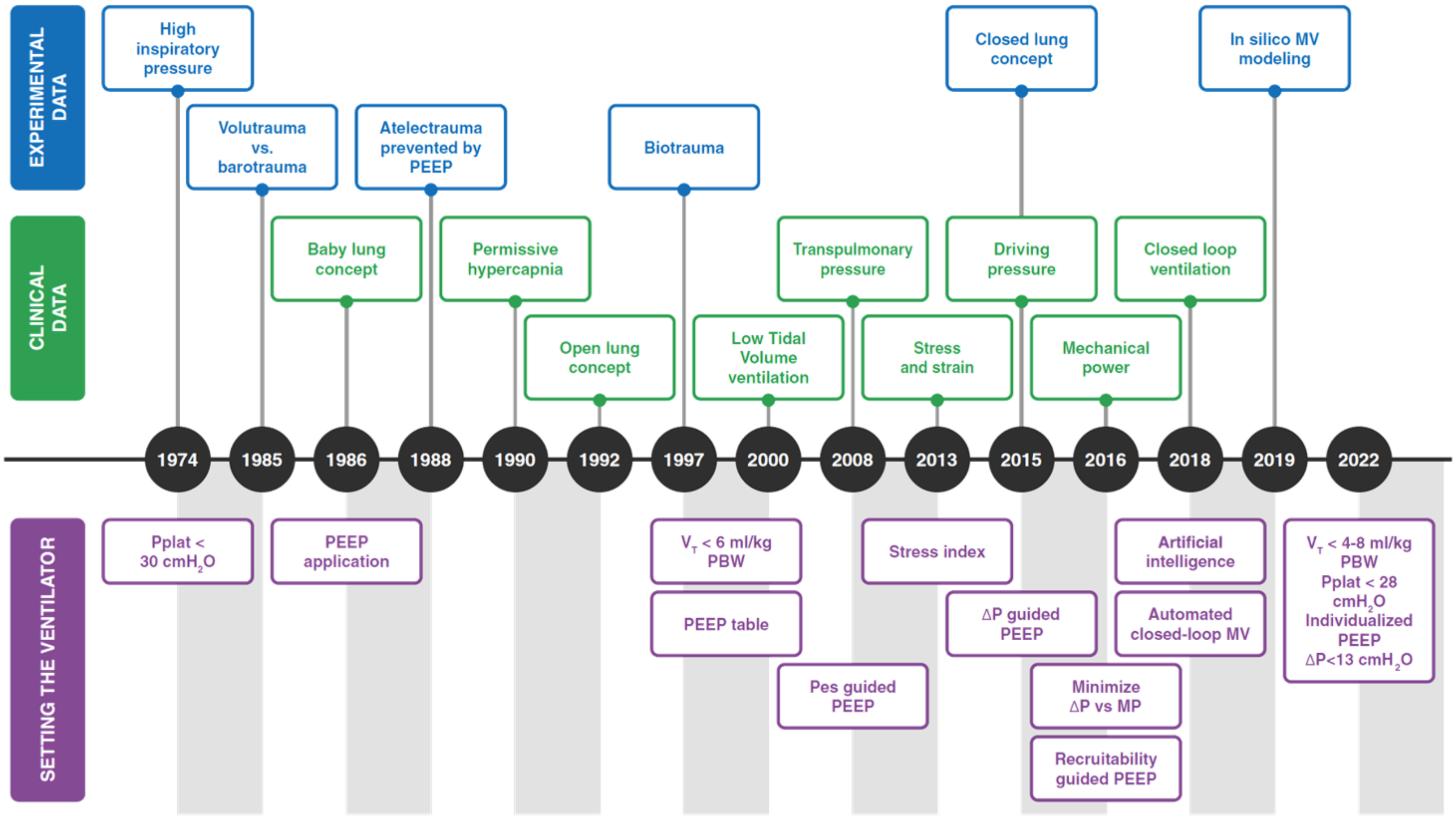


Fig. 1 Contributions over time to the knowledge of how to apply protective ventilation

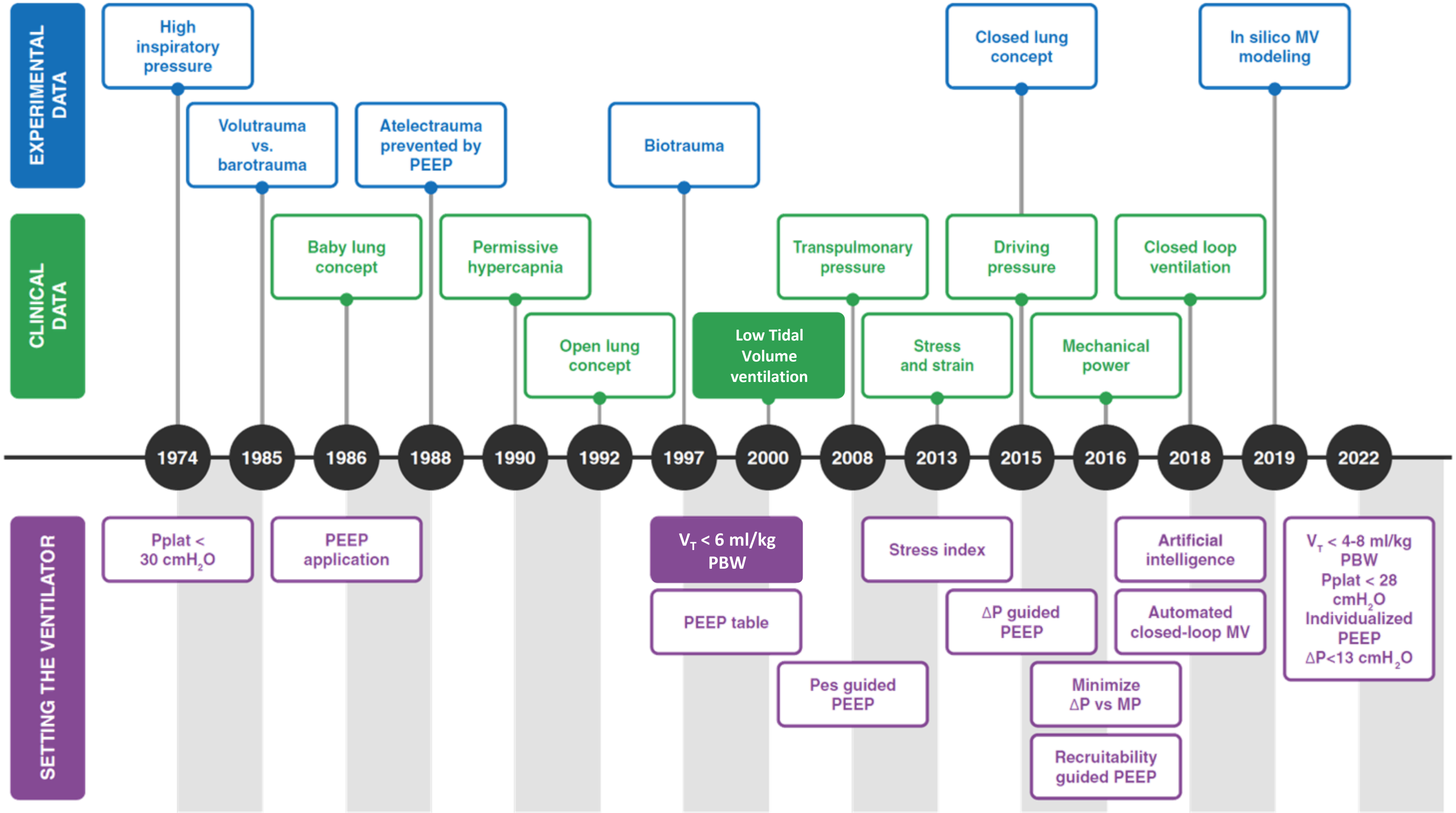


Fig. 1 Contributions over time to the knowledge of how to apply protective ventilation

The NEW ENGLAND JOURNAL of MEDICINE

QUESTION Does the use of a lower tidal volume (V_T) with mechanical ventilation affect important clinical outcomes in ARDS patients?

CONCLUSION Ventilation with a lower V_T than is traditionally used results in decreased mortality and increases the number of days without ventilator use.

POPULATION

344 Women **516** Men

patients with ARDS

mean age: **52** years

LOCATION

ICUs in the USA

VENTILATION STRATEGIES

861 patients with mild, moderate or severe ARDS

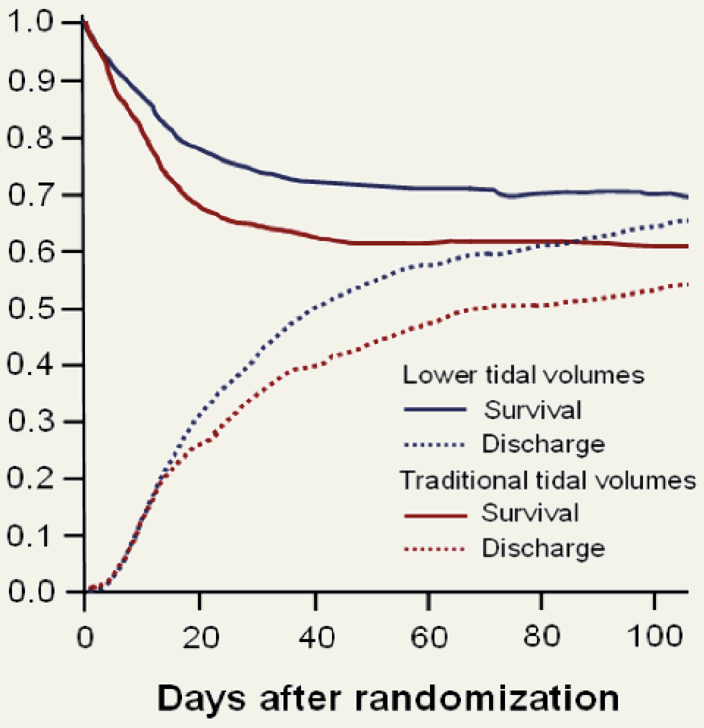
432 patients
lower V_T
(6 ml/kg)
[~ 400 to 500 ml]

429 patients
traditional V_T
(12 ml/kg)
[~1000 to 1200 ml]

(PRIMARY) OUTCOME

hospital mortality and duration of invasive ventilation

FINDINGS



ARDS Network investigators. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. [*New Eng J Med* 2000; **342**:1301 doi: 10.1056/NEJM200005043421801]

JAMA Network™

QUESTION For patients in the ICU who are ventilated for reasons other than ARDS, is low tidal volume superior to intermediate tidal volume?

CONCLUSION Among ICU patients receiving invasive ventilation, a strategy with a low tidal volume was not superior to using intermediate tidal volume.

POPULATION

621 Men **340** Women

ICU patients without ARDS expected to be intubated for more than 24 hours

Median age: **68** years (IQR, 59-76)

LOCATIONS

6
ICUs in the Netherlands

INTERVENTIONS

961 Patients randomized

477 Randomized
475 Analyzed

Low tidal volume

Started at tidal volume of 6 mL/kg; tidal volume then decreased in steps of 1 mL/kg predicted body weight

484 Randomized
480 Analyzed

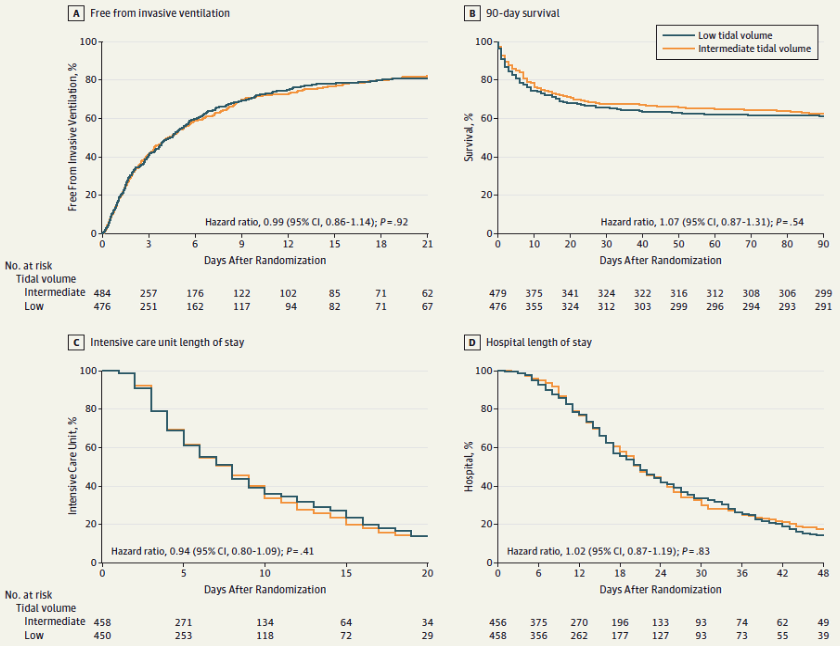
Intermediate tidal volume

Started at tidal volume of 10 mL/kg; if plateau pressure exceeded 25 cm H_2O, tidal volume was decreased in steps of 1 mL/kg predicted body weight

PRIMARY OUTCOME

Number of ventilator-free days and alive at day 28

FINDINGS



Writing Group for the PReVENT Investigators. Effect of a low vs intermediate tidal volume strategy on ventilator-free days in intensive care unit patients without ARDS: a randomized clinical trial [published online October 24, 2018]. *JAMA*. doi:10.1001/jama.2018.14280

ATS Journals

QUESTION What is the impact of mechanical power on mortality in patients with ARDS as compared with that of primary ventilator variables such as the ΔP, V_T, and RR?

CONCLUSION Mechanical power was associated with mortality during controlled mechanical ventilation in ARDS, but a simpler model using only the ΔP and RR was equivalent.

