LARGE GROUP: VENTILATOR MANAGEMENT 2
Case Examples in ARDS and Respiratory Failure

Friday, January 18, 2019 – 3:45 p.m. – 4:30 p.m.

Lance Pangilinan, RRT
UC San Francisco
Adult Critical Care Respiratory Therapist

Lance Pangilinan, RRT, is an Adult Critical Care Respiratory Therapist for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, he currently serves as a bedside therapist and educator. Lance is a lecturer for the Critical Care Residency Program at ZSFG on the topics of Mechanical Ventilation Mechanics and ARDS management. He is a published researcher and has spoken nationally at a number of respiratory and critical care conferences on the subjects of strategic ventilation practices and the use of non-invasive end-tidal monitoring.

Justin Phillips, RRT
UC San Francisco
Adult Critical Care Respiratory Therapist

Justin Phillip, RRT, is an Adult Critical Care Respiratory Therapist for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, he currently serves as a bedside therapist and educator. Justin is a lecturer for the Critical Care Residency Program at ZSFG on the topics of Mechanical Ventilation Mechanics and ARDS management. Additionally, he is Adjunct Faculty for the Respiratory Care Program at Ohlone College for Health Sciences and Technology. Justin is a published researcher and has spoken nationally at a number of respiratory and critical care conferences on the subjects of strategic ventilation practices and the use of non-invasive end-tidal monitoring.

Gregory Burns, RRT
UC San Francisco
Respiratory Care Practitioner

Gregory Burns, RRT, is a Respiratory Care Practitioner for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, he currently serves as interim Equipment Manager. Gregory's research interests include the effect of inhaled vasodilators on patients with the Acute Respiratory Distress Syndrome.

Vivian Yip, BS, RRTACCS
UC San Francisco
Adult and Neonatal Critical Care
Respiratory Therapist

Vivian Yip, BS, RRT-ACCS, is a Adult and Neonatal Critical Care Respiratory Therapist for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, she currently serves as a bedside therapist and educator. Vivian is a lecturer for the Critical Care Residency Program at ZSFG on the topics of Mechanical Ventilation Mechanics and ARDS management. Vivian is a published researcher and has spoken at a number of respiratory and critical care conferences on the subjects of spontaneous breathing trials and the impact of THAM in patients with severe acidosis in ARDS.

Rich Kallet, MS, RRT
UC San Francisco
Respiratory Therapist

Rich Kallet, MS, RRT received his baccalaureate degree in respiratory therapy from SUNY Upstate Medical University in Syracuse NY and his masters of sciences degree in health sciences from San Francisco State University. He spent the majority of his 42 year career working for the University of California, San Francisco Department of Anesthesia at San Francisco General Hospital and the UCSF Cardiovascular Research Institute. He was a research coordinator for NIH ARDS Network from 1996-2011 and has worked as a project manager and director of clinical research for the CVRI, the San Francisco Injury Center and both the Critical Care Management Group and the Respiratory Care Services at SFGH. He retired in 2018 and currently is section editor for the Respiratory Care Journal.

UCSF University of California San Francisco

ZUCKERBERG SAN FRANCISCO GENERAL Hospital and Trauma Center

Live Ventilator Management Workshop

A Case Example in ARDS and Respiratory Failure

Lance Pangilinan, RRT
Vivian Yip, RRT
Gregory Burns, RRT
Justin Phillips, RRT
Rich Kallet, MS RRT

Respiratory Care Services
UCSF Department of Anesthesia
Zuckerberg San Francisco General Hospital & Trauma Center

Disclosure of Conflict of Interest

- We have no relevant financial relationships with commercial interests to disclose

Overview

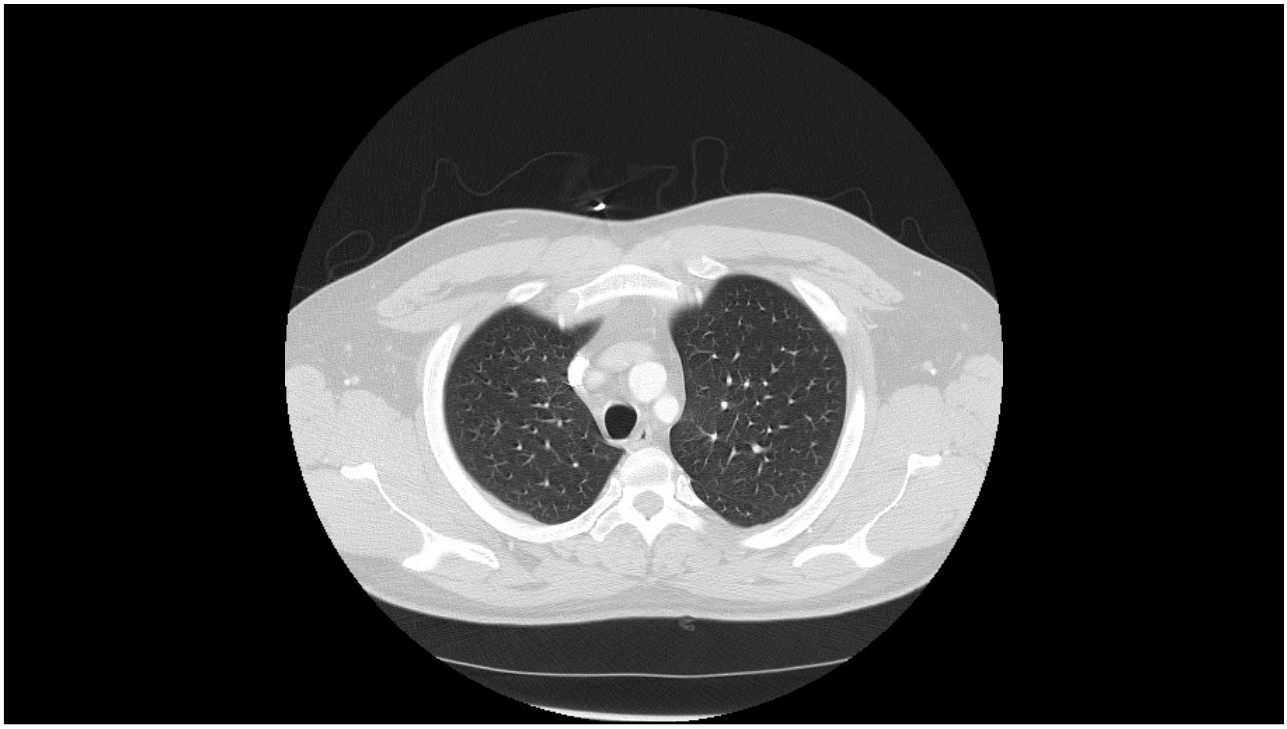
- Forty-five (45) minute interactive panel discussion and case review on Acute Respiratory Distress Syndrome (ARDS), integrating recreated live simulated clinical scenarios via a high-fidelity lung model to a live audience

