

COVID19: FOR THE ANESTHESIA/CRITICAL CARE PROVIDER

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- ▶ I have no financial disclosures
 - ▶ Special thanks to the slides provided where many of the images and slides come from by Dr. Kristina Goff, MD from Department of Anesthesiology at UT Southwestern Medical Center
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- ▶ The Anesthesia Provider's evolving Role
- ▶ Understand COVID19 Basic Science, Transmission, and PPE
- ▶ Treatment COVID19
 - ▶ Workup and Medicinal Therapies
 - ▶ Hypoxia and ARDS therapies
- ▶ Lots of information – use slides as reference

GOALS AND OBJECTIVES



- ▶ Minimize personal/ patient exposure to COVID 19 in the perioperative Setting
- ▶ OR's can be converted to Intensive Care Unit Beds (Italy, Washington State, New York, China etc.)
- ▶ We are all intensivists in the OR – YOU CAN HELP
- ▶ Kaweah Delta is developing Protocols for Anesthesia to provide Intensive Care
- ▶ Anesthesia providers will need to adapt and become critical care providers

**Disaster Planning OR to ICU Bed Conversion Protocol
(Last Revision, March 19, 2020)**

Locations: Filled according to the following priority levels
10 additional converted Operating Room to Intensive Care Unit beds (OR/ICU bed's)
Priority 1 (i.e. filled first): OR 2, 3, 4, 5, 6, 7, 8,
Priority 2: OLD OB OR 1 and 2
Priority 3: CV OR 7
Collectively known as the OR Block of ICU beds.

Physician Anesthesiologist and CRNA, Chain of Command

-Attending Intensivist will be responsible for admitting patients into the converted operating room/ ICU beds. He/she will be in charge of all aspects related to the care of the patient including appropriate oversight and delegation of various responsibilities to OR/ICU supervisors (see below for definition).
-Resident Anesthesiologists report to their supervising physician under all circumstances
-CRNAs when supervising OR/ICU rooms report directly to the attending intensivist. They will remain independent when performing regular anesthesia duties
-Physician Anesthesiologist when supervising OR/ICU rooms will report to the intensivist.
Anesthesiologist may also take on the role of the attending intensivist for patients if appropriately cross trained. When the physician anesthesiologist is the attending intensivist, they must abdicate their role of OR/ICU room supervisor.

Staff Assignments

All staff members will report to the OR/ICU Room Supervisor or Attending Intensivist

1 ICU or CVICU charge nurse in charge of nursing for the OR Block of ICU beds.

OR Nursing to flex to ICU Nurses

1 Float CCRN to 4 OR RN Model for consultative and break purposes, CCRN cannot be responsible for 2 priority locations, They cannot be assigned their own patients.

1:1 Patient to OR Nurse Ratio

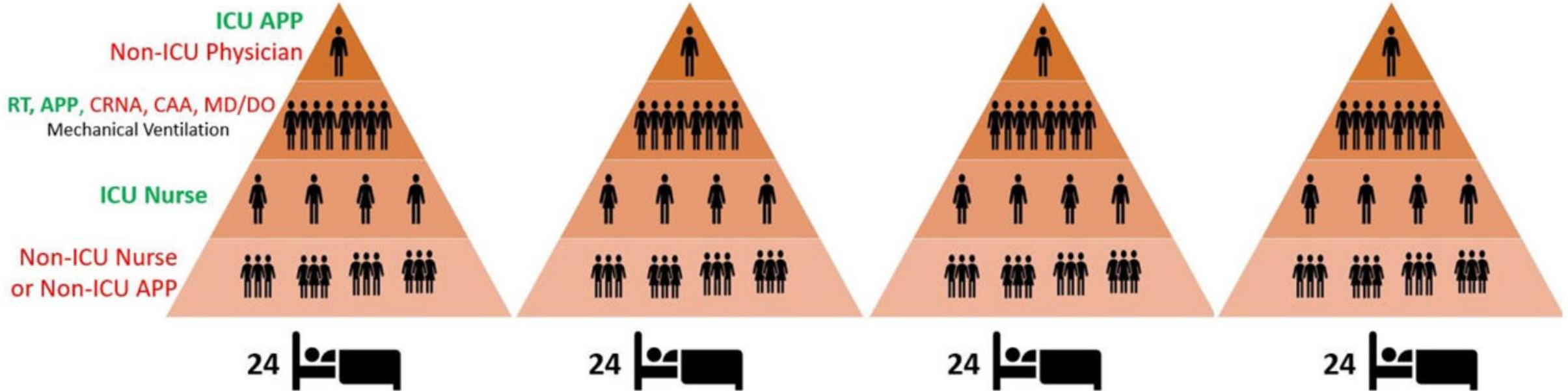
THE ANESTHESIA PROVIDER'S EVOLVING ROLE IN THIS PANDEMIC

Tiered Staffing Strategy for Pandemic

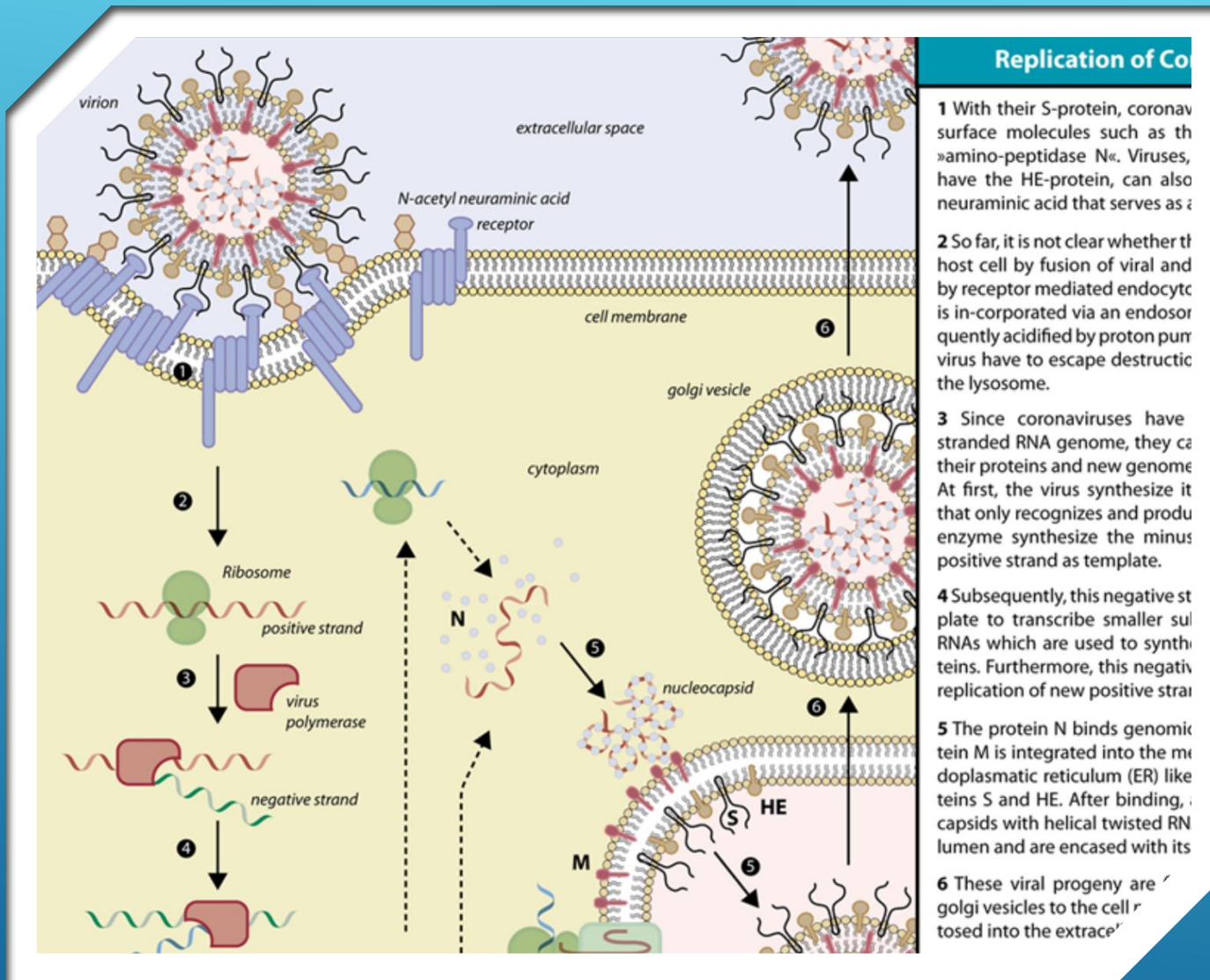
Requiring Significant Mechanical Ventilation



Trained or Experienced Critical Care Physician



Modified from the Ontario Health Plan for an Influenza Pandemic Workgroup. *Critical Care During a Pandemic.*



SARS-COV2 VIRUS

- ▶ Causes the disease known as Covid19
- ▶ A Coronavirus - Named after the characteristic solar flare like image seen on Electron Microscopy
- ▶ SARS, MERS, and now COVID19
- ▶ positive sense RNA
- ▶ COVID19 primarily enters Angiotensin Converting Enzyme 2 Receptor in lung epithelium
- ▶ Transmission via COVID-19 viruses in respiratory droplets

CORONAVIRUS PANDEMIC

COVID-19






COVID-19 is an infectious disease caused by SARS-CoV-2, a new type of coronavirus detected in China in late 2019.

Data shows the disease is mild in 80 percent of patients, severe in 13 percent, and critical in 6 percent.

