Acute Ventilation in Pediatrics

BC Children’s Hospital PICU Physicians
& Respiratory Therapists

August 30, 2024

PHYSICIAN TO PHYSICIAN

CRITICAL CARE SUPPORT FROM BCCH PEDIATRIC INTENSIVE CARE UNIT (PICU)

Most Responsible Physician (MRP) identifies the need for pediatric consult for transport or advice from the BCCH Pediatric ICU (PICU)

↓

MRP/delegate phones Patient Transfer Network (PTN):

1-866-233-2337

Requests a call with BCCH Pediatric Transport Advisor

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PTN connects with PICU Pediatric Transport Advisor & MRP to collaborate on an ADVICE CALL

New option available:
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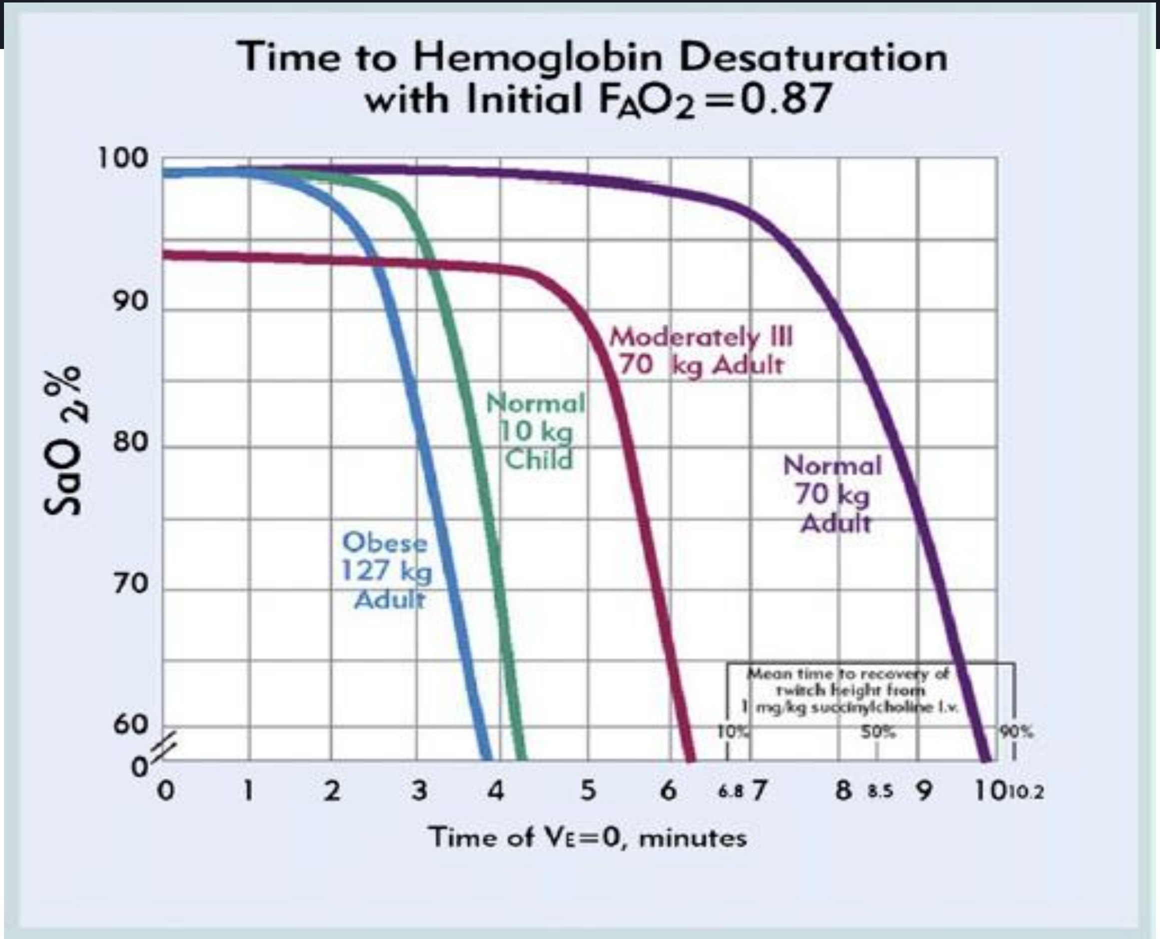
Options for Oxygenation/Ventilation in Children