POPULATION

1728 Women **2821** Men

Patients with ARDS

Mean Age: **55** years

LOCATION

6 RCTs and **1** observational study

VENTILATION PARAMETERS

4549 patients with mild, moderate or severe ARDS

MP
0.32 J/min/kg

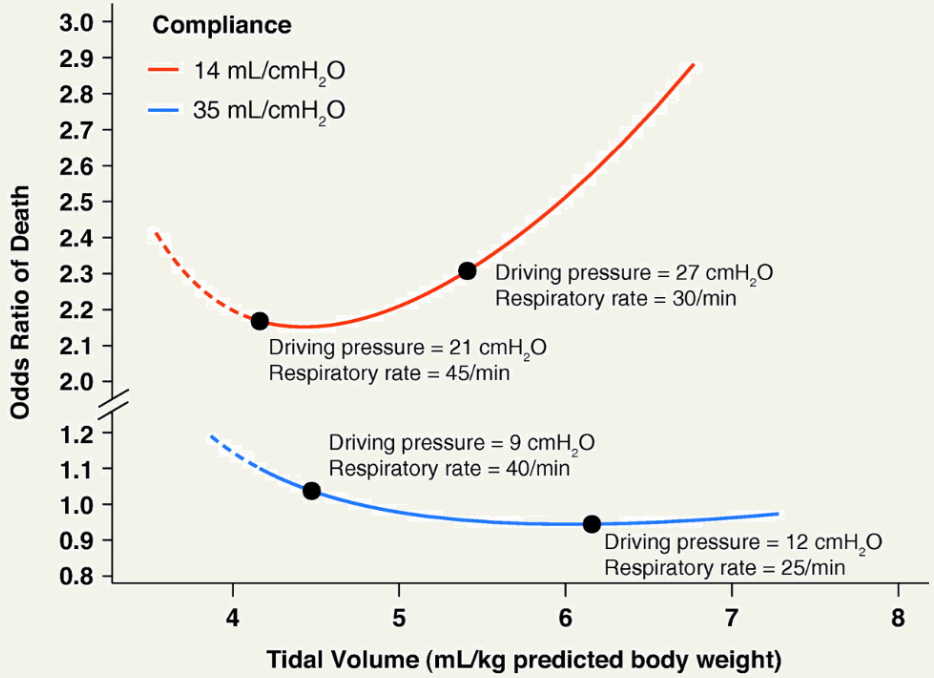
RR
26 breath/min

ΔP
15 cm H_2O

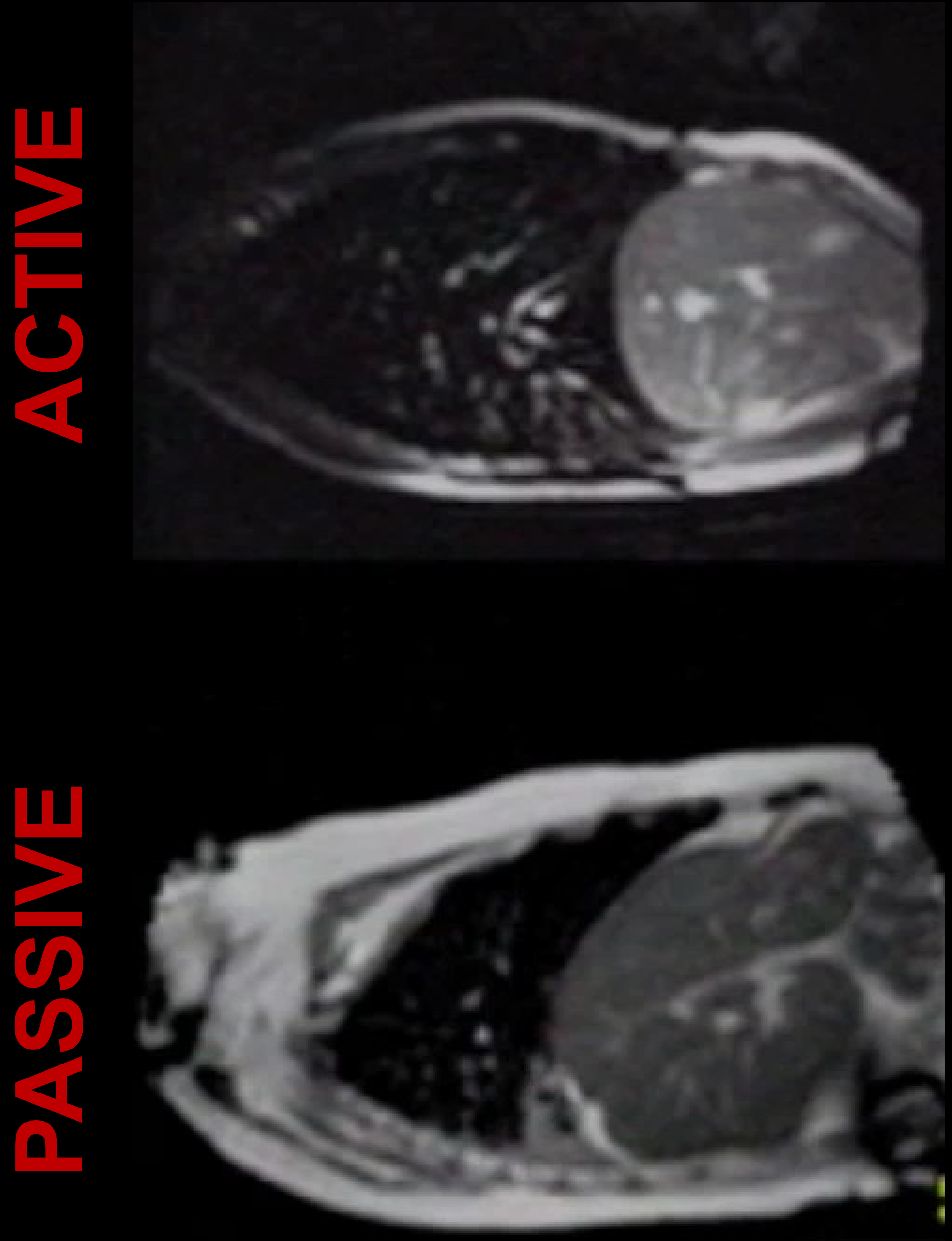
(PRIMARY) OUTCOME

Mortality at 28 or 60 days

FINDINGS



Costa et al. Ventilatory Variables and Mechanical Power in Patients with the acute respiratory distress syndrome. [*American Journal of Respiratory and Critical Care Medicine* 2021; **204**:303 doi:10.1164/rccm.202009-3467OC]



during spontaneous *vs* non–spontaneous ventilation, note:

- the position of diaphragm
- the aerated lung size
- presence of atelectasis
- presence of overdistension

Juffermans *Intensive Care Med* 2022; **48**:1629

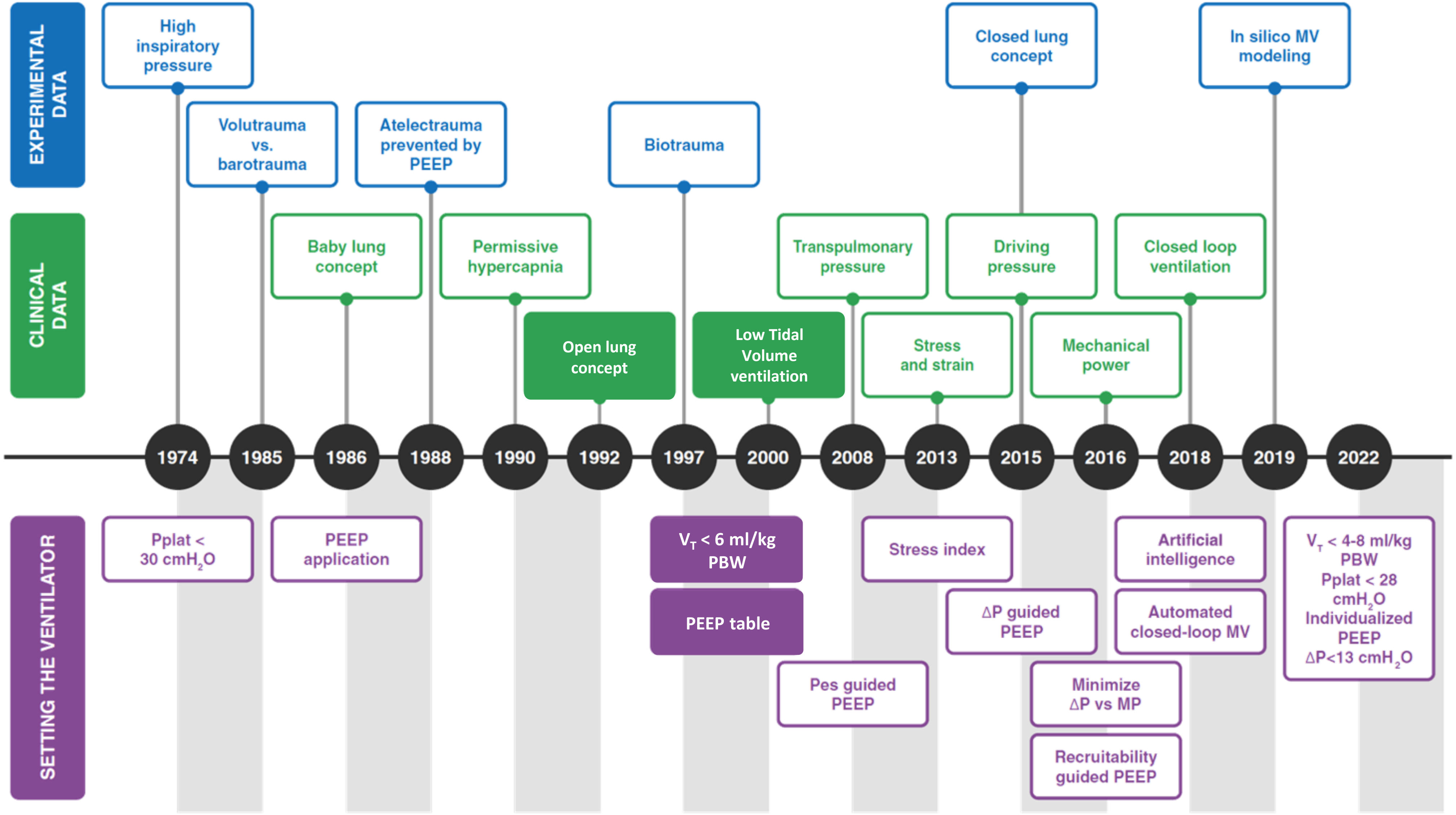


Fig. 1 Contributions over time to the knowledge of how to apply protective ventilation

JAMA Network

QUESTION Does use of a lung recruitment maneuver associated with PEEP titration according to the best respiratory-system compliance reduce 28-day mortality of patients with moderate to severe ARDS, compared with a conventional low-PEEP strategy?

CONCLUSION A strategy using a lung recruitment maneuver and titrated PEEP increased mortality of patients with moderate to severe ARDS.

POPULATION

379 Women **631** Men

consecutive patients with moderate to severe ARDS

Mean Age: **51** years

LOCATION

120 ICUs from **9** countries

VENTILATION STRATEGIES

1010 patients with moderate or severe ARDS

501 patients
titrated (high) PEEP [>15 cm H_2O] with RM

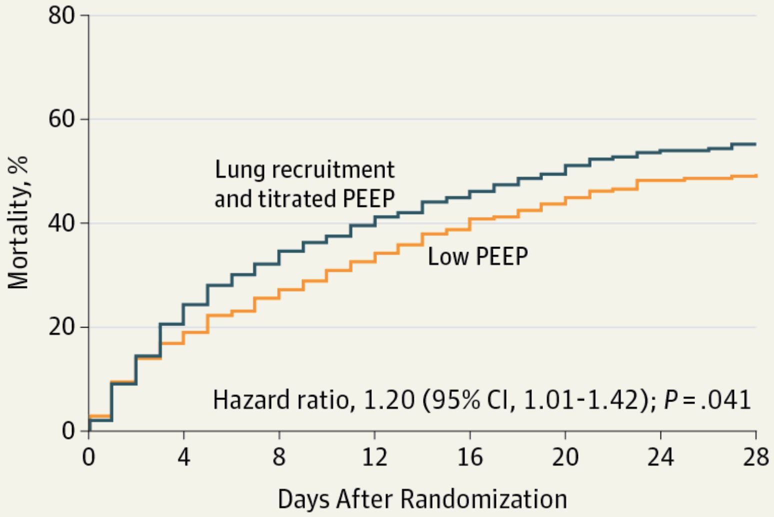
509 patients
standard (low) PEEP [< 12 cm H_2O] without RM

(PRIMARY) OUTCOME

28–day mortality; length of ICU and hospital stay; VFD28; pneumothorax requiring drainage or barotrauma within 7 days

FINDINGS

better oxygenation, but worse outcomes, and more pneumothorax and barotrauma with high PEEP



Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators. Effect of Lung Recruitment and Titrated PEEP vs Low PEEP on Mortality in Patients With ARDS–A Randomized Clinical Trial [*JAMA* 2017; **318**:1335]

BJA

QUESTION Is there heterogeneity in treatment effects in patients enrolled in the ART, using a machine learning approach?

CONCLUSION Recruitment maneuvers and titrated PEEP may be harmful in ARDS patients with pneumonia or requiring vasopressor support. Driving pressure appears to modulate the association between the ART study intervention, etiology of ARDS, and mortality.

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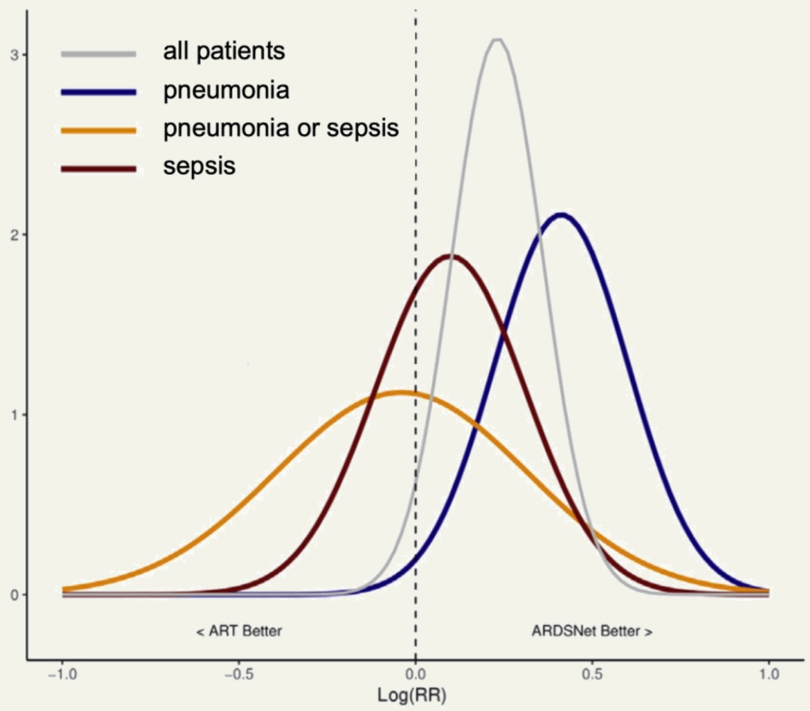
OUTCOME OF THE BAYESIAN ANALYSIS

28–day mortality

FINDINGS



Zampieri F for the ART Investigators. Heterogeneous effects of alveolar recruitment in acute respiratory distress syndrome: a machine learning reanalysis of the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial [*BJA* 2019; **123**:88; 10.1016/j.bja.2019.02.026]

THE LANCET
Respiratory Medicine

QUESTION Does a mechanical ventilation strategy that is personalized to individual patients' lung morphology improve the survival of patients with ARDS when compared with standard of care?

