Question 1
What are the pre-intubation options for patients with COVID-19?

Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy

Disease process:
-1,300 received respiratory support

-88% required invasive mechanical ventilation

-26% mortality

Table 1. Demographic and Clinical Characteristics of Patients in the First 24 Hours of ICU Admission for COVID-19 in Lombardy, Italy

	Patients by age, y, No. (%)								
	All	0-20	21-40	41-50	51-60	61-70	71-80	81-90	91-100
No. (%)	1591 (100)	4 (<1)	56 (4)	143 (9)	427 (27)	598 (38)	341 (21)	21 (1)	1 (<1)
Age, median (IQR), y	63 (56-70)	16 (14-19)	34 (31-38)	47 (44-49)	56 (54-59)	65 (63-68)	74 (72-76)	83 (81-84)	91
Males	1304 (82)	3 (75)	44 (79)	119 (83)	355 (83)	484 (81)	279 (82)	19 (90)	1 (100)
Females	287 (18)	1 (25)	12 (21)	24 (17)	72 (17)	114 (19)	62 (18)	2 (10)	0
Comorbidities, No. with data	1043	3	35	82	273	380	253	1	1
None	334 (32)	0	23 (66)	50 (61)	107 (39)	107 (28)	47 (19)	0	0
Hypertension	509 (49)	0	4 (11)	21 (26)	121 (44)	195 (51)	156 (62)	12 (75)	0
Cardiovascular disease[a]	223 (21)	0	1 (3)	4 (5)	43 (16)	87 (23)	81 (32)	6 (38)	1 (100)
Hypercholesterolemia	188 (18)	0	1 (3)	1 (1)	30 (11)	92 (24)	59 (23)	5 (31)	0
Diabetes, type 2	180 (17)	0	1 (3)	4 (5)	40 (15)	86 (23)	46 (18)	3 (19)	0
Malignancy[b]	81 (8)	0	0	2 (2)	10 (4)	33 (9)	33 (13)	3 (19)	0
COPD	42 (4)	0	1 (3)	0	8 (3)	12 (3)	20 (8)	1 (6)	0
Chronic kidney disease	36 (3)	0	0	2 (2)	10 (4)	17 (4)	7 (3)	0	0
Chronic liver disease	28 (3)	0	0	2 (2)	8 (3)	13 (3)	5 (2)	0	0
Other[c]	205 (20)	3 (100)	6 (17)	10 (12)	49 (18)	77 (20)	55 (22)	5 (31)	0
Respiratory support, No.	1300	2	46	108	351	487	287	18	1
Invasive mechanical ventilation	1150 (88)	2 (100)	37 (80)	87 (81)	315 (90)	449 (92)	246 (86)	14 (78)	0
Noninvasive ventilation	137 (11)	0	8 (17)	16 (15)	33 (9)	36 (7)	39 (14)	4 (22)	1 (100)
Oxygen mask	13 (1)	0	1 (2)	5 (5)	3 (1)	2 (<1)	2 (1)	0	0
PEEP, cm H_2O									
No.	1017	2	33	81	278	377	234	11	1
Median (IQR)	14 (12-16)	9.5 (5-14)	14 (10-15)	14 (12-15)	14 (12-15)	14 (12-16)	14 (12-15)	12 (8-15)	10
Fio_2, %									
No.	999	2	31	81	270	375	228	11	1
Median (IQR)	70 (50-80)	40 (30-50)	60 (50-70)	60 (50-80)	65 (50-80)	70 (55-80)	70 (50-80)	60 (50-90)	60
Pao_2/Fio_2 ratio									
No.	781	2	26	58	213	306	169	7	0
Median (IQR)	160 (114-220)	259 (195-323)	201.5 (123-248)	168.5 (112-260)	163 (120-230)	152.5 (110-213)	163 (120-205)	150 (86-250)	NA
Prone position, No./total (%)	240/875 (27)	0/2	3/25 (12)	24/71 (34)	70/247 (28)	90/337 (27)	51/187 (27)	2/6 (33)	NA
ECMO, No./total (%)	5/498 (1)	NA	0/15	0/42	2/149 (1)	3/193 (2)	0/95	0/4	NA

Abbreviations: COPD, chronic obstructive pulmonary disease; ECMO, extracorporeal membrane oxygenation; Fio_2, Fraction of inspired oxygen; ICU, intensive care unit; IQR, interquartile range; NA, not applicable; Pao_2, arterial partial pressure of oxygen; PEEP, positive end-expiratory pressure.

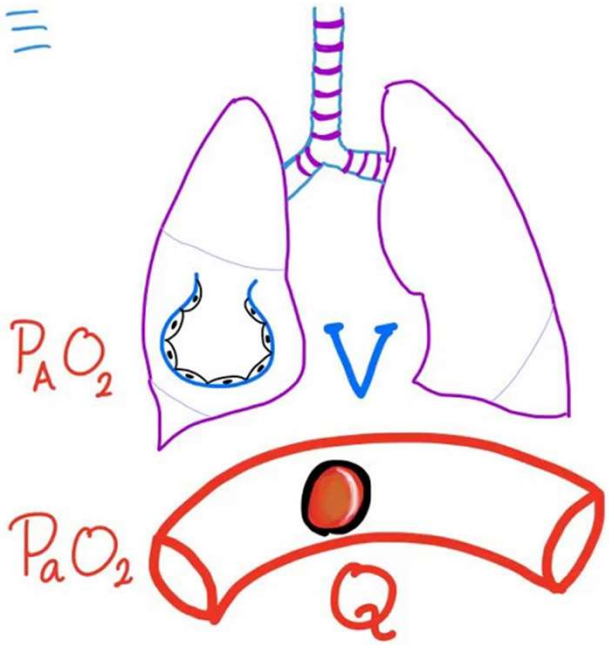
[a] Cardiovascular disease includes cardiomyopathy and heart failure.

[b] Malignancy includes active neoplasia and neoplasia in remission.

[c] Other includes anemia, asthma, inflammatory bowel disease, epilepsy, chronic respiratory insufficiency, endocrine disorders, connective tissue diseases, neurologic disorders, chronic pancreatitis, immunocompromise, and organ transplant.