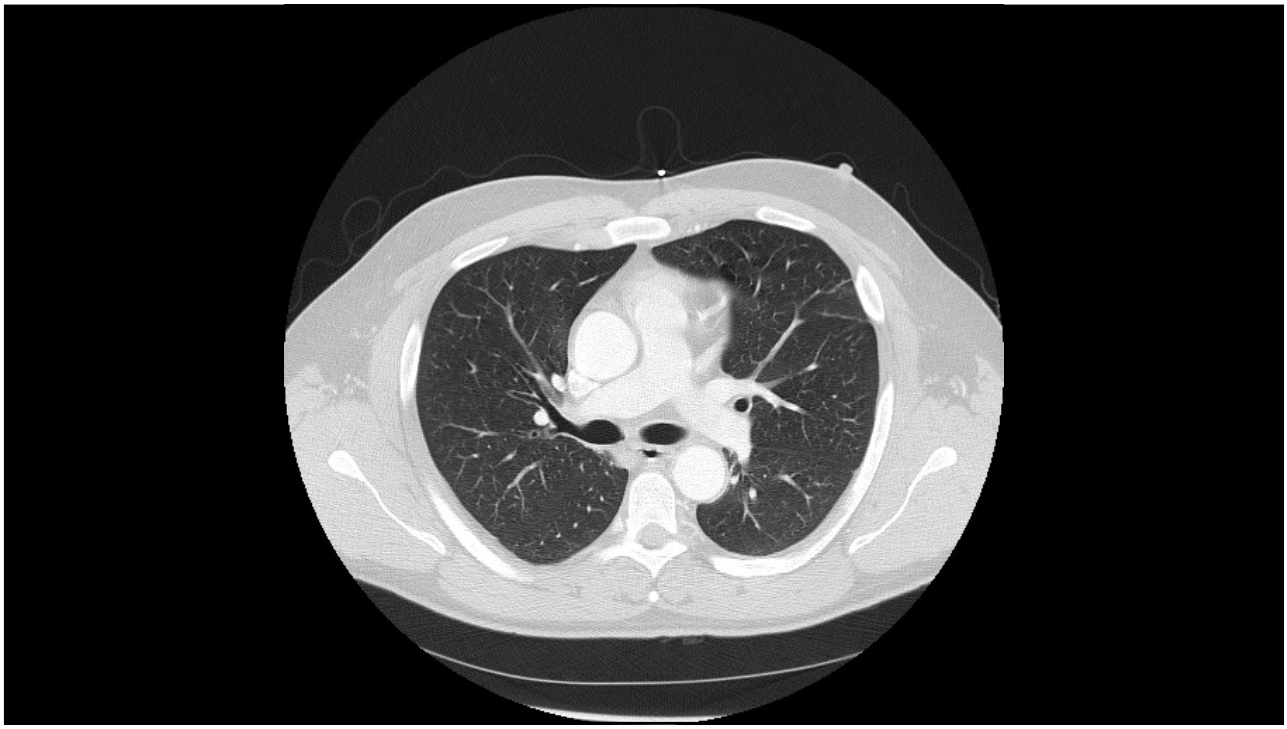
Introduction

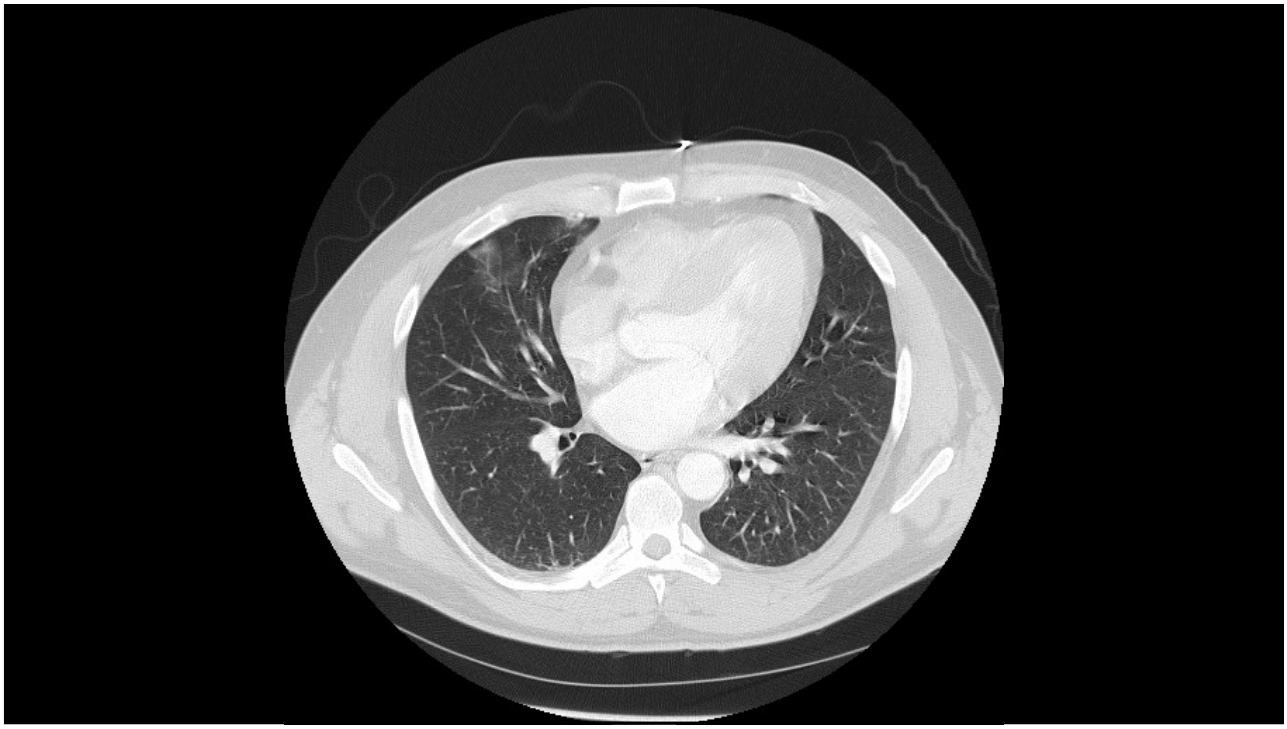
- Present an ARDS case study that illustrates current concepts in ARDS management
- Illustrate the effects of prone positioning on respiratory system mechanics using a live simulator
- Clinical application and interpretation of driving pressure (ΔP)