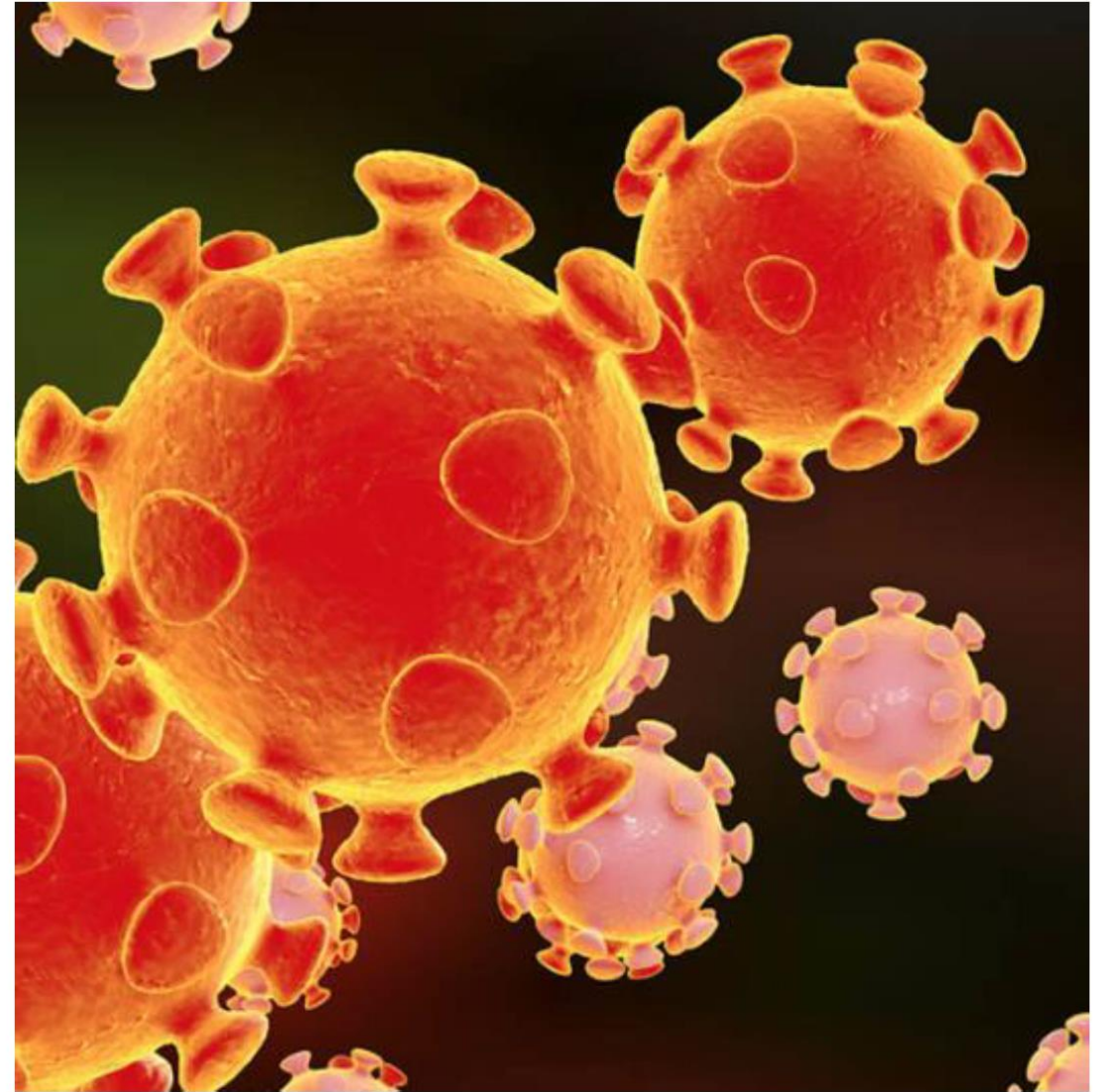
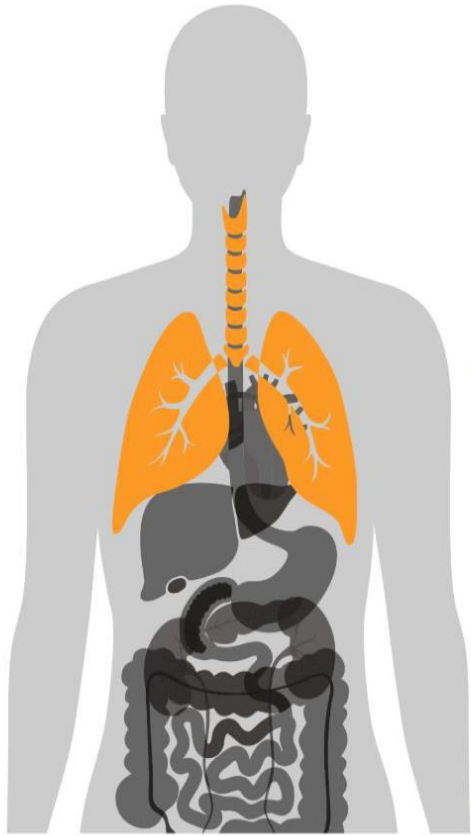
Most common symptoms:

-  Fever
-  Fatigue
-  Dry cough

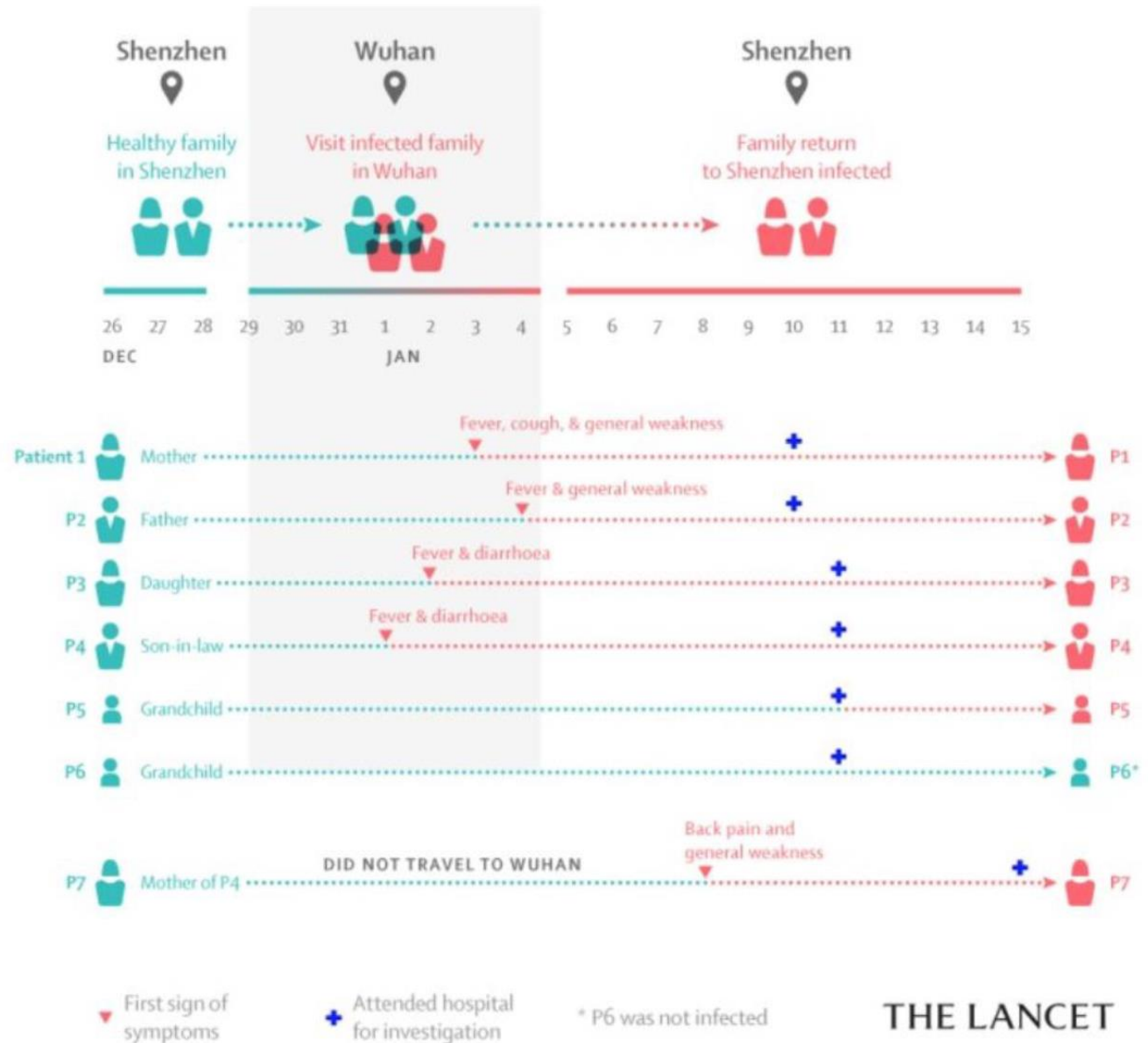
Some patients may also have:

-  Aches and pains
-  Runny nose
-  Sore throat
-  Shortness of breath
-  Diarrhoea

In critical cases, COVID-19 can cause severe pneumonia or a multiple-organ failure and can lead to death.



Shenzhen-based family visit infected relatives in Wuhan, and return with illness



Slide from: Goff, Covid-19 and Acute Respiratory Distress Syndrome, UT SOUTHWESTERN

STOP THE SPREAD OF GERMS

Help prevent the spread of respiratory diseases like COVID-19.

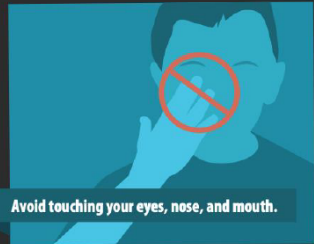
Avoid close contact with people who are sick.



Cover your cough or sneeze with a tissue, then throw the tissue in the trash.



Avoid touching your eyes, nose, and mouth.



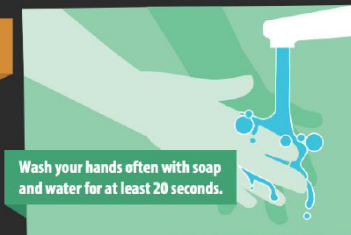
Clean and disinfect frequently touched objects and surfaces.



Stay home when you are sick, except to get medical care.



Wash your hands often with soap and water for at least 20 seconds.



[cdc.gov/COVID19](https://www.cdc.gov/COVID19)

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Transmission

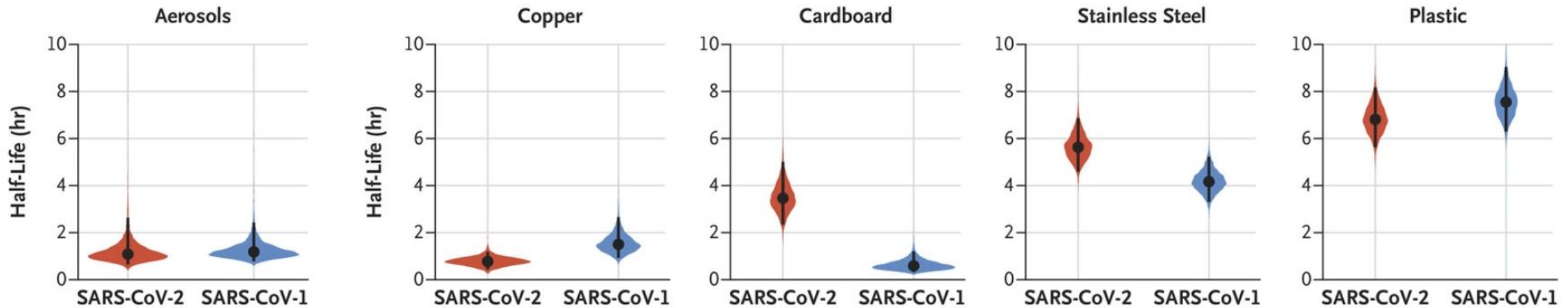
$$R_0=2-4$$

COVID-19 is spread via **DROPLETS** and **FOMITES** in close spaces.

Airborne spread has not been reported but is theoretically possible when droplets become aerosolized.

Fecal shedding is possible but fecal-oral transmission is not believed to be a major route of transmission.

C Half-Life of Viable Virus



HALF LIFE OF VIRUS ON DIFFERENT SURFACES

- ▶ Airborne precautions: N95 mask and face protection
- ▶ Droplet precautions: surgical mask
- ▶ Contact precautions: gloves and gown, dedicated disposable equipment

PERSONAL PROTECTIVE EQUIPMENT

COVID-19 PPE GRID- What personal protective equipment to wear and when?

It is critical for all of us to apply critical thinking skills in using Standard Precautions, essentially donning PPE that is appropriate for situations in which we anticipate exposure to body fluids and respiratory secretions.