CONCLUSION Personalization of ventilation decreased mortality in patients with ARDS [in the posthoc analysis]; a ventilator strategy misaligned with lung morphology substantially increases mortality.

POPULATION

114 Women **286** Men

patients with ARDS for less than 12 hours

Median Age: **62** years

LOCATION

20 ICUs in France

INTERVENTION

400 patients with moderate to severe ARDS

204
standard care
V_T 6 ml/kg PBW
low PEEP

196
personalized care

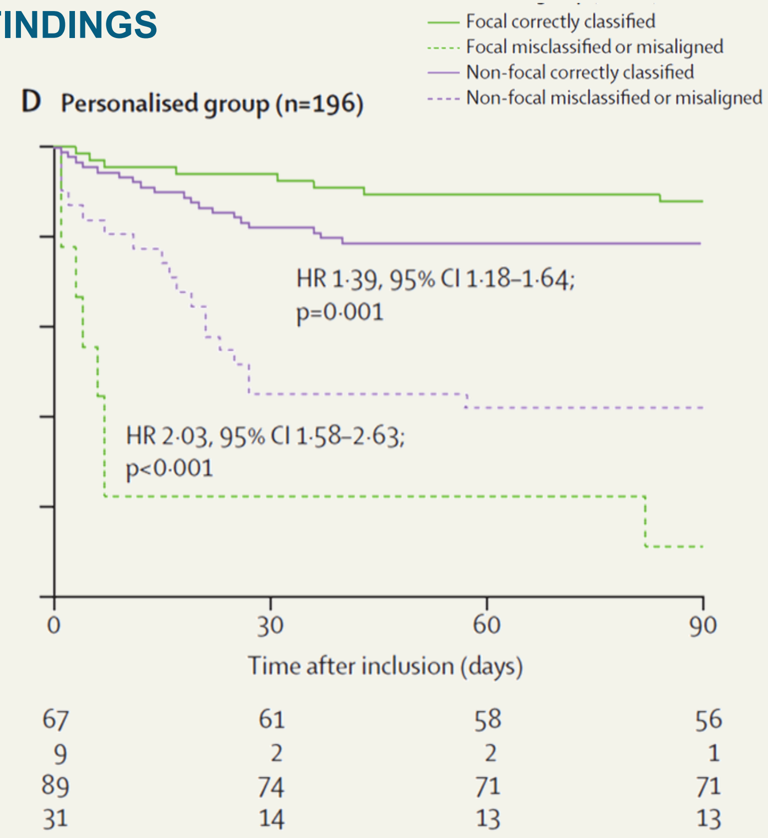
non–focal
V_T 6 ml/kg PBW
high PEEP
with RM

focal
V_T 8 ml/kg PBW
low PEEP and
prone positioning

(PRIMARY) OUTCOME

mortality at day 90; ventilator–free days, ARDS resolution; LOS in ICU; barotrauma

FINDINGS



LIVE–investigators. Personalized mechanical ventilation tailored to lung morphology versus low PEEP for patients with ARDS in France: a multicenter, single–blind, randomized clinical trial. [*Lancet Respir Med* 2019; **7**:870; doi:10.1016/S2213-2600(19)30138-9. Epub 2019 Aug 6]

JAMA Network

QUESTION In ICU patients who received invasive ventilation for reasons other than acute respiratory distress syndrome (ARDS), is a strategy with lower positive end-expiratory pressure (PEEP) noninferior to higher PEEP with respect to ventilator-free days at day 28?

CONCLUSION This clinical trial found that among ICU patients receiving invasive ventilation, a strategy with lower PEEP was noninferior to a strategy using higher PEEP for the outcome of ventilator-free days, supporting the use of lower PEEP in patients without ARDS.

POPULATION

623 Men **346** Women

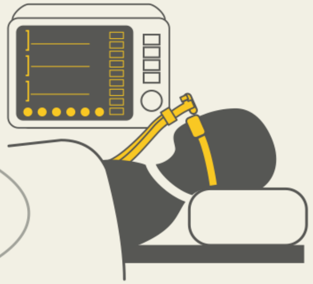
Adults without ARDS expected not to be extubated within 24 hours of intubation

Median age: **66** years

LOCATIONS

8 ICUs in the Netherlands

INTERVENTION



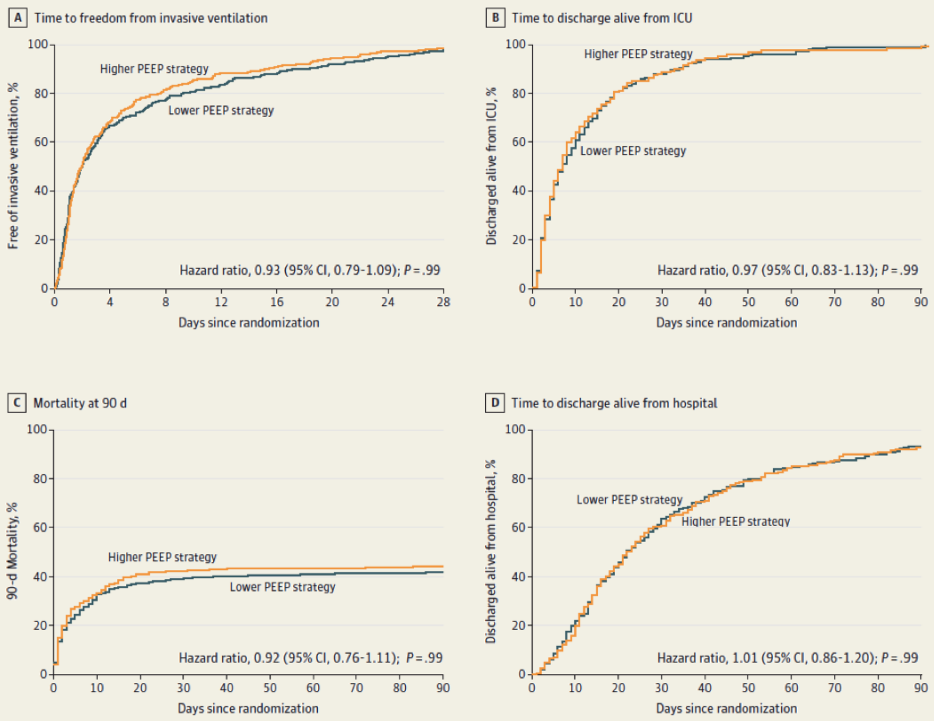
980 Patients randomized
969 Patients analyzed

476 **Lower PEEP strategy**
Lowest level between 0-5 cm H_2O

493 **Higher PEEP strategy**
Lowest level of 8 cm H_2O

PRIMARY OUTCOME

Number of ventilator-free days by study day 28 (noninferiority margin of −10%)



Writing Committee for the RELAx Collaborative Group. Effect of a lower vs higher positive end-expiratory pressure strategy on ventilator-free days in ICU patients without ARDS: a randomized clinical trial. *JAMA*. Published online December 9, 2020. doi:10.1001/jama.2020.23517

Juffermans *Intensive Care Med* 2022; **48**:1629

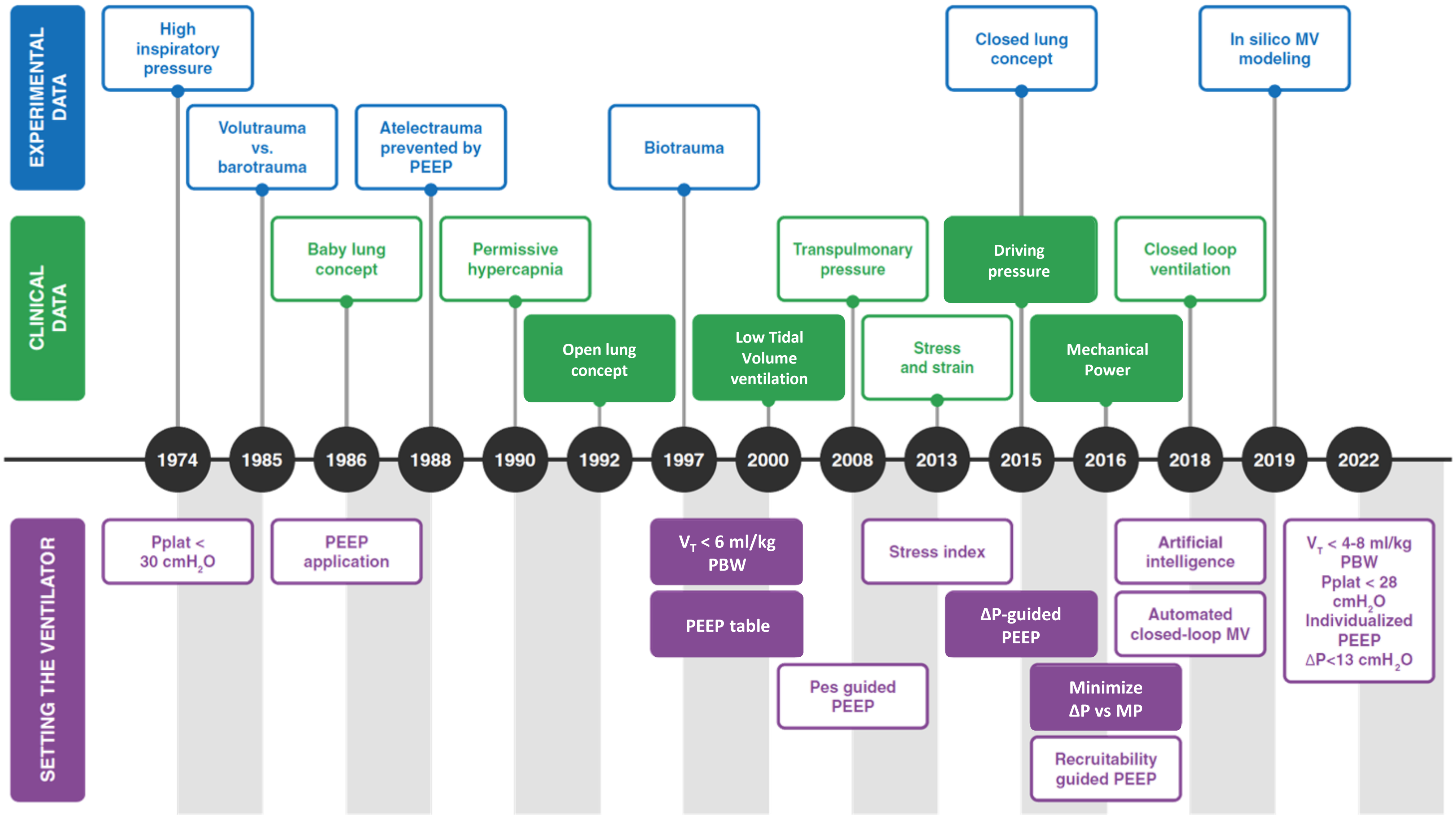


Fig. 1 Contributions over time to the knowledge of how to apply protective ventilation

The NEW ENGLAND JOURNAL of MEDICINE

QUESTION Is ΔP an index more strongly associated with survival than V_T or PEEP in patients who are not actively breathing?

CONCLUSION ΔP is the ventilation variable that best stratified risk; decreases in ΔP owing to changes in ventilator settings may be strongly associated with increased survival.

POPULATION

~40% Women **~60%** Men

patients with ARDS included in RCTs

Mean Age: from **34** to **60** years

SOURCE

9 trials worldwide

METHODS

multilevel mediation analysis of individual patient data from **3562** patients

prediction model
univariate
multivariate

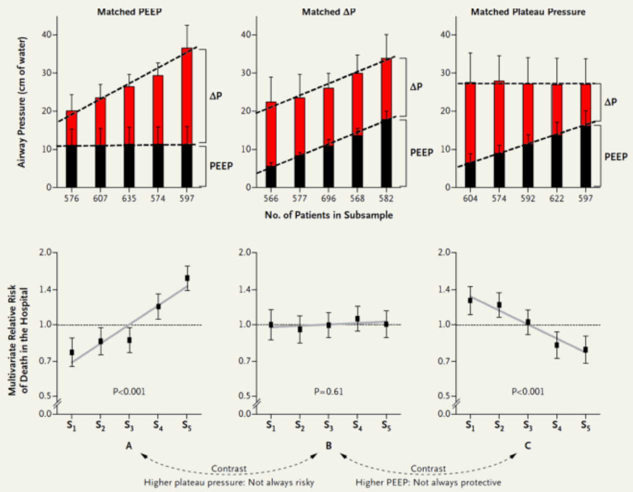
mediation analysis

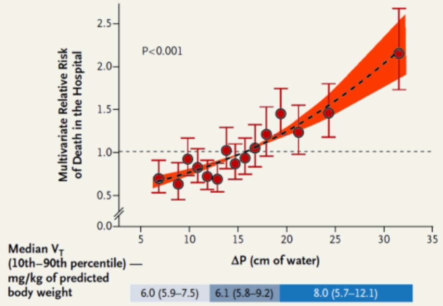
risk priority
of ΔP, V_T and PEEP

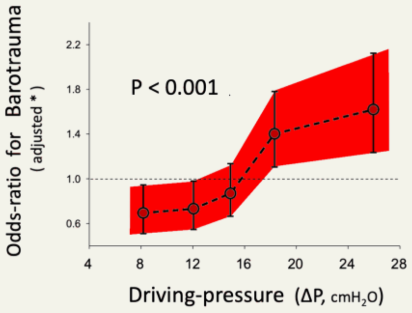
(PRIMARY) OUTCOME

60–day mortality

FINDINGS







Amato M. Driving Pressure and Survival in the Acute Respiratory Distress Syndrome. [*New Eng J Med* 2015; **372**:747; doi:10.1056/NEJMsa1410639]

THE LANCET
Respiratory Medicine

QUESTION What is the association between exposure to different intensities of mechanical ventilation over time and intensive care unit (ICU) mortality in patients with acute respiratory failure?

CONCLUSION Cumulative exposure to higher intensities of mechanical ventilation was harmful, even for short durations.