- Low flow oxygen
- Heated humidified high flow nasal cannula oxygen therapy (HHHFNC)
  - 2L/kg/min
  - maybe useful in some children with bronchiolitis with desaturation not responding to low flow oxygen
- BiPAP (Bi-level positive airway pressure)
  - ventilator delivers an inspiratory positive pressure
  - expiration returns to baseline continuous positive end expiratory pressure
  - good for oxygenation and ventilation problems
  - early initiation in asthma not responding to aggressive medical therapy
- Invasive mechanical ventilation

Basic Physiology

- Children more prone to respiratory failure
  - greater airways resistance at baseline
  - pliable chest walls predispose to reduced FRC and atelectasis
  - desaturate much quicker with apnea – airways close above FRC

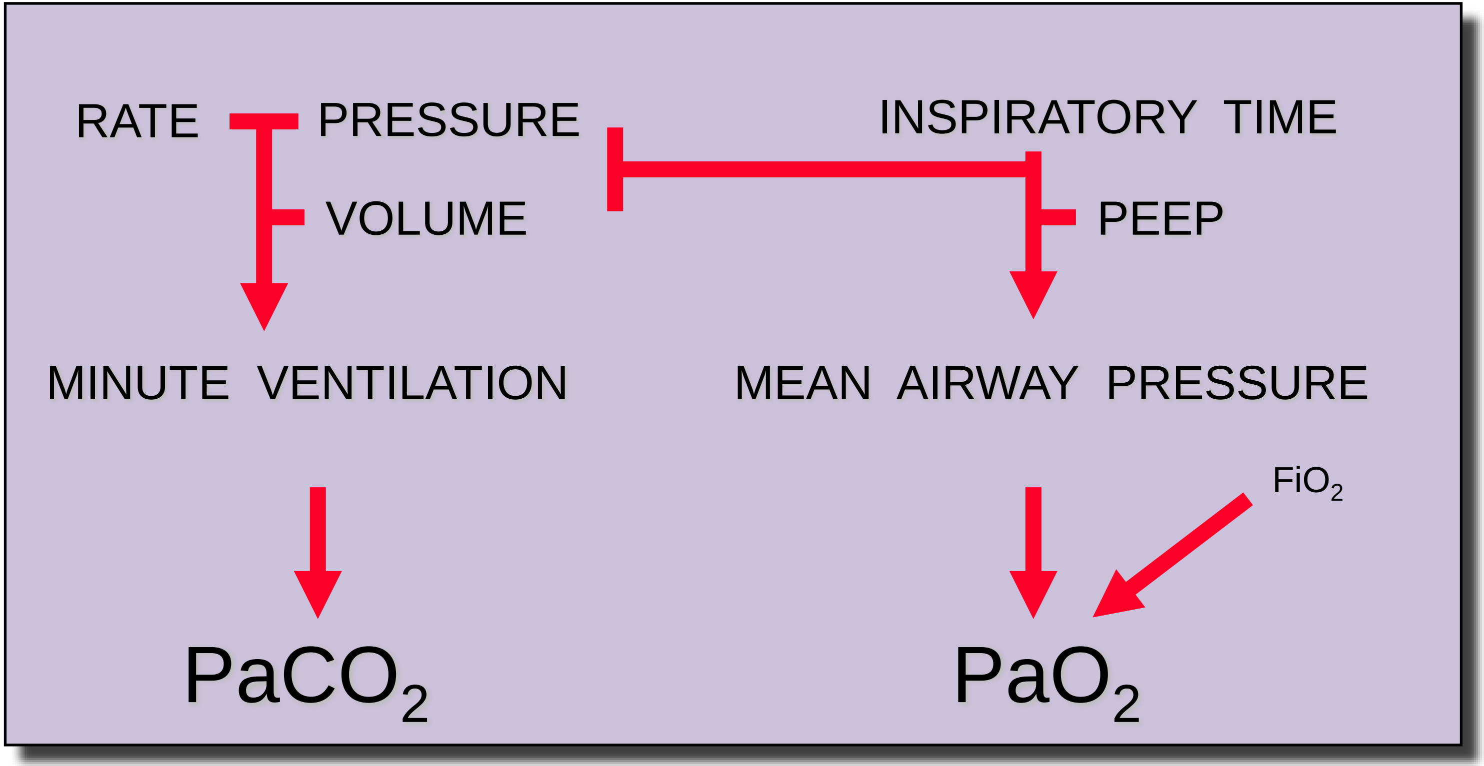
Less Time


Time to Hemoglobin Desaturation
with Initial F_AO_2=0.87
SaO_2,%
100
90
80
70
60
0
0
1
2
3
4
5
6
6.8
7
8
8.5
9
10
10.2
Time of V_E=0, minutes
Moderately Ill
70 kg Adult
Normal
10 kg
Child
Normal
70 kg
Adult
Obese
127 kg
Adult
Mean time to recovery of
twitch height from
1 mg/kg succinylcholine I.v.
10%
50%
90%

