Your Patient is Intubated.....Now What?

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I have no relevant relationships with ineligible companies to disclose within the past 24 months.
(Note: Ineligible companies are defined as those whose primary business is producing,
marketing, selling, re-selling, or distributing healthcare products used by or on patients.)

Objectives

- Review ventilator basics
- Discuss common ventilator settings
- Explore common ventilator problems and solutions

My Disclosure

This presentation is not meant to be a comprehensive discussion of ventilators, mechanical ventilation physiology or management of the critical care patient. It is meant to help alleviate some neusome headaches that can occur with recently intubated patients

Intubation and Mechanical Ventilation

In the US annually, 15 million operating room intubations and 650,000 hospital intubations outside the operating room are performed, including 346,000 emergency department (ED) intubations.[1]

Patients are intubated for airway protection, hypoxia & hypercapnia

Patients can be intubated for a short time (OR) or prolonged duration

PAs commonly intubate and subsequently manage ventilators

"Hey this the ER, we just intubated this patient in Trauma 3. We're going to need y'all to come admit this guy "

So now you have an intubated patient.....

“Look Back to Move Forward”

History of Ventilators

“In the late 19th century, ventilators based largely on (currently) accepted physiological principles were developed. Essentially, ventilation was delivered using subatmospheric pressure delivered around the body of the patient to replace or augment the work being done by the respiratory muscles” [2]

“In 1864, Alfred Jones invented one of the first such body enclosing devices. The patient sat in a box that fully enclosed his body from the neck down. There was plunger, which was used to decrease pressure in the box, which caused inhalation; the converse produced exhalation” [2]

Jones was very proud of his invention as noted in his patent, because the ventilator “cured paralysis, neuralgia, seminal weakness, asthma, bronchitis, and dyspepsia. Also deafness . . . and when judiciously applied, many other diseases may be cured” [2]

History of Ventilators

In 1876, Alfred Woillez built the first workable iron lung, which he called the “spirophore” [3]

It was proposed to place these ventilators along the Seine River to help drowning victims. The spirophore had a metal rod that rested on the chest; movement of this rod was used as an index of the VT. [3]

The first iron lung to be widely used was developed in Boston by Drinker and Shaw in 1929 and used to treat patients with polio [4]

History of Ventilators

"One problem with these devices was that it was extremely difficult to nurse patients because it was difficult to get access to the patient's body. To address this problem, Peter Lord patented a respirator room, in which the patient lay with her head outside the room" [2]

"Inside, huge pistons generated pressure changes, which caused air to move into and out of the lungs. The ventilator room had a door so that the medical staff could enter the ventilator to care for the patient. Of course these ventilators were extremely expensive, so James Wilson developed a ventilation room in which multiple patients could be treated" [2]

"One such room was used at Children's Hospital, Boston, for several epidemics" [2]

History of Ventilators

"The resurgence of polio (1952) marked a watershed in the history of mechanical ventilation. Before this time, mechanical ventilation was believed to have some usefulness but was not used widely. Afterward, the benefits of ventilation were dramatic and obvious, leading to its widespread use worldwide" [2]

"At the height of the epidemic, 50 patients a day were being admitted at Blegdams Infectious Disease Hospital (Copenhagen), many with respiratory muscle or bulbar paralysis" [2]

Mortality in these patients was exceedingly high (80%). [5]

History of Ventilators

”Bjorn Ibsen, an anesthesiologist who had trained in Boston in Beecher’s lab, realized that these symptoms were not caused by renal failure but by respiratory failure. As such, he recommended tracheostomy and positive pressure ventilation. Lassen, who was the hospital’s chief physician, initially rejected this approach but soon relented when Ibsen demonstrated its efficacy. Mortality dropped dramatically—from 87% to approximately 40%, almost overnight“ [2]

“At the height of the epidemic 70 patients were simultaneously being manually ventilated. In total, by the end of the epidemic, approximately 1,500 students provided manual ventilation for a total of 165,000 hours” [2]

History of Ventilators

Since then the greatest advance in delivering mechanical ventilation has been in minimizing its side effects.

Improved modalities allowing for more patient control and lung protective modalities have vastly decreased ventilator associated M&M

"A defining moment with respect to lung-protective strategies in ARDS was the 2000 publication of the ARDSNet randomized clinical trial, which demonstrated a decreased mortality from 40 to 31%" [2]

First things first....

Just like any other “new” patient

-<u>History</u>: CC / HPI, Past / Social histories

“Why was the patient intubated?”

Who intubated? How was the intubation process? RSI Rxs used?