The CDC and Cal-OSHA/OSHA requires certain types of transmission based precautions for different scenarios. Based on these recommendations what follows is a table with appropriate precautions given a particular scenario...scenarios or questions not captured please contact command center **624-5000**.

Scenario	Transmission Based Precaution (Healthcare Personnel)	PPE required	Patient	Disinfect Surfaces
Respiratory Symptom Patient in Waiting Room/Lobby/ED Triage this includes Clinics/Urgent Care.	Droplet/Contact	*Facemask; Yellow or White Isolation Gown; Gloves. PPE needed only if treating patient	Facemask	Purple top disinfectant (Offices only - QT3 disinfectant)
Respiratory Symptom Patient in CT, MRI, Ultrasound, X-ray, nuclear medicine, Cath lab.	Droplet/Contact	*Facemask; Yellow or White Isolation Gown; Gloves	Facemask	Purple top disinfectant (Offices only - QT3 disinfectant)
Respiratory Symptom patient suspected of COVID-19 Before specimen collection or after specimen collection completed.	Droplet/Contact	*Facemask; Yellow or White Isolation Gown; Gloves	Facemask	Purple top disinfectant (Offices only - QT3 disinfectant)
Respiratory Symptom Patient with suspected or confirmed COVID-19 during specimen collection AND all other Aerosol Generating Procedures (during intubation, sputum induction, ET aspiration, bronchoscopy, nebulizer treatments, BiPap, HiFlo, extubation). Coordinate with Respiratory therapy for a hepa filter for use during the collection.	Airborne/Contact (HEPA filter or negative air pressure rooms)	N95 Mask; Yellow or White Isolation Gown; Gloves; Goggles or Face shield as needed	Facemask	Purple top disinfectant (Offices only - QT3 disinfectant)
Confirmed positive COVID-19 patient	Droplet/Contact	Facemask; Yellow or White Isolation Gown; Gloves	N/A	Purple top disinfectant (Offices only - QT3 disinfectant)
Cleaning COVID-19 patient room or specimen collection room	Droplet/Contact	**Facemask; Yellow or White Isolation Gown; Gloves	N/A	Purple top disinfectant (Offices only - QT3 disinfectant)
Anesthesia (during intubation/LMA/extubation).	Airborne/Contact (Negative Pressure, HEPA filter, AIIR not needed)	N95 Mask; Yellow or White Isolation Gown; Gloves; Goggles or Face shield as needed	None	Oxivir disinfectant wipes
Surgery/Endoscopy.	Droplet/Contact	*Facemask; Yellow or White Isolation Gown; Gloves	None	Oxivir disinfectant wipes
Home Health/Private Home Care/Hospice/Community Outreach.	Droplet/Contact	*Facemask; Yellow or White Isolation Gown; Gloves	Facemask or None	Purple top disinfectant (Offices only - QT3 disinfectant)

**PPE is required only when the patient is not wearing a Facemask or is unable/unwilling to contain his/her respiratory secretions.*

***PPE is only required if patient is present during room cleaning*

Goggles or face shield as needed = use if secretions are expected

White gown should be used when secretions or bodily fluid saturation is expected

Recommendations for Airway Management in a Patient with Suspected Coronavirus (2019-nCoV) Infection

Liana Zucco^{1,2}, Nadav Levy^{1,2}, Desire Ketchandji¹, Mike Azizi¹, Satya Krishna Ramachandran¹

1. Beth Israel Deaconess Medical Center Dept Anesthesia, Critical Care & Pain Medicine, Boston, USA

2. Healthcare Quality and Safety (MHQS), Harvard Medical School, Boston, USA

3. Oregon Health & Science University, Department of Anesthesiology & Perioperative Medicine, Portland, Oregon, USA

General

Your personal protection is the priority. Personal protective equipment (PPE) should be available for all providers to ensure droplet/contact isolation precautions can be achieved. Providers and organizations should review protocols for donning and doffing PPE. Careful attention is required to avoid self-contamination.

Patients with confirmed or suspected 2019-nCoV infected cases:

- Should **NOT** be brought to holding or PACU areas
- Should be managed in a **designated OR**, with signs posted on the doors to minimize staff exposure.
- Should be **recovered in the OR** or **transferred to ICU** into a negative pressure room. Ensure a high quality HMEF (Heat and Moisture Exchanging Filter) rated to remove at least 99.97% of airborne particles 0.3 microns or greater is placed between the ETT and reservoir bag during transfers to avoid contaminating the atmosphere.

Plan ahead:

- For time to allow all staff to apply PPE and barrier precautions
- Consider intubation early to avoid the risk of a crash intubation when PPE cannot be applied safely.

During Airway Manipulation

Apply:

- Disposable mask, goggles, footwear, gown and gloves. Consider adopting the **double glove** technique.
- Standard ASA monitoring should be applied before induction of anesthesia.
- N95 mask at a minimum should be utilized. PAPR devices may offer superior protection when manipulating an airway of an infected patient.



Assign:

- Designate the most experienced anesthesia professionals available to perform intubation, if possible. Avoid trainee intubation for sick patients.



Avoid:

- Awake fiberoptic intubation, unless specifically indicated. Atomized local anesthetic can aerosolize the virus.



Prepare to:

- Preoxygenate for 5 minutes with 100% FIO2
- Perform a rapid sequence induction (RSI) to avoid manual ventilation of patient's lungs and potential aerosolization of virus from airways.
- Consider using a video-laryngoscope.



RSI:

- Depending on the clinical condition, the RSI may need to be modified. If manual ventilation is required, apply small tidal volumes.

Use:

- Ensure there is a high quality HMEF (Heat and Moisture Exchanging Filter) rated to remove at least 99.97% of airborne particles 0.3 microns or greater placed in between the facemask and breathing circuit or between facemask and reservoir bag.



Dispose:

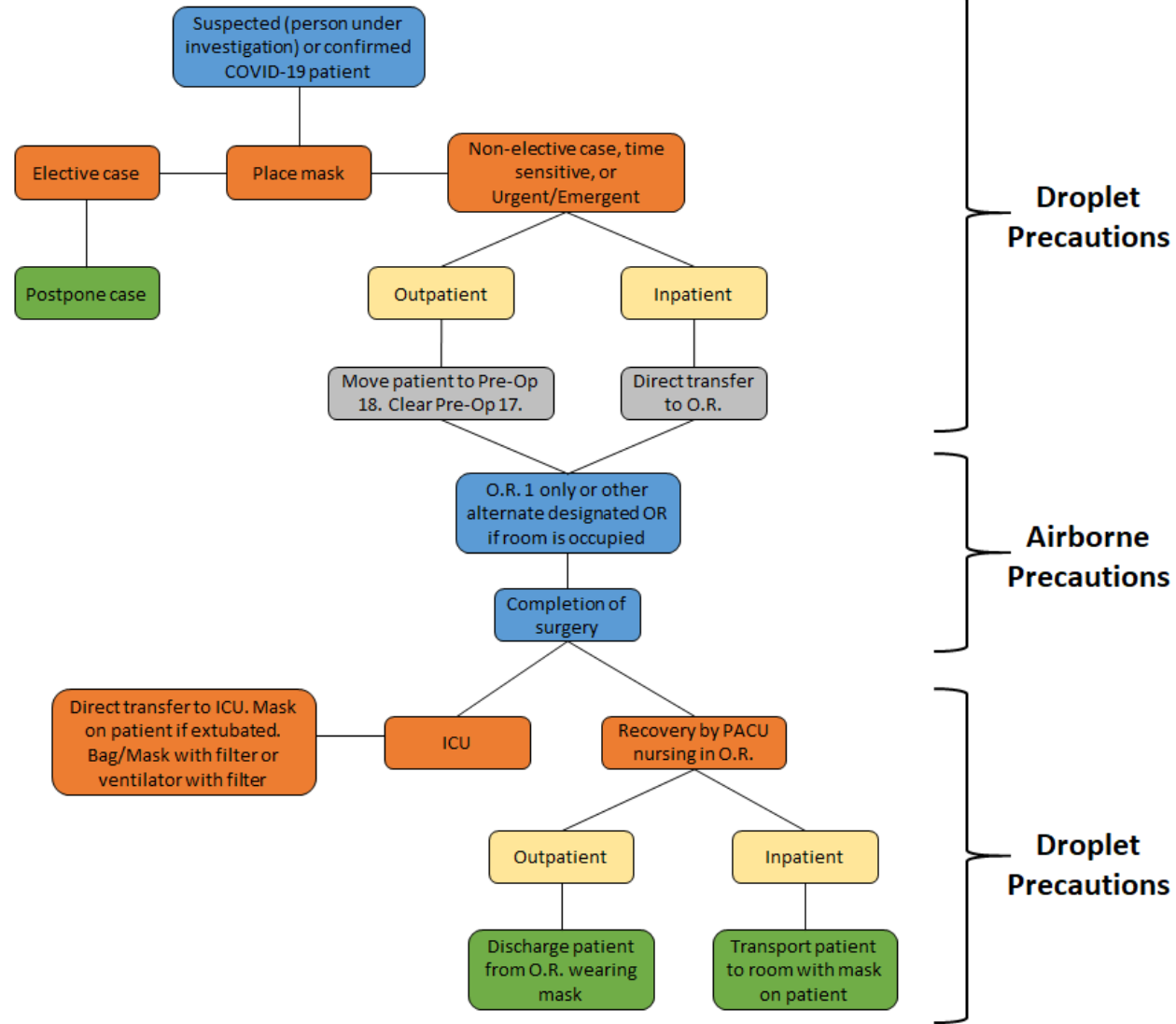
- Re-sheath the laryngoscope immediately post intubation (**double glove technique**)
- Seal all used airway equipment in a double zip-locked plastic bag. It must then be removed for decontamination and disinfection.



Remember:

- After removing protective equipment, avoid touching your hair or face before washing hands.

