COVID-19

Treatment of Severe Disease

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SGH
Outram Community Hospital
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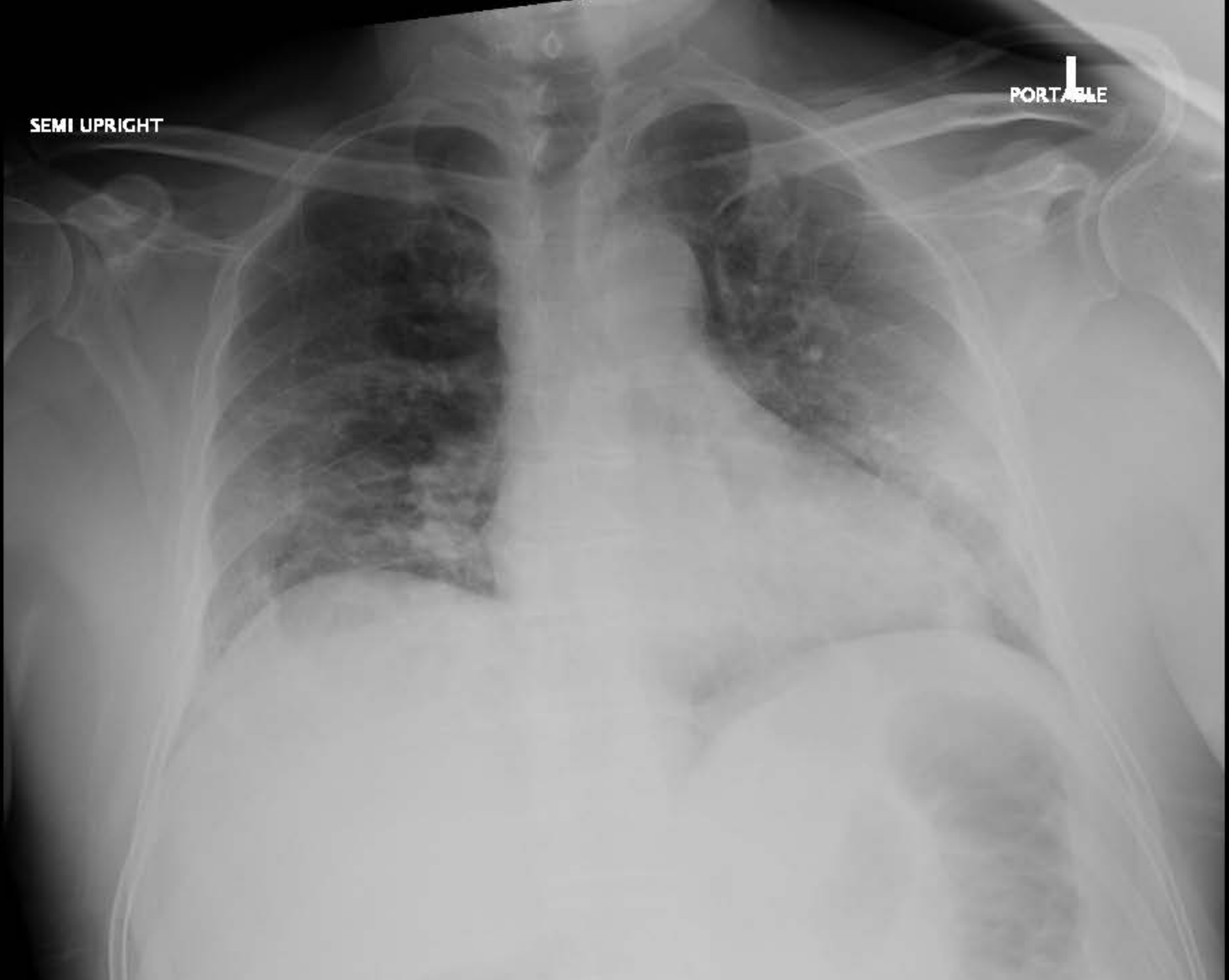
ARMED FORCES MEDICAL

Topics for discussion

1. Recognition of severe disease and ICU triage
2. Modalities of respiratory support and respiratory monitoring
3. Intubation of patients with severe COVID-19
4. Ventilator management of severe COVID ARDS
5. Prone positioning, intubated and non-intubated
6. General critical care for severe COVID-19
7. Preparation for a COVID-19 surge

Case 1

- 59-year-old man with cough and fever for six days. Son and daughter in law were sick a week ago but recovered. No past medical history. Works as a cook, never smoker, no drugs or alcohol.
- T 38, HR 105/min SBP 130/80 SpO2 95% on 2L NC oxygen
- Looks well, able to walk, talk and eat.
- COVID screen positive
- Ferritin 2400, CRP 17, D-dimer 1.3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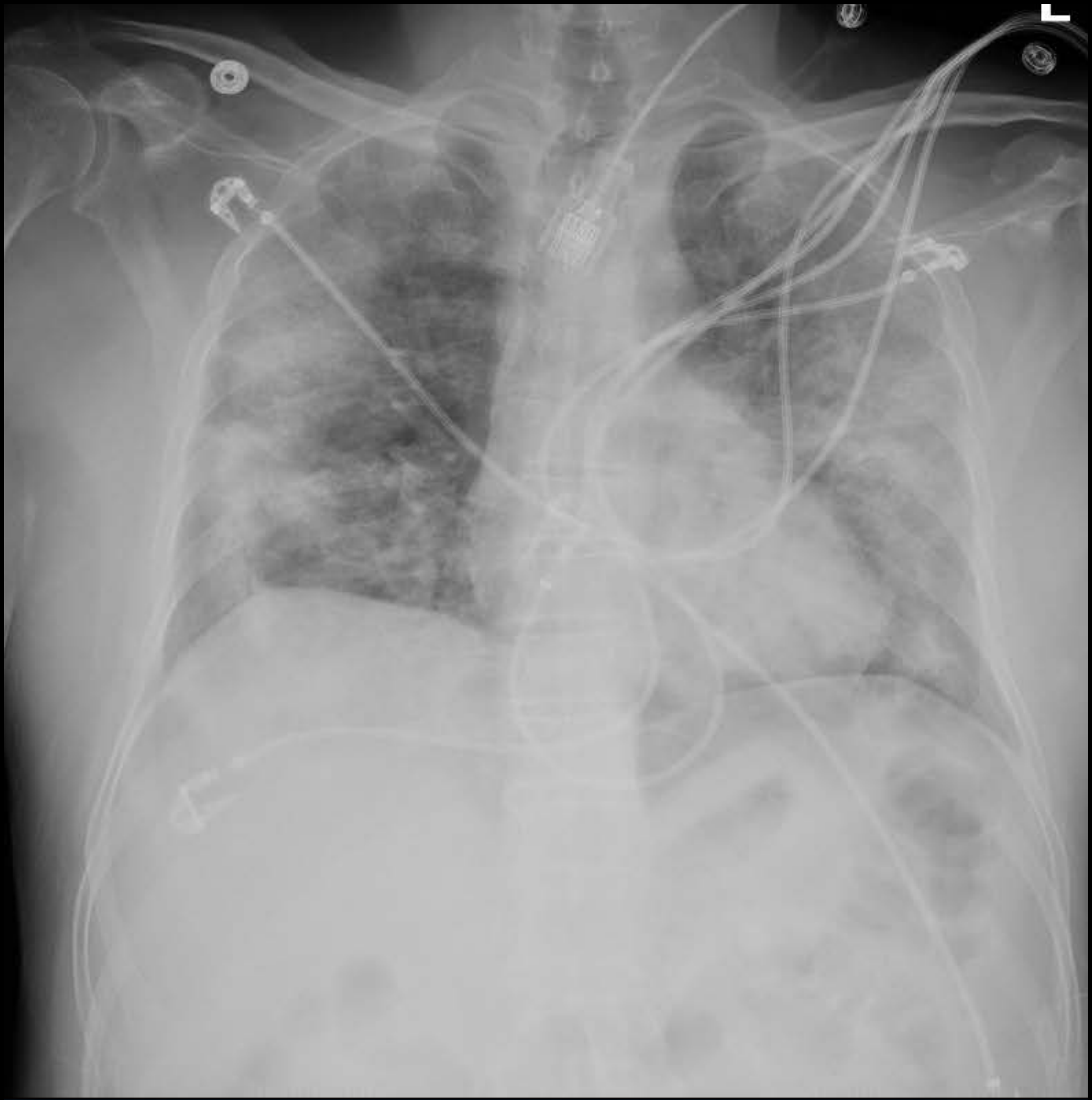
Triage

- Admitted to hospital because of hypoxia
- Triaged to general medical floor
- Treated with Tylenol, cough syrup and oxygen
- Enoxaparin 40 mg QD for DVT prophylaxis
- ID consultation for Remdesivir

Day 2

- Patient agrees for Remdesivir treatment
- Patient reports that he feels the same
- Oxygen requirement is now 3-4 L/min, O2 saturation 90-95%
- “does not appear to have increased work of breathing”
- Continues to have high temperatures
- Tachycardic 100-110/min
- Repeat CRP, ferritin and D- dimer are increase by almost 2X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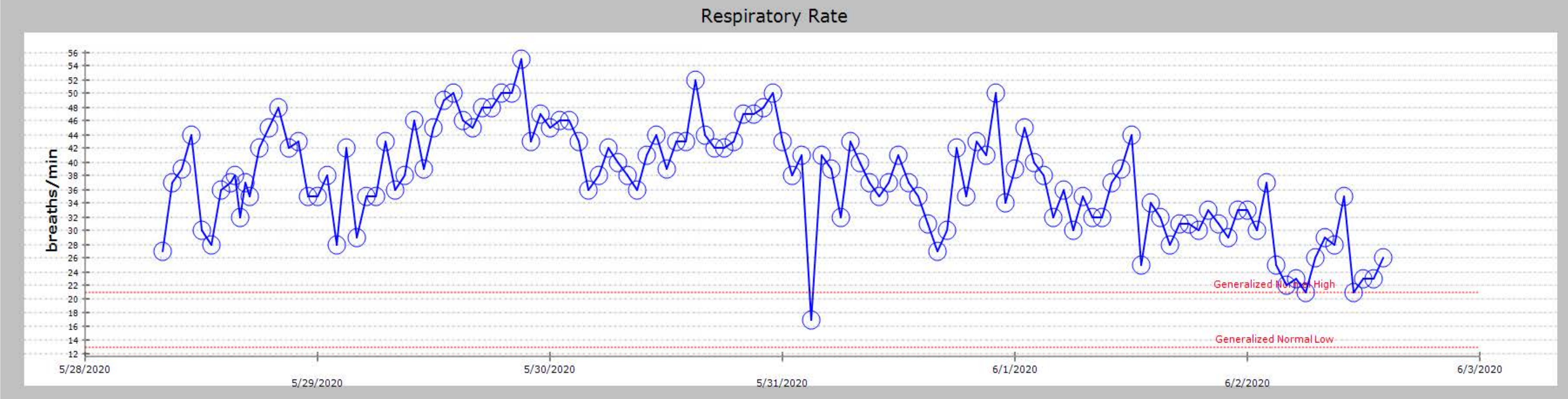
Day 3

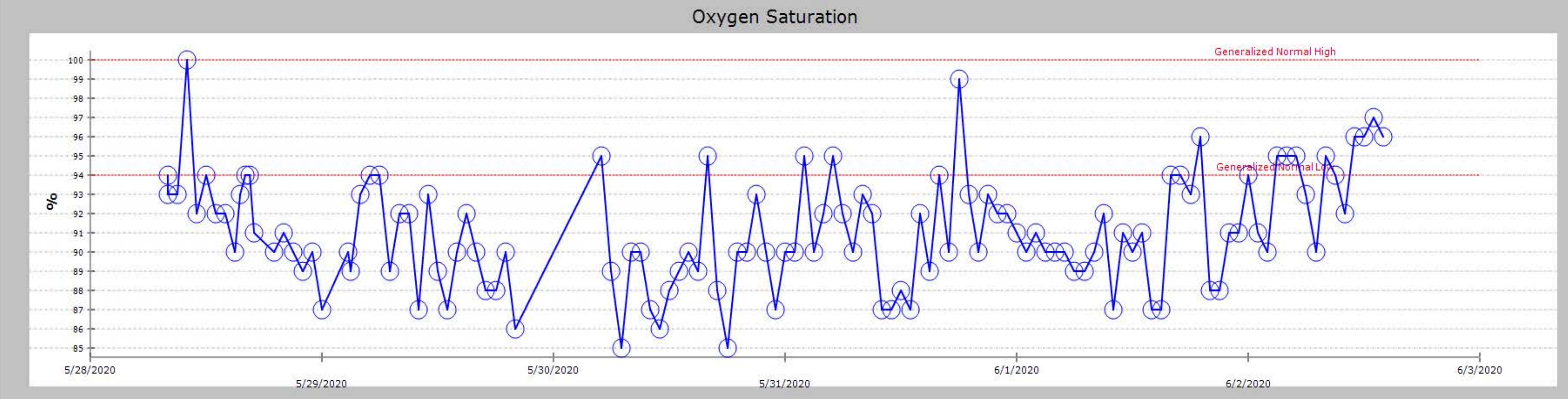
- MICU consulted for dyspnea and hypoxia requiring 5L/min oxygen with SpO2 88-90%
- MICU “RR 30/min, 15L/min NRM with SpO2 90%, unable to speak full sentences, transfer to MICU for high flow oxygen and respiratory monitoring. US DVT”