JAMA. Published online April 06, 2020. doi:10.1001/jama.2020.5394

$\dot{V}/Q$ mismatch



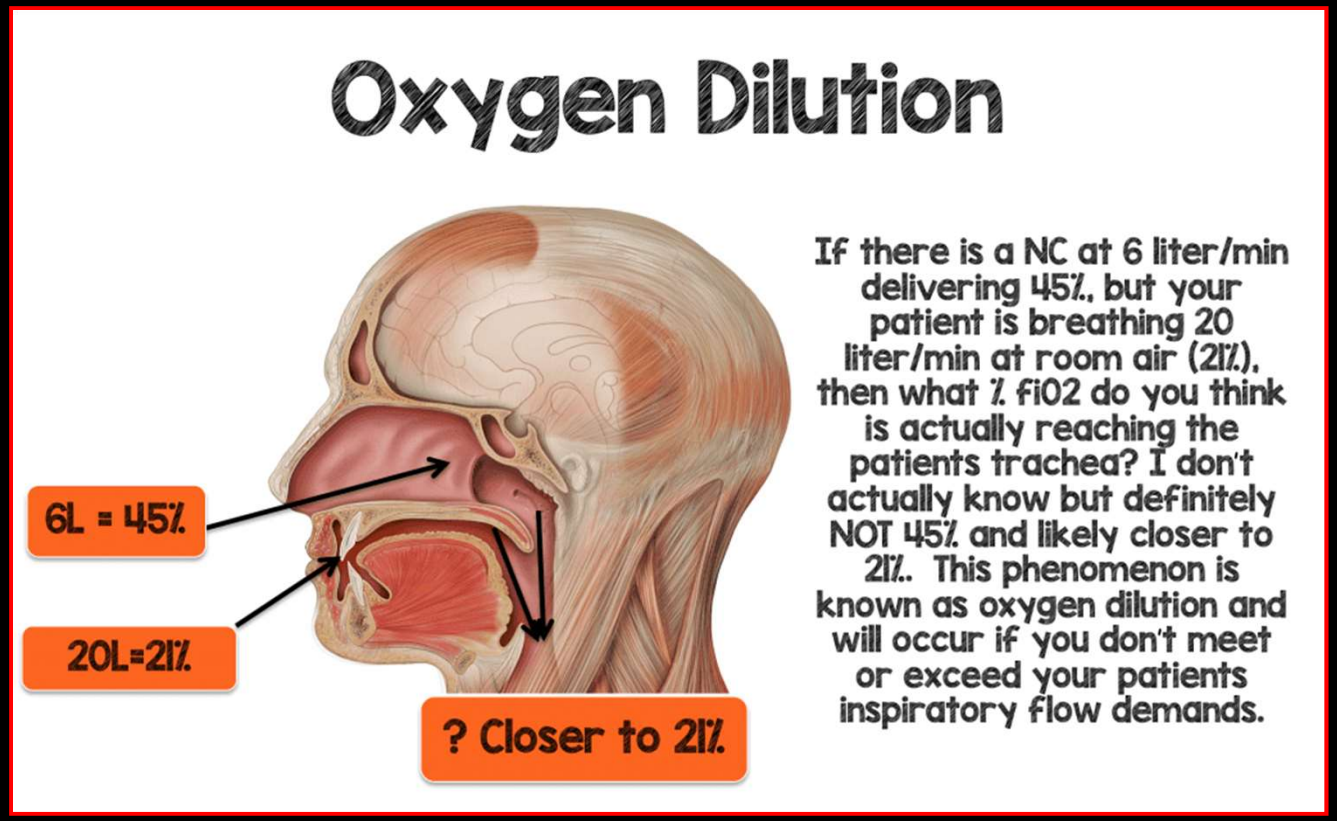
"Intubation should be prioritized."
Gattinoni et al. AJRCCM, March 2020

Nasal Cannula

High Flow NC

Non -rebreather

Optiflow/Airvo



Treatment for severe acute respiratory distress syndrome from COVID-19

www.thelancet.com/respiratory **Published online March 20, 2020 https://doi.org/10.1016/S2213-2600(20)30127-2**

High-flow nasal oxygen	Might prevent or delay the need for intubation

(figure).[2] Before endotracheal intubation, it is important to consider a trial of high-flow nasal oxygen for patients with moderately severe hypoxaemia. This procedure might avoid the need for intubation and mechanical ventilation because it provides high concentrations of humidified oxygen, low levels of positive end-expiratory pressure, and can facilitate the elimination of carbon dioxide.[4] WHO guidelines support the use of high-flow nasal oxygen in some patients, but they urge close monitoring for clinical deterioration that could result in the need for emergent intubations because

Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group

David J Brewster[1], Nicholas C Chrimes[1], Thy BT Do[1], Kirstin Fraser[1], Chris J Groombridge[1], Andy Higgs[1], Matthew J Humar[1], Timothy J Leeuwenburg[1], Steven McGloughlin[2], Fiona G Newman[1], Chris P Nickson[1], Adam Rehak[1], David Vokes[1], Jonathan J Gatward[1]

[1]Safe Airway Society (SAS), Australia and New Zealand

[2]Australian New Zealand Intensive Care Society (ANZICS)

Twitter: @SafeAirway

In general ICU patients, HFNO has been found to decrease the need for tracheal intubation in acute hypoxaemic respiratory failure compared to conventional oxygen therapy, without impacting mortality.(9) Its utility in viral pandemics is unknown. A small cohort study of Influenza A patients showed that treatment with HFNO avoided intubation in 45% of patients, although almost all patients with a higher severity of illness eventually received invasive ventilation. (10) Reports in the online media suggest that NIV and HFNO are being used extensively in the COVID-19 patient group. This is likely in patients with milder disease, though

Assessment of the potential for pathogen dispersal during high-flow nasal therapy

M. Kotoda [a,b,*], S. Hishiyama [a], K. Mitsui [c], T. Tanikawa [a], S. Morikawa [a], A. Takamino [a], T. Matsukawa [a]

[a] Department of Anesthesiology, Faculty of Medicine, University of Yamanashi, Yamanashi, Japan
[b] Kirby Neurobiology Center, Boston Children's Hospital, Harvard Medical School, Boston, USA
[c] Surgical Center, University of Yamanashi Hospital, University of Yamanashi, Yamanashi, Japan