- ▶ RSI when possible, 5 minutes of pre-oxygenation
- ▶ Video Laryngoscopy when possible
- ▶ Airborne Precautions, Contact, and Eye protection
- ▶ Double Glove
- ▶ Dispose of AIRWAY equipment properly



Medical
Treatments

Respiratory
Treatments for
Hypoxia and
ARDS

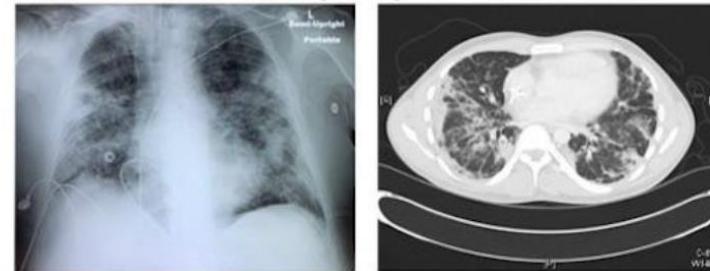
WORKING UP THE COVID19 PATIENT

Diagnosics

Common Lab Findings:

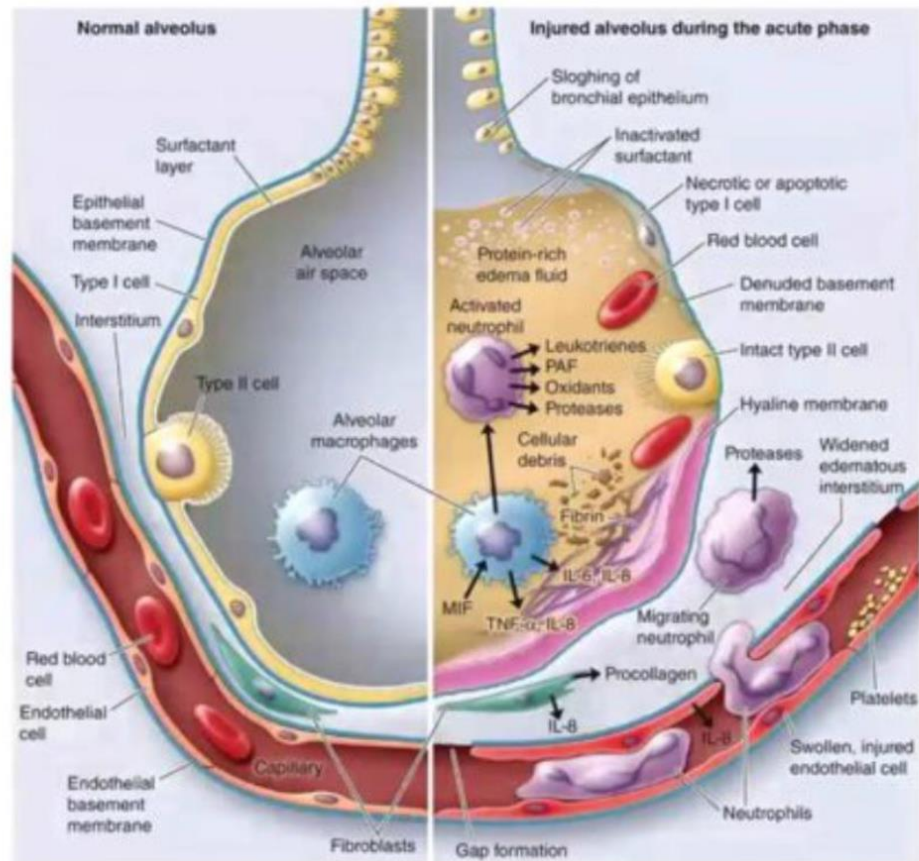
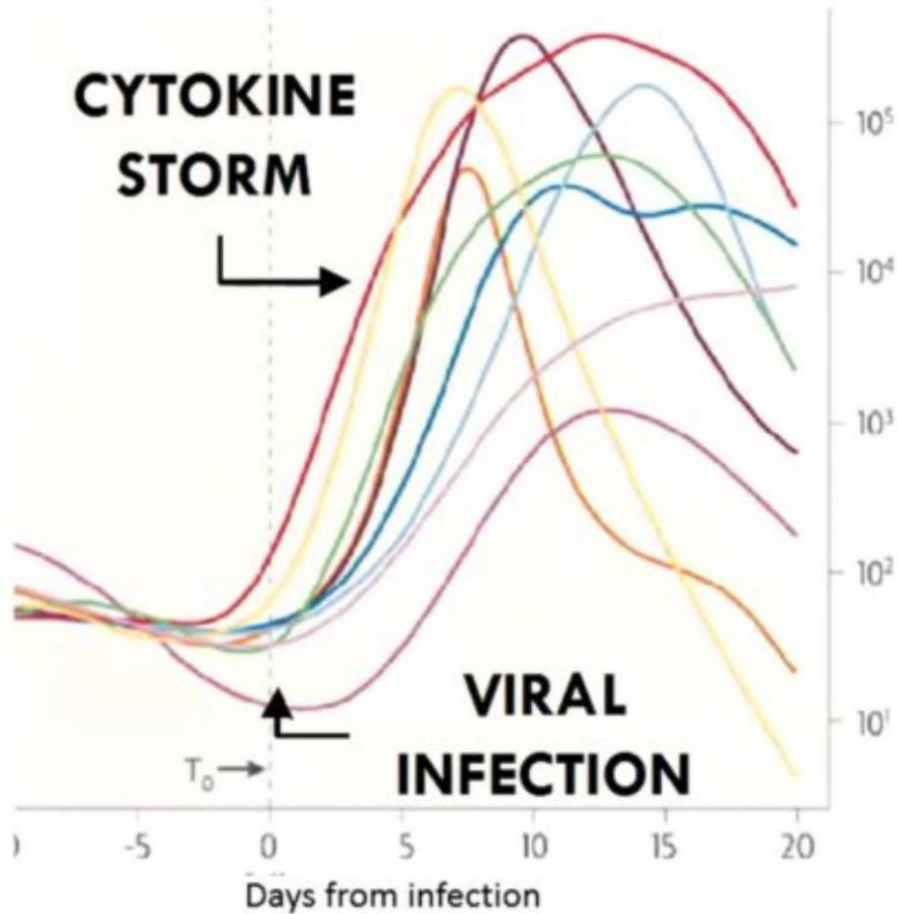
- ↓↑ WBC
- ↓ Total lymphocyte count
- ↑ LDH, CRP, Ferritin, D-Dimer
- ↓ Procalcitonin
- ↑ AST/ALT

Chest Imaging: CXR vs CT vs US



Definitive Testing with RT-PCR

Severe COVID-19 Manifestations



1

1) Obtain
Appropriate
Diagnostics

2

2) Risk stratify Patients

3

3) Apply Treatment
Guidelines based on
diagnostics and
patient risk
Stratification

COVID 19 TREATMENT GUIDELINES FROM MASS GENERAL HOSPITAL/HARVARD

Table 1: Laboratories for diagnosis, prognosis / risk stratification, and/or safety of agents

Suggested for all hospitalized patients with confirmed or suspected COVID-19

<p><u>Recommended daily labs:</u></p> <ul style="list-style-type: none">• CBC with diff (trend total lymphocyte count)• Complete metabolic panel¹• CPK (creatine kinase)	<p><u>Viral serologies:</u>²</p> <ul style="list-style-type: none">• HBV serologies (sAb, cAb, and sAg)• HCV antibody, unless positive in past• HIV 1/2 Ab/Ag
<p><u>For risk stratification (may be repeated q2-3 days if abnormal or with clinical deterioration):</u></p> <ul style="list-style-type: none">• D-dimer• Ferritin / CRP / ESR• LDH• Troponin³• Baseline ECG⁴	<p><u>If clinically indicated:</u></p> <ul style="list-style-type: none">• Routine blood cultures (2 sets)• For acute kidney injury (i.e. serum creatinine >0.3 above baseline), send urinalysis and spot urine protein:creatinine• Procalcitonin• IL-6 See below for criteria
<p><u>Radiology:</u></p> <ul style="list-style-type: none">• Portable CXR at admission• High threshold for PA/lateral in ambulatory patients, consider only if low suspicion for COVID-19 and result would change	<p><u>Following up-to-date infection control guidelines and appropriate PPE:</u></p> <ul style="list-style-type: none">• SARS-CoV-2 test, if not already performed.⁵• If available, send influenza A/B and RSV test

CO-INFECTION IS RARE (LESS THAN 2%),
OBTAIN CORRECT LABS/DIAGNOSTICS

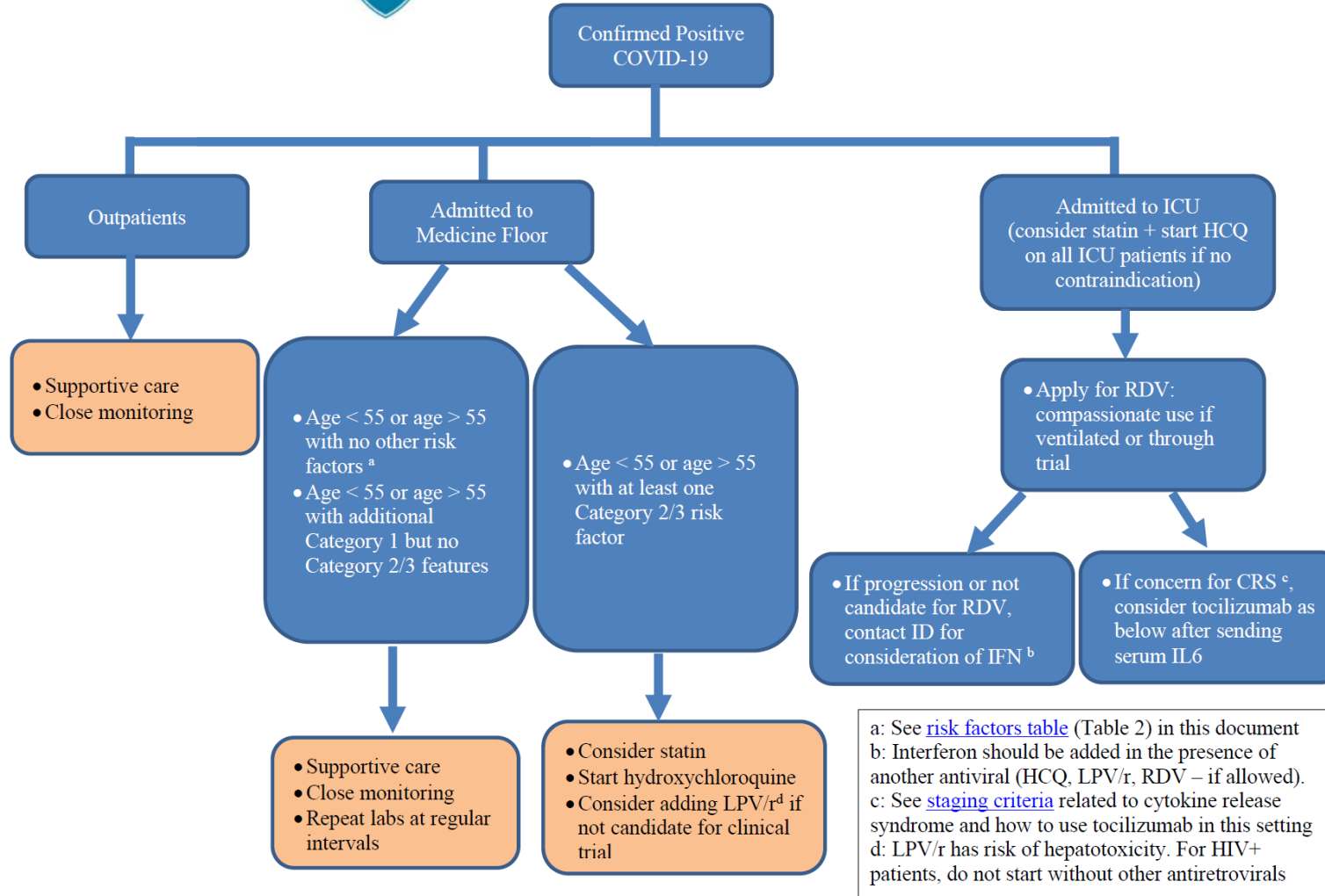
Table 2: Risk Factors for Severe COVID-19 Disease