Hospital course

- Specific therapy
  - Remdesivir x 10 days, Tocilizumab x 1
  - Convalescent plasma x 1
  - Full dose anticoagulation for chronic DVT
  - Antibiotics for a secondary UTI
  - SC insulin for new diagnosis of diabetes
- Respiratory support
  - High flow oxygen 60L/min
  - Weaned down to nasal cannula
  - Awake prone position was used intermittently as tolerated by the patient
  - Talking and eating throughout his stay
- Discharged home on anticoagulation and oral anti-diabetics after two weeks in the hospital



Respiratory Rate
breaths/min
Generalized Normal High
Generalized Normal Low
5/28/2020
5/29/2020
5/30/2020
5/31/2020
6/1/2020
6/2/2020
6/3/2020



Oxygen Saturation
%
Generalized Normal High
Generalized Normal Low
5/28/2020
5/29/2020
5/30/2020
5/31/2020
6/1/2020
6/2/2020
6/3/2020

Case 2

- HPI: 48-year-old female with history of obesity and diabetes mellitus. One week of fever, and myalgias, multiple sick family members.
- Exam: T 39, HR 90, RR 24/min, SPO2 88% RA, 95% on 2L/min, obese, no distress, talking full sentences
- Labs: COVID positive, high ferritin 1000, D-dimer of 1.94, CRP 19
- CXR: Bilateral infiltrates
- US DVT negative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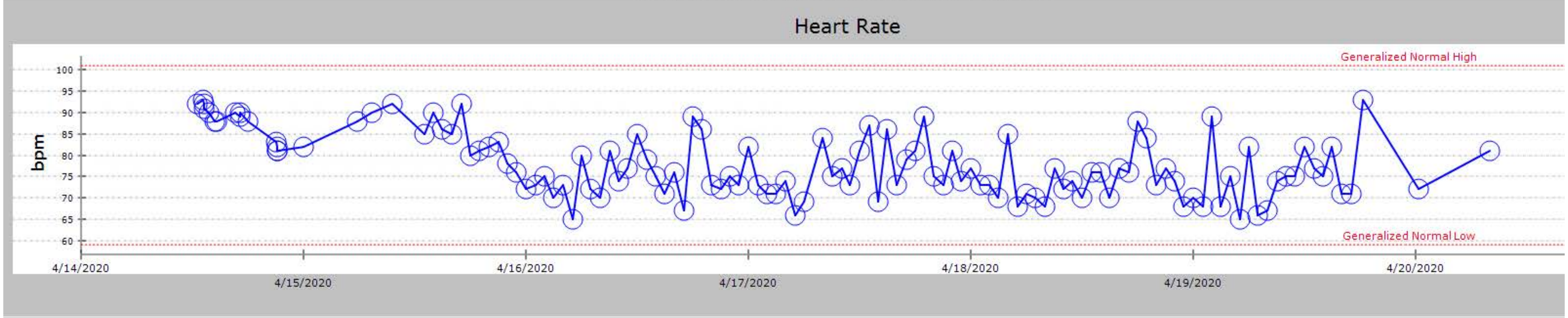
AP Portable
Upright


Heart Rate
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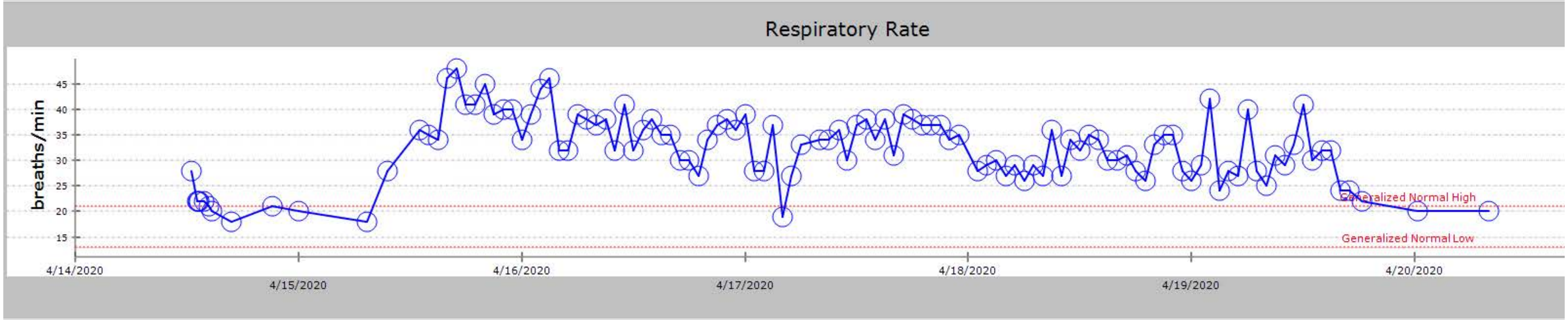
4/20/2020


Respiratory Rate
breaths/min
Generalized Normal High
Generalized Normal Low
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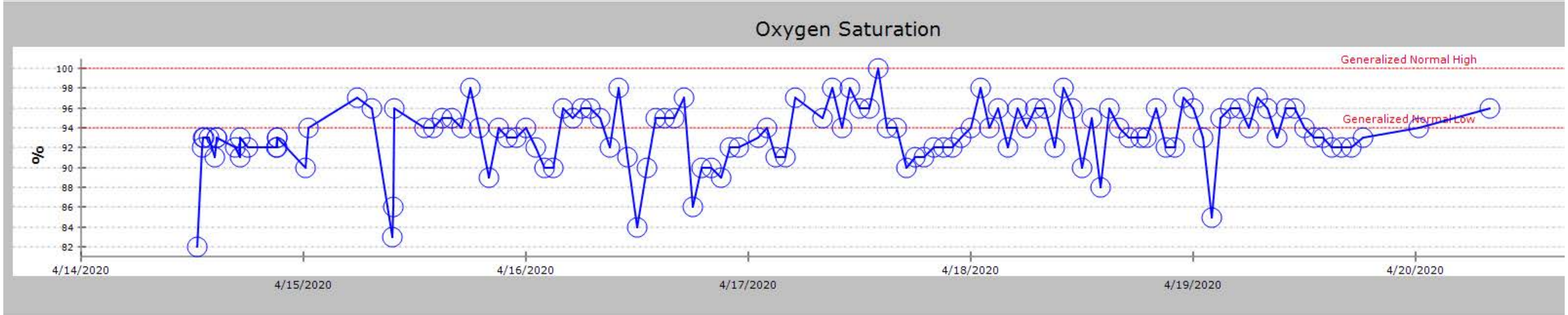
Oxygen Saturation
%
Generalized Normal High
Generalized Normal Low
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4/14/2020
4/15/2020
4/16/2020
4/17/2020
4/18/2020
4/19/2020
4/20/2020

Hospital course

- Treated with CPAP 10, FiO_2 60%
- Intermittent prone positioning as tolerated during NIV breaks
- Tocilizumab and hydroxychloroquine
- Full recovery and discharged to home

Case 1&2 – Topics for discussion

1. Recognition of severe disease and ICU triage
2. Modalities of respiratory support and respiratory monitoring
3. Awake prone positioning

Recognition of severe disease

- Physiologic parameters
  - HR, RR, Pulse oximetry
  - “work of breathing”
- Chest X-findings
- Laboratory markers (ferritin, D-dimer, CRP)
- Age and co-morbidities

ICU triage for severe disease

- ICU triage is always context sensitive
- Strong considerations for ICU triage
  - 6L/min NC oxygen for SpO2 92%
  - RR > 30 /min (manually counted for 1 minute)
  - Excessive work of breathing
  - Rapidly increasing oxygen requirements
  - Clinician gestalt
- Formal policy regarding ICU triage is helpful
  - Removes decision fatigue

OXYGEN DELIVERY SYSTEMS

Device: Nasal Cannula
Flow: 1 - 6 L/min
FiO2: 25 - 40%
(~4%/L of flow)

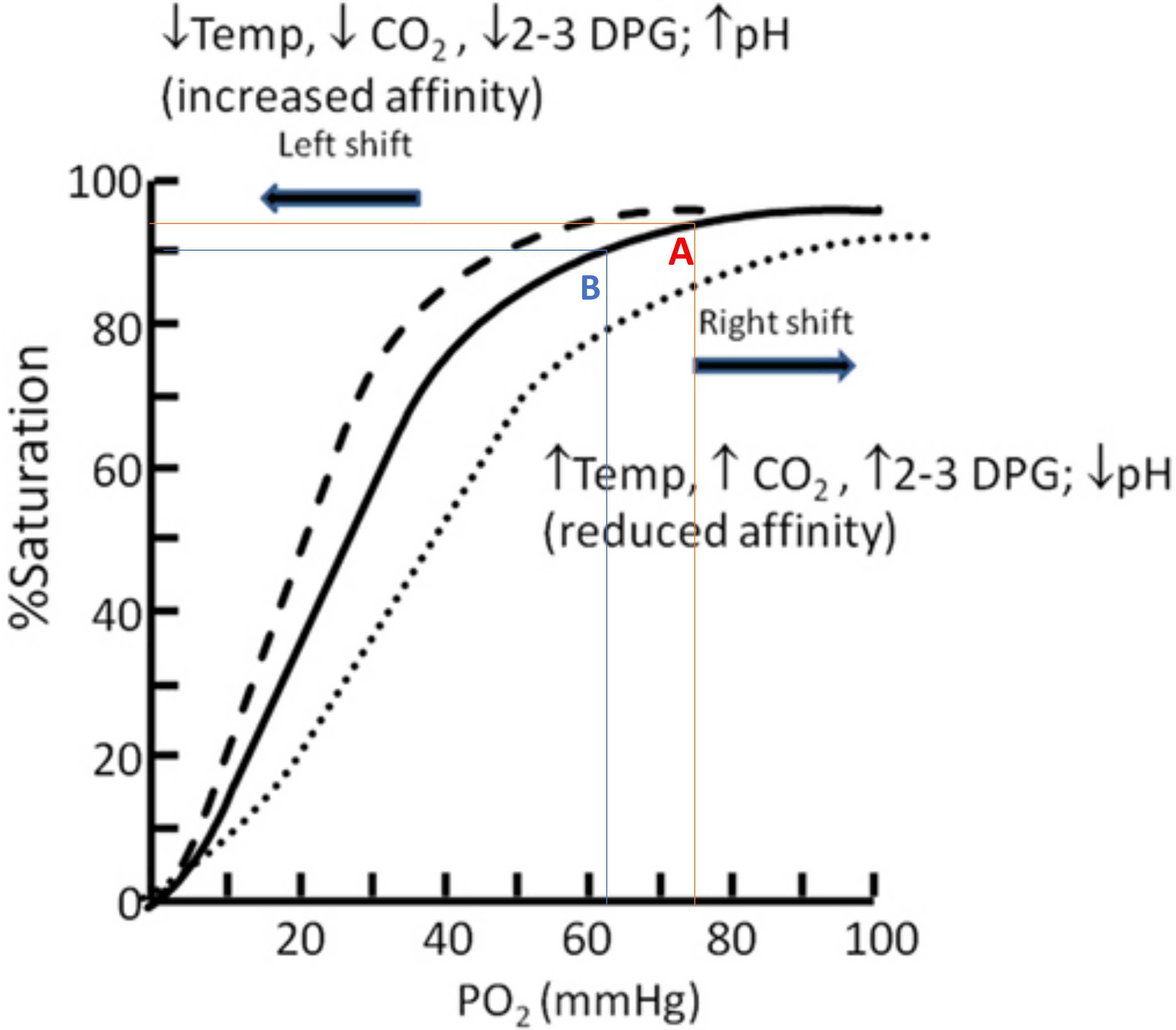
Device: Face Mask
Flow: 5 - 10 L/min
FiO2: 40 - 60%

Device: Face Tent
Flow: 10 - 15 L/min
FiO2: ~40%

Device: Venturi Mask
Flow: 2 - 15 L/min
(based on valve)
FiO2: 24 - 60%
(precisely controlled)