POPULATION

5141 Women **8267** Men

patients receiving ventilation for 4 hours or more

Median Age: **62** years

LOCATION

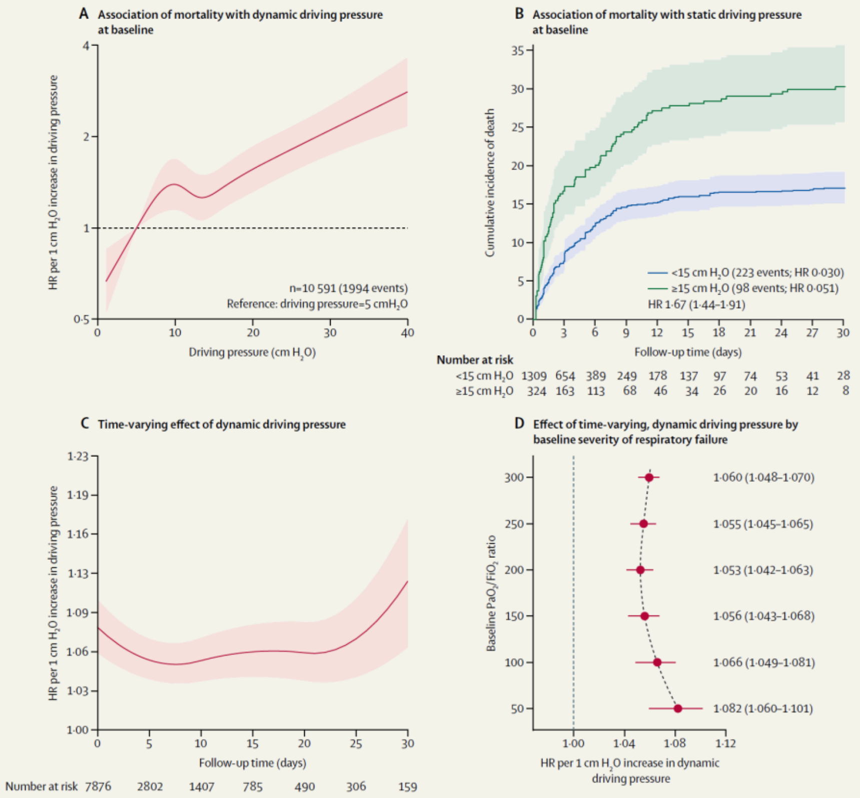
9 ICUs in Toronto, Canada

FINDINGS

	Exposure to high driving pressure		Exposure to high mechanical power	
	HR estimate (95% CrI)	p value	HR estimate (95% CrI)	p value
Baseline variables				
PaO_2/FiO_2, mm Hg	0·945 (0·896–0·994)	0·026	0·977 (0·930–1·031)	0·38
Age, years	1·108 (1·048–1·160)	<0·0001	1·128 (1·080–1·182)	<0·0001
APACHE III score	1·602 (1·526–1·680)	<0·0001	1·591 (1·524–1·669)	<0·0001
APACHE pH	0·832 (0·809–0·859)	<0·0001	0·840 (0·820–0·864)	<0·0001
Time-varying variables				
Days with driving pressure ≥15 cm H_2O	1·049 (1·023–1·076)	<0·0001	..	..
Days with mechanical power ≥17 J/min	..	..	1·069 (1·047–1·092)	<0·0001

1622 (20·6%) of 7876 patients died; 64 281 daily observations were recorded. HRs were the adjusted HRs associated with a 1-SD increment in the given variable. Values higher than 1 indicate increased mortality. The values used for SDs were as follows: PaO_2/FiO_2 ratio 119; pH 0·11; age 17 years; and APACHE III score 29. The effects of the number of days with either driving pressure greater than or equal to 15 cm H_2O or mechanical power greater than or equal to 17 J/min were estimated using Quasi-Poisson models in the joint model analyses. HR=hazard ratio. CrI=credible interval. PaO_2=partial pressure of oxygen. FiO_2=fraction of inspired oxygen. APACHE=Acute Physiology and Chronic Health Evaluation.

Table 3: **Cumulative effect on HRs of exposure to high intensities of mechanical ventilation for 7876 patients with available data**



Urner M. Time-varying intensity of mechanical ventilation and mortality in patients with acute respiratory failure: a registry-based, prospective cohort study. [*Lancet Resp Med* 2020; **8**:905; doi: 10.1016/S2213-2600(20)30325-8]

European Journal of Anaesthesiology

QUESTION Does the intensity of ventilation, reflected by the mechanical power of ventilation (MP), has an association with outcome in invasively ventilated patients without ARDS.

CONCLUSION In ICU patients without ARDS, MP has an independent association with mortality. This finding suggest that MP holds an added predictive value over its individual components, making MP an attractive parameter to monitor and target in these patients.

POPULATION

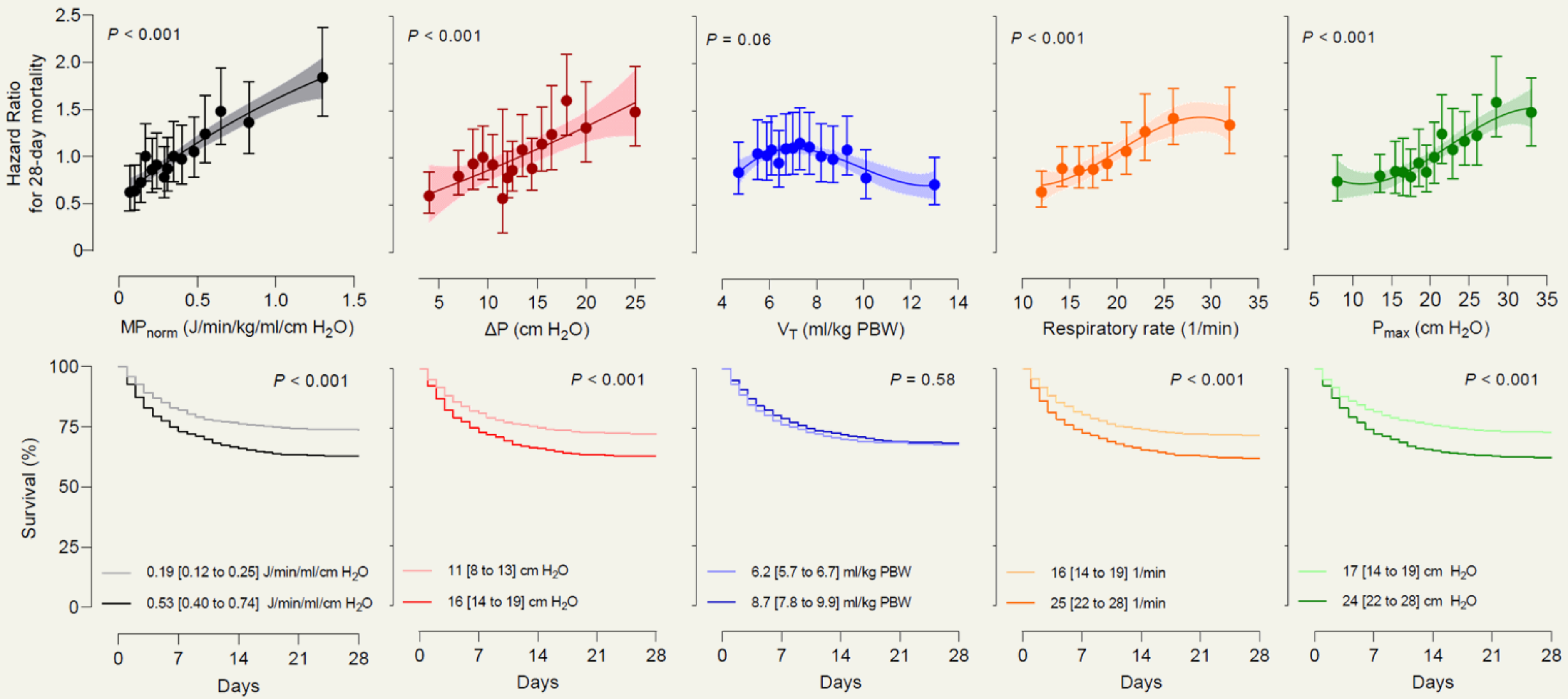
1962 Patients

ICU patients without ARDS, expected to need invasive ventilation > 24 hours

Median Age: **67** years

LOCATION

8 ICUs in the Netherlands



van Meenen D, for the NEBULAE–, PReVENT– and RELAx–investigators. Effect of Intensity of Ventilation on Outcome in Invasively Ventilated ICU patients without ARDS—An IPD–analysis of Three Randomized Clinical Trials. [*Eur J Anaesth* 2022; Nov 21; doi:10.1097/EJA.0000000000001778]

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- history of automated ventilation
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- need for automated ventilation?
- wrap–up

Juffermans *Intensive Care Med* 2022; **48**:1629

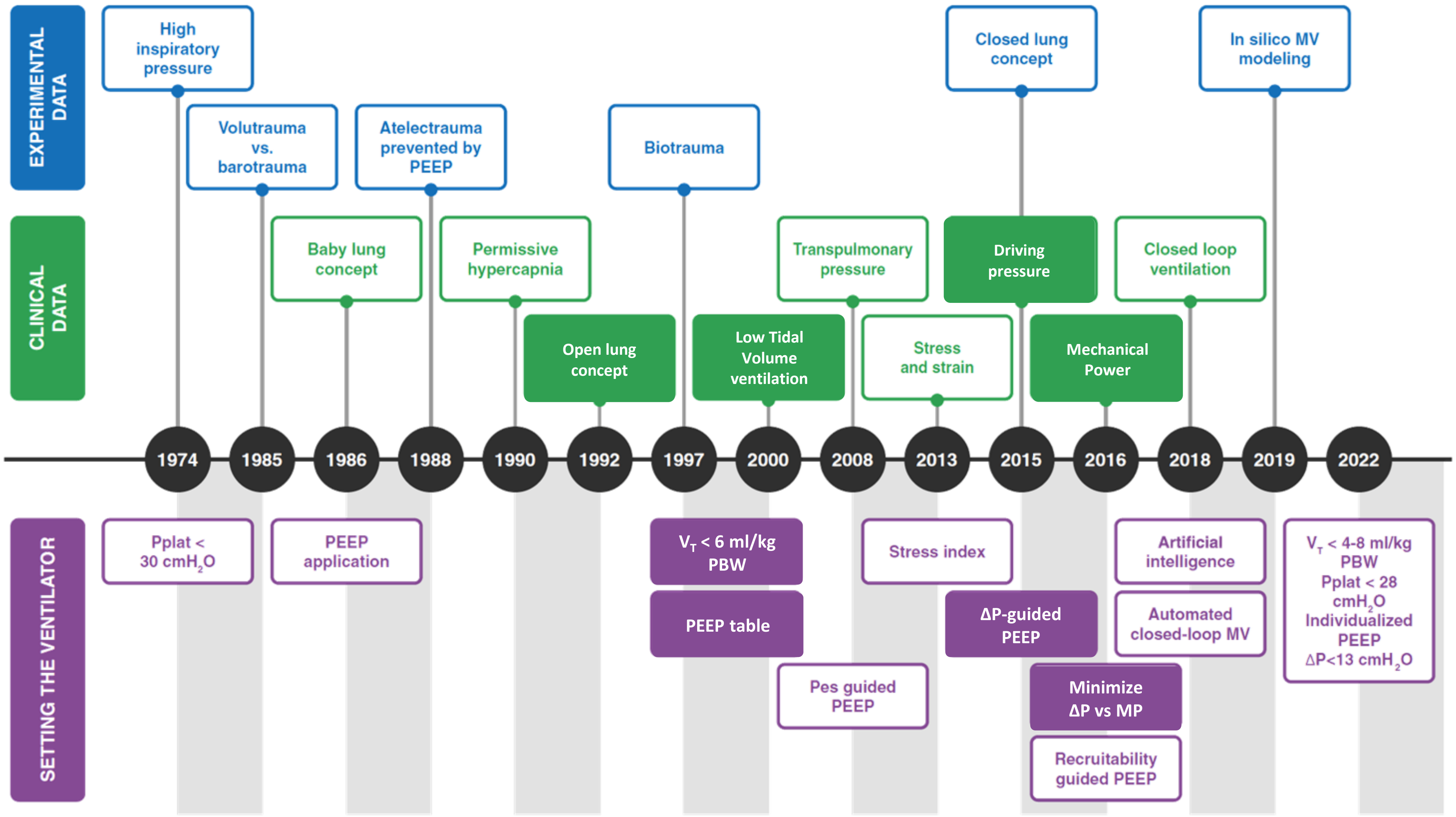

Fig. 1 Contributions over time to the knowledge of how to apply protective ventilation

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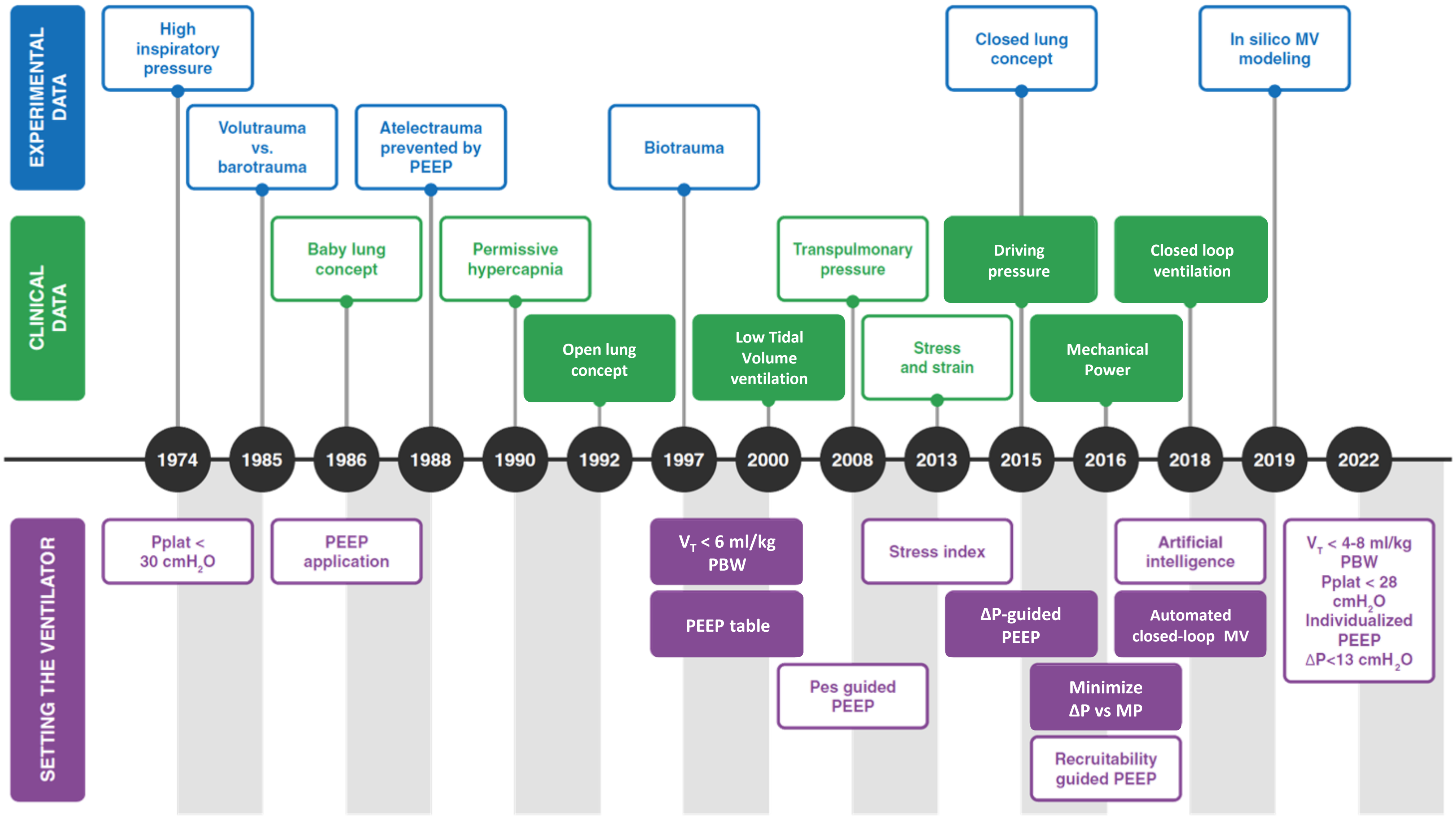