Background

- 34 y/o male with a PMH of pancreatitis (Dx 4 months prior)
- Chief complaint:
  - Epigastric pain and nausea
- Exam: Abdomen distended, hypertensive, tachycardic, febrile
- Admitting Dx: alcoholic pancreatitis
  - Admitted to MICU







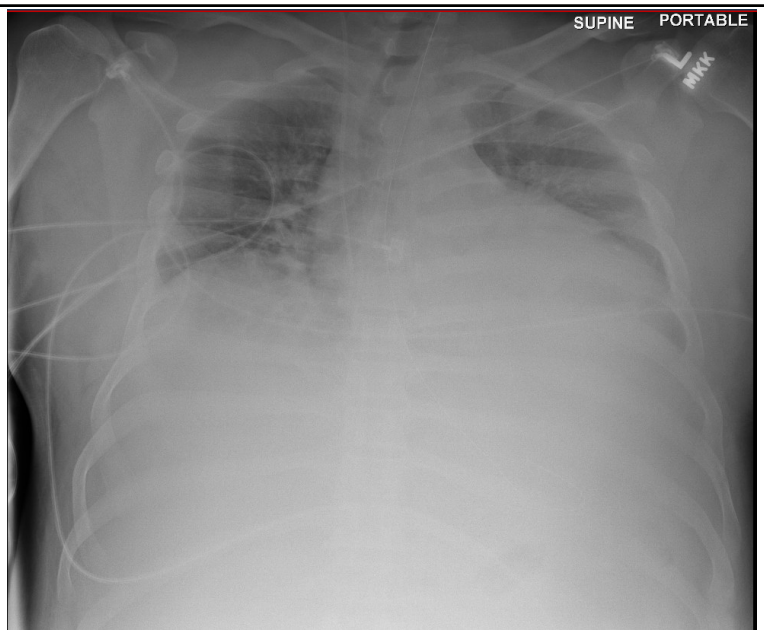
Background

- Transferred to surgical service due to development of acute abdominal compartment syndrome & sepsis
- Developed acute respiratory failure during initial fluid resuscitation
- Intubated for Type I & II respiratory failure
- As his hospitalization progressed, he further developed ARDS & multi-organ system failure
- ECMO referral service declined intervention due to lack of supporting clinical outcome evidence in acute pancreatitis (2014)

Day 1

Exam & Imaging

- **Physical**
  - Elevated bladder pressure, 26 mm Hg
- **CVS**
  - Labile, vasoactive gtt support
- **Pulm**
  - Hypoxemic, increased WOB on 3L NC
  - Impending respiratory failure, intubated
- **Neuro**
  - Altered mental status
- **GI**
  - Abdomen distended
- **Radiology Reading**
  - *"Low lung volumes are noted. Slight increase in basilar opacities identified, may represent worsening atelectasis. No pneumothorax."*



Day 1

Vital Signs

Blood Pressure	114/63 (72)
Heart Rate	143
Temp	39.7
SPO2	93%
Respiratory Rate	14

Laboratory Data

Na^+	138
Cl^-	104
K^+	3.9
BUN	35
Creatinine	1.17
Glucose	204
ABG	7.25/50/86/21.9/ - 5.3
WBC	8.6
HBG	12.1
HCT	36.5
PLT	143