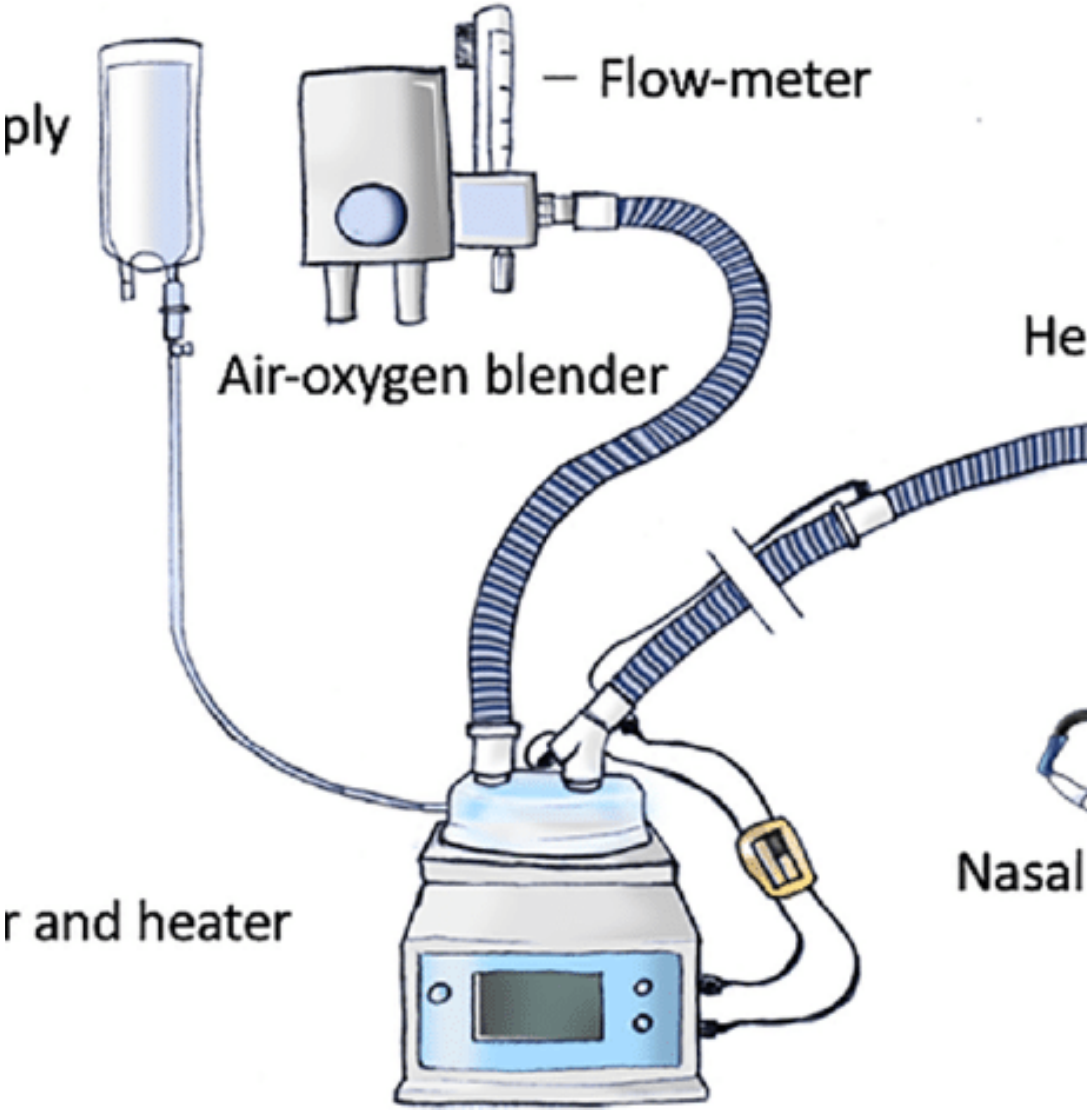
Device: Non-Rebreather
Flow: 10 - 15 L/min
FiO2: 80 - 95%

Device: High Flow Nasal Cannula
Flow: up to 60 L/min
FiO2: 21 - 100%



A: FiO2 25%, SpO2 93-94% pO2 75 mm Hg
B: FiO2 25%, SpO2 90%, pO2 62
Pulse oximetry went down by 3 or 4%
But partial pressure of oxygen went down by 17%

Respiratory Monitoring by Pulse Oximetry



High flow oxygen

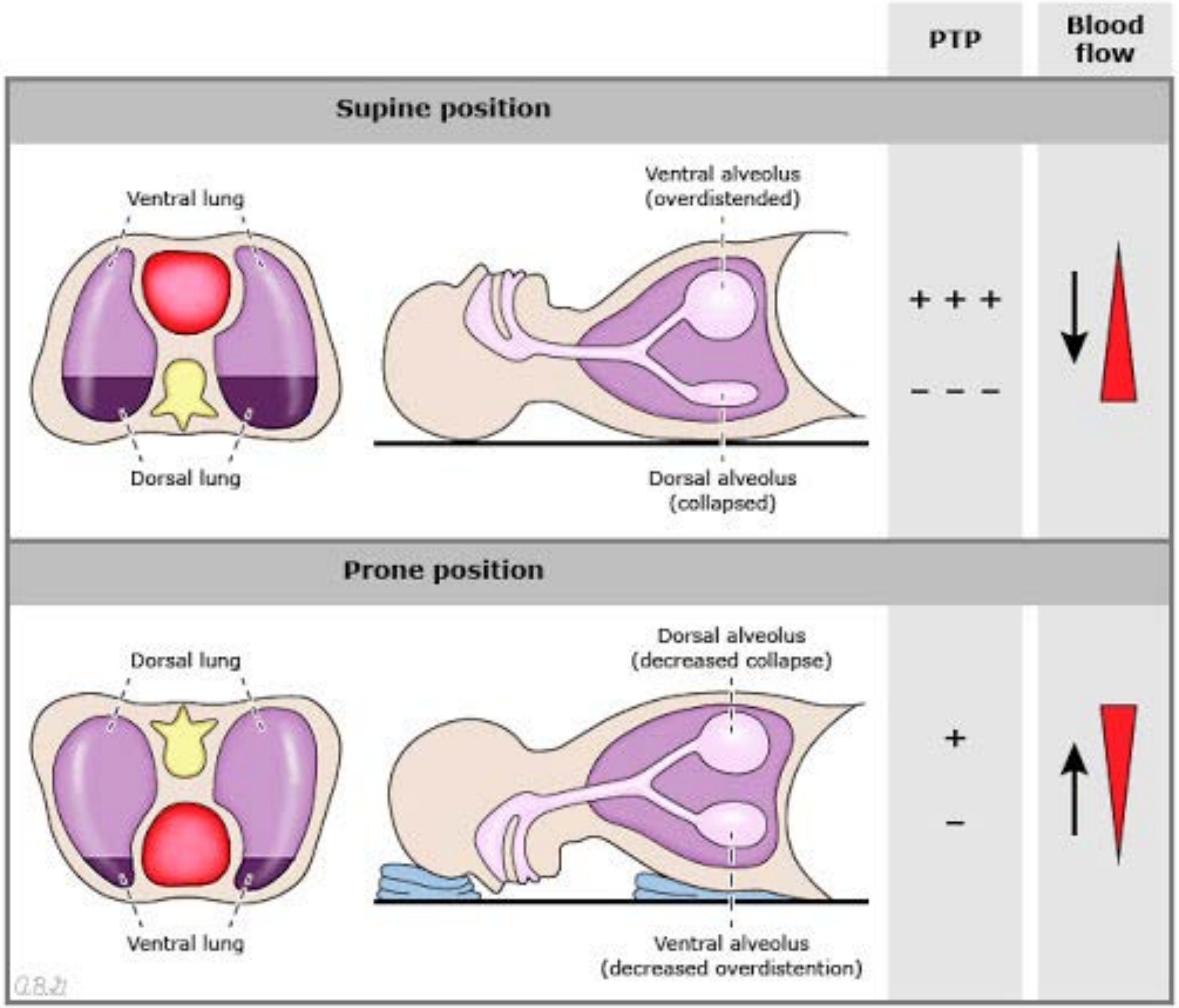
- High flow oxygen system
  - 40-60L/min with heated and humidified nasal prongs
  - FiO2 titrated independent of air flow.
- FLORALI trial – acute hypoxic respiratory failure
- Comfort, mild CPAP effect, easier to prone

Non-invasive ventilation

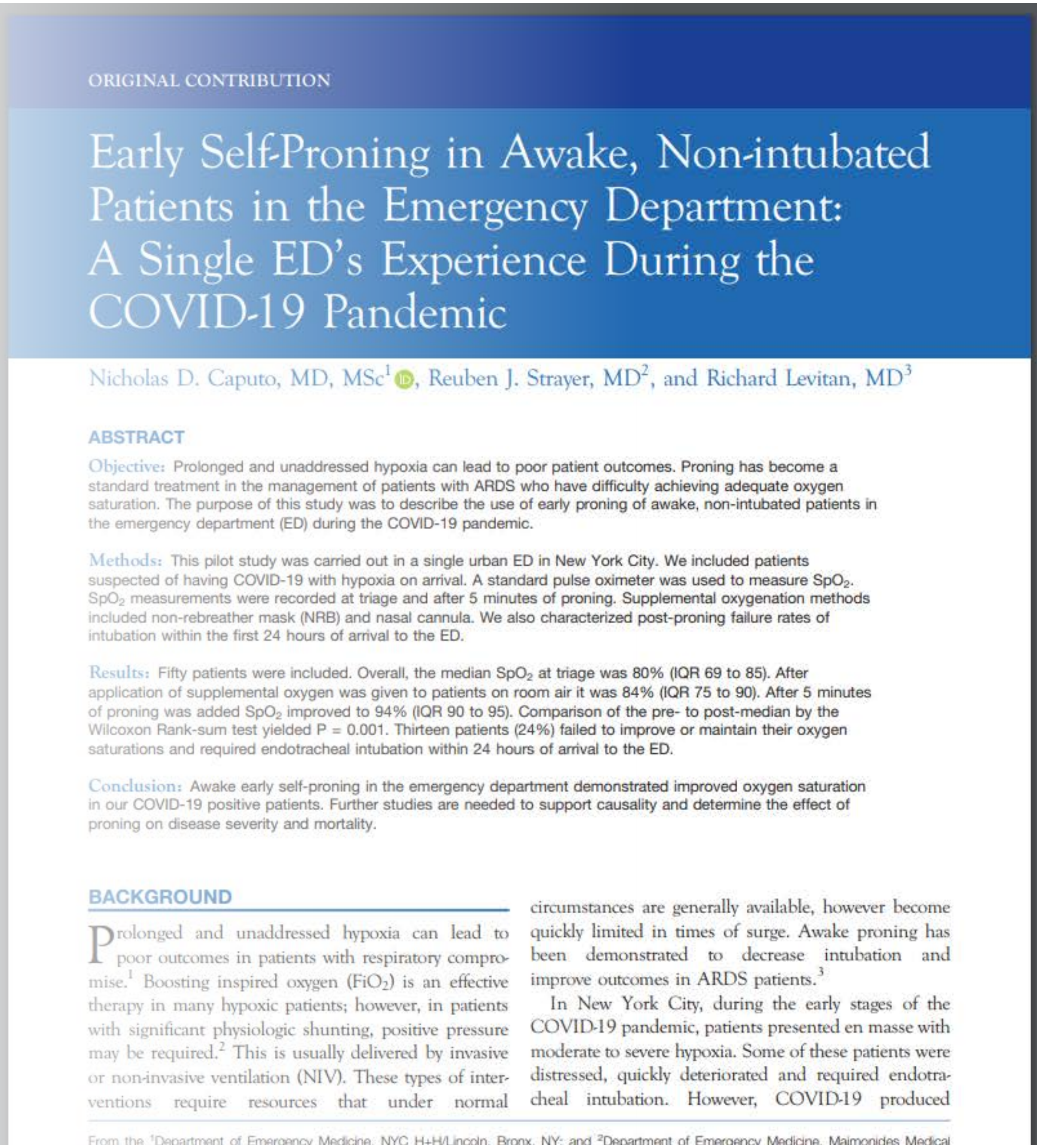
- CPAP or BiPAP
- Helps oxygenation, relieve work of breathing
- May help overcome upper airway obstruction in obese patients
- Concern for tolerability over the long term
- Aspiration risk
- Ventilator induced lung injury by excessively large tidal volumes under high pressure
- May "delay" intubation

Awake prone positioning

- PROSEVA 2013 for intubated patients
- Multiple case series described of awake proning in COVID-19
- Benefits oxygenation, redistributes inflammation
- Dependent on patient cooperation and tolerability
- Intensive Care Society – timed position changes for COVID-19



Awake prone positioning



ORIGINAL CONTRIBUTION

Early Self-Proning in Awake, Non-intubated Patients in the Emergency Department: A Single ED's Experience During the COVID-19 Pandemic

Nicholas D. Caputo, MD, MSc[1], Reuben J. Strayer, MD[2], and Richard Levitan, MD[3]

ABSTRACT

Objective: Prolonged and unaddressed hypoxia can lead to poor patient outcomes. Proning has become a standard treatment in the management of patients with ARDS who have difficulty achieving adequate oxygen saturation. The purpose of this study was to describe the use of early proning of awake, non-intubated patients in the emergency department (ED) during the COVID-19 pandemic.