Journal of Hospital Infection 104 (2020) 534–537

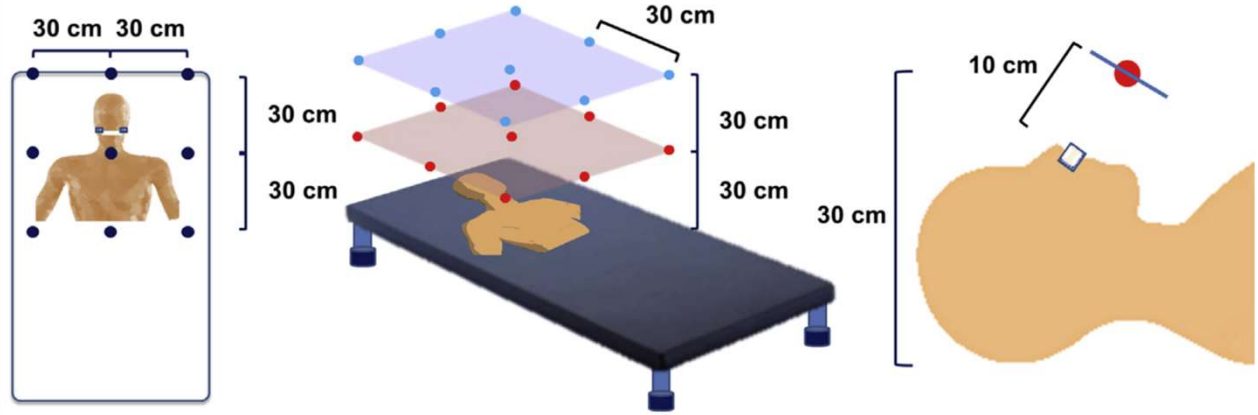


Figure 1. Experimental design for assessing the dispersal of water and yeast.

areas >60 cm away from the face. These results suggest that use of high-flow nasal canula does not increase the risk of droplet infection because coughing or sneezing may generate droplets that can travel farther [6].

TRANSMISSION ASSESSMENT REPORT:

High Velocity Nasal Insufflation (HVNI) Therapy Application in Management of COVID-19

Leonard, S. BSME[1], Volakis, L.I., MS PhD[1], DeBellis, R., PharmD FCCP[1], Kahlon, A., MD[1], Mayar, S., MSc RRT[1], Dungan II, G.C., MPhil (Medicine)[1,2,3]

1. *Department of Science & Innovation, Vapotherm, Inc. Exeter, NH USA*
2. *Education and Human Services, Canisius College, Buffalo, NY USA*
3. *CIRUS, Sydney, NSW Australia*

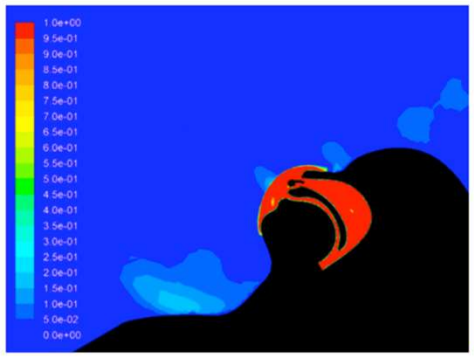


Figure 7. HVNI with Mask – velocity

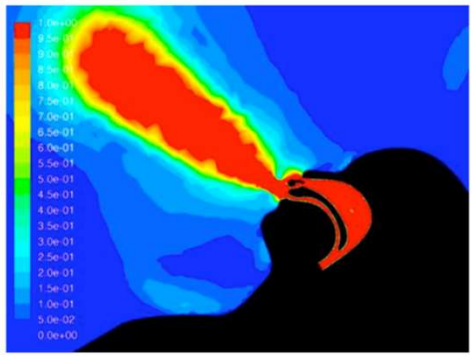


Figure 8. HVNI without Mask - velocity

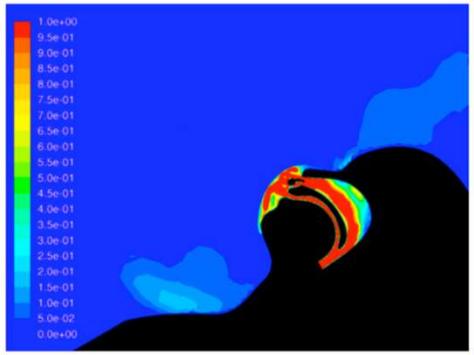


Figure 9. Low Flow Nasal Cannula with Mask – vel

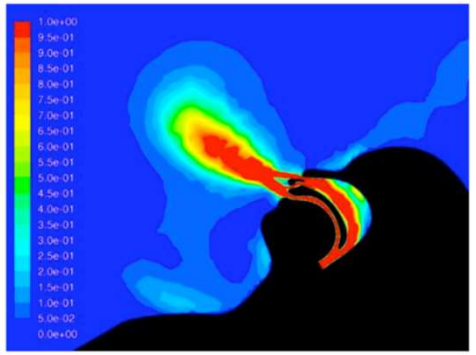


Figure 10. Low Flow Nasal Cannula w/o Mask - vel

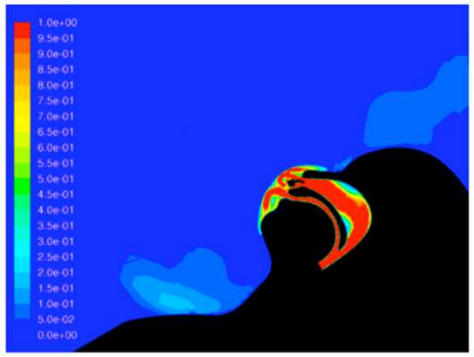


Figure 11. No Therapy with Mask - vel

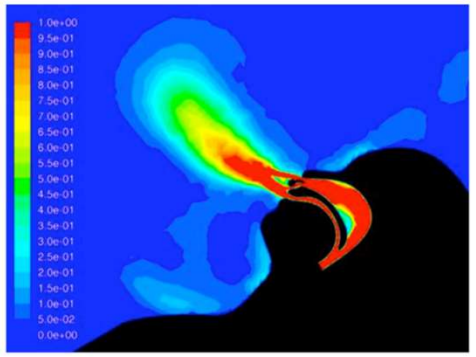


Figure 12. No Therapy without Mask - vel

Repurposed Industrial Respirator Could Free Ventilators for COVID-19 Patients

Researchers from the University of Michigan have developed a helmet solution to provide support for COVID-19 patients, protect health care workers and safeguard hospital systems.