Pulmonary Data

P/F Ratio	86
$\triangle P$	20
C_{STAT}	26
$P_{ET}CO_2$	46
V_D/V_T	N/A

Significant or abnormal vitals/labs

Significant or abnormal pulmonary measures

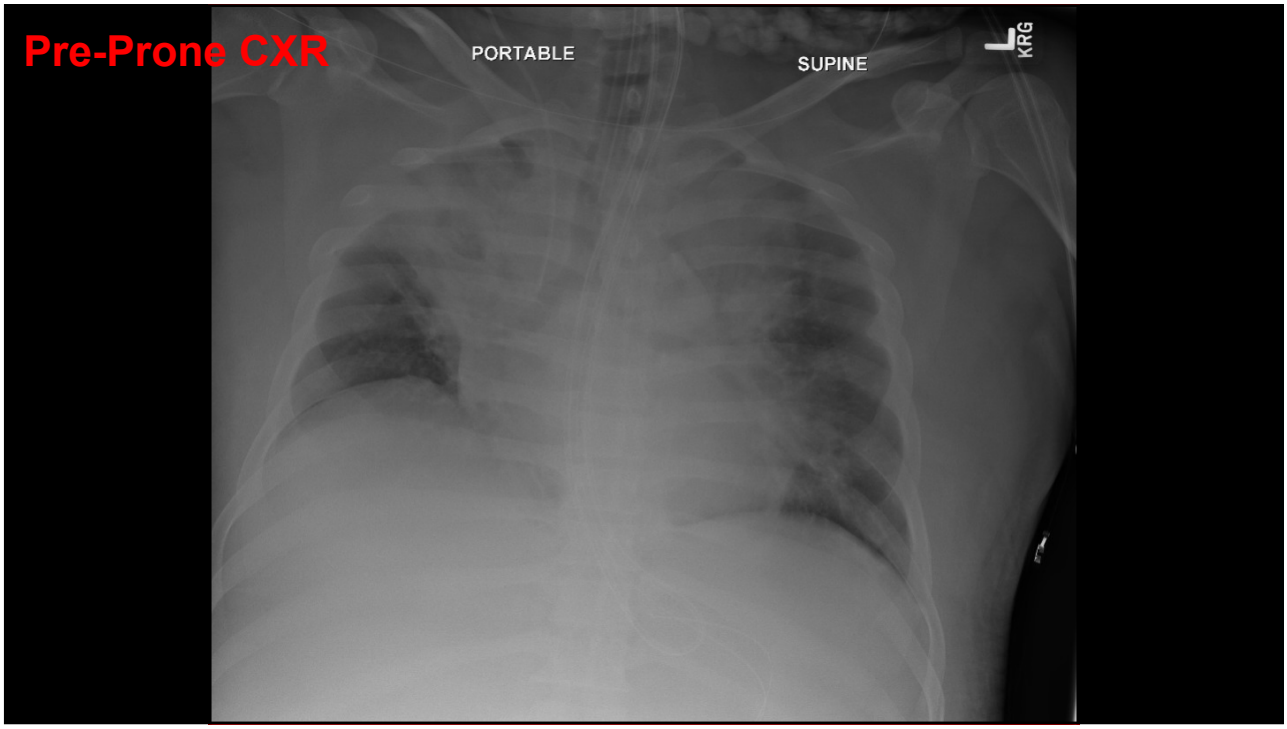
Adjunctive Therapies Considered

Tx's considered

- ARDSnet (alveoli grid)
  - BERLIN? (P/F = 86)
  - SEVERE
- NMBA
- Adaptive pressure control
- Judicious levels of PEEP,
  - 16 - 24 cm H2O in effort to improve C_{RS} and P/F ratio
    - PEEP level relative to hemodynamic instability
- RM
  - Aborted due to associated hypotension
- PGI2- ↔ PaO2/FiO2

Day 1: Summary of Interventions

- Admitted to the MICU
- Intubated due to AMS and hypoxemia
- Quickly transitioned to lung protective ventilation via ARDS Network Protocol
  - Severe ARDS by Berlin Definition
- Adjunctive therapies (NMBA, Mode change, PEEP titration, RMV, PGI2)
- Abd Decompression → 2 L of fluid removal, positive initial improvement in C_{RS}
  - C_{RS} subsequently worsened shortly after



Prone Positioning

Prone Positioning (PP) Day 1 – x 5 hours

ABG Pre-Prone

7.31 / 54 / 66 / 27.2 / +0.9

Pulmonary Data

ΔP 13	C_{STAT} 30
PetCO2 45	V_D/V_T 0.56
PaO2/FiO2 66	FiO2 1.0

ABG Post prone x 5 hours (PP)

7.31 / 57 / 82 / 28.7 / +2.4

Pulmonary Data

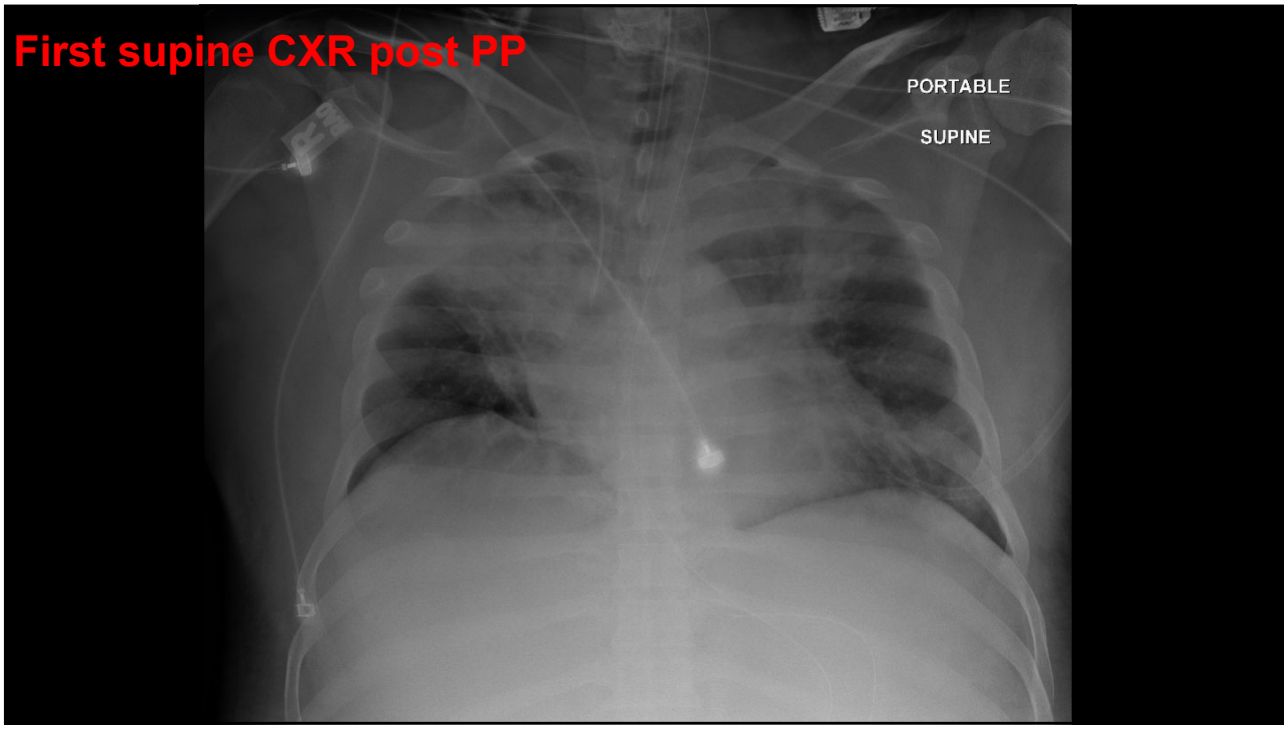
ΔP 15	C_{STAT} 26
PetCO2 44	V_D/V_T N/A
PaO2/FiO2 82	FiO2 1.0