Take note of the ETT size, ETT depth, ETT securement

-<u>Physical Exam</u>: VS, **Height** / weight, Cardiopulmonary exam

Initial Ventilator Orders

”Must Have” orders:

Mode

Rate

Tidal Volume

FiO2

PEEP

MODE

Mode selection is really determined on patient's ventilatory needs

For instance, a TBI patient who will be intubated for several days wouldn't necessarily need the same mode of ventilation as say an overdose patient who you expect will need ventilatory support for a much shorter amount of time

MODE

So when choosing certain mode you are really choosing how you want to *ventilate* your patient

Ventilation controls the CO2 level of your patient

Minute Ventilation = Tidal Volume (Vt) x Resp Rate

Higher MV = Lower CO2 (i.e. hyperventilating)

Lower MV = Higher CO2

MODE

The second goal of mechanical ventilation is *Oxygenation*

Settings that influence oxygenation include

PEEP and FiO2

As PEEP (to a certain degree) and FiO2 are increased so should PaO2 and/or SpO2 increase

MODE

Types:

Volume Control Mode

Pressure Control Mode

Dual Control Mode

MODE

Volume Control Mode

Gives the patient a set volume of with each breath

The volume remains constant, while the pressure in the lungs will vary depending on compliance

Examples include A/C (assist/control) and SIMV (synchronized intermittent mandatory ventilation)

MODE

Pressure Control Mode

This mode delivers breaths based on a set pressure

The pressure is set and remains constant and thus the volume may vary depending on the patient's lung compliance

Examples include Pressure Control (PC), APRV (Airway Pressure Release Ventilation), SIMV-PC

MODE

Dual Control Mode

"Dual control modes use computer algorithms to deliver the best of both worlds" [6]

They can switch between pressure and volume control during or between breaths [6]

They try to achieve a target Vt while regulating the pressure with each breath [6]

Examples: PRVC, VC+, Automode, ASV

RATE

Normal respiratory rate is 12-20 breaths per minute

Depending on your patient, lung compliance, ventilatory goals you'll need to choose a rate between 12-20

Higher metabolic states may need a higher rate

Personally I usually settle on 14-16 set breaths per minute

Tidal Volume

Lung protective ventilation = 6-8 ml/kg of IBW [7]

Ideal Body Weight based on HEIGHT

Multiple IBW formulas exist

Male: (Height in inches - 60) x 2.3 + 50

Female: (Height in inches - 60) x 2.3 + 45.5

Or just use any medical calculator app....

PEEP

Positive end expiratory pressure

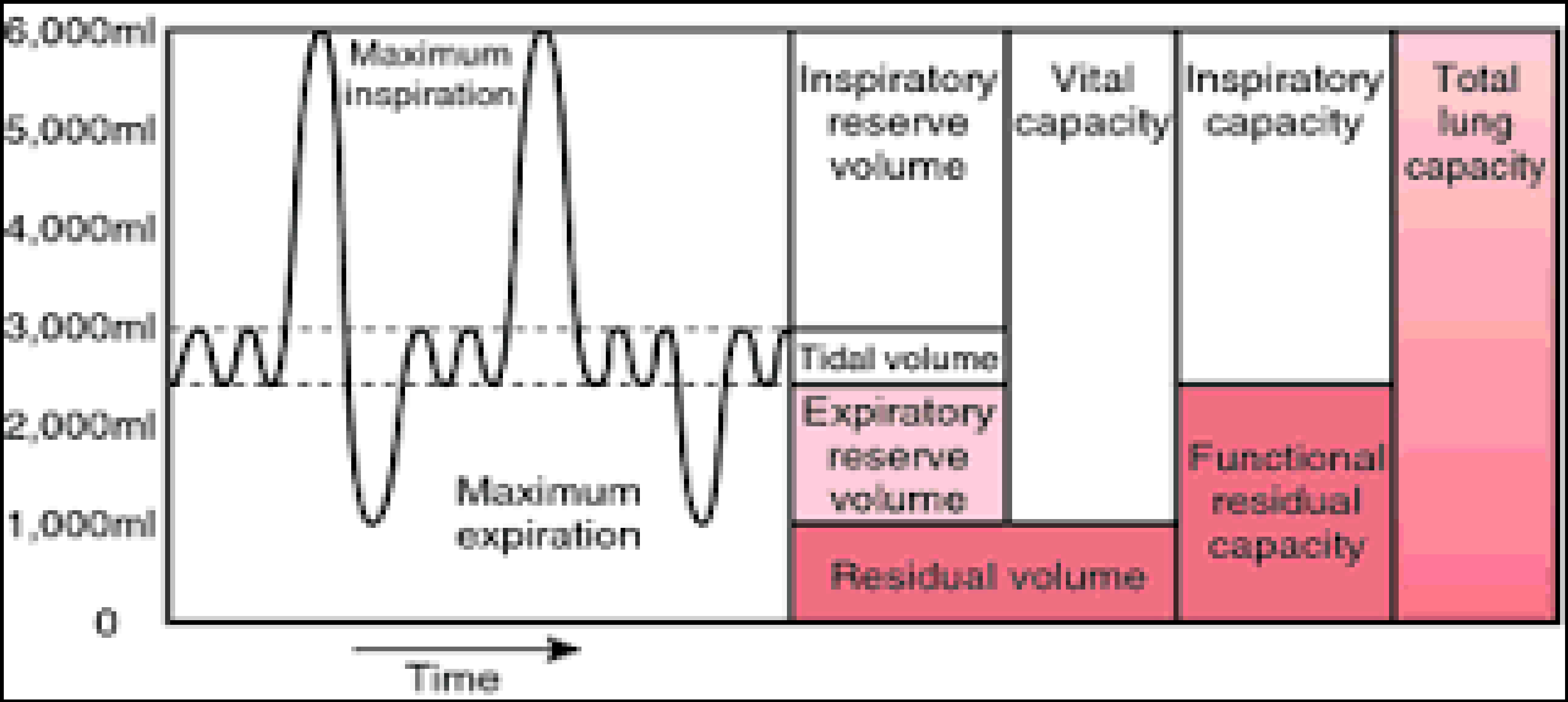
Physiologic PEEP reflected as residual volume in pulmonary function test (~3 cmH_2O)