Methods: This pilot study was carried out in a single urban ED in New York City. We included patients suspected of having COVID-19 with hypoxia on arrival. A standard pulse oximeter was used to measure SpO_2. SpO_2 measurements were recorded at triage and after 5 minutes of proning. Supplemental oxygenation methods included non-rebreather mask (NRB) and nasal cannula. We also characterized post-proning failure rates of intubation within the first 24 hours of arrival to the ED.

Results: Fifty patients were included. Overall, the median SpO_2 at triage was 80% (IQR 69 to 85). After application of supplemental oxygen was given to patients on room air it was 84% (IQR 75 to 90). After 5 minutes of proning was added SpO_2 improved to 94% (IQR 90 to 95). Comparison of the pre- to post-median by the Wilcoxon Rank-sum test yielded $P = 0.001$. Thirteen patients (24%) failed to improve or maintain their oxygen saturations and required endotracheal intubation within 24 hours of arrival to the ED.

Conclusion: Awake early self-proning in the emergency department demonstrated improved oxygen saturation in our COVID-19 positive patients. Further studies are needed to support causality and determine the effect of proning on disease severity and mortality.

BACKGROUND

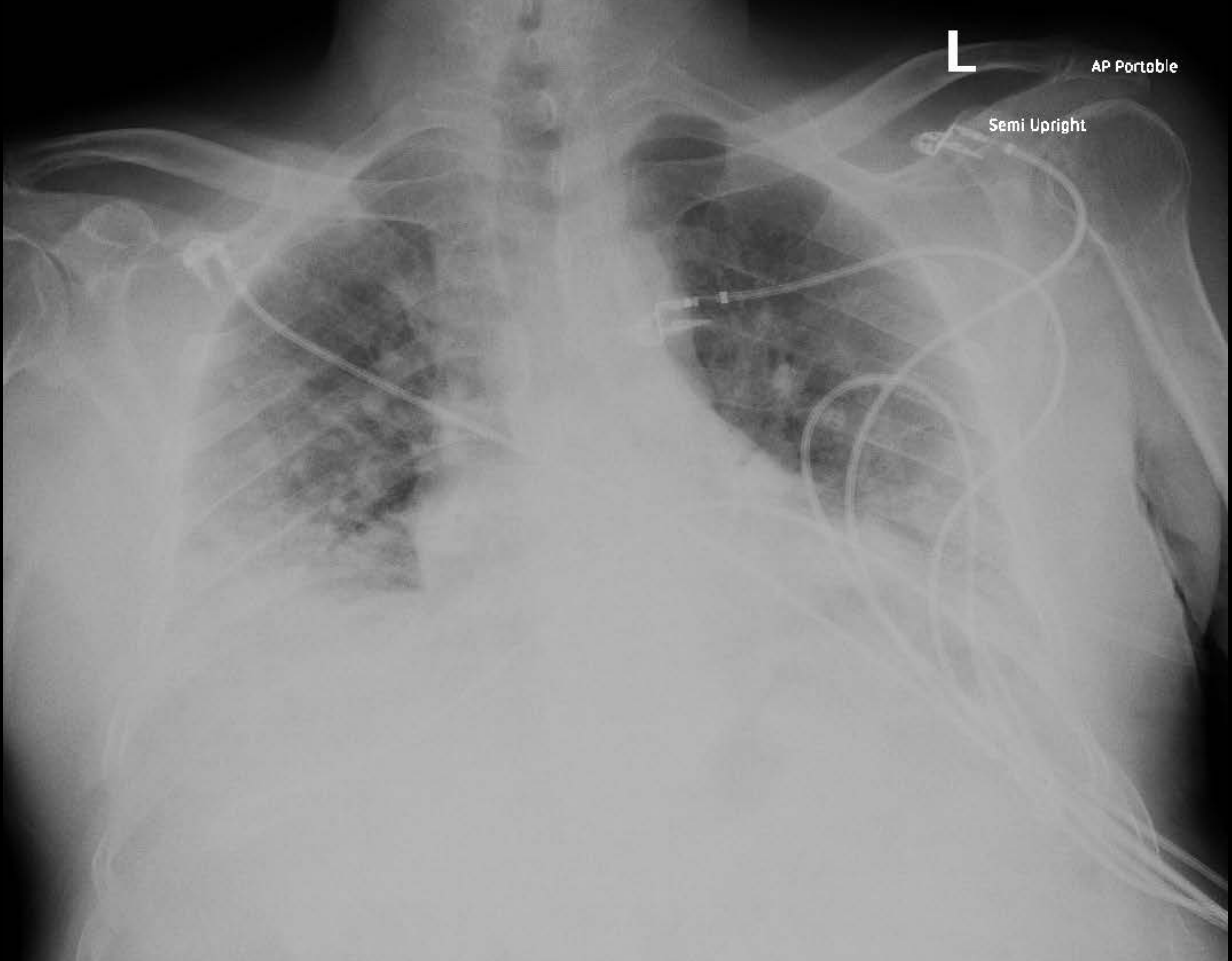
Prolonged and unaddressed hypoxia can lead to poor outcomes in patients with respiratory compromise.[1] Boosting inspired oxygen (FiO_2) is an effective therapy in many hypoxic patients; however, in patients with significant physiologic shunting, positive pressure may be required.[2] This is usually delivered by invasive or non-invasive ventilation (NIV). These types of interventions require resources that under normal circumstances are generally available, however become quickly limited in times of surge. Awake proning has been demonstrated to decrease intubation and improve outcomes in ARDS patients.[3]

In New York City, during the early stages of the COVID-19 pandemic, patients presented en masse with moderate to severe hypoxia. Some of these patients were distressed, quickly deteriorated and required endotracheal intubation. However, COVID-19 produced

From the [1]Department of Emergency Medicine, NYC H+H/Lincoln, Bronx, NY; and [2]Department of Emergency Medicine, Maimonides Medical

Case 3

- HPI: 70-year-old man with history of poorly controlled diabetes and hypertension presented with two weeks of fever, sore throat and myalgias. Now with cough and dyspnea.
- Exam: T 37, HR 90, SpO2 82% (RA, 95% on 2L/min NC), BP 140/80. Looked “ill”, normal size and built, bilateral crackles on auscultation. Talking full sentences, not using accessory muscles
- Labs: COVID screen positive, TWC 15, lymphocyte count was low, Glucose 250, Lactate 3.5, Ferritin 16 mg/ml, CRP 5, D-dimer 0.8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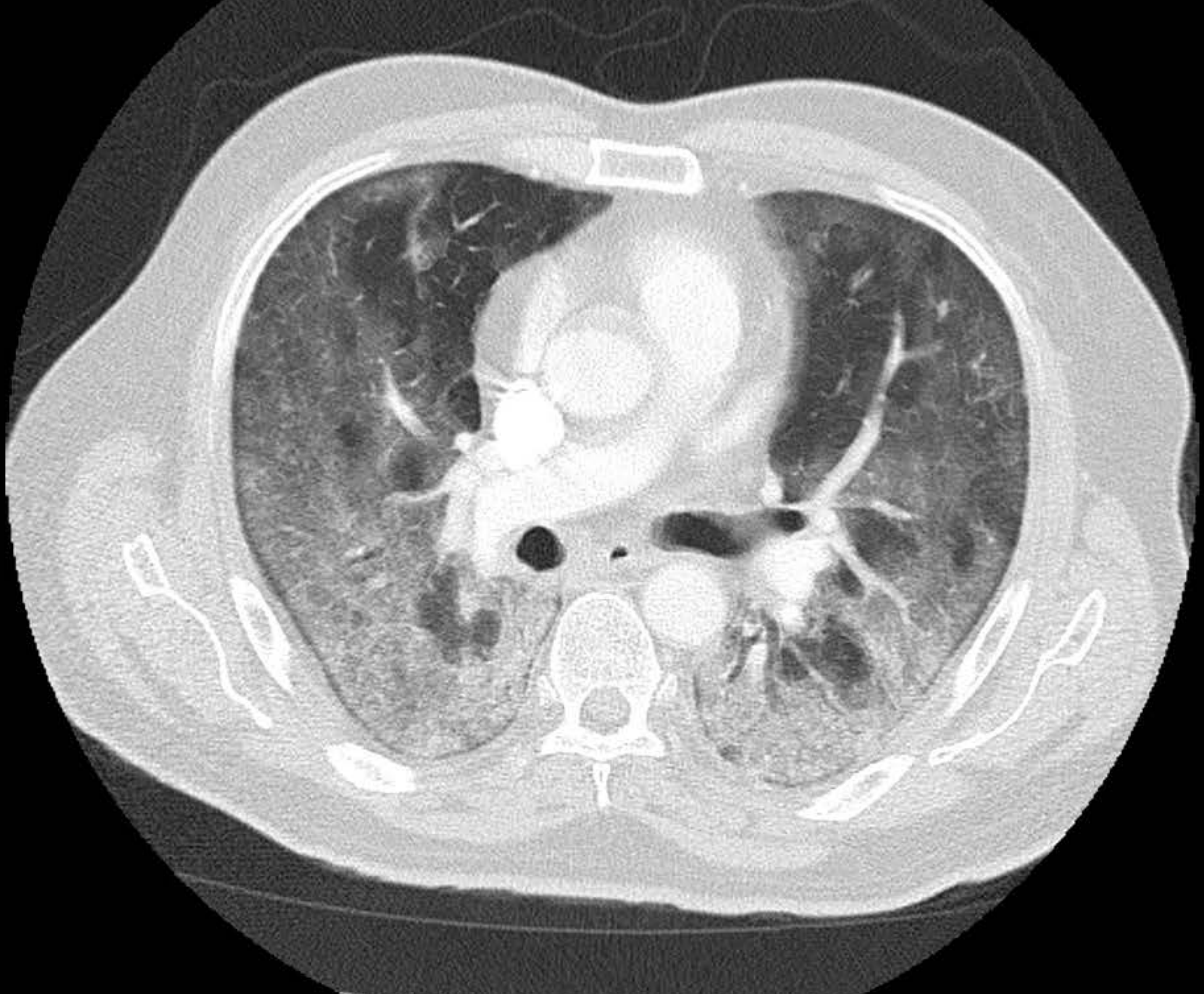
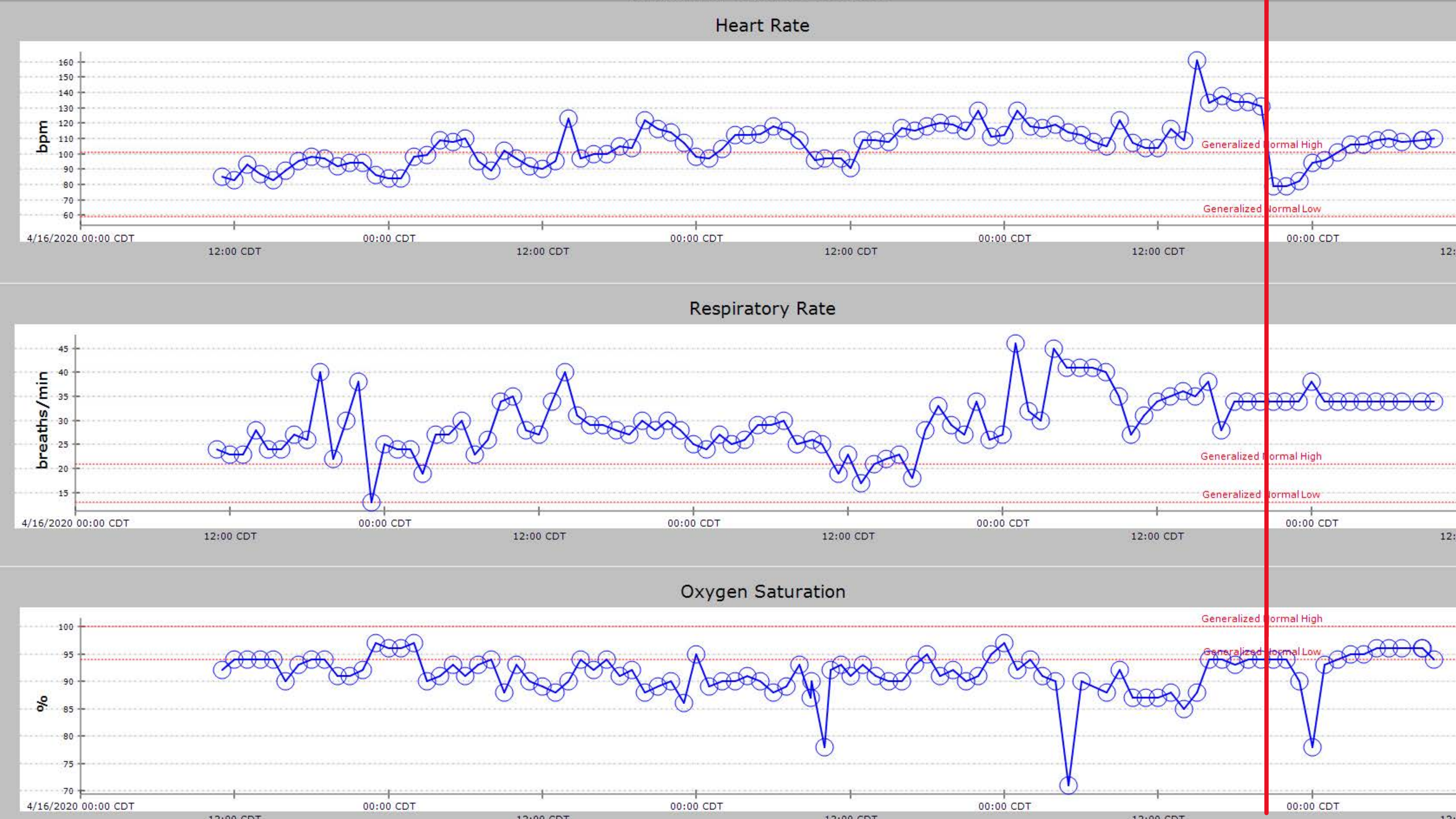
Day 2-4