First Supine Trial

ABG post supine x 1.5 hours

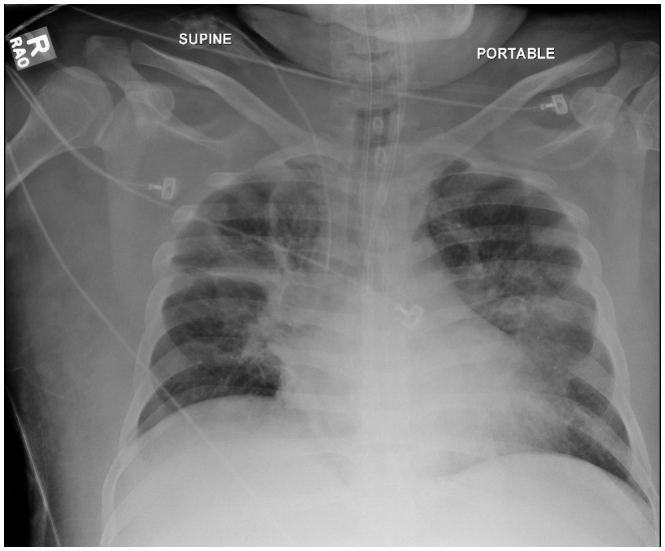
7.34 / 51 / 72 / 27.5 / +1.7

ΔP 14	C_{STAT} 28
PetCO2 43	V_D/V_T N/A
PaO2/FiO2 80	FiO2 0.9



Day 15 in ICU

- Pt. has been through various prone : supine regimens
  - 4:1, 8:1, 12:1, 7:5
  - With Reverse Trendelenburg positioning during supine
  - Current regimen as of day 15 in ICU = 7:5, additional…
    - Remains on NMBA
    - PGI2
    - ARDSnet ventilation goals/parameters



Day 15 in ICU

At this time, pt. has been supine half-way through the 5 hour allotted time period

Current supine ABG (x2.5 hours)

7.36 / 63 / 88 / 35.6 / +10.2

ΔP 15	C_{STAT} 27
PetCO2 40	V_D/V_T N/A
PaO2/FiO2 88	FiO2 1.0

Pt. proned after the allotted supine time period

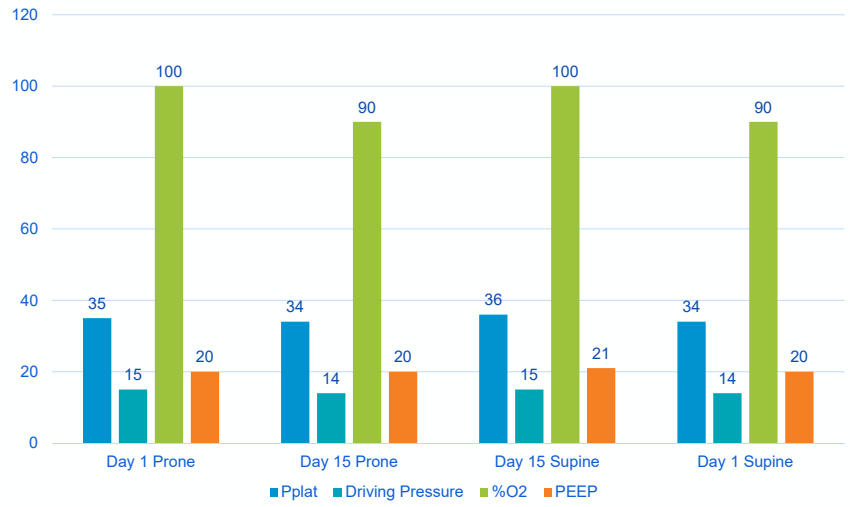
Current prone ABG (x3.5 hours)

7.41 / 54 / 203 / 34.2 / +9.6

ΔP 14	C_{STAT} 29
PetCO2 39	V_D/V_T N/A
PaO2/FiO2 226	FiO2 0.9

Pt. remained proned until 7 hour time marker

Summary Prone/Supine Day 1 v. Day 15



AMERICAN THORACIC SOCIETY DOCUMENTS

An Official American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine Clinical Practice Guideline: Mechanical Ventilation in Adult Patients with Acute Respiratory Distress Syndrome

Eddy Fan, Lorenzo Del Sorbo, Ewan C. Goligher, Carol L. Hodgson, Laveena Munshi, Allan J. Walkey, Neill K. J. Adhikari, Marcelo B. P. Amato, Richard Branson, Roy G. Brower, Niall D. Ferguson, Ognjen Gajic, Luciano Gattinoni, Dean Hess, Jordi Mancebo, Maureen O. Meade, Daniel F. McAuley, Antonio Pesenti, V. Marco Ranieri, Gordon D. Rubenfeld, Eileen Rubin, Maureen Seckel, Arthur S. Slutsky, Daniel Talmor, B. Taylor Thompson, Hannah Wunsch, Elizabeth Uleryk, Jan Brozek, and Laurent J. Brochard; on behalf of the American Thoracic Society, European Society of Intensive Care Medicine, and Society of Critical Care Medicine

American Journal of Respiratory and Critical Care Medicine. 2017;195(9):1253-1263.
doi:10.1164/rccm.201703-0548st

policy decisions. No guideline or recommendations can take into account all the compelling and unique clinical features of individual patients, and therefore clinicians, patients, policy makers, and other stakeholders should not regard these recommendations as mandatory. Finally, although there may be good reasons to extrapolate these treatments to other causes of acute hypoxemic respiratory failure or to all mechanically ventilated patients, we exclusively reviewed data on patients with ARDS, and recommendations therefore apply only to this group of patients. A summary of our recommendations is as follows:

1. The recommendations *for* the following interventions for the treatment of ARDS are strong:
   a. Mechanical ventilation using lower tidal volumes (4–8 ml/kg predicted body weight) and lower inspiratory pressures (plateau pressure < 30 cm H_2O) (moderate confidence in effect estimates)
   b. Prone positioning for more than 12 h/d in severe ARDS (moderate confidence in effect estimates)
2. The recommendation *against* the following intervention for the treatment of ARDS is strong:
   a. Routine use of high-frequency oscillatory ventilation in patients with moderate or severe ARDS (high

Introduction

ARDS is a life-threatening form of respiratory failure characterized by inflammatory pulmonary edema resulting in severe hypoxemia (1). The severity of ARDS is classified according to the degree of hypoxemia (Pa_{O_2}/Fi_{O_2} ratio), with mutually exclusive categories of mild (Pa_{O_2}/Fi_{O_2}, 201–300), moderate (Pa_{O_2}/Fi_{O_2}, 101–200), and severe ($Pa_{O_2}/Fi_{O_2} \leq 100$) (2). ARDS is common, is associated with substantial morbidity, is frequently fatal, and represents an important public health problem (3–5). Despite decades of research, there are limited therapeutic options directed at the underlying pathological processes (6), and supportive care with mechanical ventilation remains the cornerstone of patient management (7). With the understanding that mechanical ventilation itself can cause and potentiate lung injury, research has focused on ventilatory strategies and adjunctive measures aimed at mitigating this so-called ventilator-induced lung injury (VILI) (8). Importantly, ARDS appears to be underrecognized by clinicians, and evidence-based interventions are underused (5). Thus, there is the potential for improved outcomes in patients with ARDS through enhanced uptake and implementation of evidence-

in the field. The committee was cochaired by E.F. and L.J.B. Committee members represented the American Thoracic Society (ATS), European Society of Intensive Care Medicine, and Society of Critical Care Medicine.

Confidentiality Agreement and Conflict-of-Interest Management

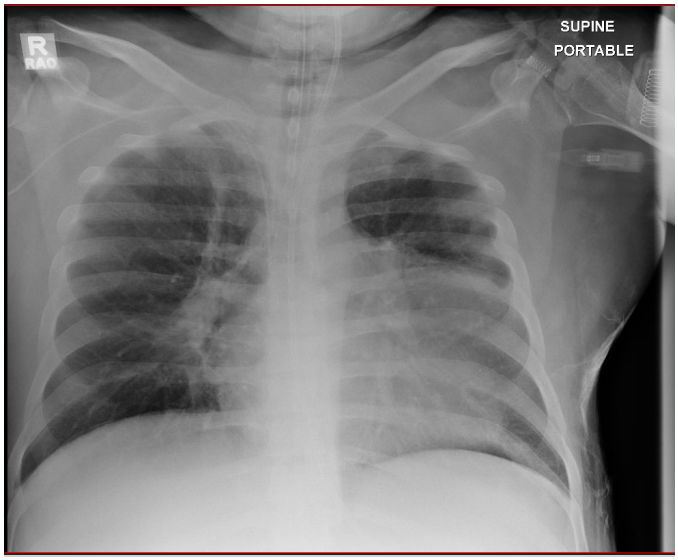
Committee members signed conflict-of-interest statements. New or updated conflicts of interest were solicited by the Co-Chair (E.F.) at the start of each in-person meeting and teleconference. The views and interests of the ATS, European Society of Intensive Care Medicine, and Society of Critical Care Medicine, or those of any commercial entity that provided funding to these professional societies, had no influence on the topics discussed and recommendations made.

Meetings

At a face-to-face meeting at the 2013 ATS International Conference in Philadelphia, Pennsylvania, the panel discussed the scope and objectives of the project and identified the specific clinical questions to be addressed. An ATS methodologist (J.B.) presented an overview of the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) process for guideline development to the panel. At the 2014 International

Day 30 in the ICU

- Pt. has been through various prone : supine regimens
- Supine time has been reflective of tolerance in that position
  - Reverse Trendelenburg position during Supine
  - Current regimen as of day 30 in ICU = 7:3, additional…
    - Remains on NMBA
    - PGI2
    - ARDSnet ventilation goals/parameters



Day 30 in ICU

At this time, pt. has been supine for the full 3 hour allotted time period prior to returning to the PP

Current supine ABG (x3 hours)

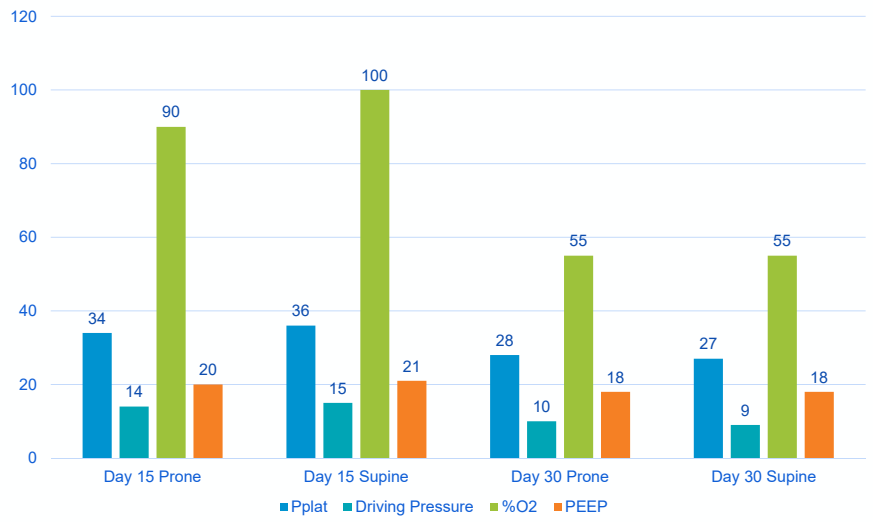
7.37 / 55 / 97 / 31.8 / +6.5

△P 9	C_{STAT} 40
PetCO2 47	V_D/V_T N/A
PaO2/FiO2 176	FiO2 0.55

No prone ABG available (x6 hours)