Initial PEEP setting is traditionally 5 cmH_2O

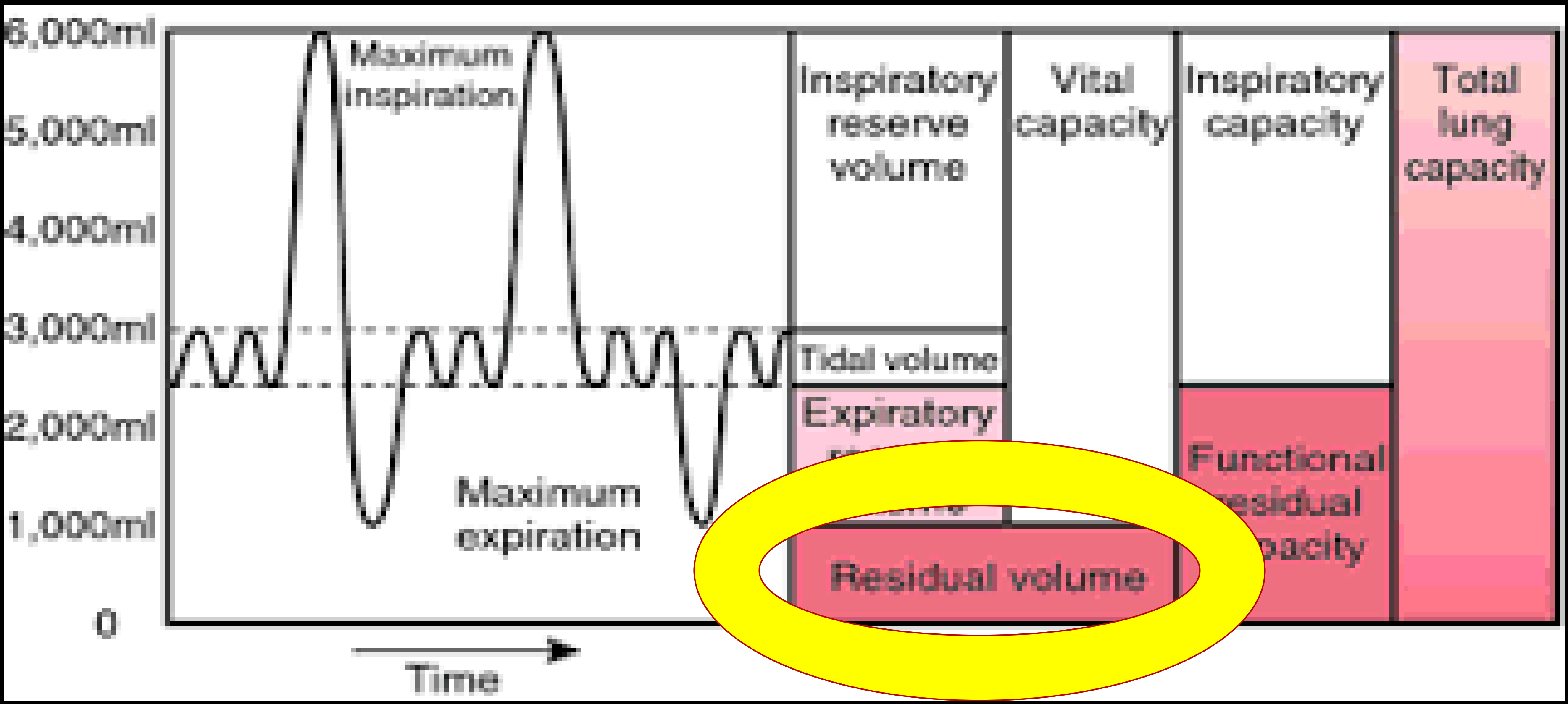
PEEP utilized to optimize SaO_2 (oxygenation)