Fig. 1 Contributions over time to the knowledge of how to apply protective ventilation

Buiteman–Kruizinga *Intensive Care Med* 2022; **48**:943

A History of

Automated Ventilation

Despite years of research in mechanical ventilation
many settings remained to be set by hand
Here is when the ventilators became smarter

PAV+ — 1 — 1992
monitors flow and volume
inspiratory assist in proportion to patient's effort

ASV — 2 — 1998
automated selection of V_T and RR
according to the least WOB (Otis)

NAVA — 3 — 2002
monitors diaphragm activity
inspiratory assist in proportion to diaphragm activity

SmartCare — 4 — 2006
automated weaning mode
monitors V_T, RR, and $etCO_2$
reduction of PS and performs SBT

INTELLiVENT–ASV — 5 — 2016
automated selection of V_T and RR
according to the least WOB (Otis) and FOB (Mead)
monitors V_T, RR, $etCO_2$ and SpO_2
automated titrations of AMV, PEEP and FiO_2
reduction of AMV via reduction of PS, performs SBT

Buiteman–Kruizinga *Clin Crit Care* 2022; *submitted*

Critical Care Explorations
Society of Critical Care Medicine
The Intensive Care Professionals

QUESTION Is the amount of mechanical power of ventilation (MP) under adaptive support ventilation (ASV) different from that under nonautomated pressure–controlled ventilation?

CONCLUSION This study suggests ASV may have benefits compared with pressure–controlled ventilation with respect to the MP transferred from the ventilator to the respiratory system in passive invasively ventilated critically ill patients.

POPULATION

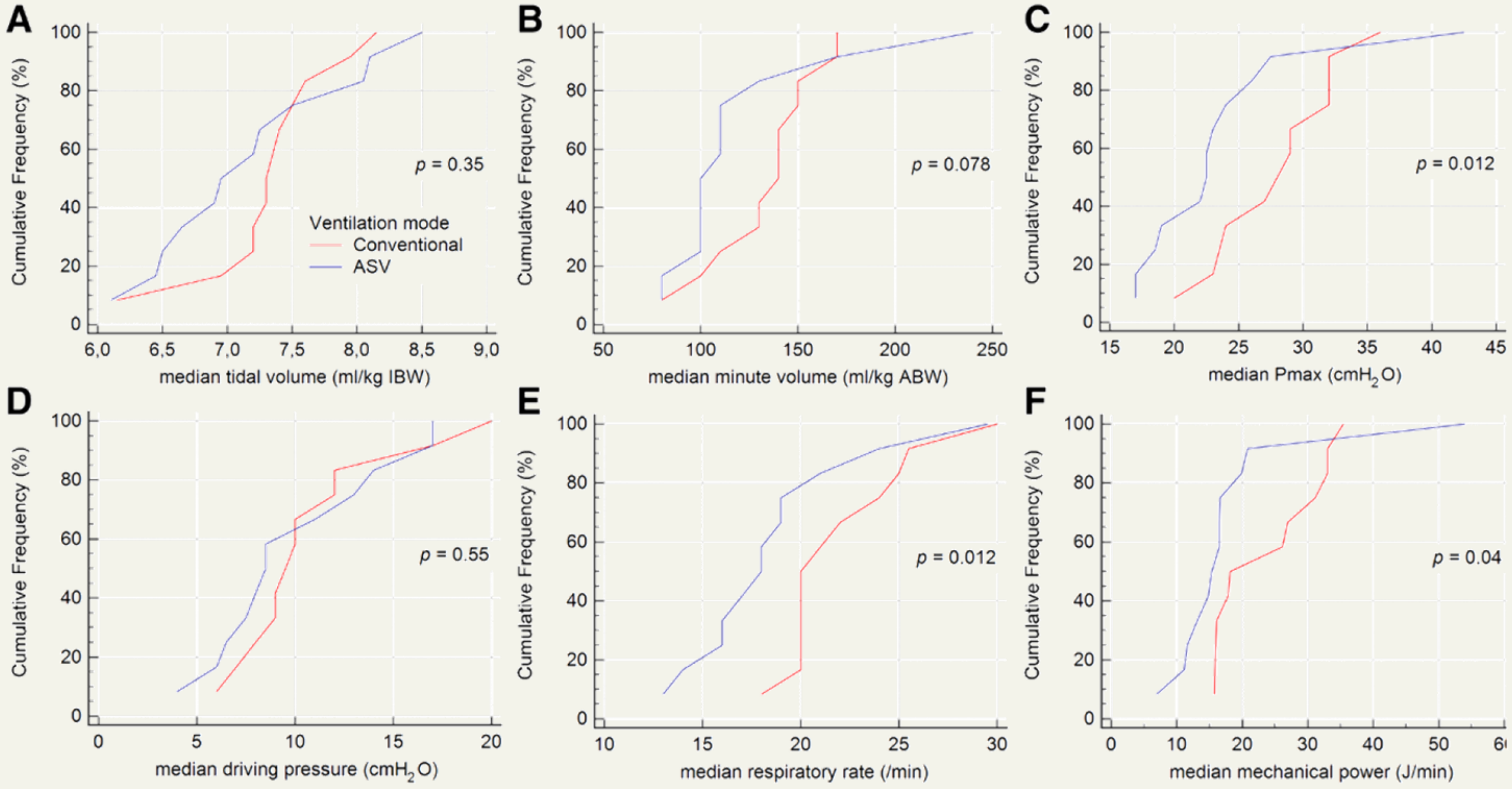
7 Women **15** Men

patients expected to nee invasive ventilation for the next 24 hours

Median Age: **67** years

LOCATION

1 ICUs in The Netherlands



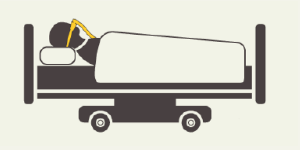
Buiteman–Kruizinga L. Comparison of Mechanical Power During Adaptive Support Ventilation Versus Nonautomated Pressure–Controlled Ventilation—A Pilot Study. [*Crit Care Explorations* 2021; **3**:e0335. doi: 10.1097/CCE.0000000000000335]

BJA British Journal of Anaesthesia

QUESTION In patients receiving post–operative ventilation after cardiac surgery, does INTELLiVENT–ASV improve the quality of breathing compared with conventional ventilation?

CONCLUSION Fully automated ventilation in patients after cardiac surgery optimized lung–protective ventilation during postoperative ventilation, with fewer episodes of severe hypoxaemia and an accelerated resumption of spontaneous breathing.

POPULATION



67 Women **153** Men

patients after uncomplicated cardiac surgery

Median Age: **62–76** years

LOCATION

1 ICU in the Netherlands

INTERVENTION

220 patients after surgery

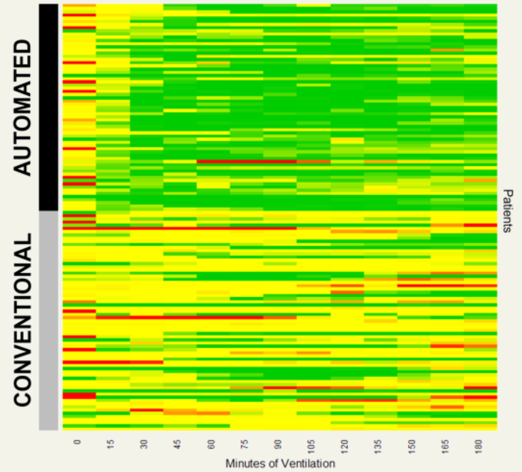
111 conventional ventilation

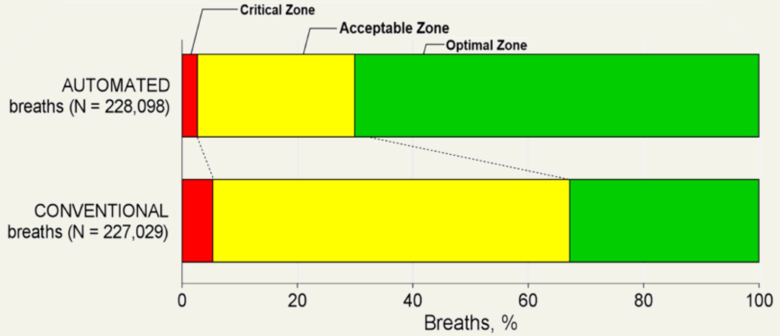
109 automated ventilation

(PRIMARY) OUTCOME

proportion of breath within predefined optimal, acceptable, and critical ranges (V_T, Pmax, SpO_2 and $etCO_2$); severe hypoxaemia (SpO_2 <85%) and resumption of spontaneous breathing

FINDINGS





POSITiVE–investigators. Fully automated postoperative ventilation in cardiac surgery patients: a randomized clinical trial. [*BJA* 2021; **125**:739; doi: 10.1016/j.bja.2020.06.037]

Journal of
Clinical Medicine

QUESTION In COVID–19 patients with ARDS, does INTELLiVENT–ASV reduce the driving pressure and mechanical power of ventilation compared with conventional ventilation?

CONCLUSION INTELLiVENT–ASV reduces the intensity of ventilation in COVID–19 patients with ARDS.

POPULATION

12 Women **39** Men

COVID–19 with moderate to severe ARDS

Median Age: **63** years

LOCATION

2 ICUs in the Netherlands

INTERVENTION

51 patients intubated in the ICU for acute hypoxemia

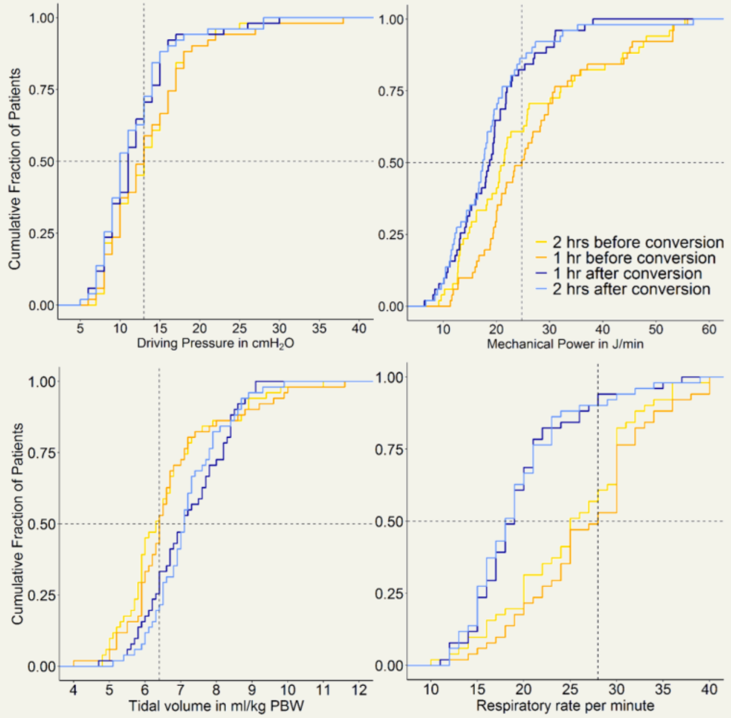
conventional ventilation → **automated ventilation**

crossover

(PRIMARY) OUTCOME

ΔP and MP before and after converting from conventional ventilation to INTELLiVENT–ASV

FINDINGS



Buiteman–Kruizinga L. Effect of INTELLiVENT-ASV versus Conventional Ventilation on Ventilation Intensity in Patients with COVID-19 ARDS—An Observational Study. [*J Clin Med* 2021; 10:5409]