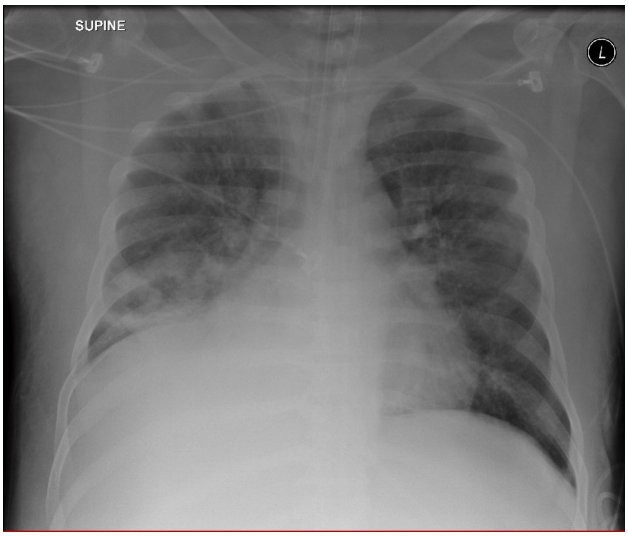
△P 10	C_{STAT} 36
PetCO2 44	V_D/V_T N/A
PaO2/FiO2 N/A	FiO2 0.55

Summary Prone/Supine Day 15 v. Day 30



Day 50 in the ICU

- Last day of PP (ICU day 50)
  - prone : supine duration as of day 50 in ICU = 8:4
  - Reverse Trendelenburg position while supine
  - Additional…
    - Remains on NMBA
    - PGI2
    - ARDSnet ventilation goals/parameters



Day 50 in the ICU

Current prone ABG (x4 hours)

7.39/57/93/34.5/+9.5

ΔP 11	C_{STAT} 37
PetCO2 56	V_D/V_T N/A
PaO2/FiO2 233	FiO2 0.4

Current supine ABG (x1 hours)

7.42/49/78/31.8/+7.3

ΔP 10	C_{STAT} 37
PetCO2 47	V_D/V_T N/A
PaO2/FiO2 195	FiO2 0.4

Prone positioning discontinued, pt. remained supine for the remainder of his mechanical ventilation course

LP2

Summary of ICU Stay

- NMBA off day 52 in ICU
- PGI2 off ICU day 53
- First pressure support ICU day 54 after patient became severely asynchronous and hyperdynamic.
  - SBT/DSI continued for a long wean.
- ICU day 62: PEEP = 8 cmH2O, FiO2 = 0.50
- Last ABG on vent: 7.41 / 48 / 80 / 30.4 / +5.8
  - Vent settings: PS = 6 cmH2O, PEEP = 5cmH2O, FiO2 = 0.40
  - Vent measures: Rate= 16, V_T = 535 (8.3ml/kg), MV = 9.13 PetCO2 = 48
- **Patient extubated to HFNC on ICU day 66**
- **D/C from ICU on day 68**

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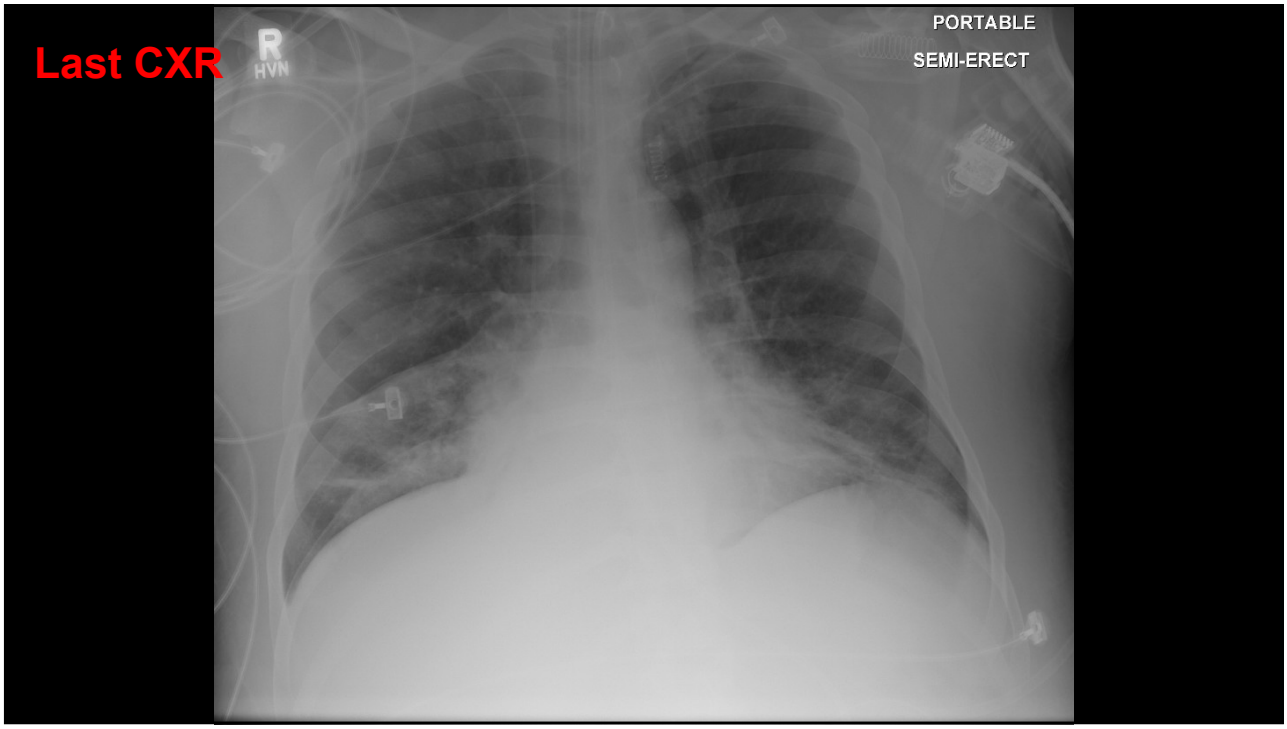
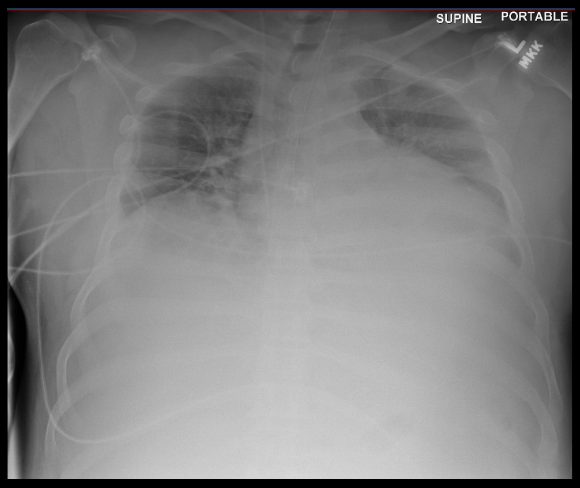