They worked for weeks, creating prototypes out of a store bought vacuum cleaner motor and various different helmets. The device they landed on utilizes existing industrial products to create a personal negative pressure environment wherever the patient is located, and it maintains that environment even if the patient requires movement, such as imaging, testing, use of the restroom or transport.

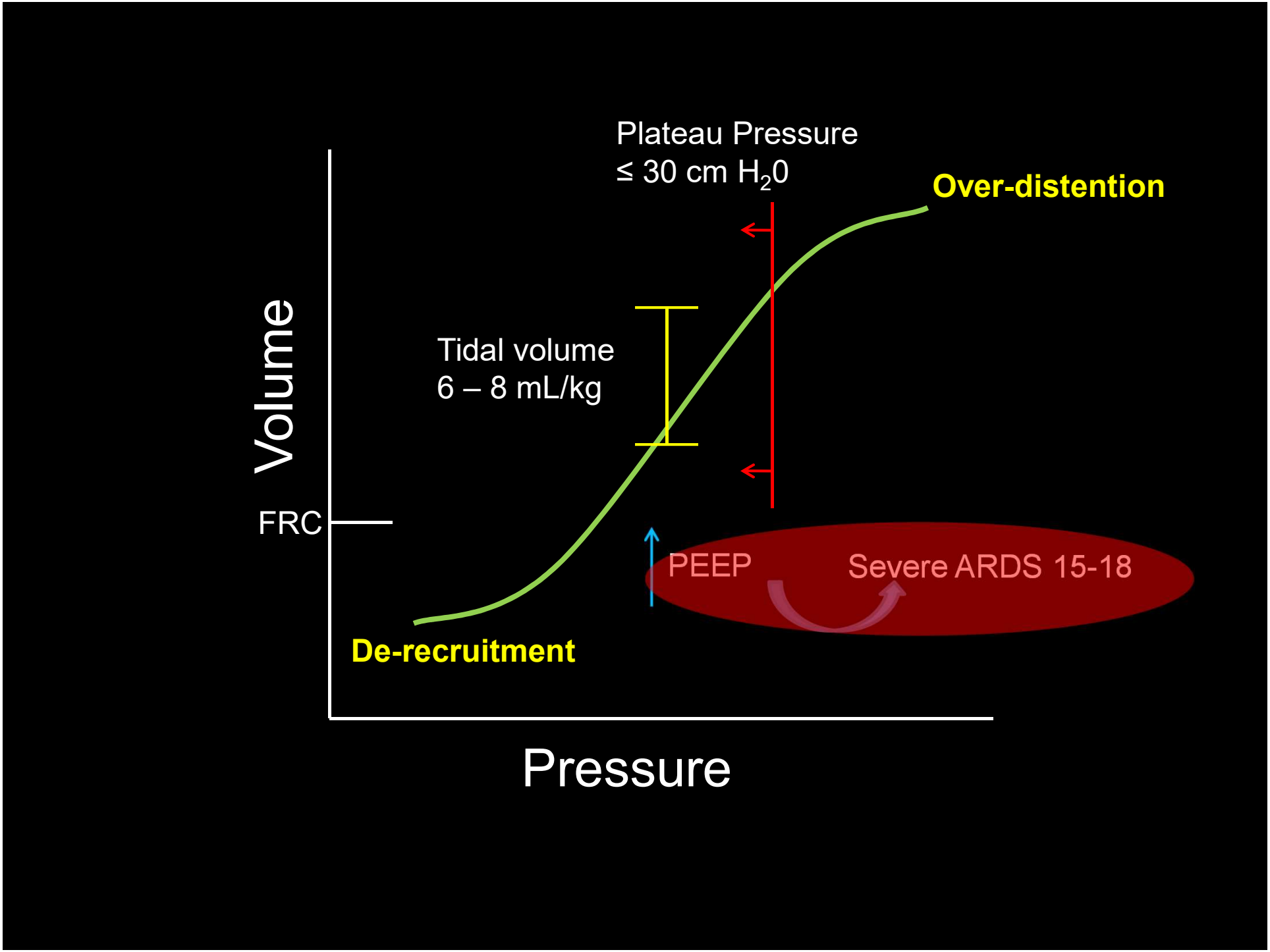
Patient self-proning with high-flow nasal cannula improves oxygenation in COVID-19 pneumonia

Marat Slessarev MD ✉, Jason Cheng MD, Michaela Ondrejicka MD, Robert Arntfield MD the Critical Care Western Research Group

Canadian Journal of Anesthesia/Journal canadien d'anesthésie (2020) | Cite this article

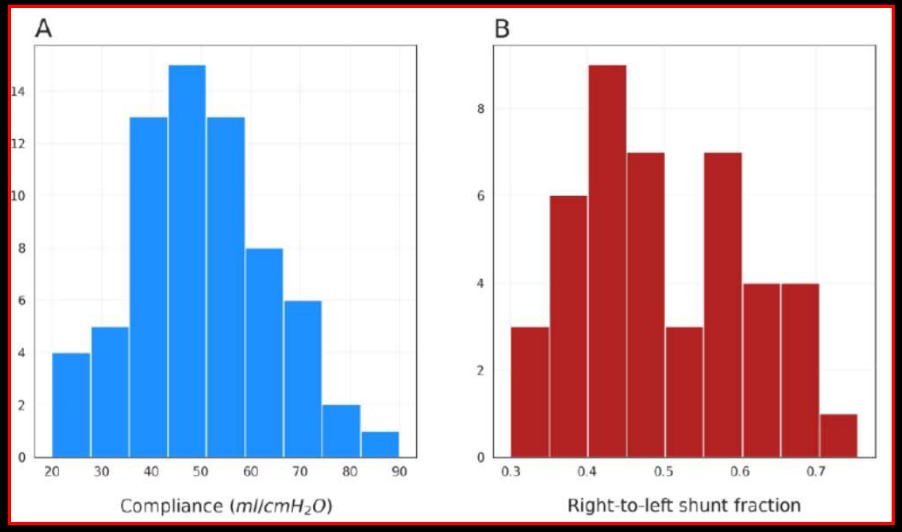
Recommendation…

Question 2
Post-intubation, what are some important mechanical ventilation issues as they pertain to COVID-19 and ARDS?

