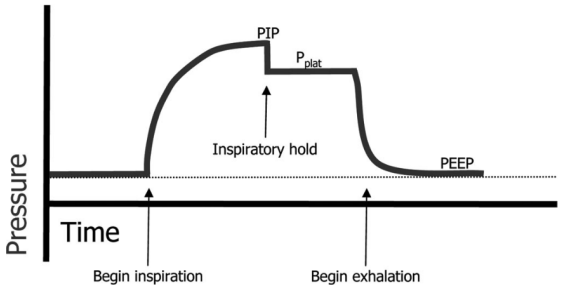
Ventilator Management Case – Basic Ventilator Management and Mechanics

Pat Burns is a 52 year old man without significant medical history who presented to the ED with likely heroin overdose. He has received multiple doses of narcan with some improvement but quickly becomes obtunded again. He is unresponsive to sternal rub and without a gag reflex. A narcan drip is ordered and he is intubated for airway protection.

Prior to intubation:
CXR: normal
Vital signs: Height 6', Weight 100 kg, Temp 98.4, HR 86, BP 110/65, RR agonal breathing, oxygen saturation 89% on RA
ABG on room air: 7.16/70/55

Please address the following questions:

1. The patient is started on mechanical ventilation (mode: AC/VC; flow: 70 L/min and a down ramp.) What additional ventilator settings would you set for this patient? *Note: AC/VC is the most common ventilator setting for patients in the MICU at NM. In this mode, the patient gets the same volume of breath whether the patient initiates the breath or not.	• Respiratory rate (RR): A rate of 10-14 breaths/min would be appropriate. A "normal" rate for this patient should quickly fix the hypercapnia. • Tidal volume (TV): 466-775 mL (6-10 cc/kg based on the patient's predicted body weight (PBW). The PBW is based on the patients HEIGHT, not weight. A PBW chart is available here. • Oxygen or FiO2: 100%. When in doubt, always start at 100% and work your way down. • PEEP: for most patients, start at 5-8 cmH20. Those with severe hypoxemia will need more.
2. How do you determine the patient's "minute ventilation"?	• The minute ventilation is the patient's RR x TV. Normal minute ventilation is 5-8 L/min. A patient with a high minute ventilation has a high drive to breathe (pain, sepsis, etc) and may not be ready to breathe comfortably without the ventilator. If a patient's minute ventilation is too low, they may retained CO2 if not mechanically ventilated.
3. How do you measure the patient's "respiratory mechanics?"	• Respiratory mechanics refer to the resistance and compliance of the respiratory system. We measure mechanics by performing an inspiratory hold/pause maneuver to determine the plateau pressure (Pplat).

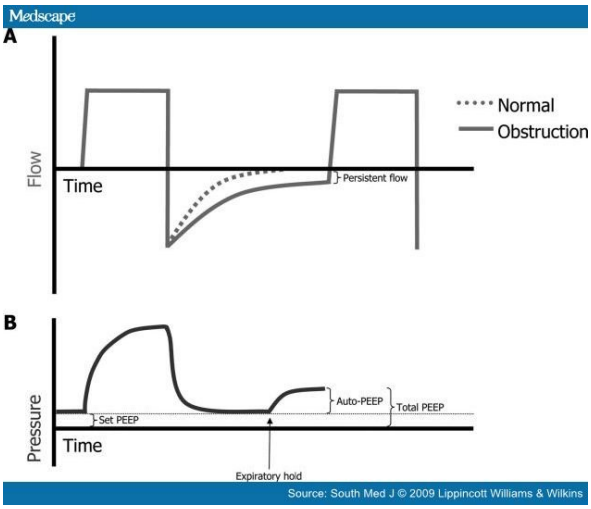
	 • The airway resistance is the difference between the Peak Pressure (PIP) and the Pplat divided by the flow. (Note – the flow must be set to a square waveform to check the airway resistance). An RT can assist with this maneuver. Normal airway resistance on the ventilator should be less than 15 cc H2O/L/s. Patients with increased airway resistance have an AIRWAY problem i.e. problems with the endotracheal tube such as mucus plugging, kinking, biting, or bronchospasm as seen in asthma or COPD. • The compliance is a measure of the stiffness of the lung and is measured as the change in volume (TV) over change in pressure (Pplat minus PEEP). Normal compliance on the ventilator is typically greater than 60 mL/cm H20. Low compliance is seen in anything that makes the lung stiff – ARDS, PNA, pulmonary edema, pleural effusions, PTX, etc. • This patient should have a relatively normal resistance and compliance since he has normal lungs and only required mechanical ventilation due to his decreased respiratory drive. • If the Peak Pressure is elevated, first check a Pplat to see if you have a problem with resistance or compliance.
4. What factors determine safety to undergo a spontaneous breathing trial?	• Patient is hemodynamically stable (not on vasopressors or on a low dose of vasopressors) • FiO2 is less than or equal to 50% • PEEP less than or equal to 8 • Patient can initiate an inspiratory effort (i.e. not apneic)
5. When the patient meets criteria for a spontaneous breathing trial, how would you perform it?	• Most commonly, the patient will undergo a pressure support trial. Sedation is held or lightened and the ventilator is switched to “pressure support” at a setting of 5/5. • If the patient appears comfortable (stable vital signs, good TV, normal RR), he should remain on PS for 30 min, and no more than 2 hours, before a decision is made to extubate.