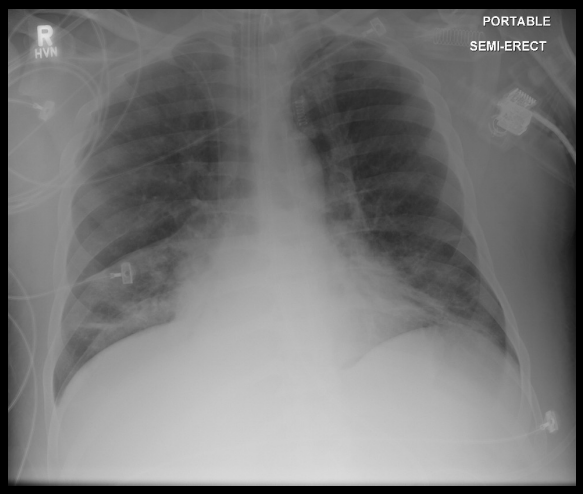
Slide 27

LP2 I deleted the previous slide which was also "Day 52 in ICU" but had abc's and vent measures.
Lance Pangilinan, 1/5/2019

First CXR



Last CXR

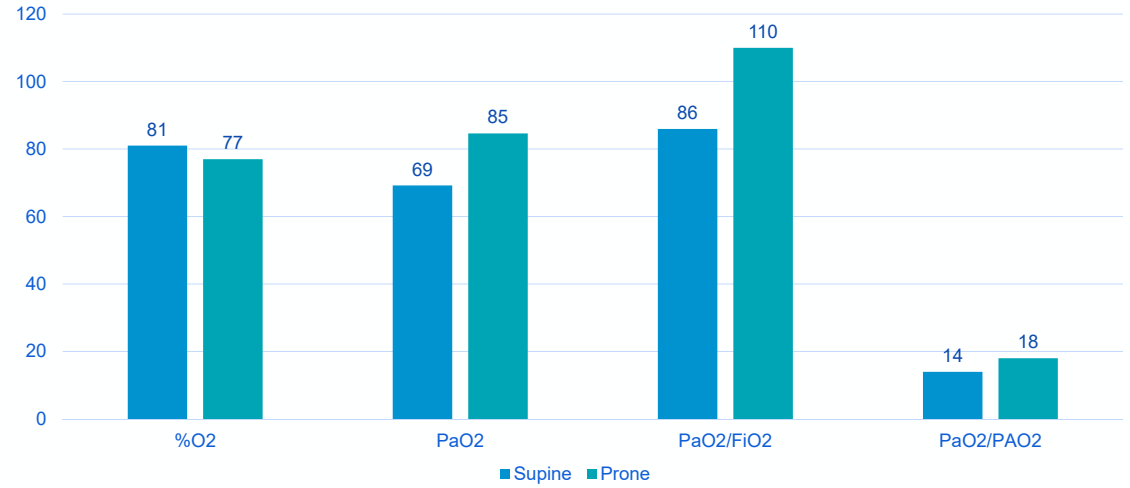


Summary of Hospital Course

- 66 days of MV
- 48 days of prone positioning
- 53 days to spontaneous breathing
- 12 days of spontaneous breathing pre extubation

Prone Position Summary

A lower FiO2 is required in the prone position



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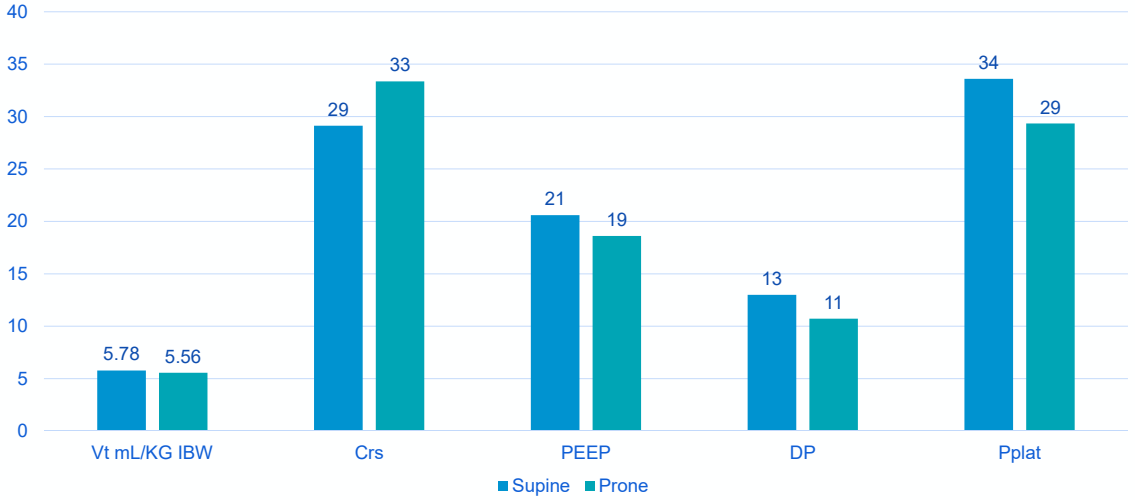
Prone Position Summary

A lower driving pressure and plateau pressure are maintained in the prone position



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