- Treated with hydroxychloroquine, remdesivir IV
- Oxygen support escalated to 6L/min nasal cannula
- Worsened dyspnea and tachypnea
- L sided pleuritic chest pain
- Moved to MICU, started on NRM oxygen at 10L/min
- Awake prone positioning – poorly tolerated
- CT Angiogram to rule out PE




Heart Rate
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Respiratory Rate
breaths/min
45
40
35
30
25
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15
Oxygen Saturation
%
100
95
90
85
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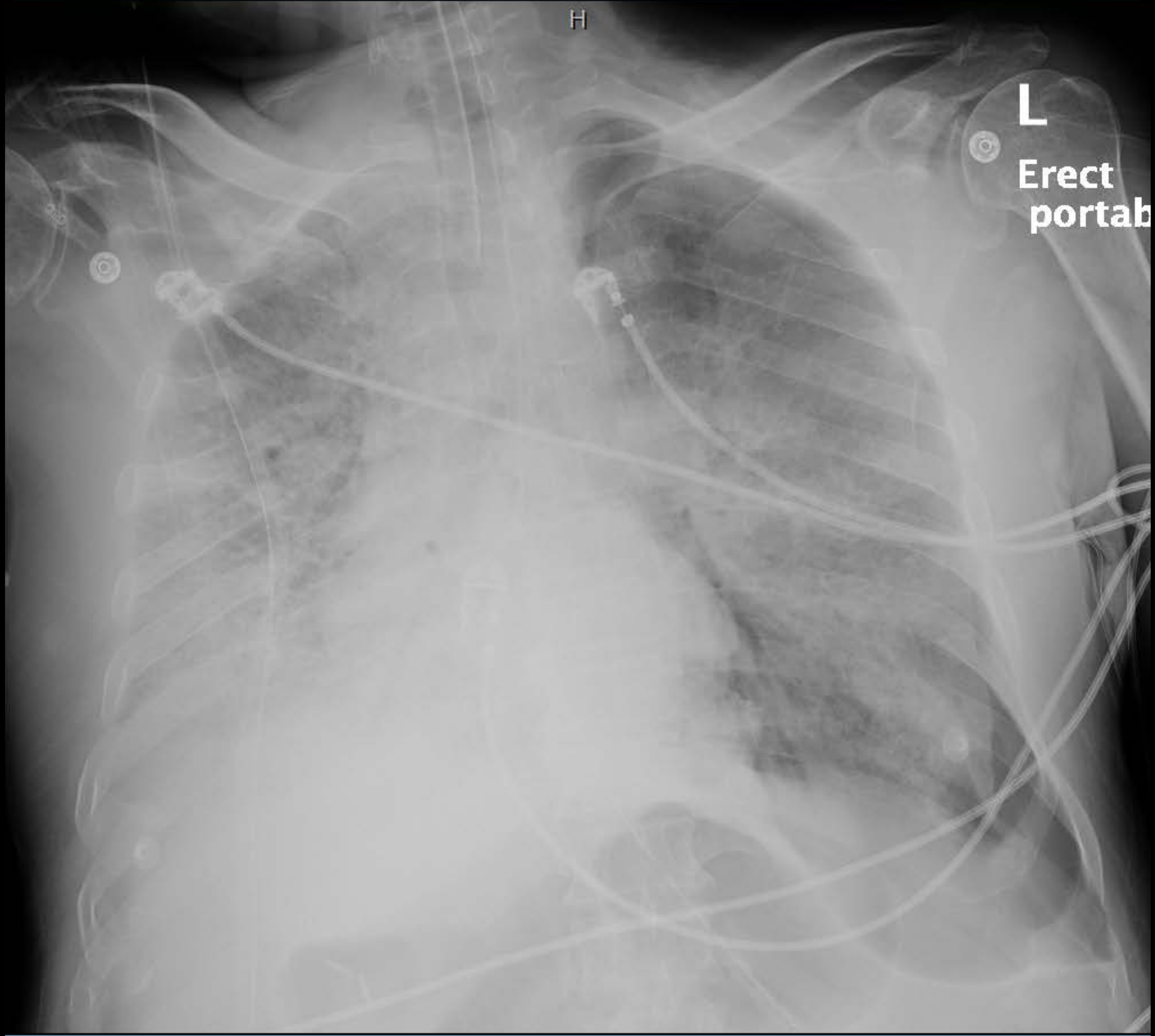
70

Day 5

- Patient is intubated and placed on mechanical ventilation
- Low tidal volume ventilation with permissive hypercapnia
- Very severely hypoxic even on 100% FiO_2
- Deep sedation, neuromuscular blockade
- PEEP titration is done by driving pressure
- Plateau pressures < 28, measured lung compliance is lower normal
- After an hour, patient starts to desaturate, worsened hemodynamics
- Peak pressure alarms sounding, lung US suggests PTX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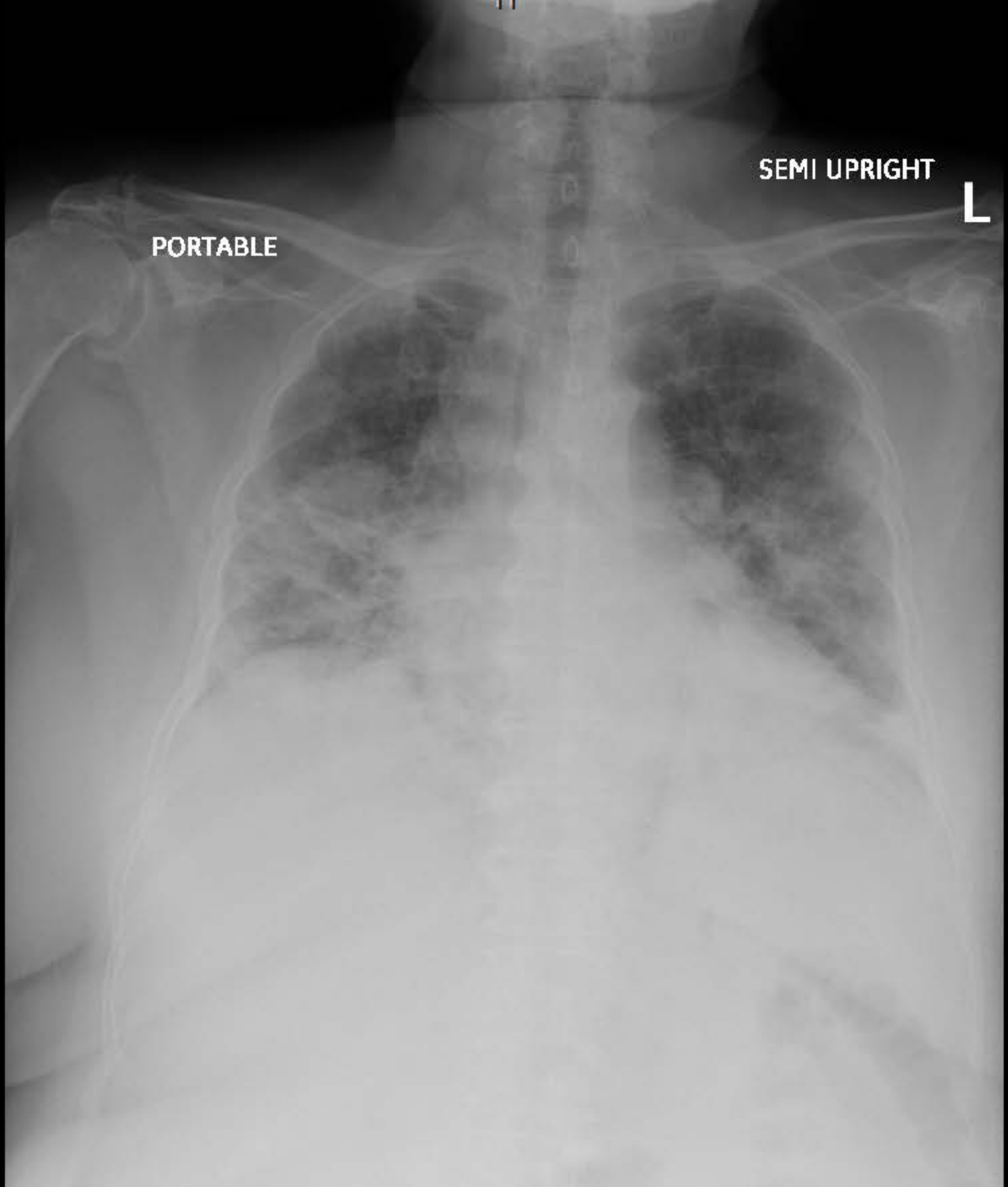
Hospital Course

- Develops severe RV failure and refractory shock, multiorgan dysfunction, renal failure, possibly bacterial superinfection, stress ulcer bleeding
- Treated with ventilatory support, paralytics, INO2, chest tube drainage
- Vasopressors, CRRT, anticoagulation with low dose heparin
- Remdesivir, Tocilizumab and HCQ
- Broad spectrum antibiotics
- IV steroids
- Dies after one month of ICU stay