<i>Epidemiological – Category 1</i>	<i>Vital Signs – Category 2</i>	<i>Labs – Category 3</i>
Age > 55	Respiratory rate > 24 breaths/min	D-dimer > 1000 ng/mL
Pre-existing pulmonary disease	Heart rate > 125 beats/min	CPK > twice upper limit of normal
Chronic kidney disease	SpO2 < 90% on ambient air	CRP > 100
Diabetes with A1c > 7.6%		LDH > 245 U/L
History of hypertension		Elevated troponin
History of cardiovascular disease		Admission absolute lymphocyte count < 0.8
Use of biologics		Ferritin > 300 ug/L
History of transplant or other immunosuppression		
All patients with HIV (regardless of CD4 count)		

RISK CATEGORIZE PATIENTS



MASSACHUSETTS GENERAL HOSPITAL



AVOID STEROIDS AND NSAIDS

- ▶ NSAIDS link to COVID19 unclear, however concern that it may worsen outcomes
 - ▶ may increase ACE receptor expression?
- ▶ Steroids should be avoided unless absolutely necessary

ADVANCED
TECHNIQUES
FOR HYPOXIA
AND ARDS

AVOID AERSOLIZATION

If possible,

No Nebulized Treatments

No Bag Mask Ventilation

No Heated High Flow Nasal Cannula

No Non-Invasive Ventilation (e.g. BiPAP)

Use a HEPA Filter

- ▶ Data from China shows that early intubation is preferred based on Disease progression Characteristics
- ▶ Anyone with a 6L requirement or greater should be transferred to an ICU and intubated (Current Cedars Sinai Protocol)
- ▶ BIPAP and High Flow Nasal cannula Not advised
- ▶ Days on Mechanical ventilation 6 to 10

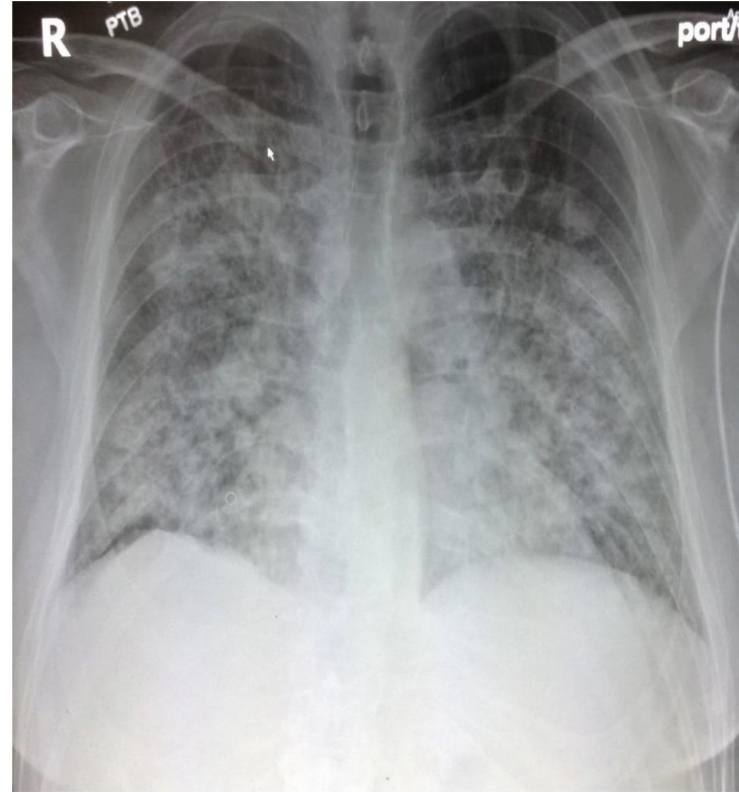
EARLY INTUBATION!

Basic Criteria

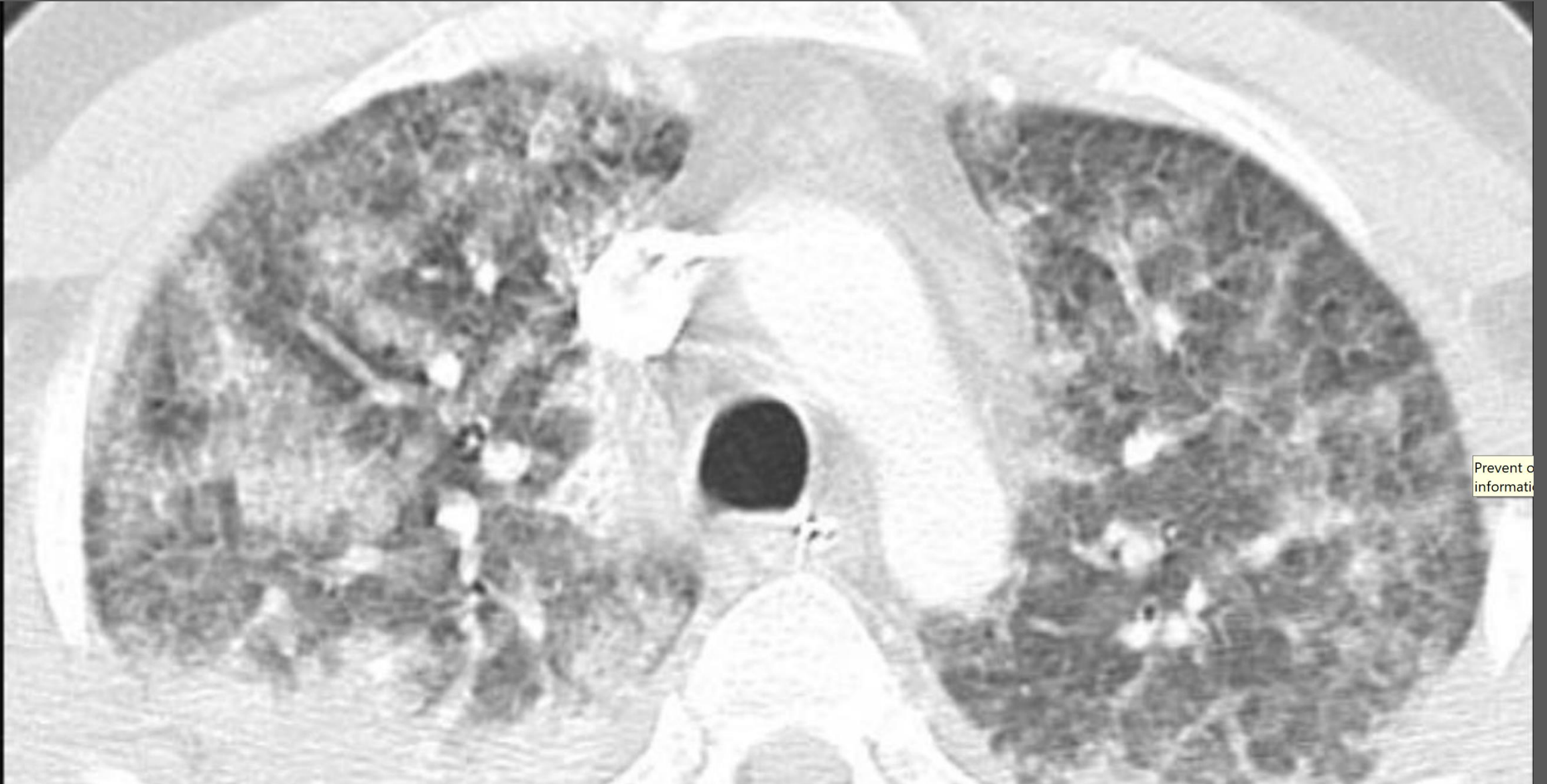
An acute condition characterized by bilateral pulmonary infiltrates and severe hypoxemia in the absence of evidence for cardiogenic pulmonary edema.



1. Acute onset
2. Bilateral disease
3. Hypoxemia
4. Non-cardiogenic



ACUTE RESPIRATORY DISTRESS SYNDROME



Prevent o
informati

Slide from: Goff, Covid-19 and Acute Respiratory Distress Syndrome, UT SOUTHWESTERN



P:F Ratio

The P:F Ratio is calculated by:

$$\text{PaO}_2/\text{FiO}_2$$

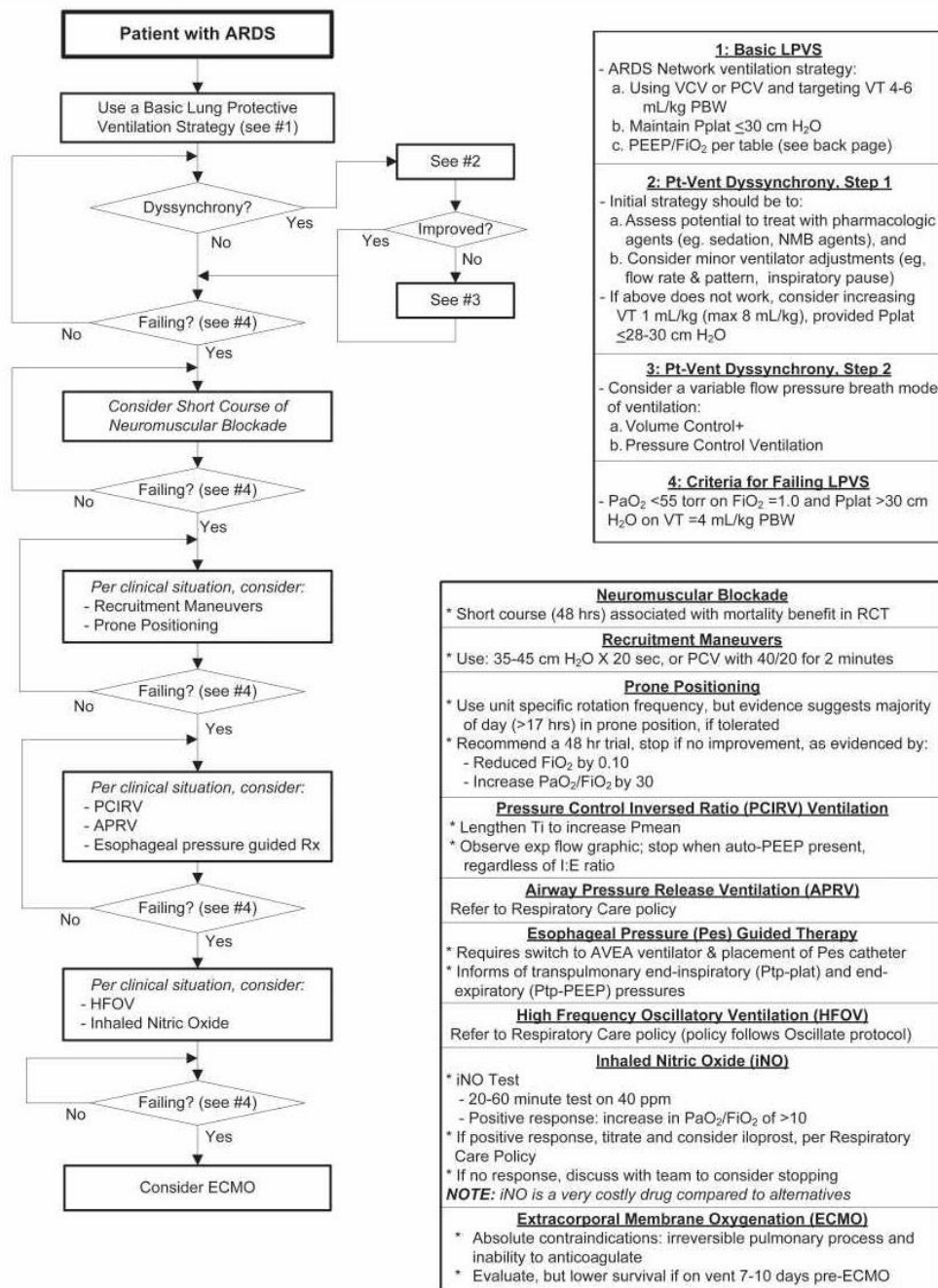
BERLIN CRITERIA :