PEEP “shunts” aveoli open

PEEP


6,000ml
5,000ml
4,000ml
3,000ml
2,000ml
1,000ml
0
Maximum inspiration
Maximum expiration
Time
Inspiratory reserve volume
Tidal volume
Expiratory reserve volume
Residual volume
Vital capacity
Inspiratory capacity
Functional residual capacity
Total lung capacity

PEEP


6,000ml
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1,000ml
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Maximum inspiration
Maximum expiration
Time
Inspiratory reserve volume
Tidal volume
Expiratory
Residual volume
Vital capacity
Inspiratory capacity
Functional
Total lung capacity

PEEP

PEEP “shunts” aveoli open

Blowing up a ballon

FiO2

Fraction of Inspired Oxygen

"Room" air 21% O2

Newly intubated patients – 100% FiO2

Wean as able for SaO2 of 80-100 mmHg on ABG

One can be on 21% FiO2 while ventilated but personally I rarely go below 40%

Implemented Ventilation- Now what?

Vital signs

Patient appearance

Physical exam

Ventilator alarms

ABG 30 minutes after mechanical ventilation. Adjustments as indicated.....

Vital Signs

Things to consider

Tachycardic: Paralyzed and not sedated, pain, comfort on ventilator, pneumothorax

Tachypnea: Pain, Sensitivity/Flow Trigger, Sedation

Hypoxia: FiO2/PEEP, MV, Pneumothorax

Patient Appearance / Physical Exam

Does the patient appear comfortable?

Equal chest rise

Equal breath sounds

Trachea midline

Ventilator Alarms

Ventilators have numerous alarms, as they should....

High Pressure Alarms

Low Volume Alarms

Rate Alarms

Peak Pressure Alarms

Peak pressure reflects pressure within large airways within the cycle of each breath.

Is a result of airway resisitence and compliance.

Values greater then 40 cmH20 concerning

Possible causes are easily remembered through the

DOPE pneumonic

DOPE

Displacement: ETT dislodged, migrated (right mainstem)

Obstruction: Mucus plugging, Patient biting the tube
Inspiratory limb of ventilator circuit being compromised

Pneumothorax

Equipment: Ventilator malfunction, Inspiratory limb of ventilator circuit being compromised

Ongoing Evaluation

Once intubated and mechanical ventilation initiated, measures need to be taken for ongoing evaluation of ventilation appropriateness. At minimum, patient needs to be on cardiac monitor, SpO_2, Rxs for sedation and pain.

ABGs should be collected 30 minutes after initiation of mechanical ventilation, after any changes have been made or any change in the patient's condition

Ongoing Evaluation

30 minute post intubation/changes:

PaCO2:

-High- then increase MV by either increasing rate or Vt

-Low- then decrease MV by decreasing rate

PaO2:

-High- then decrease FiO2

-Low- then increase PEEP (FiO2 if not already on 100%)

Ongoing Evaluation

To achieve optimal results from mechanical ventilation, the patient needs to be "comfortable" if awake (i.e. pain medication or mode selection).

If the patient is awake, ventilated and unable to tolerate mechanical ventilation while awake (anxiety)- sedate (PRN Rxs or IV gtt)

Easier to ventilate a completely sedated (Ø spontaneous breaths) patient if your knowledge of ventilator modes is limited.

You are not alone....

If your facility has the ability to admit ventilated patients, then you probably have available help.

-Respiratory therapist

-Intensivist

-Other PAs

-Literature

Shane-isms

We all have quiet days of desperation.

Your talent and abilities are gifts from God,

What you do with them is your gift back to him.

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THANK YOU

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