Case 4

- 63-year-old lady with past history of diabetes mellitus and obesity admitted with one week of cough and fevers. Multiple family members with COVID-19. Husband hospitalized with severe disease.
- T 39, HR 100/min, RR 30/min, SPO2 90% on 6L/min
- Admitted to ICU, subsequently intubated, started on MV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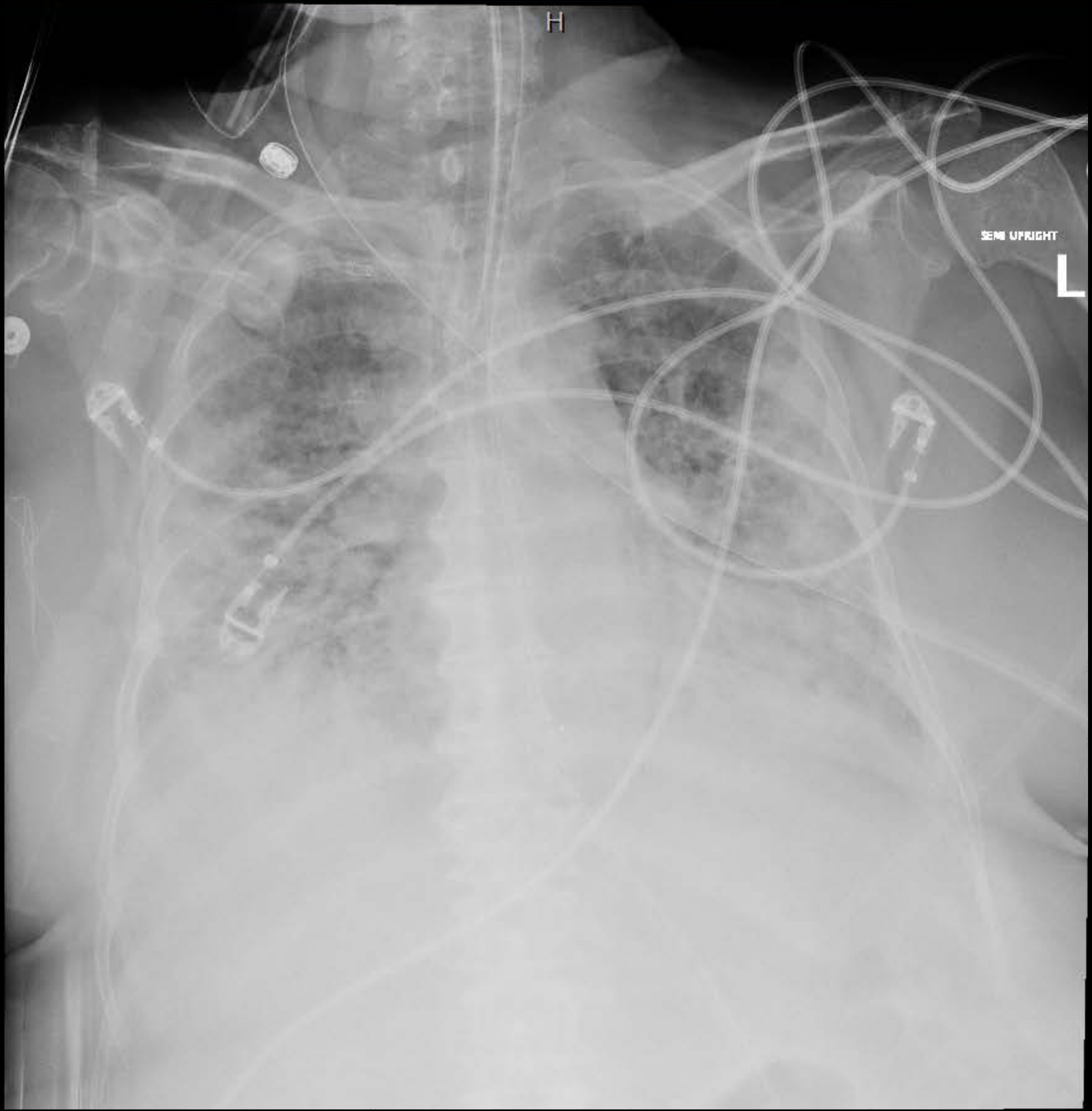
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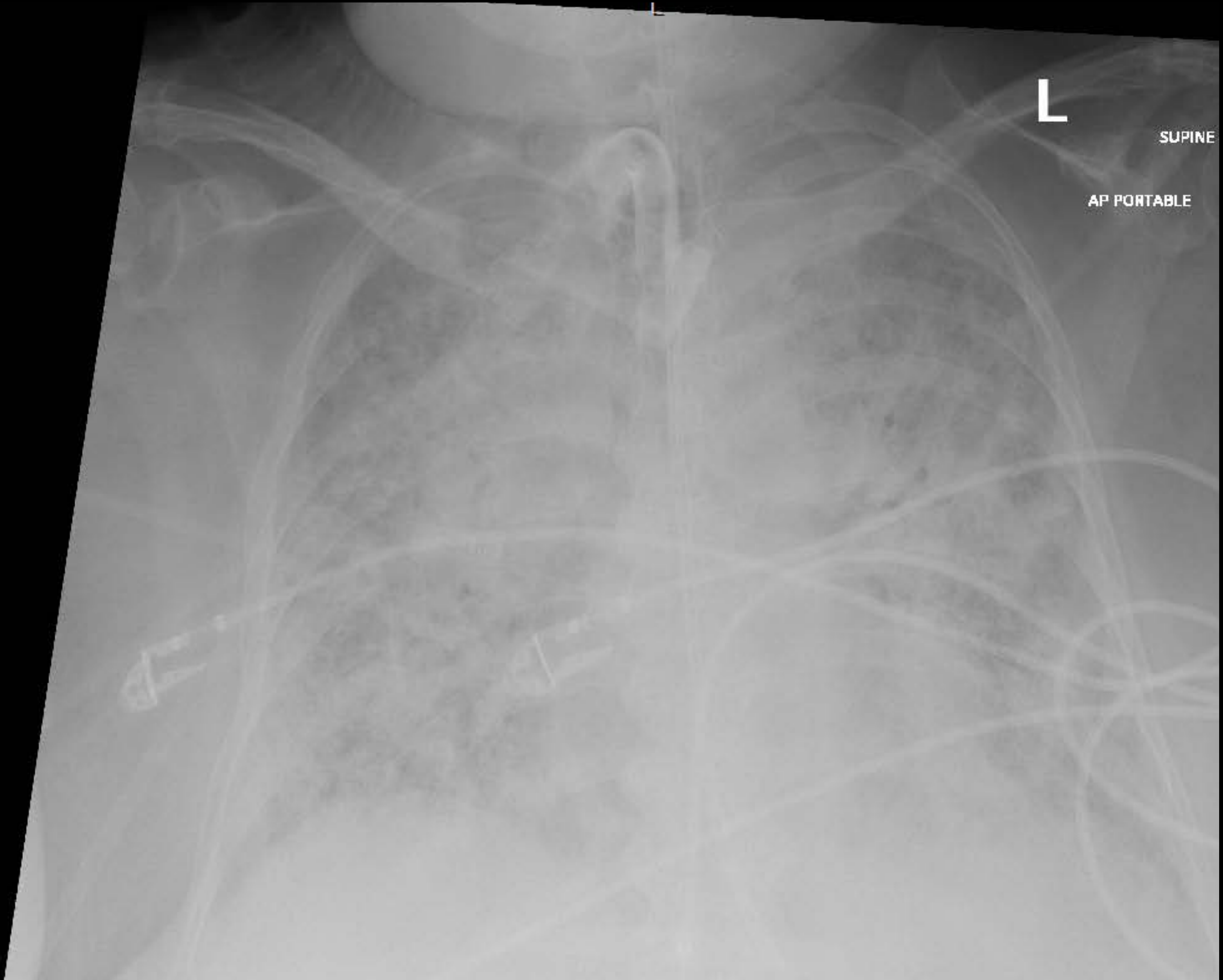
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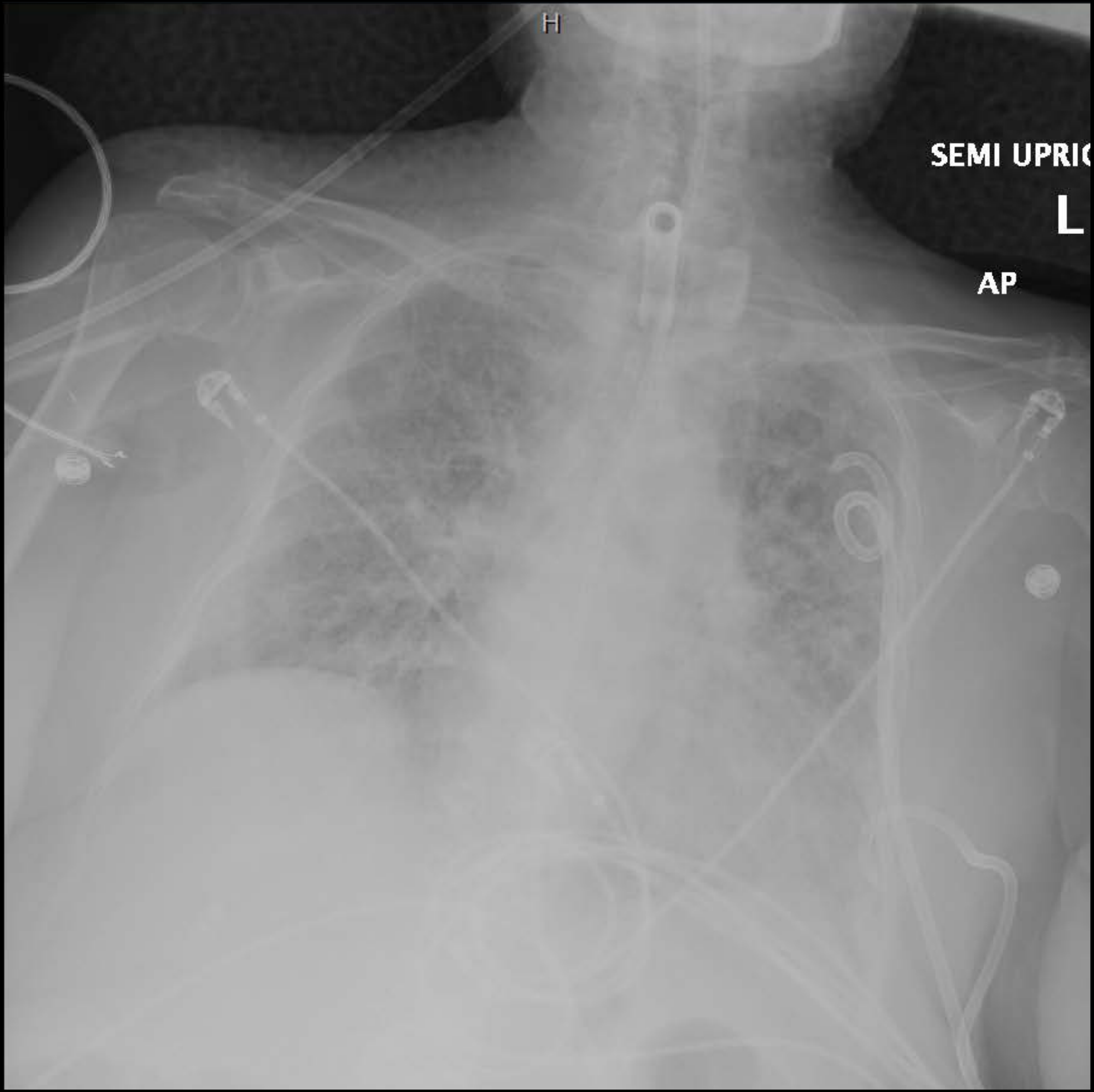
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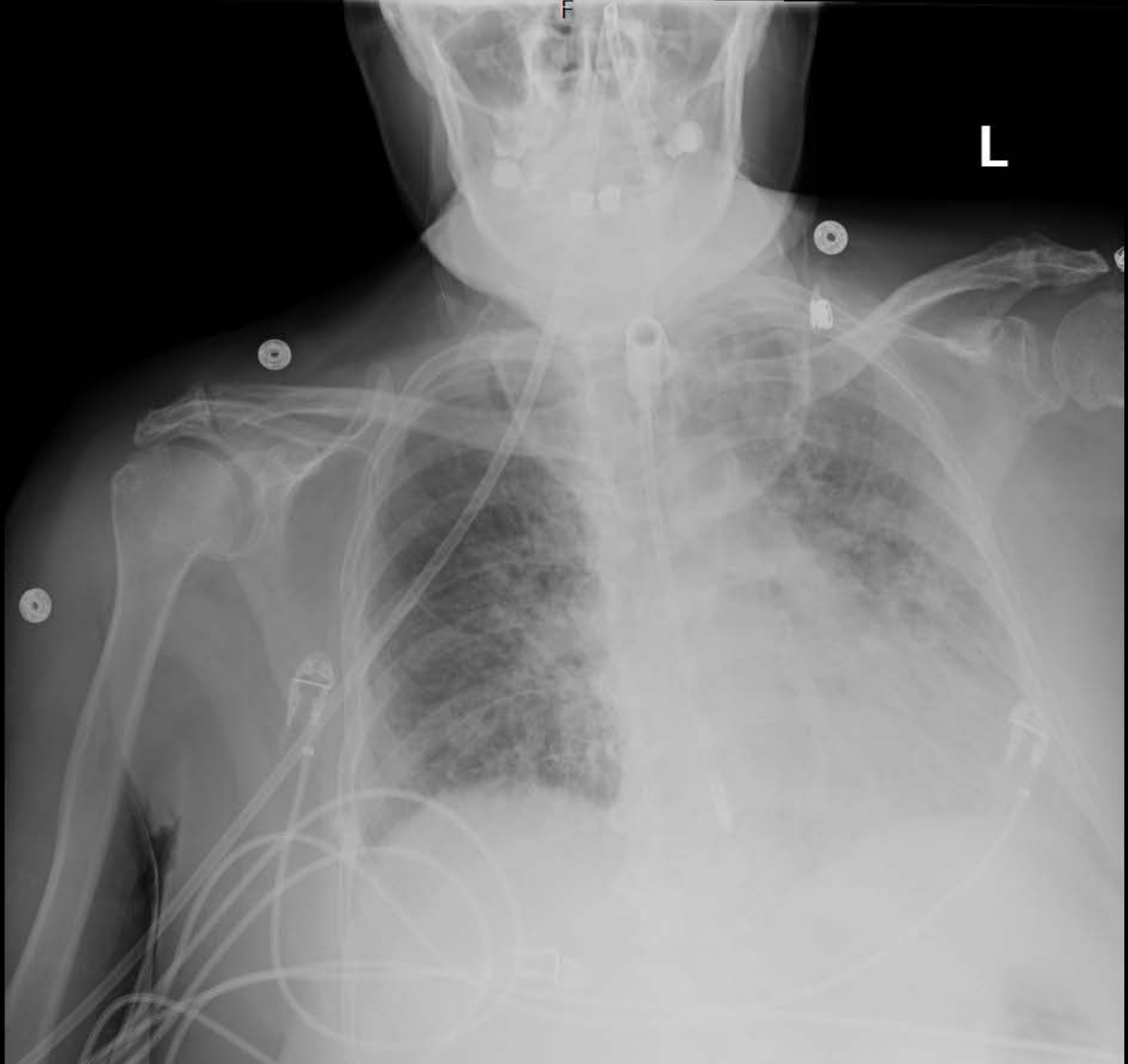
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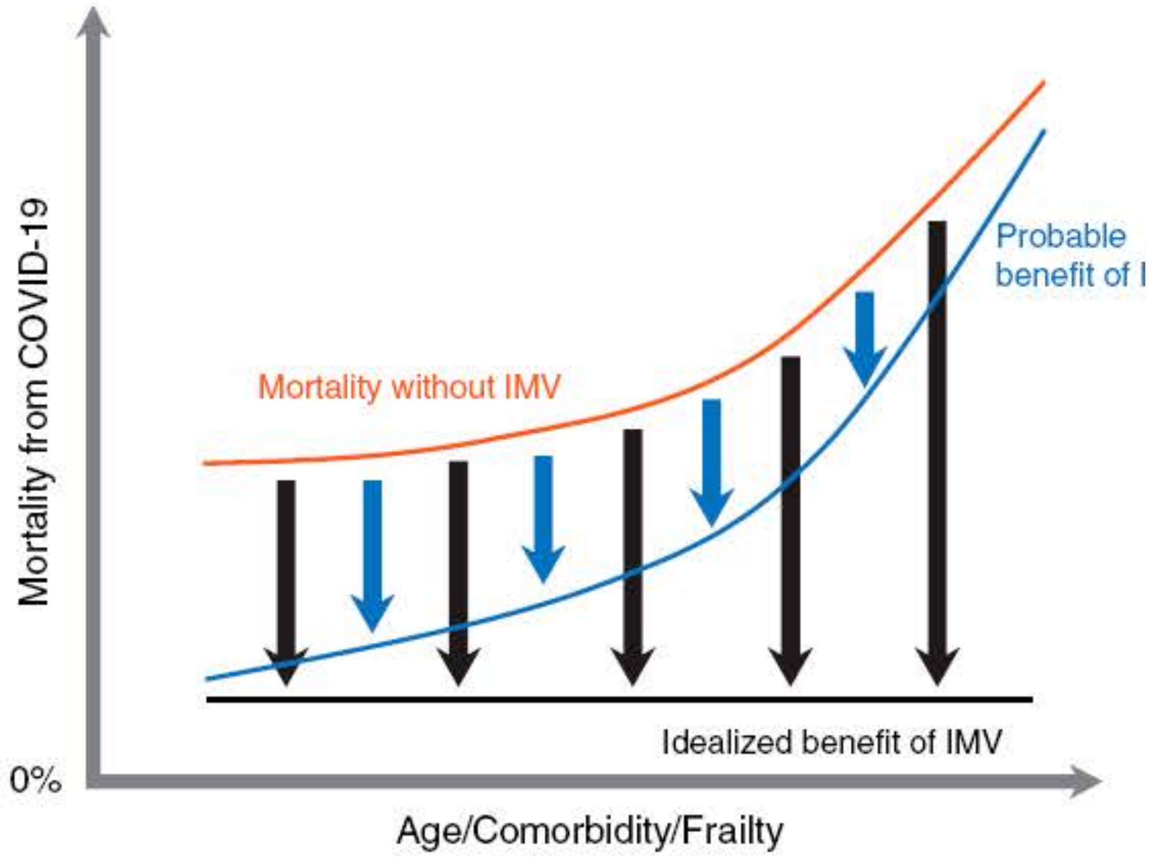
Case 3 & 4 - Topics of discussion