Mild ARDS = P/F <300 but >200

Moderate ARDS = P/F <200 but >100

Severe ARDS = P/F <100

Figure 6-2. University of Michigan ARDS algorithm: sample stepwise approach to mechanical ventilation in acute respiratory distress syndrome (ARDS)



▶ Evidenced Based Strategies for Reducing Mortality

- ▶ Lung Protective Ventilation (ARDSNET)
- ▶ Paralysis (ACURASYS/ROSE-PETAL)
- ▶ PRONING (PROSEVA)
- ▶ Conservative Fluid Resuscitation (FACCT)
- ▶ ECMO (CESAR and EOLIA)
- ▶ Access to Ventilators contributes reduction in Mortality

University of Michigan: <https://aneskey.com/on-acute-respiratory-distress-syndrome/>

Lung Protective Ventilation

ARDS NETWORK 2000

Reduce volu/barotrauma

6 mL/kg *Predicted Body Weight*

Recommend starting at 8mL/kg and titrating down as able, adjust RR to maintain MV

If Pplat > 30 cmH₂O at 6mL/kg, decreased VT as able to achieve Pplat < 30 cmH₂O (minimum of 4mL/kg)

Significantly improves mortality and decreases ventilator days



Disadvantages:

Uncomfortable

Decreases ventilation

PEEP Ladder

ARDS NETWORK 2000

FiO2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.00
PEEP	5	5-8	8-10	10	10-14	14	14-18	18-24

Oxygenation Goal: PaO2 55-80mmHg or SpO2 88-95%

Sample type	75.0 %	Arterial		
Blood Gas Values				
pH	7.295			
↑ pCO ₂	63.2	mmHg	[35.0 - 45.0	
↓ pO ₂	57.7	mmHg	[75.0 - 100	
Oximetry Values				
↓ ctHb	90	g/L	[130 - 180	
↓ sO ₂	87.0	%	[95.0 - 100.0	
↓ FO ₂ Ht	84.9	%	[94.0 - 99.0	
↑ FCOHb	2.1	%	[0.0 - 1.5	
↑ FHHb	12.7	%	[0.0 - 5.0	
FMetHb	0.3	%	[0.0 - 1.5	
Electrolyte Values				
cK ⁺	3.8	mmol/L	[3.4 - 5.5	
↓ cNa ⁺	13.1	mmol/L	[136 - 146	
cCa ²⁺	1.22	mmol/L	[1.15 - 1.30	
cCl ⁻	96	mmol/L	[94 - 107	
Metabolite Values				
cGlu	4.4	mmol/L		
cLac	1.2	mmol/L	[0.5 - 2.0	
ctBil	3	μmol/L	[-	
Oxygen Status				
ctO ₂ c	10.8	Vol%		
p50 _c	29.31	mmHg		
Acid Base Status				
cBase(B) _c	2.9	mmol/L	[-3.0 - 3.0	
↑ cHCO ₃ (P) _c	25.0	mmol/L	[22.0 - 28	

Permissive Hypercapnia

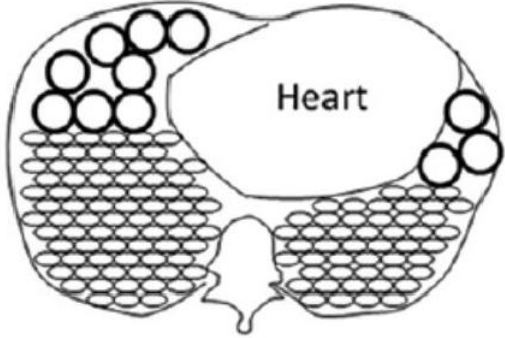
Smaller VT often means decreased ventilation

PaCO₂=65mmHg and/or pH=7.20 generally very well tolerated

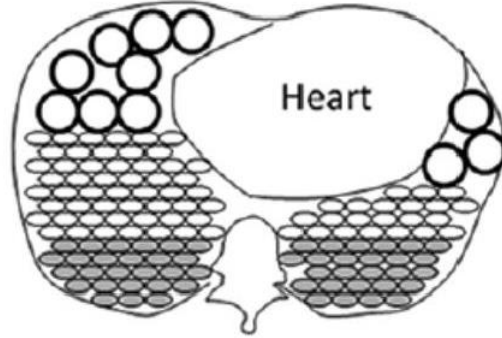
Sodium bicarbonate infusion generally not recommended

Hypercapnia MAY confer physiologic benefit

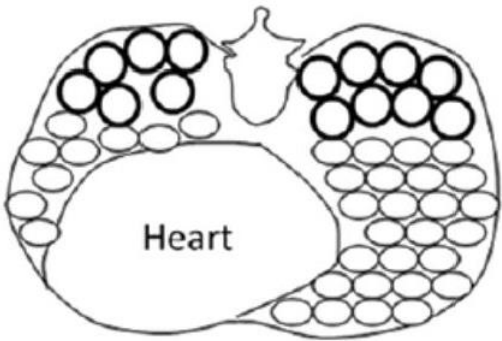
**A. Supine Position
Normal Lung**



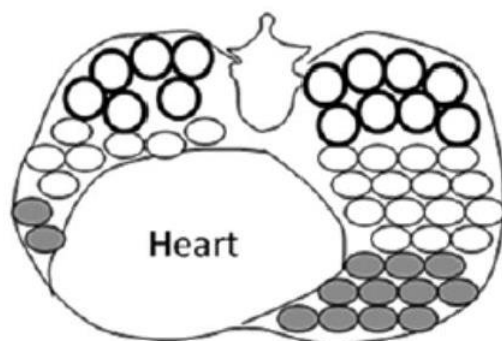
**B. Supine Position
ARDS Lung**



**C. Prone Position
Normal Lung**



**D. Prone Position
ARDS Lung**



Prone Positioning

Prone Positioning

(PROSEVA 2013)

Prone positioning confers physiologic benefit by several mechanisms:

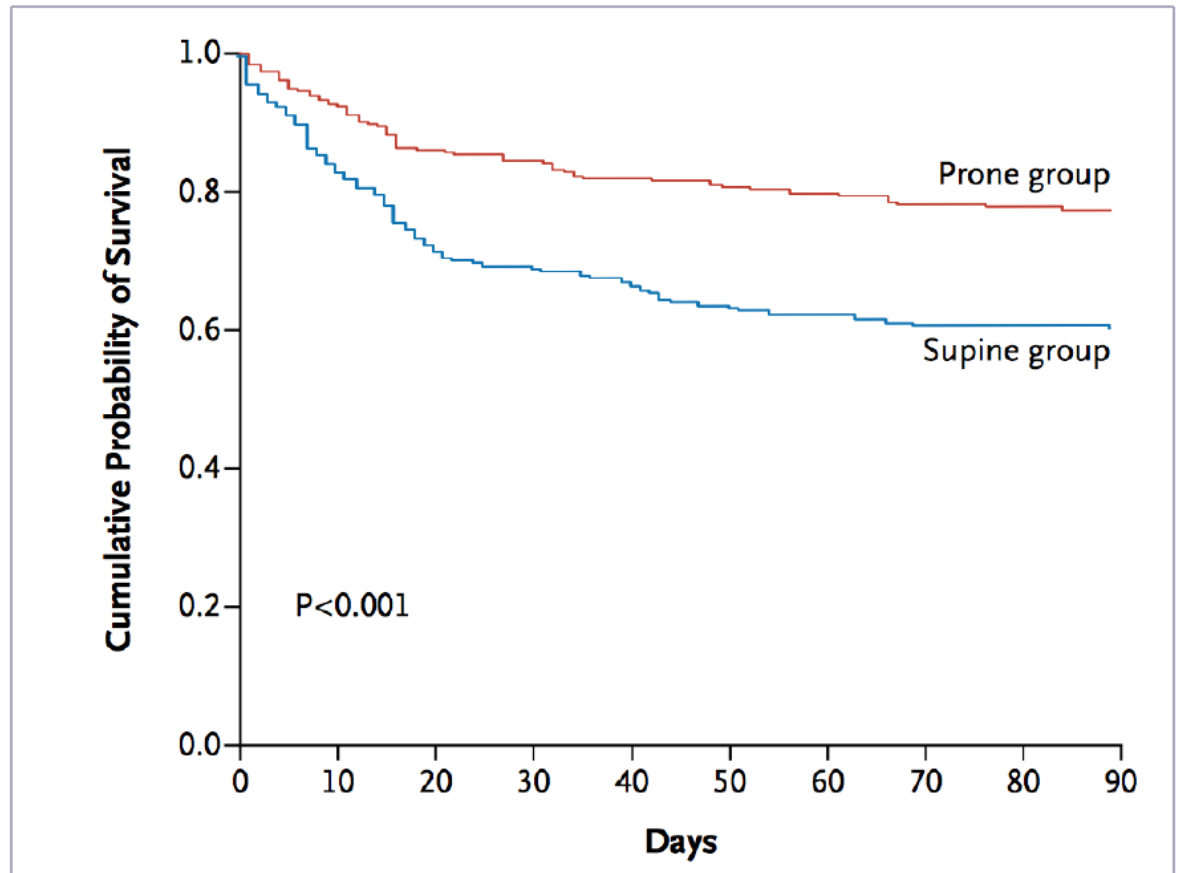
Improves V/Q Matching

Decreases lung compression

Improves bronchial drainage

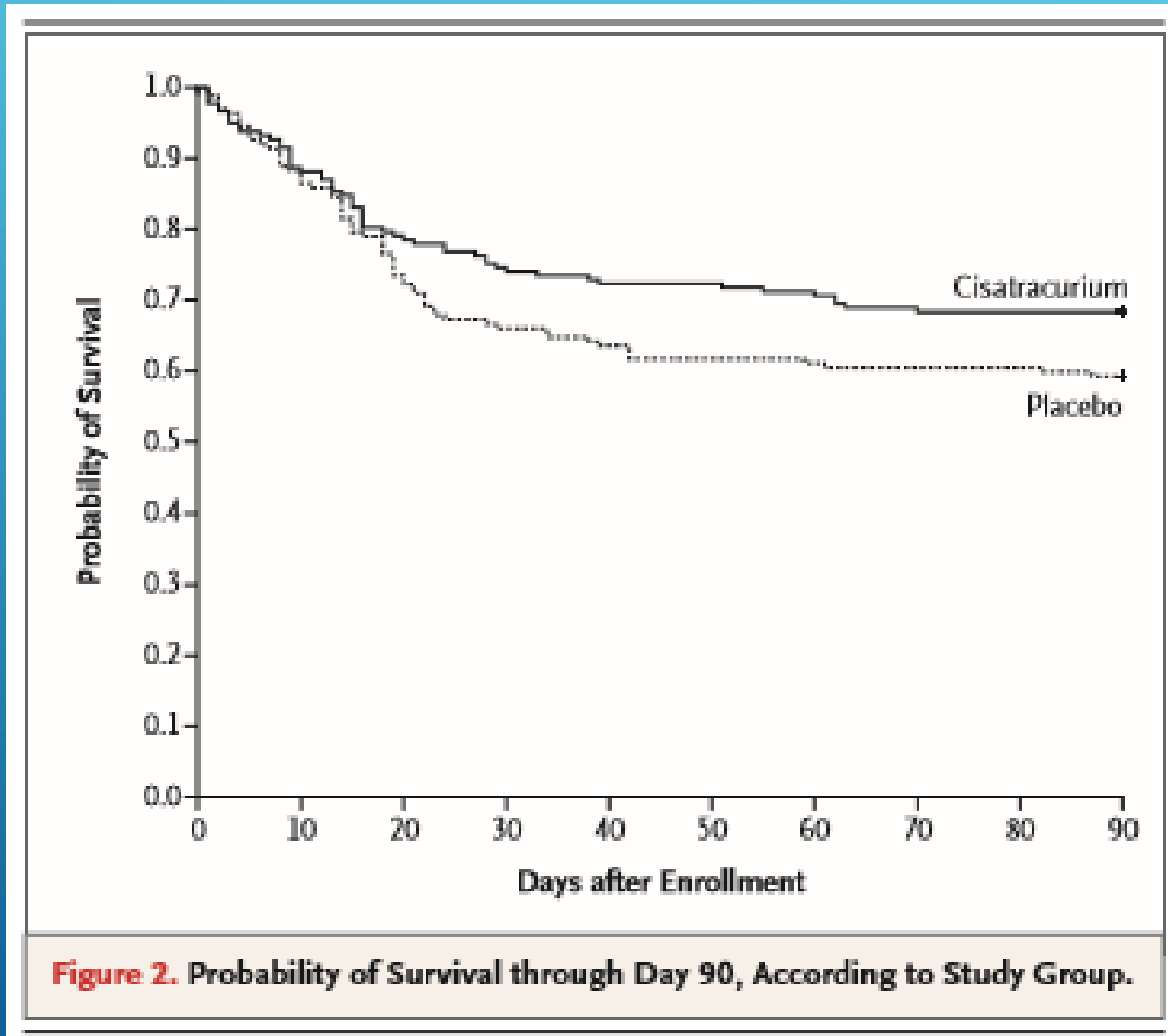
Potentially increases FRC

51% relative mortality risk reduction with early proning



Guerin C, et al. PROSEVA. NEJM 2013

ACURASYS – THE PREVIOUS STUDY



- ▶ Landmark Study, Multi-center, Randomized Controlled Trial.
- ▶ Significant mortality improvement in the Cisatracurium group in patients with ARDS
- ▶ No standardization for proning, steroids, nitric oxide use

- ▶ AKA “Rose-Petal” Trial, Randomized, Multi-Center
- ▶ Inclusion Criteria
 - ▶ P/F <150mmHg
 - ▶ PEEP>8
 - ▶ Bilateral Opacities
 - ▶ Not pulmonary edema/fluid Overload
- ▶ Exclusion Criteria
 - ▶ ECMO
 - ▶ NMB prior to enrollment
 - ▶ P:F> 200 at time of randomization.

(ROSE) National Heart, Lung, and Blood Institute PETAL Clinical Trials Network
 Moss M, Huang DT, et al. Early Neuromuscular Blockade in the Acute Respiratory Distress Syndrome. N Engl J Med 2019; 380:1997.

ORIGINAL ARTICLE

Early Neuromuscular Blockade in the Acute Respiratory Distress Syndrome

The National Heart, Lung, and Blood Institute PETAL Clinical Trials Network*

Article **Figures/Media**

Metrics

May 23, 2019

N Engl J Med 2019; 380:1997-2008

DOI: 10.1056/NEJMoa1901686

43 References 5 Citing Articles 3 Comments

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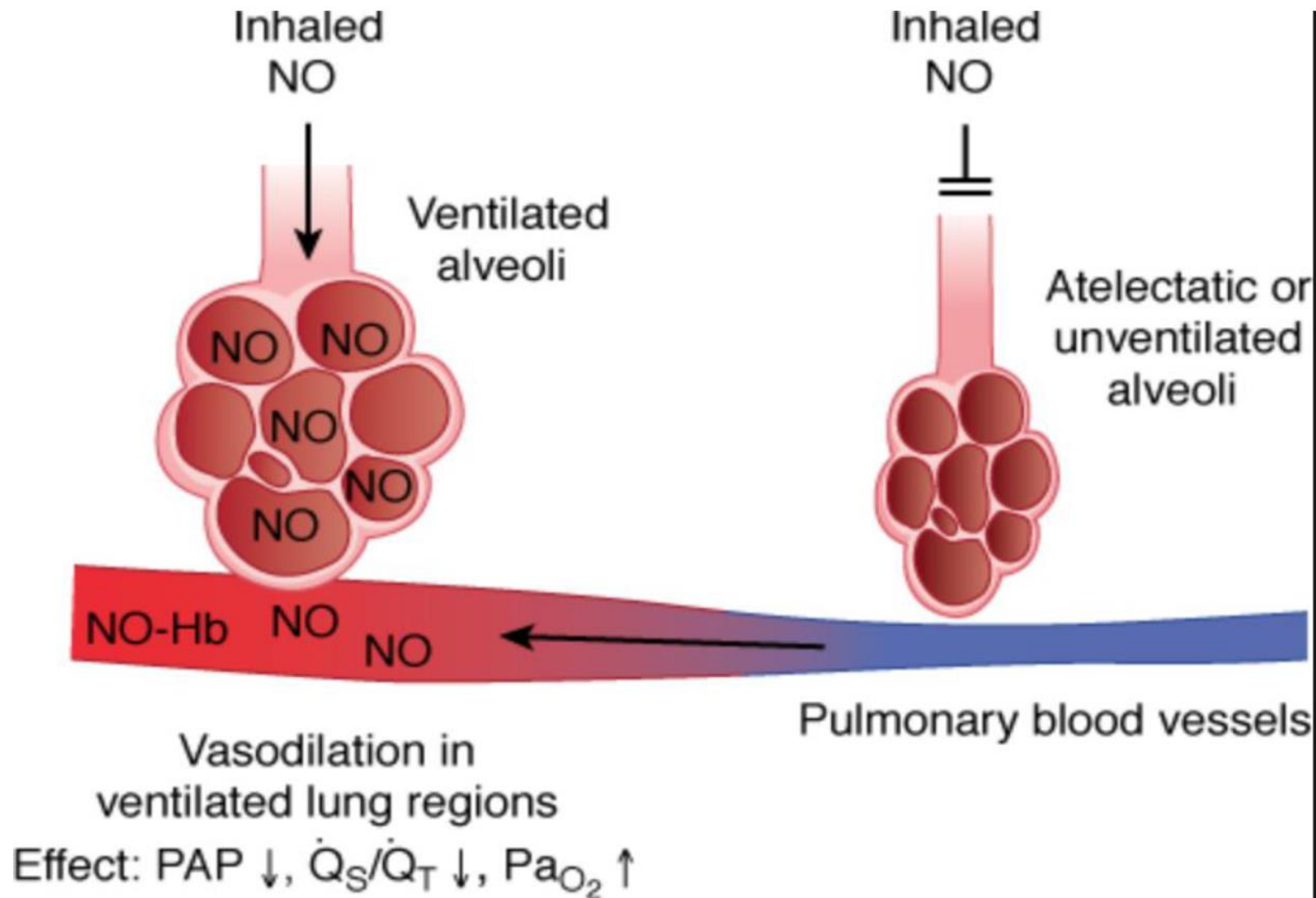
43 References 5 Citing Articles 3 Comments

- ▶ Randomly assigned patients with moderate to severe ARDS (PaO₂ less than 150, PEEP > 8cm) to Cisatracurium or “usual-care approach” without routine NMB blockade.
- ▶ End point was in-hospital death at 90 days
- ▶ Larger trial, very strict protocol, Use of higher PEEP (5 in Acurasys)
- ▶ Lighter Sedation Targets in non-intervention group (Possible confounder)
- ▶ **Exclusion criteria possibly Achilles heel (655 received neuromuscular blockade)**
- ▶ **Large difference between proning between this (fewer prone patients) and ACURASYS.**

(ROSE) National Heart, Lung, and Blood Institute PETAL Clinical Trials Network, Moss M, Huang DT, et al. Early Neuromuscular Blockade in the Acute Respiratory Distress Syndrome. N Engl J Med 2019; 380:1997.

- ▶ For severe ventilator dis-synchrony I will continue to use paralysis
- ▶ NMB still acceptable, shows no harm
- ▶ Lack of benefit, may be because underpowered for the study population
 - ▶ Vent Dis-synchrony may not have been adequately addressed and significant proportion of already paralyzed patients excluded

MY TAKE ON PARALYSIS (ACURASYS VS ROSE-PETAL)



Source: Tobin MJ: *Principles and Practice of Mechanical Ventilation*, 3rd Edition: www.accessanesthesiology.com

Pulmonary Vasodilators

Examples: Epoprostenol, inhaled nitric oxide

Improves P:F ratio, at least transiently

No significant benefit with regard to mortality or duration of mechanical ventilation

Potential adverse effects include decreased platelet aggregation, renal dysfunction and methemoglobinemia

ORIGINAL ARTICLE

Comparison of Two Fluid-Management Strategies in Acute Lung Injury

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network*

ABSTRACT

BACKGROUND

Optimal fluid management in patients with acute lung injury is unknown. Diuresis or fluid restriction may improve lung function but could jeopardize extrapulmonary-organ perfusion.

METHODS

In a randomized study, we compared a conservative and a liberal strategy of fluid management using explicit protocols applied for seven days in 1000 patients with acute lung injury. The primary end point was death at 60 days. Secondary end points included the number of ventilator-free days and organ-failure-free days and measures of lung physiology.

RESULTS

The rate of death at 60 days was 25.5 percent in the conservative-strategy group and 28.4 percent in the liberal-strategy group ($P=0.30$; 95 percent confidence interval for the difference, -2.6 to 8.4 percent). The mean (\pm SE) cumulative fluid balance during the first seven days was -136 ± 491 ml in the conservative-strategy group and 6992 ± 502 ml in the liberal-strategy group ($P<0.001$). As compared with the liberal strategy, the conservative strategy improved the oxygenation index (mean airway pressure \times the ratio of the fraction of inspired oxygen to the partial pressure of arterial oxygen) $\times 100$ and the lung injury score and increased the number of ventilator-free days (14.6 ± 0.5 vs. 12.1 ± 0.5 , $P<0.001$) and days not spent in the intensive care unit (13.4 ± 0.4 vs. 11.2 ± 0.4 , $P<0.001$) during the first 28 days but did not increase the incidence or prevalence of shock during the study or the use of dialysis during the first 60 days (10 percent vs. 14 percent, $P=0.06$).

CONCLUSIONS

Although there was no significant difference in the primary outcome of 60-day mortality, the conservative strategy of fluid management improved lung function and shortened the duration of mechanical ventilation and intensive care without increasing nonpulmonary-organ failures. These results support the use of a conservative strategy of fluid management in patients with acute lung injury. (ClinicalTrials.gov number, NCT00281268.)