Journal of
Clinical Medicine

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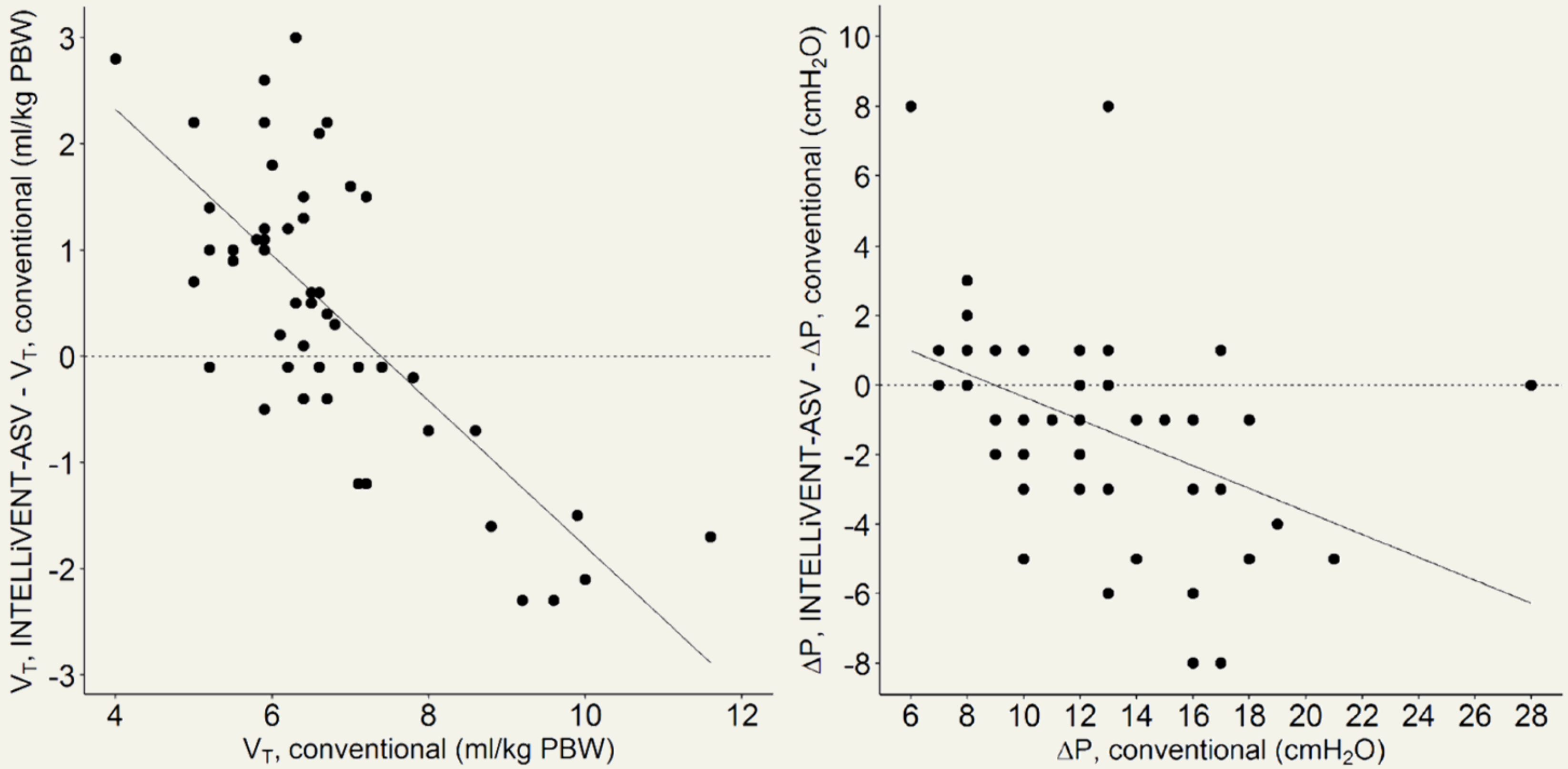


Buiteman–Kruizinga L. Effect of INTELLiVENT-ASV versus Conventional Ventilation on Ventilation Intensity in Patients with COVID-19 ARDS—An Observational Study. [*J Clin Med* 2021; 10:5409]

frontiers | Frontiers in Medicine

QUESTION What is the effect of automated closed–loop oxygen control, compared to automated ventilation with manual oxygen titrations, on time spent in predefined pulse oximetry (SpO_2) zones in pediatric critically ill patients?

CONCLUSION In this randomized crossover trial in pediatric critically ill patients under invasive ventilation with ASV, the percentage of time spent within in optimal SpO_2 zones increased with the use of closed–loop oxygen control.

POPULATION

37 Pediatric Patients

children with or without ARDS under invasive ventilation

Median Age: **1** year

LOCATION

1 ICU in Turkey

INTERVENTION

37 patients under ASV for acute hypoxemia

↓

2 hours manual or automated FiO_2 control

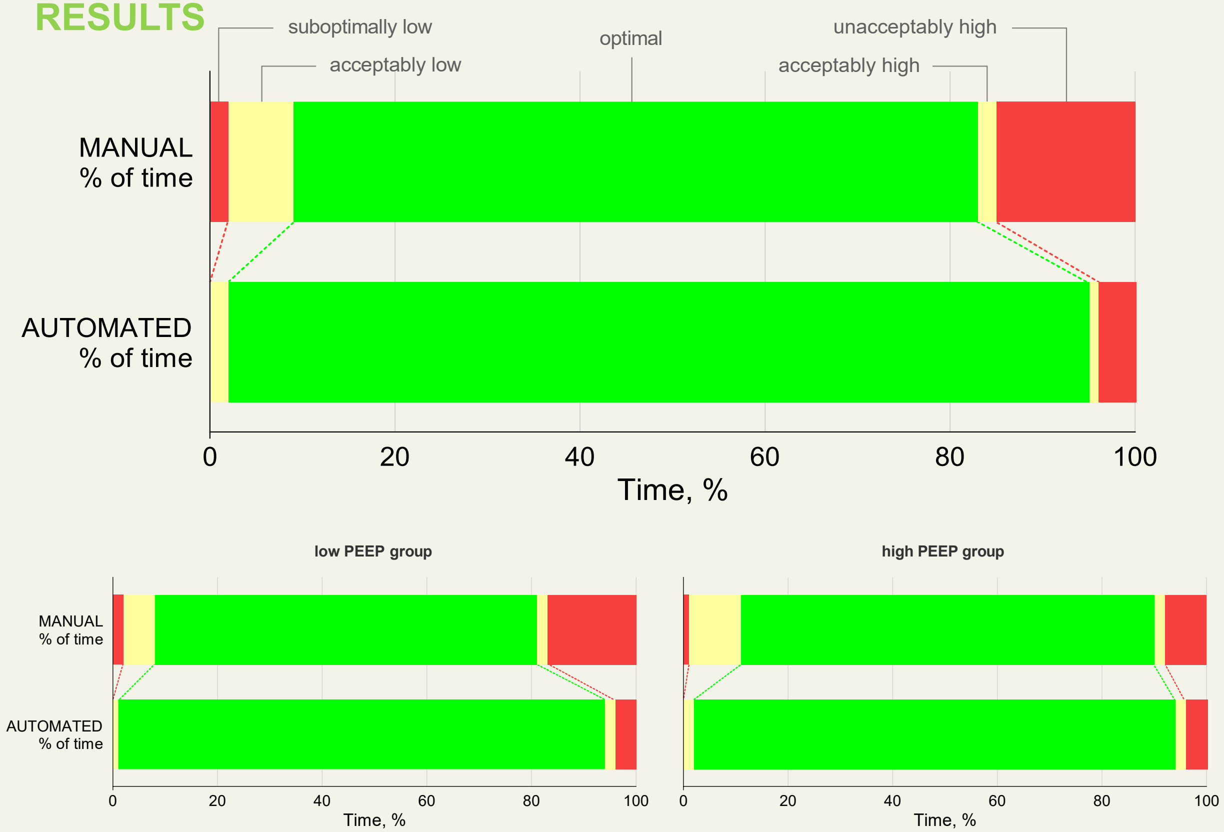
↓ *crossover*

2 hours automated or manual FiO_2 control

(PRIMARY) OUTCOME

FiO_2 settings and SpO_2 readings

RESULTS



Soydan E & Ceylan G. Automated Closed–loop FiO_2 Titration Increases the Percentage of Time spent in Optimal Zones of Oxygen Saturation in Pediatric Patients—a randomized crossover clinical trial [Frontiers Med 2022; 9:969218; doi: 10.3389/fmed.2022.969218]

CRITICAL CARE

QUESTION What is the efficacy of a closed–loop oxygen control in critically ill patients with moderate to severe acute hypoxemic respiratory failure (AHRF) treated with high flow nasal oxygen (HFNO).

CONCLUSION Closed–loop oxygen control improves oxygen administration in patients with moderate-to-severe AHRF treated with HFNO, increasing the percentage of time in the optimal oxygenation range and decreasing the workload of healthcare personnel.

POPULATION

45 patients under HFNO

patients with moderate to severe ARF, including patients with COVID–19

Median Age: **49** year

LOCATION

1 ICU in Spain

INTERVENTION

45 patients under HFNO

4 hours manual or automated FiO_2 control

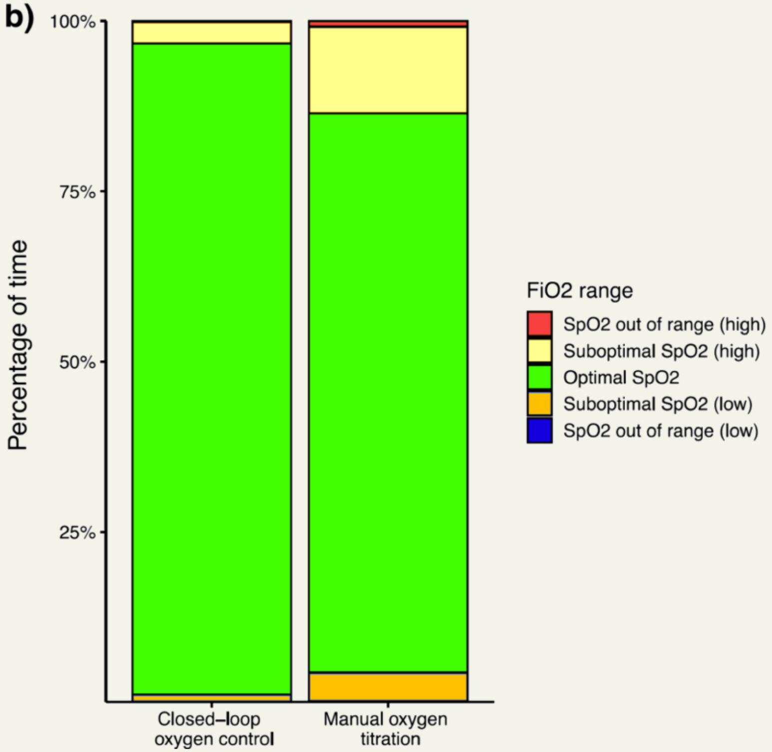
crossover

4 hours automated or manual FiO_2 control

(PRIMARY) OUTCOME

percentage of time spent in the individualized optimal SpO_2 ranges

RESULTS



Roca O. Closed–loop oxygen control improves oxygen therapy in acute hypoxemic respiratory failure patients under high flow nasal oxygen (HILOOP): a randomized cross-over study. [*Crit Care* 2022; **26**:108; doi10.1186/s13054-022-03970-w] frontiers | Frontiers in Medicine

QUESTION What is the effect of HFNO with closed–loop control of the fraction of inspired oxygen (FiO_2), compared to HFNO with manual titrations of the FiO_2, on time spent in predefined pulse oximetry (SpO_2) zones in pediatric critically ill patients?

CONCLUSION In this randomized crossover trial in pediatric critically ill patients under HFNO, the percentage of time spent within in optimal SpO_2 zones increased with the use of closed–loop FiO_2 control.

POPULATION

23 Pediatric Patients

children with acute hypoxemic respiratory failure under HFNO

Median Age: **1** year

LOCATION

3 ICUs in Turkey

INTERVENTION

23 patients under HFNO for acute hypoxemia

↓

manual or automated FiO_2 control

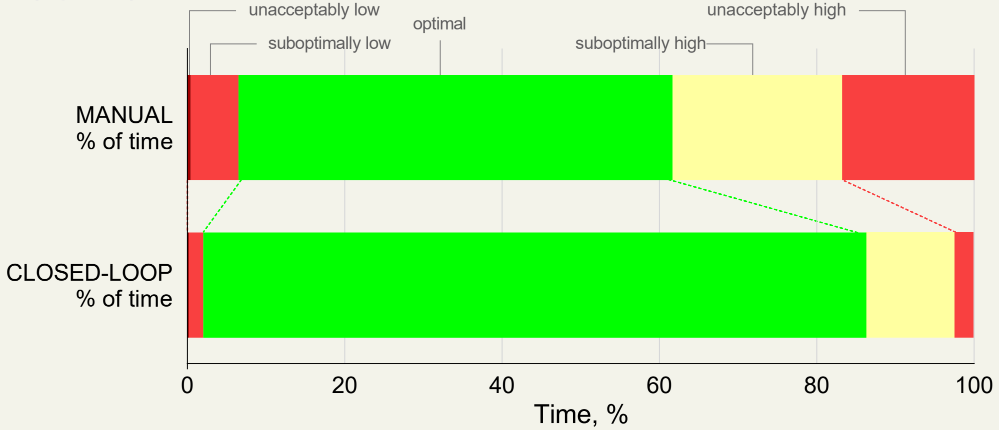
↓ *crossover*

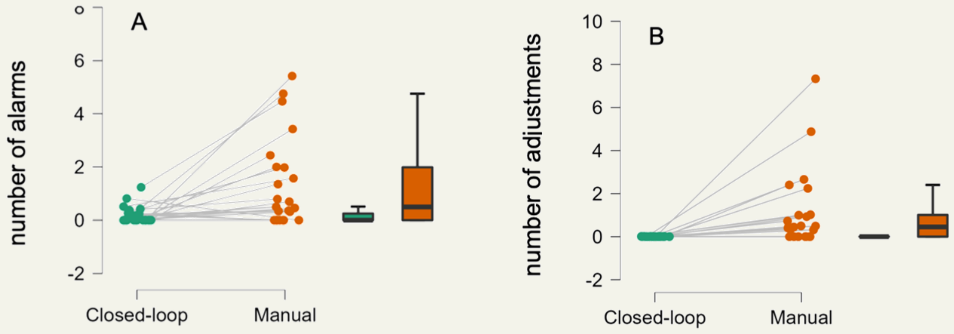
automated or manual FiO_2 control

(PRIMARY) OUTCOME

FiO_2 settings and SpO_2 readings; alarms and manual adjustments

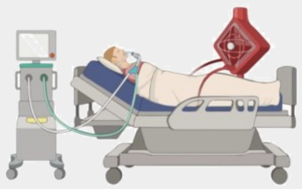
RESULTS



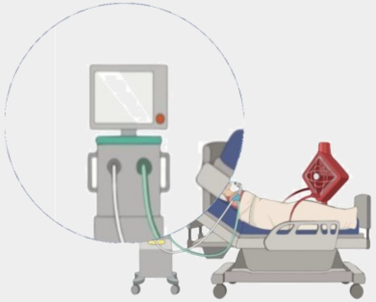


Sandal O. Closed–loop Oxygen Control Improves Oxygenation in Pediatric Patients Under High–flow Oxygen Therapy – a randomized crossover study. [Frontiers Med 2022; *in press*]

Lung Protective Ventilation during ECMO



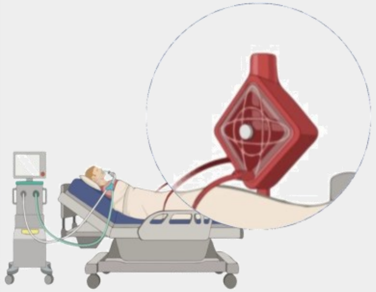
how to set the ventilator (and adjust ECMO) by hand
and the potential role of automation



cannulation for ECMO

1. **initiation**
start on time, to prevent unnecessarily long use of harmful ventilation
2. **blood flow**
use sufficiently high blood flows, to provide optimal oxygenation
3. **initial sweep gas flow**
use sufficiently high gas flows, to provide good decapneization
4. **sweep gas flow**
adjust to allow use of even lower V_T and RR, to keep the energy transfer low

decannulation



tracheal intubation

1. **tidal volume**
target a low V_T, from 4 to 8 ml/kg PBW
2. **positive end–expiratory pressure**
use PEEP levels that prevent too much alveolar collapse (with ECMO PEEP is suggested to be set > 10 cm H_2O)
3. **respiratory rate**
target an alveolar minute volume that fits patient's need, and use permissive hypercapnia
4. **driving pressure**
adjust V_T and titrate PEEP, so that ΔP stays low
5. **mechanical power**
titrate ventilator settings and use permissive hypercapnia, so that the energy transferred to the lung stays low

extubation

automated modes (but studies that support their use during ECMO remain lacking)