3. Intubation of patients with severe COVID-19
4. Ventilator management of severe COVID ARDS
5. Prone positioning, intubated and non-intubated
6. General critical care for severe COVID-19

The decision to intubate

- Composite assessment
    - Vital signs
    - Clinical assessment
    - Patient views and preferences
    - Resources available
- Never a consequence of pre-determined indices
- Failure of alternatives
- "If you are considering intubation, and the patient cannot talk you out of it, intubate them"
- Does intubation and mechanical ventilation change improve the trajectory of diease in the absence of a disease modifying treatment?

The assumptions behind the benefit of IMV



Wunsch H. Mechanical Ventilation in COVID-19: Interpreting the Current Epidemiology. Am J Respir Crit Care Med. 2020;202(1):1-4

Early vs Late intubation

“Early” intubation

- Use traditional indices for and paradigms for institution of IMV, especially hypoxia
- Proponents argue lower mortality in ventilated patients
- Avoids P-SILI
- “do something now before its too late”

“Late” intubation

- Permissive hypoxia – “silent- happy hypoxic”
- Proponents argue lower overall ICU mortality
- Avoids antecedent risks of invasive life-support system
- “if it ain’t broke, don’t fix it”

Tobin MJ, Laghi F, Jubran A. Why COVID-19 Silent Hypoxemia Is Baffling to Physicians. Am J Respir Crit Care Med. June 2020

Table 1. Comparison of Rates of Invasive Mechanical Ventilation in a Sample of Epidemiology Studies of Patients with COVID-19

Study	Location	Hospitalized (*n*)	ICU Admission (*n*)	Invasive Mechanical Ventilation: *n*	Invasive Mechanical Ventilation: Percent of ICU Patients	Invasive Mechanical Ventilation: Percent of Hospitalized Patients
Richardson (4)	New York City	5,700	1,281	1,151	89.9	20.2
Petrilli (17)	New York City	1,999	534*	445	83.3	22.3
Goyal (13)	New York City	393	NA	130	NA	33.1
ICNARC (14)	UK	NA	3,883	2,291†	59.0	NA
Grasselli (15)	Lombardy, Italy	NA	1,300‡	1,150	88.5	NA
Zhou (18)	Wuhan, China	191	50	32	64.0	16.8
Wang (3)	Wuhan, China	NA	344	100	29.1	NA
Guan (19)	China	1,099	55	25	45.5	2.3

Definition of abbreviations: COVID-19 = coronavirus disease; ICNARC = Intensive Care National Audit & Research Centre; NA = not available.

Rates of IMV

Comparison of the rates of IMV across a sample of epidemiological actions

Wunsch H. Mechanical Ventilation in COVID-19: Interpreting the Current Epidemiology. Am J Respir Crit Care Med. 2020;202(1):1-4

Table 2. Reported Data on Mechanically Ventilated ICU Patients and Outcomes for Selected Cohorts with Possible Range of ICU or Hospital Mortality Accounting for Patients Still Receiving Care

Study	Location	Total (*n*)	Died (*n*)	Survived to ICU Discharge (*n*)	Still Receiving Care (*n*)	Range of Possible Mortality (%)
Richardson (4)	New York City	1,151	282	38 (hospital)	831	24.5–96.7
ICNARC (14)	UK	2,291*	698†	355	1,238	30.5–84.5
Grasselli (15)‡	Lombardy, Italy	1,581	405	256	920	25.6–83.8

Definition of abbreviation: ICNARC = Intensive Care National Audit & Research Centre.
Lower bound assumes everyone receiving care survives; upper bound assumes they all die.
*Mechanically ventilated within first 24 hours.
†Received advanced organ support; may include patients who received mechanical ventilation after the first 24 hours.
‡All patients in ICU, not just those mechanically ventilated.

Mortality for patients who receive mechanical ventilation

Wunsch H. Mechanical Ventilation in COVID-19: Interpreting the Current Epidemiology. Am J Respir Crit Care Med. 2020;202(1):1-4

Early Vs Late intubation

Tobin *et al. Ann. Intensive Care* (2020) 10:78
https://doi.org/10.1186/s13613-020-00692-6

Annals of Intensive C

REVIEW

Open Acc

Caution about early intubation and mechanical ventilation in COVID-19

Martin J. Tobin*, Franco Laghi and Amal Jubran

A fear of ventilator shortage with COVID-19 panicked politicians into demanding automakers to branch into ventilator manufacture.

Some experts have argued that mechanical ventilation should be employed early in order to prevent COVID-19 patients progressing from mild disease to more severe lung injury. This viewpoint has been expressed most forcefully by Marini and Gattinoni in a *JAMA Editorial* [1], where they attest that vigorous spontaneous inspiratory efforts can rapidly lead to patient self-induced lung injury (P-SILI).

P-SILI is thought to parallel ventilator-induced lung injury (VILI), an entity supported by decades of experimentation and randomized trials [2]. In contrast, P-SILI has surfaced only in the past 4–5 years [3]. Two research studies are commonly cited by authors warning about P-SILI [1, 3–5].

To induce hyperventilation, Mascheroni et al. [6] infused salicylate into the brainstem of spontaneously breathing sheep. The authors claim that the consequent ~ threefold increase in minute ventilation produced lung injury, and this was prevented by mechanical ventilation. Tidal volume (the focus of authors warning about P-SILI) [1, 3–5] increased from 178 to 235 ml. The proportional tidal volume in healthy humans would be 502 ml—much less than experienced by healthy pregnant women.

In a non-blinded, observational study, patients with acute respiratory failure who failed noninvasive ventilation had higher tidal volume than successfully managed

patients. Carteaux et al. [7] concluded that high tida
ume predicted need for endotracheal intubation. Pa
ultimately intubated were significantly sicker than
intubated patients: more frequent immunosup
sion (37.5% v 6.7%), higher SAPS II (41 v 30), and
PaO_2/FiO_2 (122 v 177). Need for intubation was
likely precipitated by severity of underlying illness
tidal-volume size (which was found to be a margina
dictor). Tidal volumes in these two studies do not c
tute a sound scientific basis for occurrence of P-S
patients with COVID-19.

Based on the P-SILI hypothesis, Gattinoni and
thors advocate radical changes to ventilator manage
of patients with COVID-19. They claim that nonin
options are of "questionable" value [5], "intubation s
be prioritized", [4] and delayed intubation will ca
P-SILI vortex that induces more severe ARDS [1].

They view heightened respiratory drive in COV
patients as maladaptive, and recommend deliberate
ering of respiratory drive in these patients [1]. They
that "near normal compliance ... explains why so
the patients present without dyspnea" [5]. If a CO
19 patient is severely hypoxic, normal lung comp
will not prevent dyspnea. Concurrently some COV
patients are free of dyspnea despite substantial h
emia (dubbed "silent-happy hypoxia") [8]. This
because the level of hypoxemia per se is not suffic
low to induce increased respiratory motor outpu
accompanying $PaCO_2$ levels blunt the hypoxic res
[2, 9].

To assess patient effort, Gattinoni and coauthor
ommend inserting an esophageal balloon as a "cr
step [5]. They specify that when esophageal-pre
swings increase above 15 cmH_2O, "the risk of lung

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Division of Pulmonary and Critical Care Medicine, Hines Veterans Affairs Hospital and Loyola University of Chicago Stritch School of Medicine,

Factors to consider

- Early vs delyed IMV
- "Happy hypoxic?“
- The idealized benefit of IMV
- The risks of IMV – VILI, sedation/paralytics, lines, tubes etc
- Ventilator induced lung injury (VILI) or patient self-induced lung injury (P-SILI)
- Alternatives to MV – High flow, Face mask oxygen

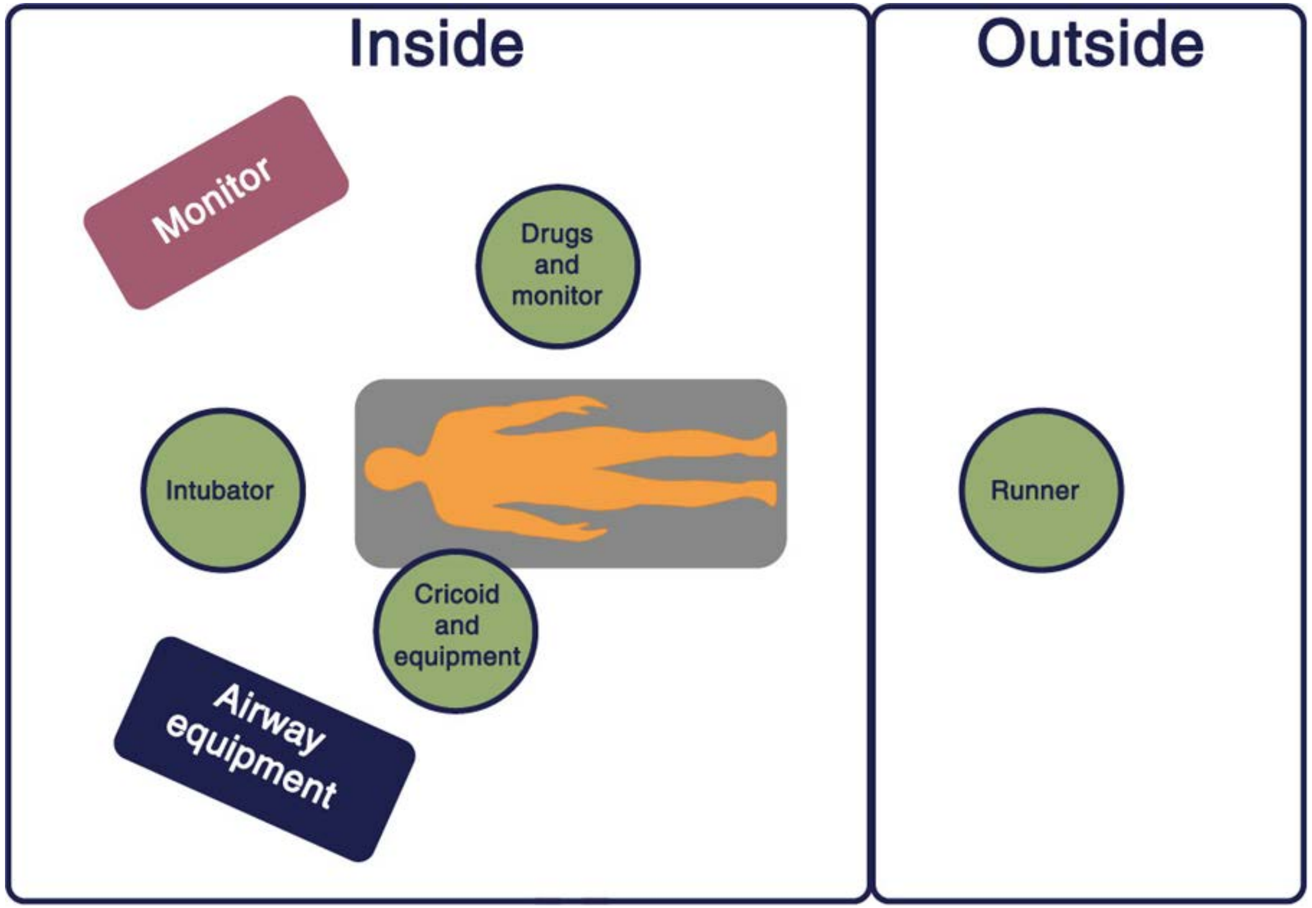
Rola, Philippe, et al. "Rethinking the early intubation paradigm of COVID-19: time to change gears?." Clinical and Experimental Emergency Medicine (2020).