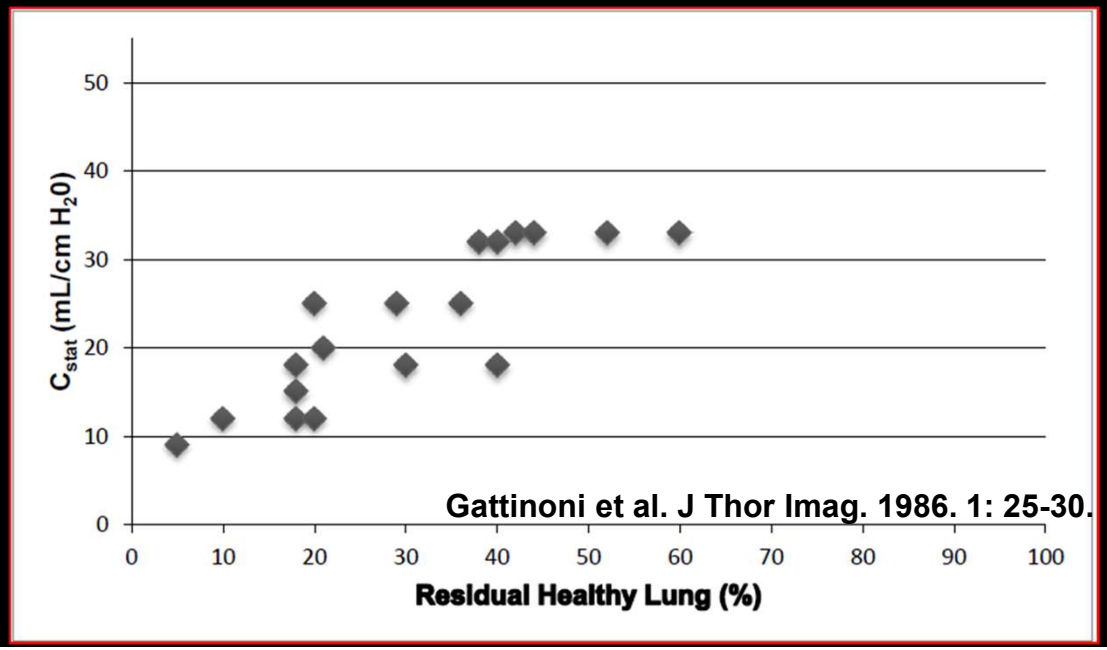

Plateau Pressure
≤ 30 cm H_20
Over-distention
Tidal volume
6 – 8 mL/kg
Volume
FRC
PEEP
Severe ARDS 15-18
De-recruitment
Pressure

Crs 50.2 (14.3) mL/cm H2O

Shunt fraction 0.50 (0.11)



Gattinoni et al, *AJRCCM*, March 2020



Bedside Estimation of Nonaerated Lung Tissue Using Blood Gas Analysis*

Andreas W. Reske, MD[1]; Eduardo L. V. Costa, MD[2,3]; Alexander P. Reske, MD[4]; Anna Rau[1], João B. Borges, MD[5]; Marcelo A. Beraldo, RRT, PhD[2]; Udo Gottschaldt, MD[1]; Matthias Seiwerts, MD[6]; Dierk Schreiter, MD[7]; David Petroff, PhD[8], Udo X. Kaisers, MD, PhD[1]; Hermann Wrigge, MD, PhD[1]; Marcelo B. P. Amato, MD, PhD[2]