PAV+
inspiratory assist in proportion to patient's effort

ASV
automated selection of V_T and RR according to the least work of breathing

NAVA
inspiratory assist in proportion to diaphragm activity

SmartCare
automated weaning: reduction of support and performs spontaneous breathing trials

INTELLiVENT–ASV
automated selection of V_T and RR according to the least work of breathing and force of breathing (power), automated titrations of AMV, PEEP and FiO_2, and automated weaning: reduction of support, performs spontaneous breathing trials

Agenda

- history of ventilation
- history of automated ventilation
- benefits of automated ventilation
- need for automated ventilation?
- wrap–up

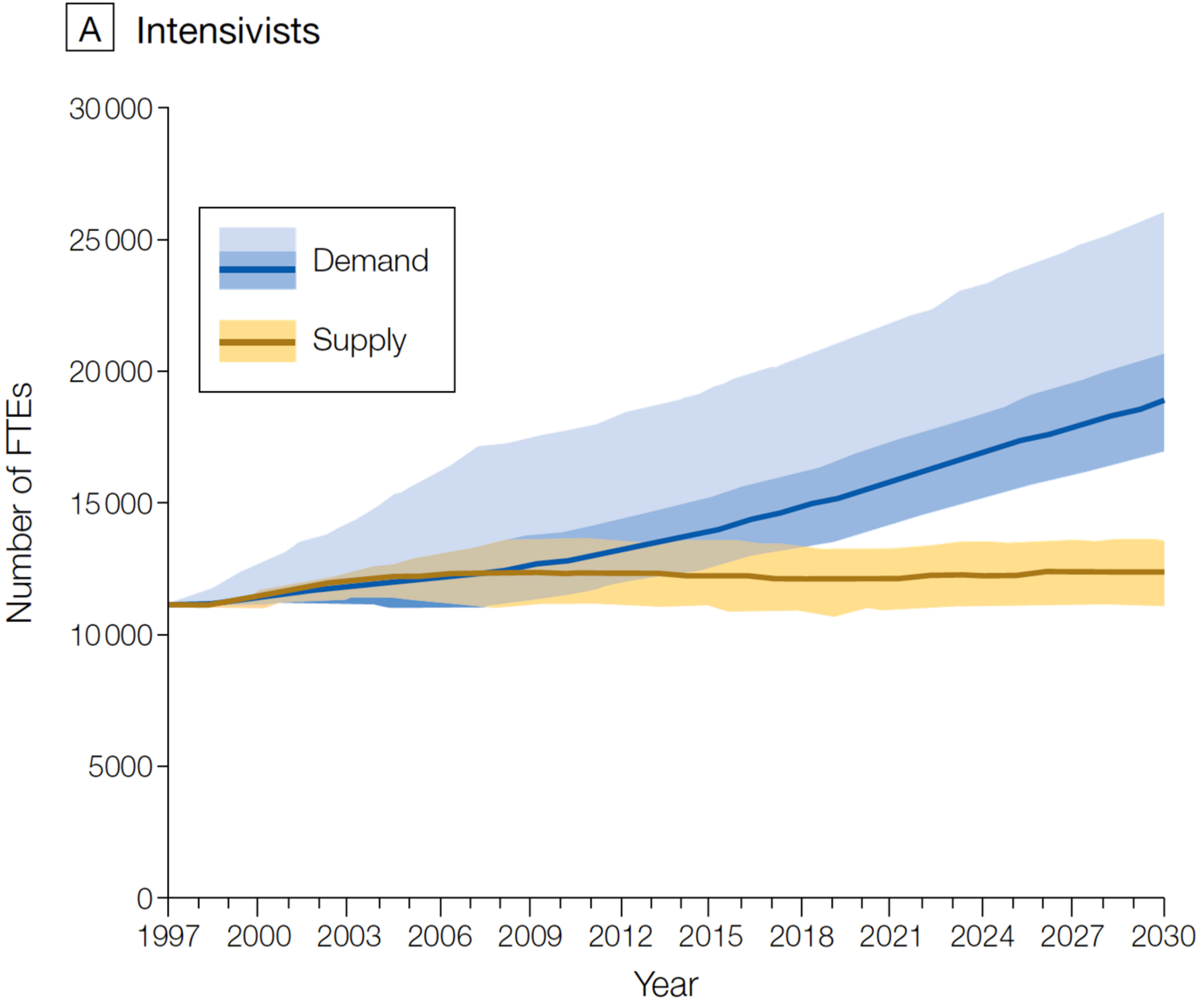
Agenda

- effectiveness
- safety
- efficacy?

Agenda

- history of ventilation
- history of automated ventilation
- benefits of automated ventilation
- need for automated ventilation?
- wrap–up

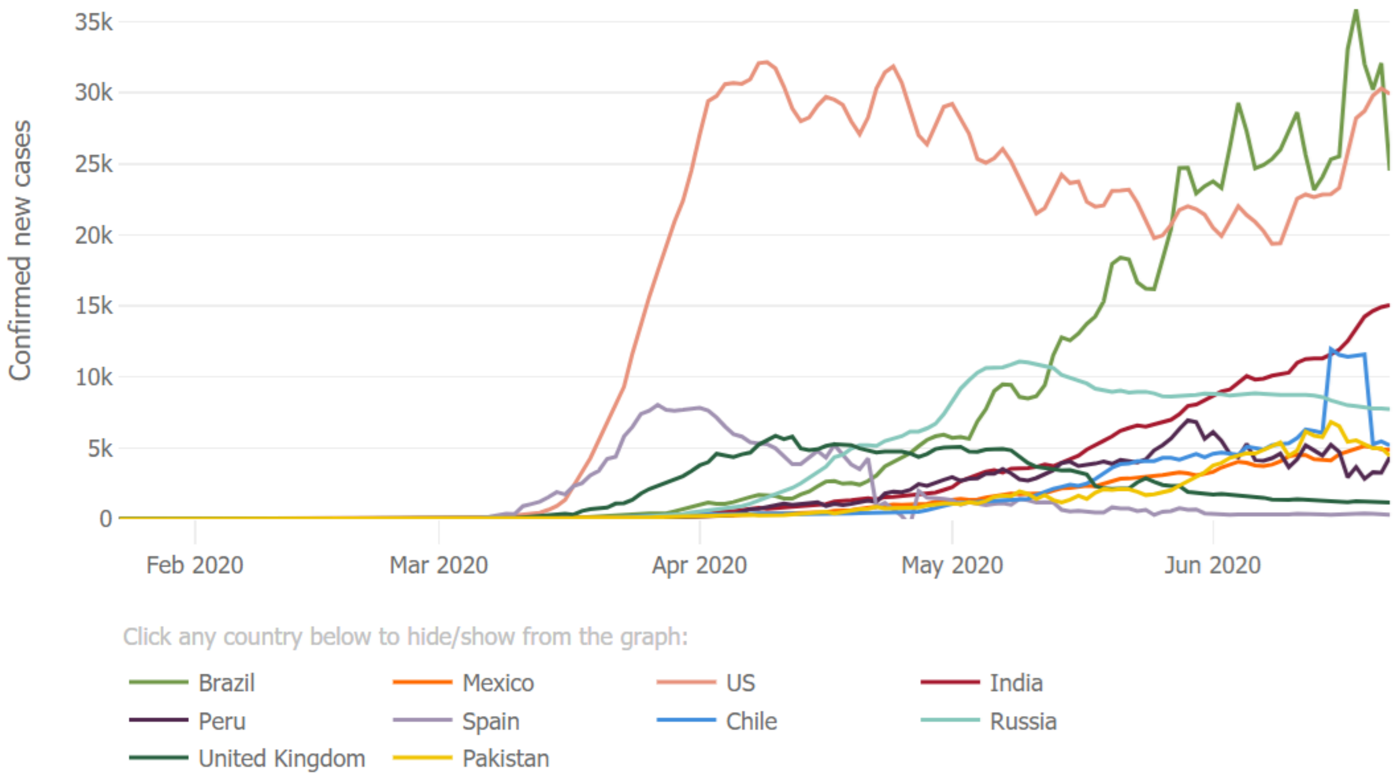
Angus *JAMA* 2000; **284**:2762



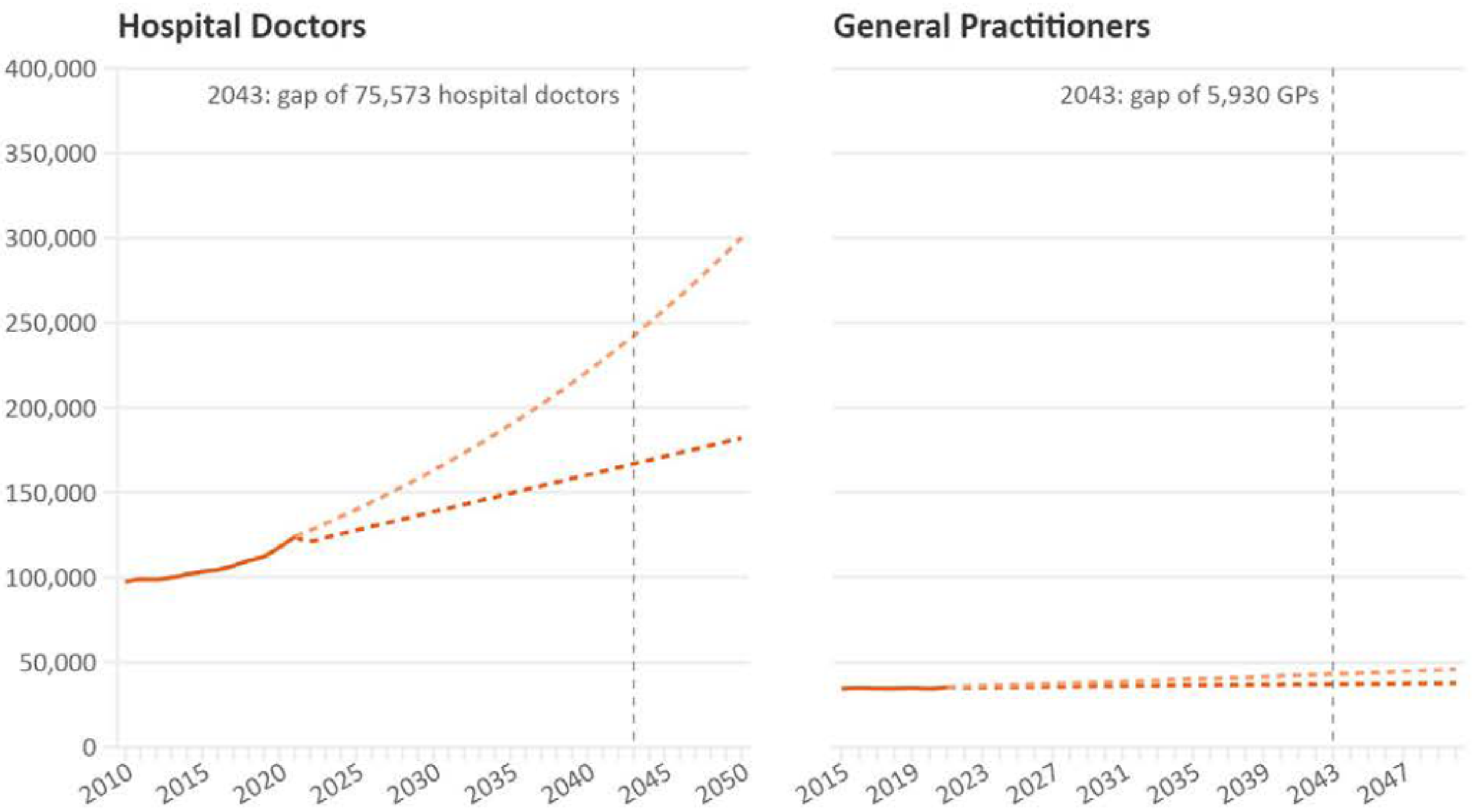
Johns Hopkins University

Daily confirmed new cases (5-day moving average)

Outbreak evolution for the current 10 most affected countries



BMA 20210134



Potential gap between supply and demand of NHS doctors (FTE)

Gap between **projected trend growth** and **required growth** to meet expected growth in activity level

QUESTION What is the precise amount of oxygen consumption with high–flow nasal oxygen (HFNO) and with mechanical ventilation in patients with acute hypoxemic respiratory failure due to COVID–19?

CONCLUSION Actual oxygen consumption, hourly oxygen consumption, and total oxygen consumption are substantially higher in COVID–19 patients that start with HFNO compared with patients that start with mechanical ventilation.

POPULATION

275 Patients

COVID–19 patients with acute hypoxemic failure receiving respiratory support

Median Age: **63** year

LOCATION

2 ICUs in Europe

COMPARISON

275 acute hypoxemic patients

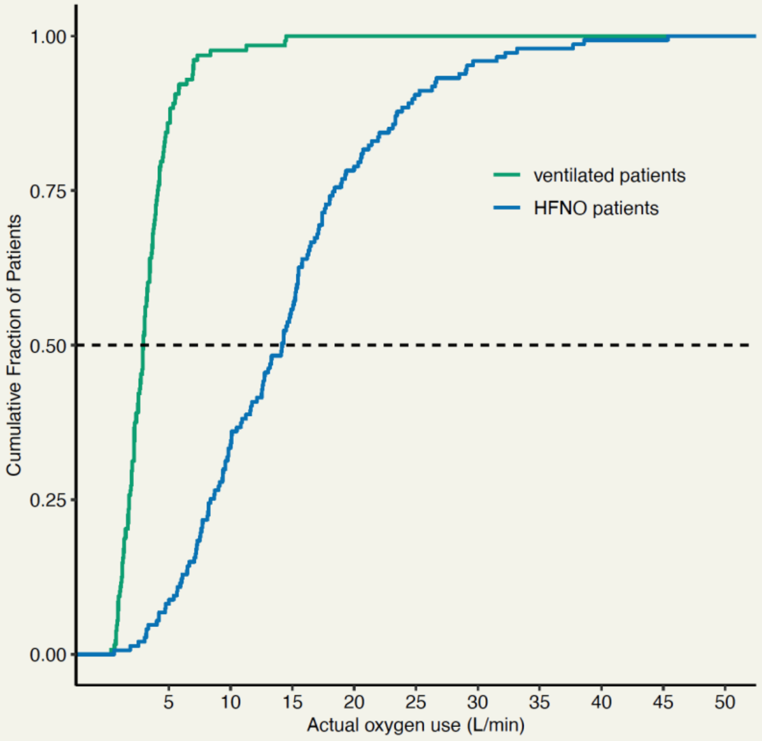
147 started with HFNO

128 started with mechanical ventilation

(PRIMARY) OUTCOME

oxygen consumption per minute during the first 2 full calendar days of ICU admission; oxygen consumption per hour and total oxygen consumption in the same time frame

FINDINGS



PROXY–COVID investigators. Oxygen Consumption with High-Flow Nasal Oxygen versus Mechanical Ventilation—an International Multicenter Observational Study in COVID–19 Patients [*Am J Trop Med Hyg* 2023; *in press*; doi:10.4269/ajtmh.22-0793]

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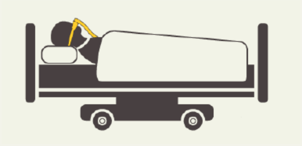
QUESTION What is the safety, efficacy and workload for the health care team of INTELLiVENT–ASV versus conventional modes over a 48–hour period?