Intubation for COVID-19

- Most experienced team member available
- All intubations - rapid sequence with full paralytic and video laryngoscopy
- No awake intubations
- PAPR + N95+ goggles + “bunny suit” + shoe covers
- Prepare all drugs and equipment outside the room
- Avoid BMV, use HME filter, twist lock connections, inflate balloon just beyond vocal cords

Cook, T. M., et al. "Consensus guidelines for managing the airway in patients with COVID-19: Guidelines from the Difficult Airway Society, the Association of Anesthetists the Intensive Care Society, the Faculty of Intensive Care Medicine and the Royal College of Anesthetists." Anesthesia 75.6 (2020): 785-799.

Intubation for COVID-19



COVID-19 airway management: SAS

Safe	for staff and patient
Accurate	avoiding unreliable, unfamiliar, or repeated techniques
Swift	timely, without rush or delay

Cook, T. M., et al. "Consensus guidelines for managing the airway in patients with COVID-19: Guidelines from the Difficult Airway Society, the Association of Anesthetists the Intensive Care Society, the Faculty of Intensive Care Medicine and the Royal College of Anesthetists." Anesthesia 75.6 (2020): 785-799.

Strategies for mechanical ventilation

Lowest TV, 4-8 ml/kg, lowest RR tolerated (permissive hypercapnia)

Lowest level of sedation tolerated, dys-synchrony -> escapes low TV

Paralytics and deep sedation if needed

Individualized PEEP (not ARDS tables) – reserve higher PEEPs for those with true lung stiffness

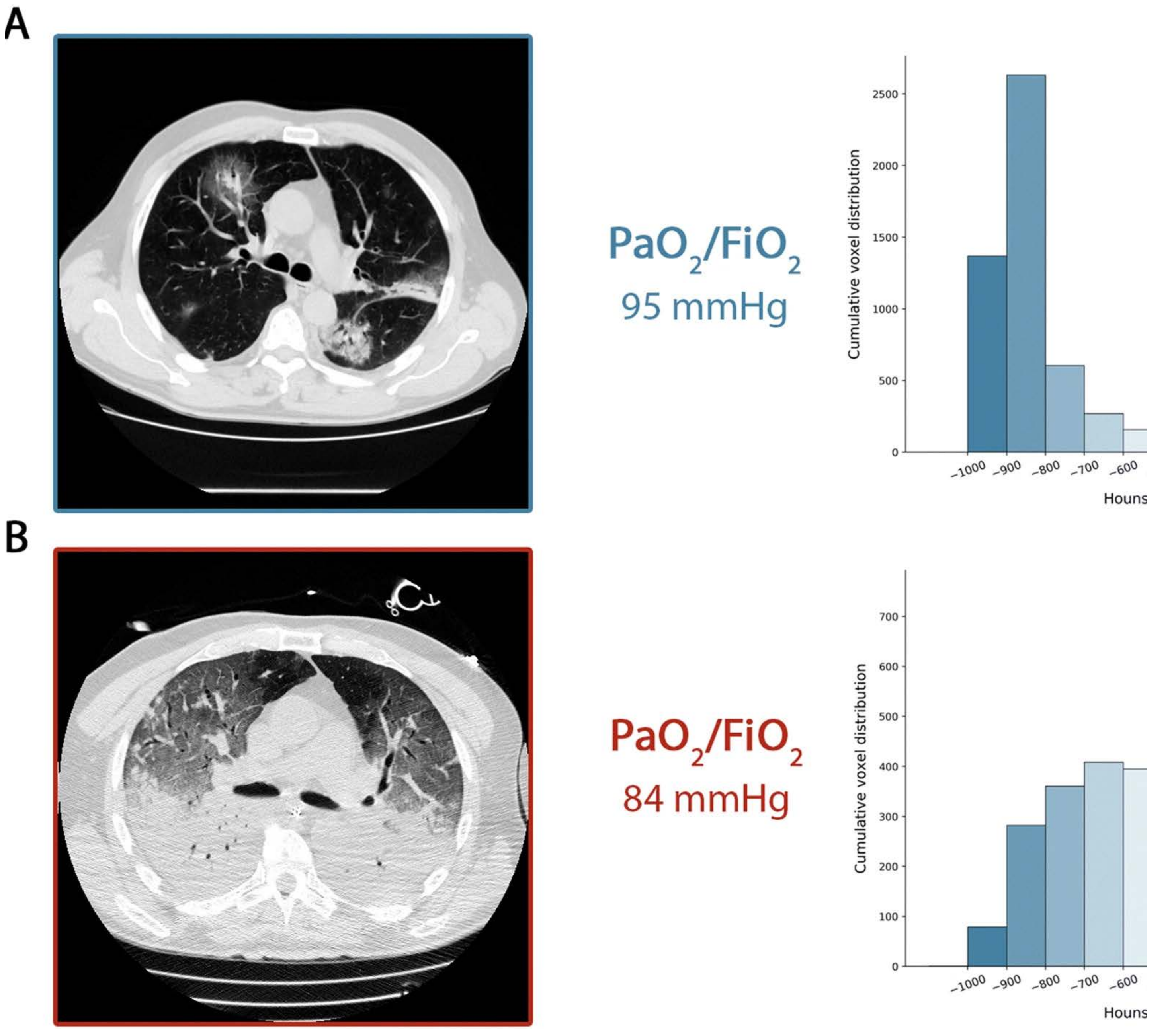
Monitor oxygenation with arterial gases

Tolerate hypoxia if no organ dysfunction

Tobin MJ. Basing respiratory management of coronavirus on physiological principles. Am J

Type H & L phenotypes of COVID-19

- The application of 5 cm of CPAP recruits significant amount of previously diseased lung tissue

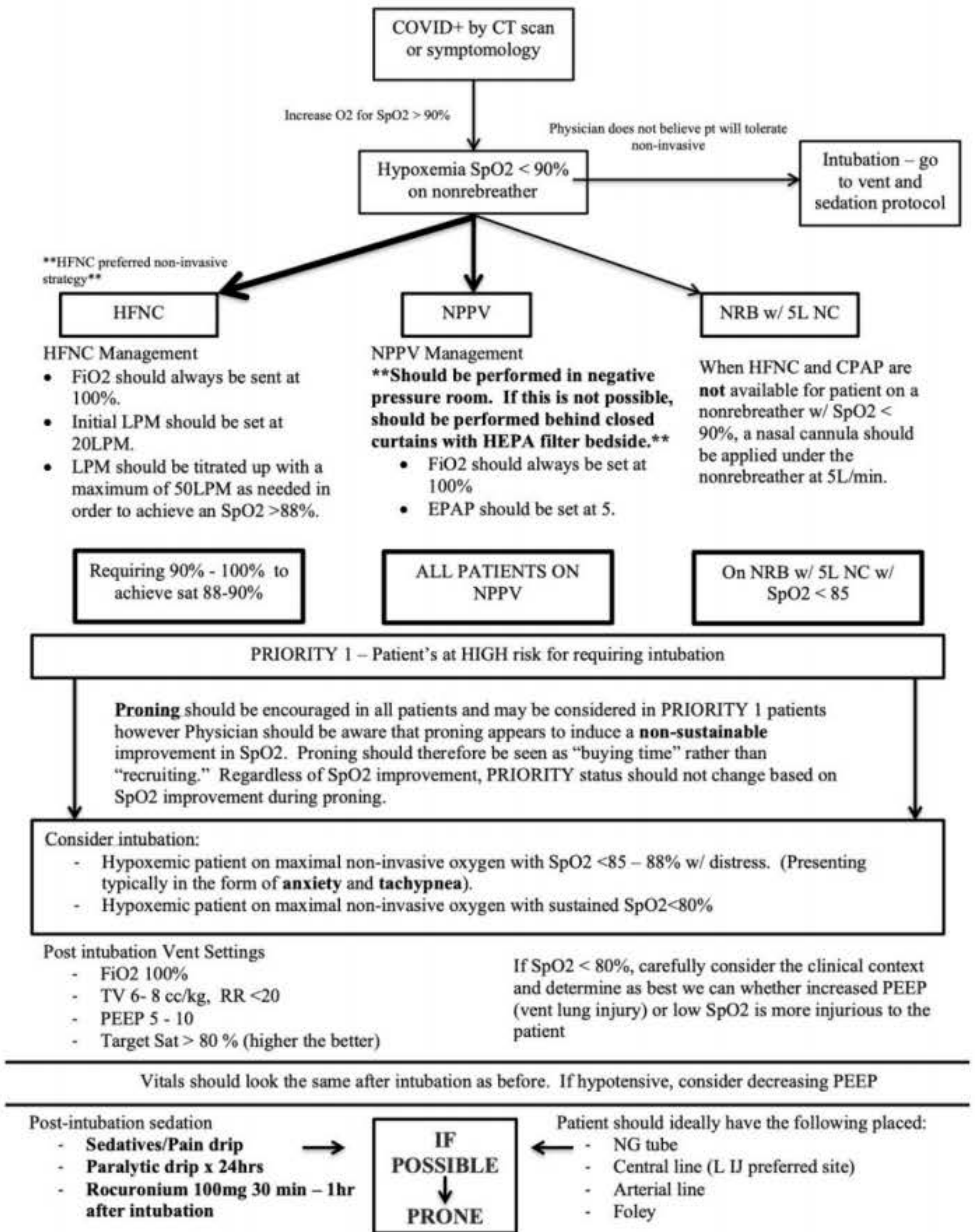


Gattinoni, Luciano, et al. "COVID-19 pneumonia: different respiratory treatments for different phenotypes?." (2020): 1099-1102.

Prone positioning

- PROSEVA 2013 trial, mortality benefit for minimum 12 hours per day of prone positioning (17% reduction in all cause mortality, with a NNT of 6)
- Recommended by ATS and SCCM guidelines
- Standard of care for ARDS
- Proning protocol and proning team
- Inclusion and exclusion criteria for prone positioning
- Watch -> chest tubes, vasopressors, and arrythmias

Figure 2 : Decisional algorithm being used at Maimonides Medical Center



Preparation for the COVID surge

- Policies, policies and policies
  - Triage – hospital admission, ICU admission
  - Family communications, designation of SDM, code status discussions
  - Intubation, extubation checklists
  - Policies on limitations of care and futility, unilateral DNR
  - Code blue/Cardiac arrest
- Engineering/administrative changes
  - Closed and designated COVID units
  - Modify rounds
  - Coordinate entry/exit in rooms between providers
    - RT, nurse, physician cross share tasks
  - Re-evaluate need for insulin drips and hourly accuchecks
  - Placement of ventilators and IV pumps

Preparation for the COVID surge

- PPE management
    - Supplies and stockpile
    - Hospital policy by location/role
    - Availability and storage
- Rotation schedules for doctors/nurses
    - Avoid fatigue
    - Ensure adequate staffing
    - Ensure redundancy
- Miscellaneous
    - Transportation policies
    - Endoscopy, elective procedures and surgeries
    - Morgue capacity, transportation of the expired
    - Patient belongings

Thank you

Questions ?