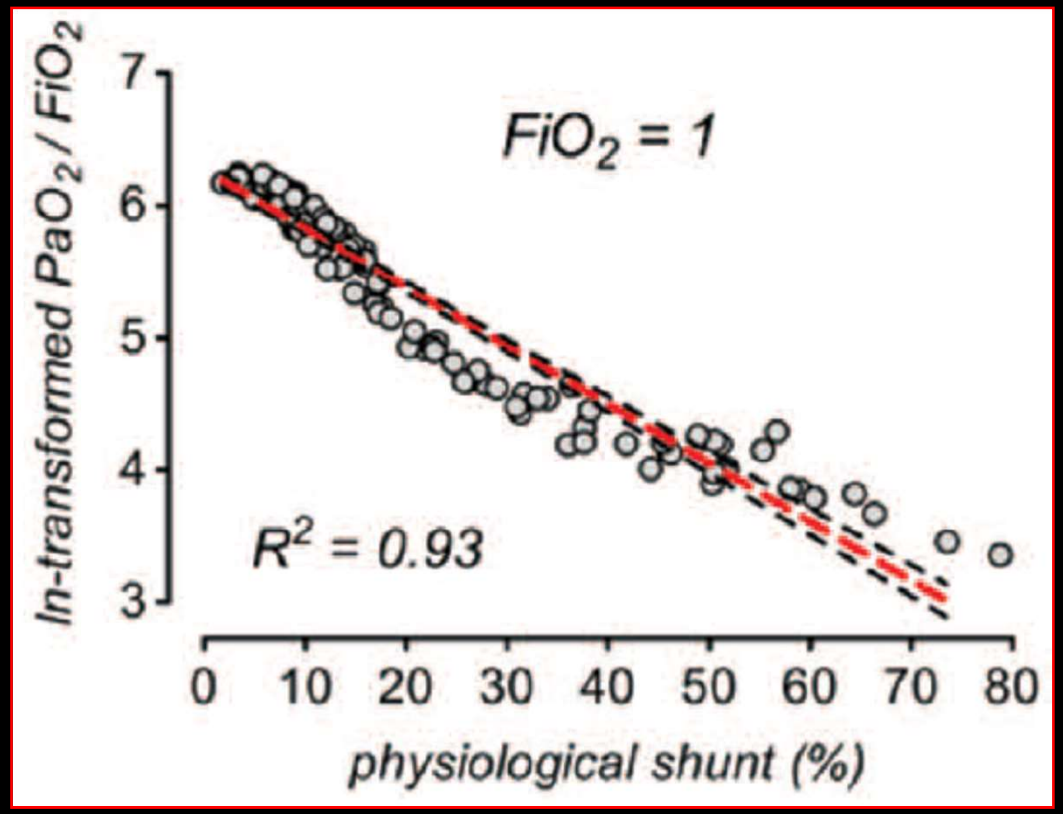
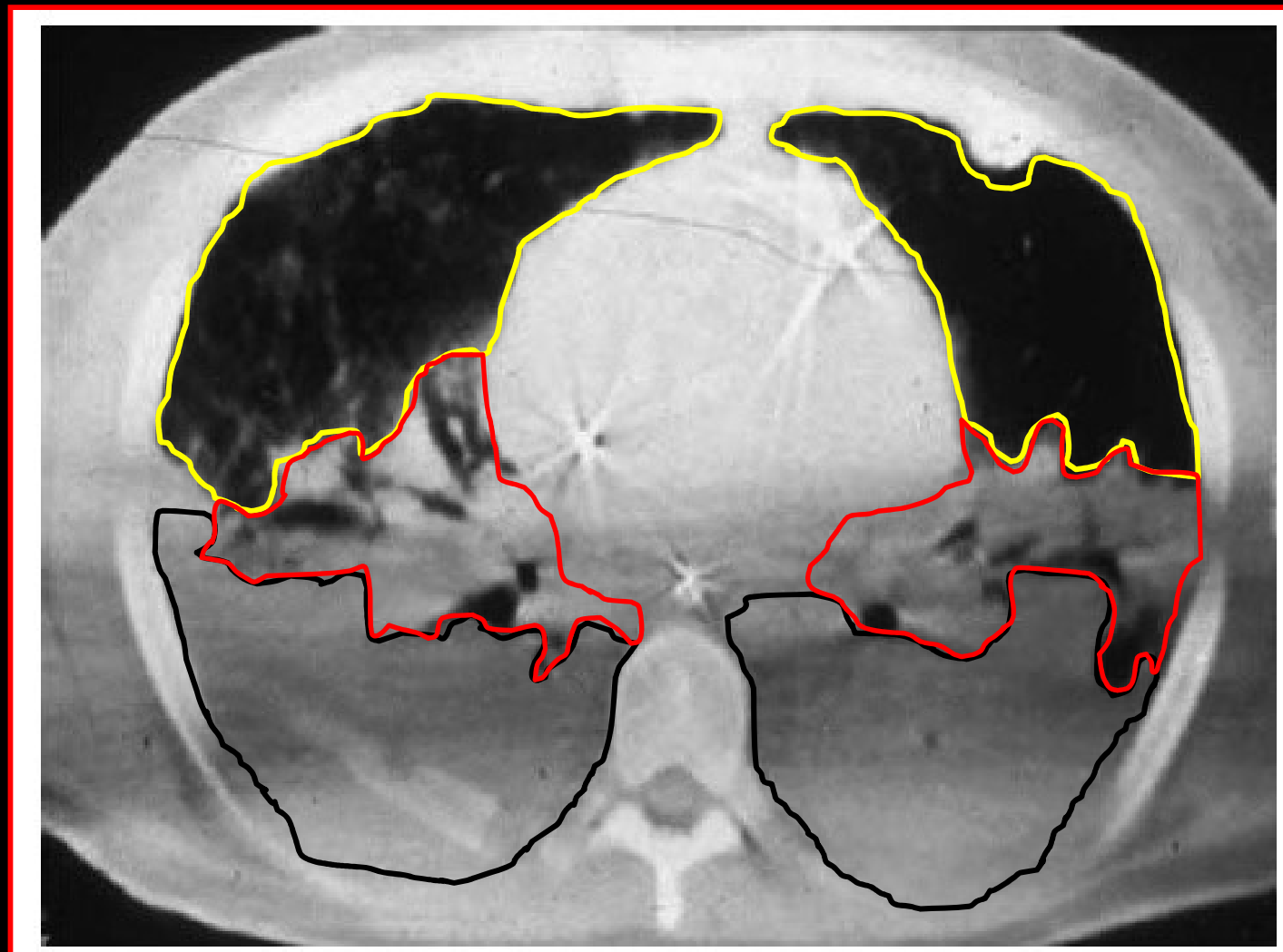