Conservative Fluid Administration

FACTT 2006

Compared conservative vs. liberal fluid management strategies in patients with "ALI"

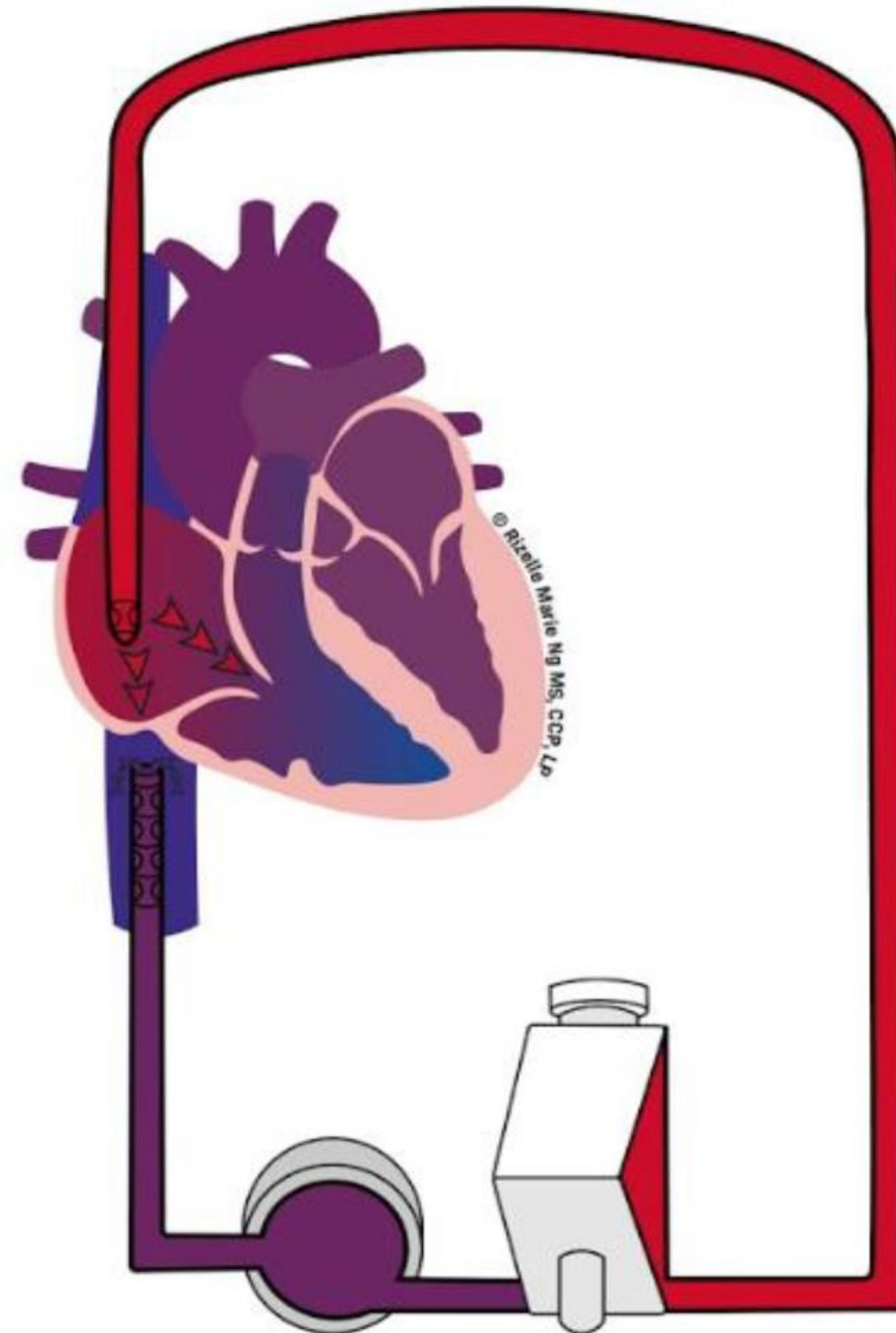
No difference in mortality at 60 days

Decreased ICU time and increased ventilator-free days in conservative group

- ▶ CESAR Trial (Lancet 2009): Decreased mortality and disability at 6 months for patients with severe ARDS transferred to ECMO center
- ▶ EOLIA Trial (NEJM 2018): No difference between early use of VV ECMO and standard MV with VV ECMO as rescue
- ▶ “WHO interim guidelines recommend offering extracorporeal membrane oxygenation (ECMO) to eligible patients with acute respiratory distress syndrome (ARDS) related to coronavirus disease 2019 (COVID-19).”

ECMO

Modified Slide from: Goff, Covid-19 and Acute Respiratory Distress Syndrome, UT SOUTHWESTERN



A Seattle Intensivist's One-pager on COVID-19

Nomenclature

Infection: Coronavirus Disease 2019 a.k.a. COVID-19
Virus: SARS-CoV-2, 2019 Novel Coronavirus
NOT "Wuhan Virus"

Biology

- 30 kbp, +ssRNA, enveloped coronavirus
- Likely zoonotic infection; source/reservoir unclear (Bats? / Pangolins? → people)
- Now spread primarily **person to person**;
 - Can be spread by asymptomatic carriers!
- Viral particles enter into lungs via **droplets**
- Viral S spike binds to ACE2 on type two pneumocytes
- Effect of ACE/ARB is unclear; ACE vs ARBs may even have opposite effects
- Other routes of infection (contact, enteric) possible but unclear if these are significant means of spread

Epidemiology

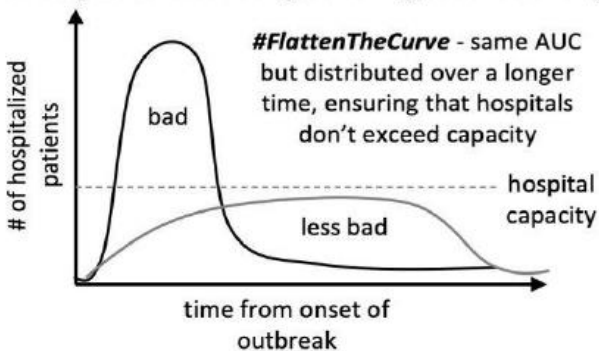
- Attack rate = 30-40%
- $R_0 = 2-4$ (similar to influenza)
- CFR = 3.4% (worldwide numbers)
- Incubation time = 4-14 days typically (up to 24 days)

Timeline:

- China notifies WHO 2019-12-31
- First US case in Seattle 2020-1-15
- WHO Declared pandemic 2020-3-11
- National emergency 2020-3-12

Disease clusters: SNFs, Conferences, other

Strategies: contact tracing, screening, social distancing



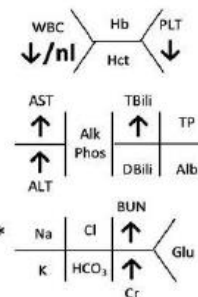
Diagnosis/Presentation

Symptoms

- 65-80% **cough**
- 45% **febrile** on presentation (85% febrile during illness)
- 20-40% dyspnea
- 15% URI symptoms
- 10% GI symptoms

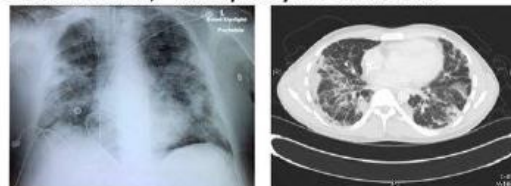
Labs

- CBC: Leukopenia & **lymphopenia** (80%+)
- BMP: **↑BUN/Cr**
- LFTs: **↑AST/ALT/Tbili**
- **↑ D-dimer, ↑ CRP, ↑ LDH**
- **↑ IL-6, ↑ Ferritin**
- **↓ Procalcitonin**
- *PCT may be high w/ bacterial superinfxn*



Imagine

- CXR: hazy **bilateral, peripheral** opacities
- CT: **ground glass opacities** (GGO), crazy paving, consolidation, *rarely may be unilateral*



- POCUS: numerous B-lines, pleural line thickening, consolidations w/ air bronchograms

Isolation

- Phone call is the best isolation (e.g. move to telemed)
- Place patient in mask, single room, limit/restrict visitors

Precautions

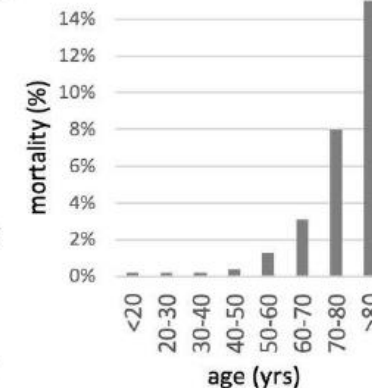
- **STANDARD + CONTACT** (double glove) +
- Either **AIRBORNE** (for aerosolizing procedures: intubation, extubation, NIPPV, suctioning, etc) or **DROPLET** (for everything else)
- N95 masks must be fit tested; wear eye protection
- PPE should be donned/doffed with trained observer
- Hand hygiene: 20+ seconds w/ soap/water or alcohol containing hand gel

Treatment

- Isolate & send PCR test early (may take **days** to result)
- GOC discussion / triage
- Notify DOH, CDC, etc
- **Fluid sparing** resuscitation
- ± empiric antibiotics
- Intubate early under controlled conditions if possible
- Avoid HFNC or NIPPV (aerosolizes virus) unless individualized reasons exist (e.g. COPD, DNI status, etc); consider **helmet mask** interface (if available) if using NIPPV
- Mechanical ventilation for ARDS
 - **LPV** per ARDSnet protocol
 - 7 P's for good care of ARDS patients: e.g **PEEP/Paralytics/Proning/inhaled Prostacyclins**, etc
 - ? High PEEP ladder may be better
 - ? ECMO in select cases (unclear who)
- Consider using POCUS to monitor/evaluate lungs
- Investigational therapies:
 - Remdesivir --| block RNA dependent polymerase
 - Chloroquine --| blocks viral entry in endosome
 - Tocilizumab --| block IL-6
 - Corticosteroids --| reduce inflammation
- None of these investigational therapies are proven, but literature is evolving quickly.

Prognosis

- **Age** and **comorbidities (DM, COPD, CVD)** are significant predictors of poor clinical outcome; admission **SOFA** score also predicts mortality.
- Lab findings also predict mortality
 - **↑ d-dimer,**
 - **↑ ferritin**
 - **↑ troponin**
 - **↑ cardiac myoglobin**
- Expect prolonged MV
- Watch for complications: Secondary infection (VAP), Stress CM, etc



- ▶ Goff, Covid-19 and Acute Respiratory Distress Syndrome, UT SOUTHWESTERN
- ▶ Mark, A Seattle Intensivist's One-Pager on COVID-19
- ▶ Massachusetts General Hospital COVID-19 Treatment Guidance Version 1.0 3/17/2020 4:00PM
- ▶ SCCM Resource availability https://sccm.org/Blog/March-2020/United-States-Resource-Availability-for-COVID-19?_zs=jxpjd1&_zl=w9pb6
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- ▶ Feel free to reach out.
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REFERENCES/RESOURCES