CONCLUSION INTELLiVENT–ASV requires less manual intervention and delivered more variable PEEP, while delivering ventilation safe and effective ventilation in terms of V_T, RR, SpO_2 and $etCO_2$.

POPULATION



86 Patients

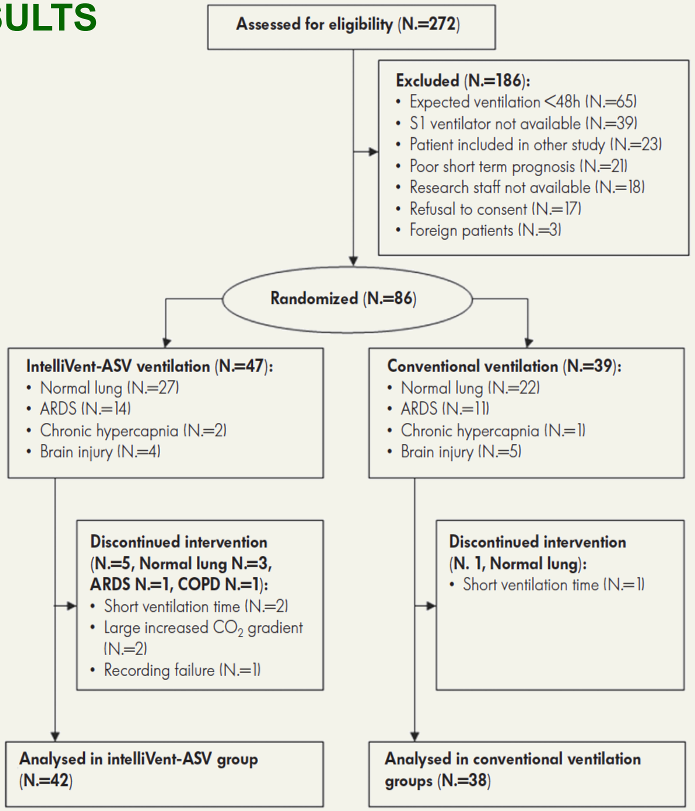
patients expected to need ventilation for more than 48 hours

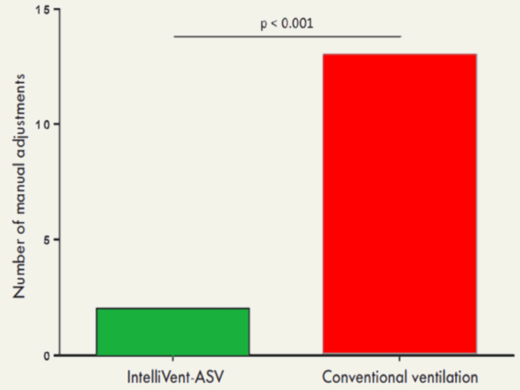
Median Age: **59** year

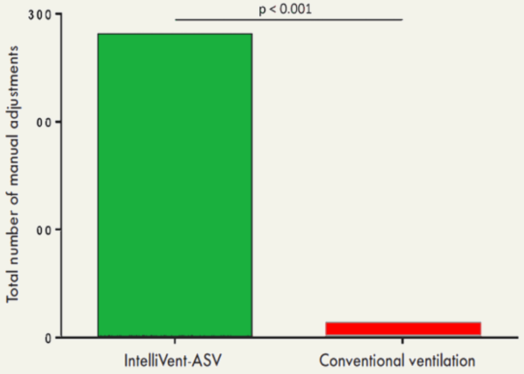
LOCATION

1 ICU in Belgium

RESULTS







Bialais E. Closed-loop ventilation mode (INTELLiVENT–ASV) in intensive care unit: a randomized trial. [*Minerva Anestesiologica* 2016; **82**:657]

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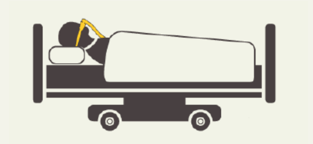
QUESTION Does INTELLiVENT–ASV reduce the number of manual ventilator setting changes compared to conventional ventilation modes like volume assist control and pressure support in ICU patients?

CONCLUSION For mechanically ventilated ICU patients, INTELLiVENT–ASV significantly reduces the number of manual ventilator setting changes with the same number of arterial blood gas analysis and sedation dose, and is easier to use.

POPULATION



60 Patients

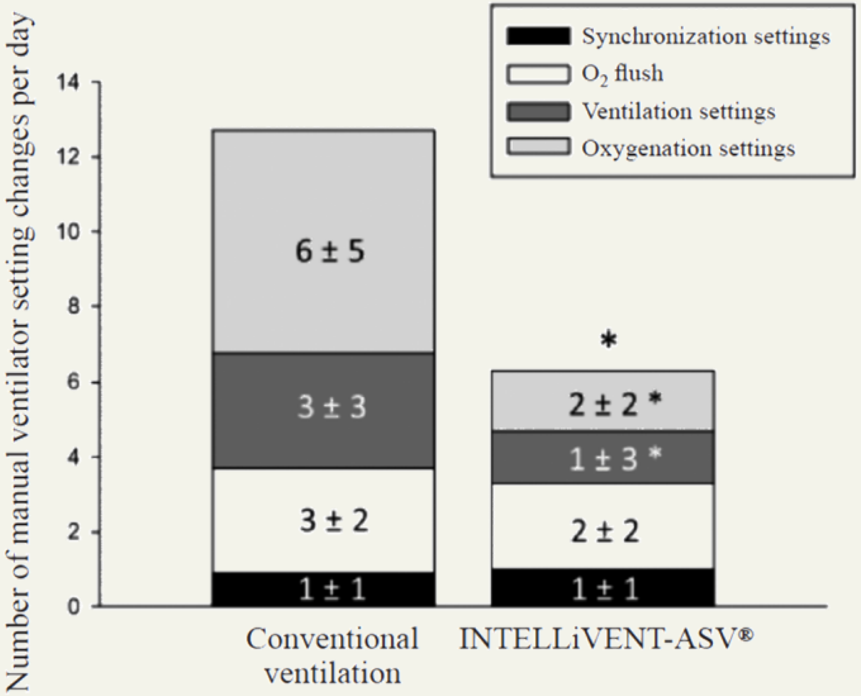
patients with an expected duration of ventilation of at least 48 hours

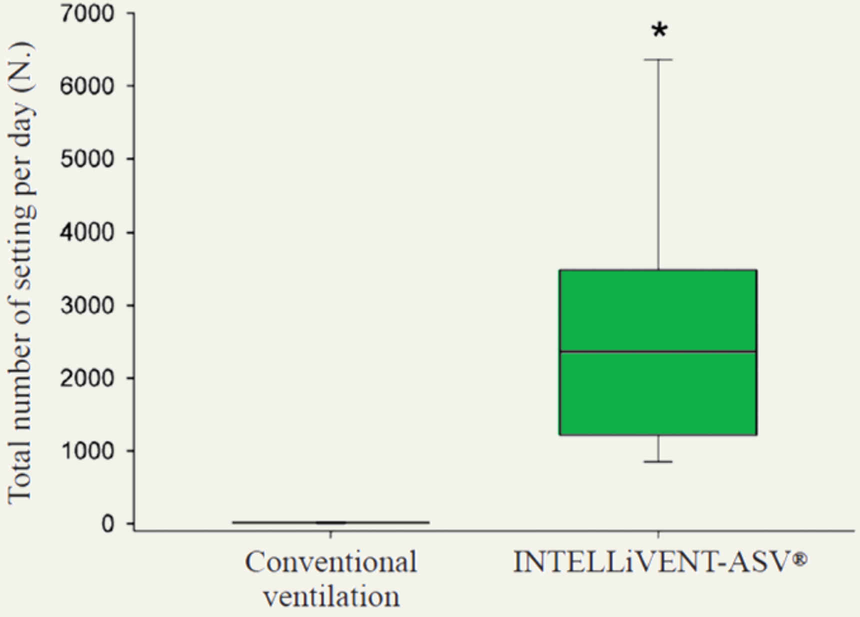
Median Age: **65** year

LOCATION

1 ICU
in France

RESULTS





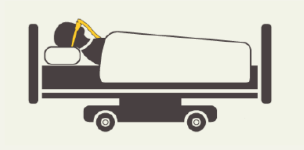
Arnal JM. Closed loop ventilation mode in Intensive Care Unit: a randomized controlled clinical trial comparing the numbers of manual ventilator setting changes. [*Minerva Anestesiologica* 2018; **84**:58; doi:10.23736/S0375-9393.17.11963-2]

SAGE journals

QUESTION How does INTELLiVENT–ASV performs, in terms of lung–protective ventilation, compared to conventional mechanical ventilation in the resource–constrained setting of the COVID–19 pandemic?

CONCLUSION During an early highpoint of the pandemic, mechanical ventilation using INTELLiVENT–ASV was associated with a higher degree of lung–protective ventilation than was conventional mechanical ventilation.

POPULATION



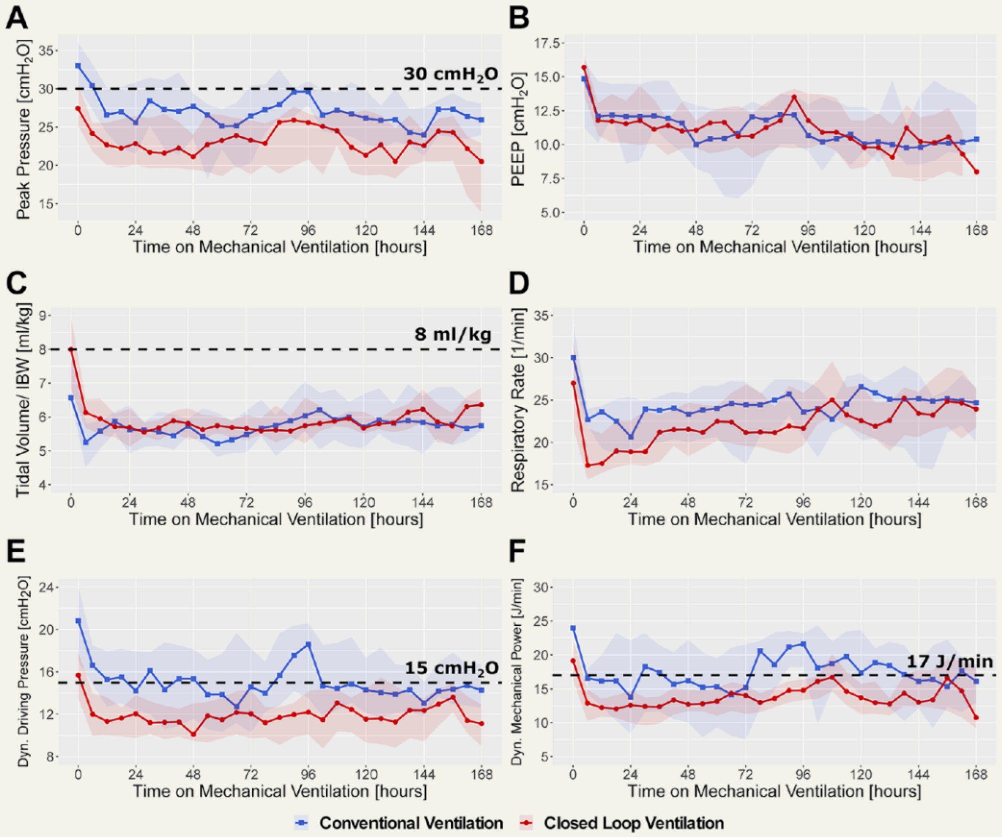
40 Patients

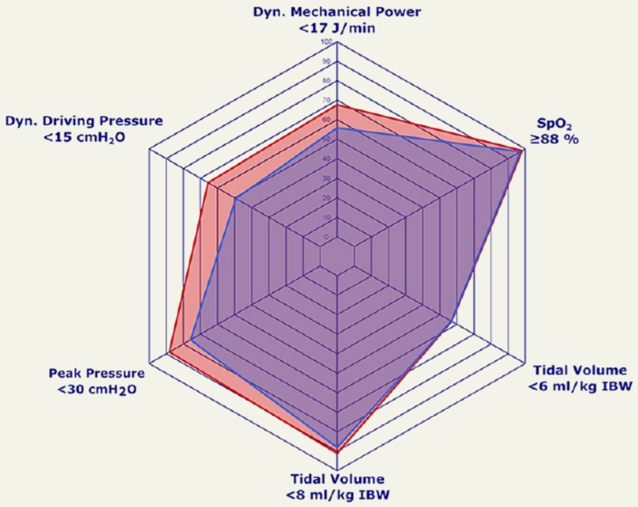
COVID–19 ARDS patients receiving mechanical ventilation

Median Age: **63** year

LOCATION

1 ICU in Switzerland





2.8 [2.3–3.6] automatic adjustments *per minute*

4 [2–7] *vs.* 7 [3–12] manual adjustments *per hour*

Wendel Garcia P. Closed–loop versus Conventional Mechanical Ventilation in Coronavirus 2019 Diseases Acute Respiratory Distress Syndrome Patients [*J Intensive Care Med* 2021; **36**:1184; doi:10.1177/08850666211024139]

Wrap–up

- ventilation can be complex and time–consuming
- automated modes are increasingly available
- effectiveness, safety, effectivity
- workload reductions