TABLE 3. Look-up Table for Prediction of CT Shunt From PaO_2/FIO_2 Values

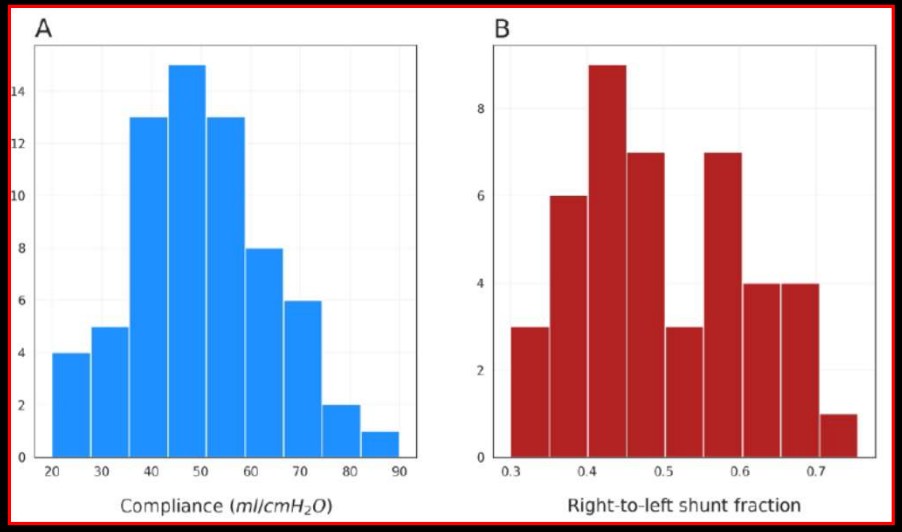
PaO_2/FIO_2	Predicted CT Shunt (%)	75% Prediction Interval (%)
40	62.1	46.5–75.5
50	60.3	44.7–74.1
60	58.5	42.9–72.6
70	56.7	41.2–71.1
80	54.9	39.4–69.6
90	53.1	37.7–68.0
100	51.3	36.0–66.3
120	47.6	32.7–62.9
140	44.0	29.6–59.4
160	40.4	26.6–55.8
180	36.9	23.9–52.1
200	33.5	21.3–48.4
220	30.3	19.0–44.8
240	27.3	16.8–41.2
260	24.5	14.9–37.6
280	21.9	13.1–34.3
300	19.5	11.5–31.0
320	17.3	10.1–28.0
340	15.3	8.9–25.1
360	13.5	7.7–22.4
380	11.9	6.7–20.0
400	10.4	5.9–17.7
420	9.1	5.1–15.7
440	8.0	4.4–13.9
460	6.9	3.9–12.2
480	6.1	3.3–10.7
500	5.3	2.9–9.4
520	4.6	2.5–8.2
540	4.0	2.2–7.2
560	3.5	1.9–6.3
580	3.0	1.6–5.5
600	2.6	1.4–4.8

Reske AW et al. Crit Care Med. 2013. 41: 732-43.



Crs 50.2 (14.3) mL/cm H2O

Shunt fraction 0.50 (0.11)



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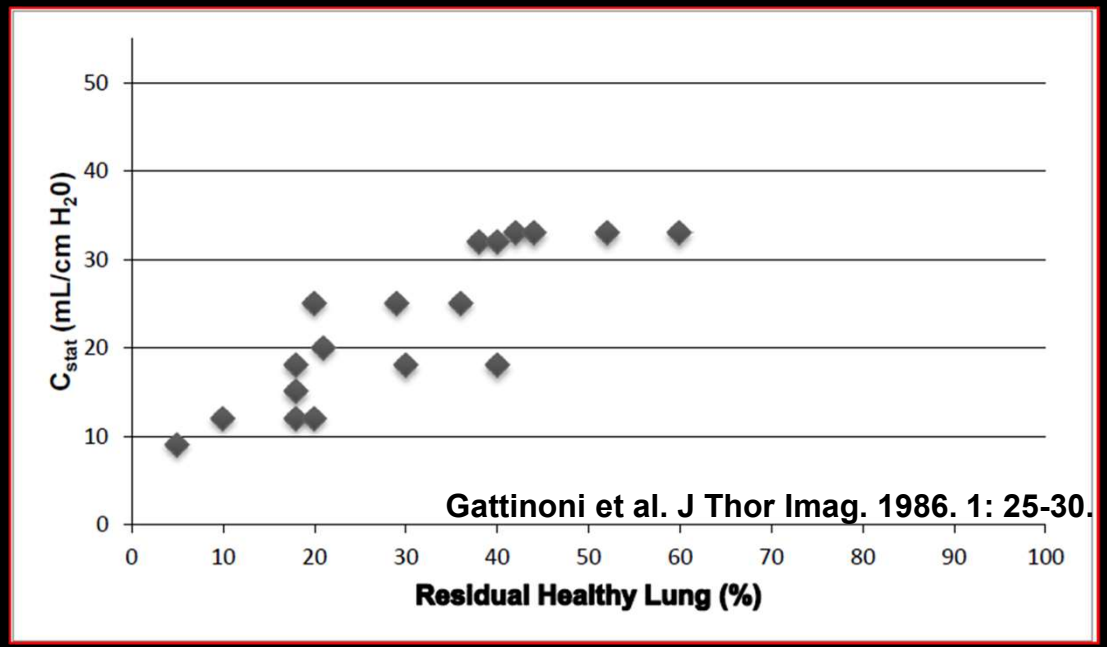


PaO_2/FiO_2
95 mmHg

PaO_2/FiO_2
84 mmHg

Infection severity, host response & reserve, time elapsed, P-SILI, management decisions, bacterial infx

COVID 19 Pneumonia, Type L	COVID 19 Pneumonia, Type H
Low elastance (high compliance)	High elastance (low compliance)
Loss of vasoregulation (dysregulated HPV)	High right-to-left shunt
Low lung weight	High lung weight
Low lung recruitability	High lung recruitability