Ventilator Management Case – Acute lung injury

Mike Stone is a 63 year old man with a history of hypertension who was admitted to the hospitalist service with suspected community acquired pneumonia and evaluation for COVID-19. He was started on ceftriaxone and azithromycin. He initially required 3L NC but has had increasing oxygen requirements and is now desaturating despite 100% non-rebreather. He is transferred to the MICU and intubated for hypoxemic respiratory failure.

Prior to intubation:
CXR: Progressive bilateral airspace opacities
Vital signs: Height 5'10", Weight 75 kg, Temp 101.1, HR 122, BP 110/65, RR 28, oxygen saturation 90% on 100% NRB

What are your recommended initial ventilator settings?	Most patients will be started on AC/VC ventilation. The RT will typically set the initial flow rate at 60-80 L/min ramp. Initial settings: • RR: given the patients respiratory distress, a faster rate is necessary. Consider 20-24 to start. • TV: lung protective (i.e. ARDS) ventilation. A general treatment algorithm can be found here. The goal TV is 6 cc/kg based on the patient's PBW (A PBW chart is available here.) For this patient, a 6 cc/kg TV is 466 mL. At times, you may need to start at a slightly higher TV and work your way down. • Oxygen or FiO2: 100%. When in doubt, always start at 100% and work your way down. • PEEP: for most patients, start at 5-8 cmH20. Since this patient has severe hypoxemia, it might be necessary to start at a PEEP of 10-12. A common down side of higher PEEP is increased intrathoracic pressure, decreased venous return, and hypotension. • Approximately 30 min after the patient is intubated, get an ABG. This is predominantly to assess the adequacy of ventilation (i.e. pH and PCO2). The FiO2 and PEEP can be titrated based on the pulse oximeter. Follow ARDS guidelines to titrate the ventilator.
What do I do if the patient is desaturating?	First, increased the FiO2 up to 100%. Call for help. Make sure the patient is deeply sedated and synchronous on the ventilator. Increase the PEEP based on the ARDS algorithm.

What is the goal Pplat for this patient?	• The Pplt should be less than 30. If the Pplt is greater than 30, the TV should be decreased even further. • As the TV is decreased, the RR should be increased to maintain an adequate minute ventilation • Patients with “stiff” lungs become increasingly difficult to ventilate safely. “Safe” ventilator settings may be inadequate to support adequate gas exchange. • When the limits of traditional mechanical ventilation are met, consider paralyzing the patient, prone positioning, and ECMO.
How high can I increase the RR to help the patient “blow-off” CO2?	• Typically the RR should not be increased above 30-35 breaths per minute. Faster than this and the patient does not have time to exhale between breaths. This can lead to breath-stacking and auto-PEEP.  • Auto-PEEP can be detected when the expiratory flow tracing does not return to zero before the next breath. • Auto-PEEP can be measured by performing an “expiratory hold maneuver”. • The most effective way to decrease auto-PEEP is by decreasing the RR. This may require sedation to prevent the patient from breathing over the set rate. • If auto-PEEP is not addressed, it can lead to diminishing TVs, hypotension, and cardiac arrest.