PaO_2/FiO_2
95 mmHg

>50% Northern Italy

COVID 19 Pneumonia, Type L

If needed (PaCO2, synchrony), can use Vt >6 mL/kg PBW

Monitor synchrony and work of breathing very closely

Lower PEEP to avoid overdistention

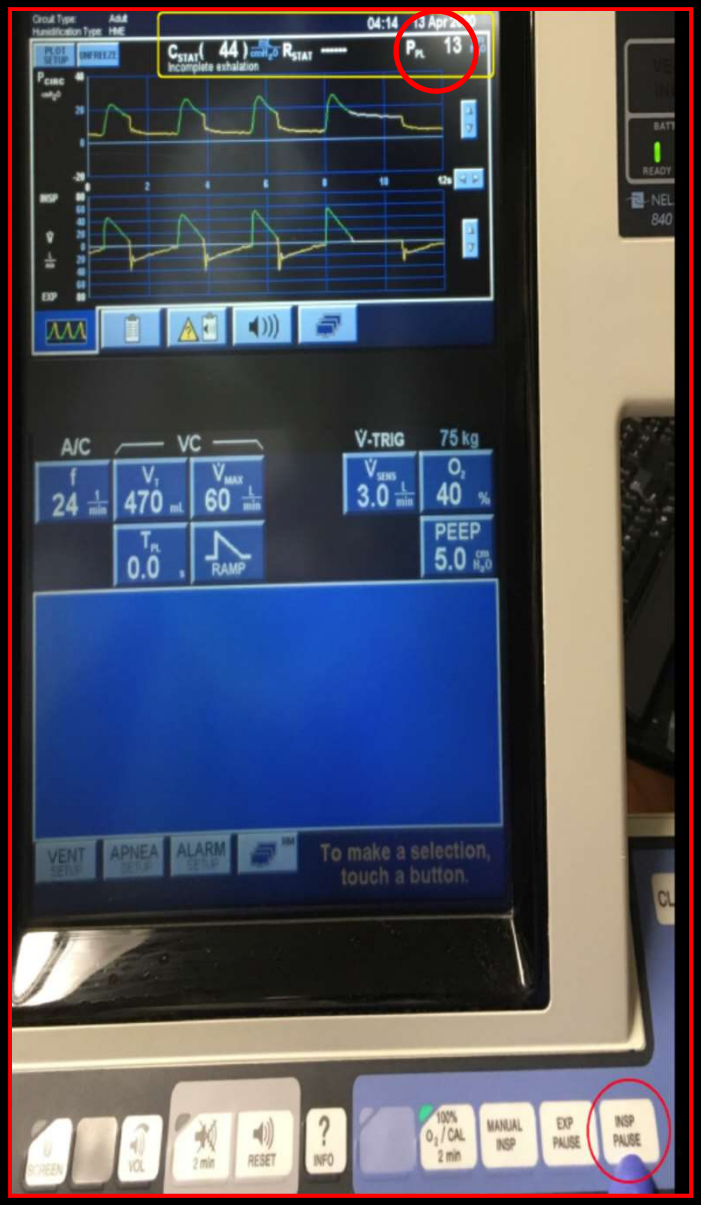
Inhaled pulmonary vasodilators

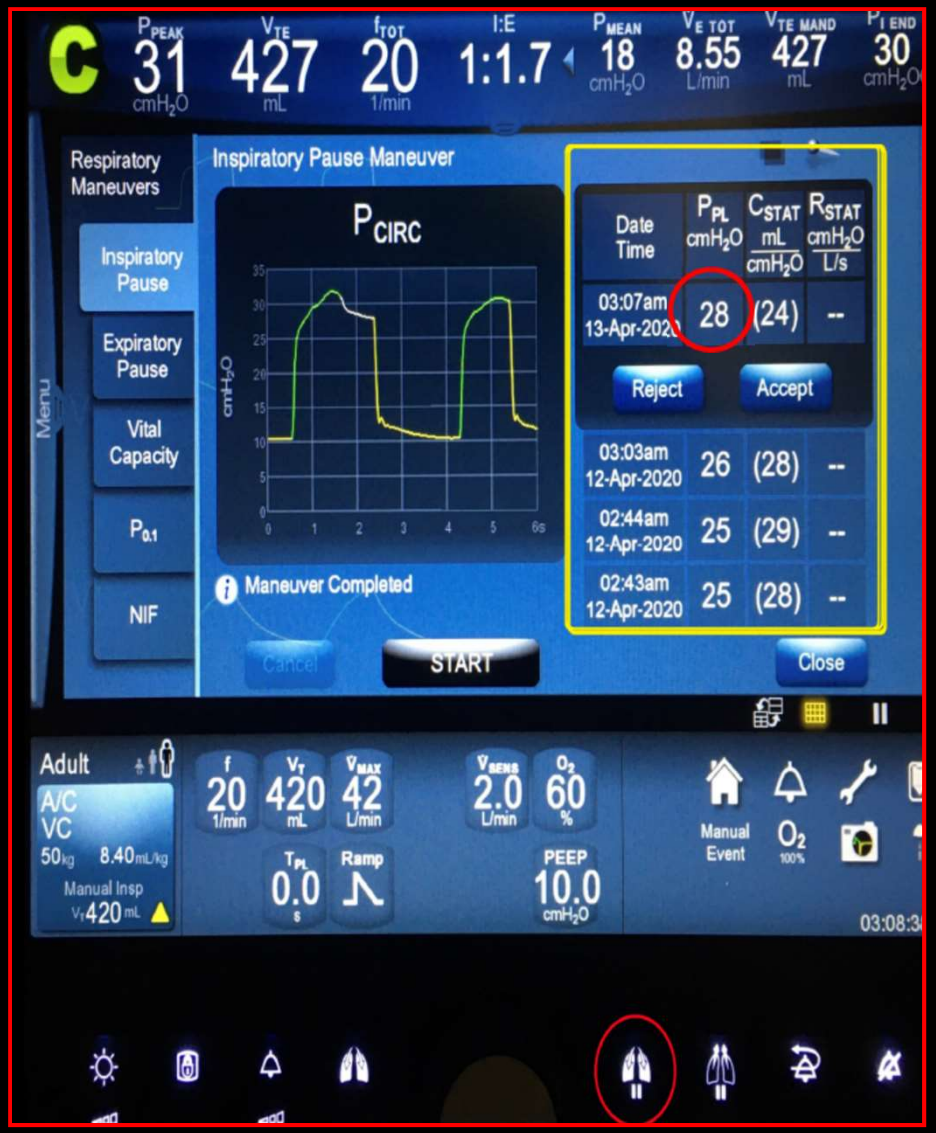
PaO_2/FiO_2
84 mmHg

20-30% Northern Italy

COVID 19 Pneumonia, Type H

Standard severe ARDS approach to tidal volume, higher PEEP, prone position, etc.


Incomplete exhalation
A/C
VC
V-TRIG
75 kg
PEEP
5.0
RAMP
To make a selection, touch a button.
VENT
APNEA
ALARM
INFO
MANUAL INSP
EXP PAUSE
INSP PAUSE


Respiratory Maneuvers
Inspiratory Pause Maneuver
Inspiratory Pause
Expiratory Pause
Vital Capacity
NIF
Menu
Maneuver Completed
Cancel
START
Close
Reject
Accept
Date Time
03:07am 13-Apr-2020
28
(24)
03:03am 12-Apr-2020
26
(28)
02:44am 12-Apr-2020
25
(29)
02:43am 12-Apr-2020
25
(28)
Adult
A/C VC
50 kg
8.40 mL/kg
Manual Insp
420 mL
PEEP
10.0
Manual Event