Types of Respiratory Failure

- Oxygenation failure
- Ventilation failure

Basic Concepts - Initial Settings on MV



Support

Oxygenation Support

- simple nasal cannula oxygen
- heated humidified high flow nasal cannula oxygen
- non invasive Bilevel (BiPAP)
- invasive MV

Ventilation Support

- non invasive Bilevel (BiPAP)
- invasive MV

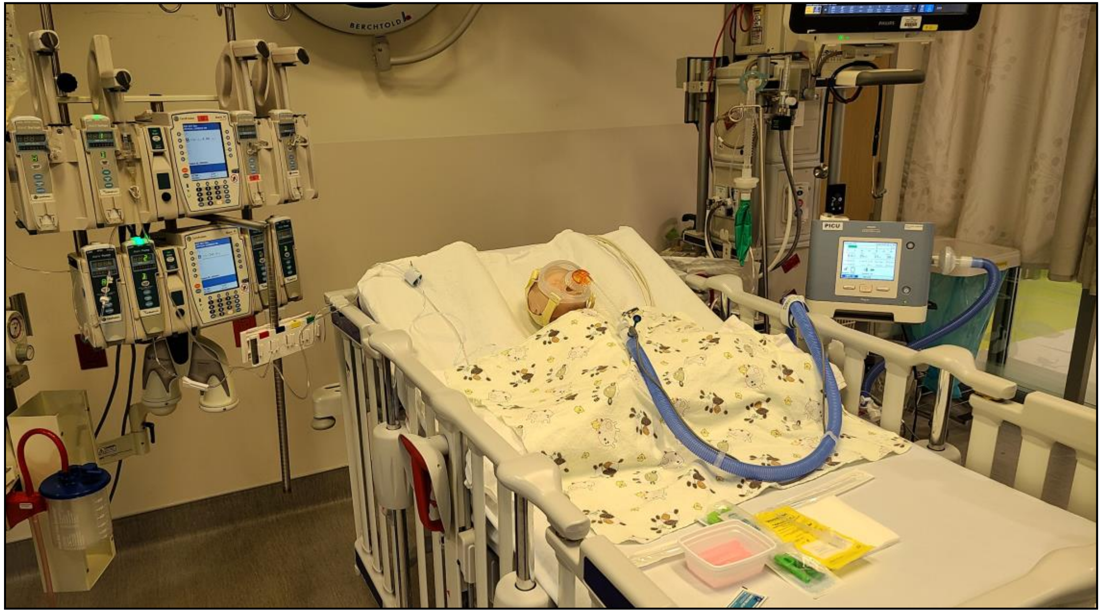
Goal: deliver adequate oxygen flow to meet or exceed the patient's peak inspiratory flow

- establishes control of FiO_2 delivery (as not diluting with room air)
- reduce WOB by supporting inspiratory flow demand
- humidification to optimize secretion clearance
- reduction of upper airway dead space

Flow Recommendations:

Weight	NHF Flow rates	FPH Mode to use
0-12 kg	2 liters/min/ kg To a max 25 liters	Junior Mode
13-15 kg	30 liters/min	Adult mode
16-30 kg	35 liters/min	Adult Mode
31-50 kg	40 liters/min	Adult mode
>50kg	50 liters/min	Adult mode
For flow rates 25 liters/min the flow rates are increased gradually over two minutes and observe how the flow rates are tolerated.		

Noninvasive PPV (NIV or BiPAP)

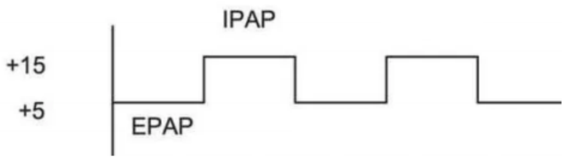


Useful for both oxygenation/ventilation failure

BiPAP Interfaces

Total face masks allow quick fitting, and eliminate nasal bridge challenges by sealing around the perimeter of the face where patients have less pressure sensitivity and smoother facial contours.

Settings on BiPAP



BiPAP is defined as the application of two positive airway pressures

- **EPAP** (expiratory positive airway pressure) = CPAP or PEEP
  - typically start at 5 or 6cmH2O

- **IPAP** (inspiratory positive airway pressure) upon trigger = peak pressure
  - typically start at 10 or 12cmH2O adjusting to achieve adequate Vt or chest rise, CO_2 clearance, patient comfort
  - IPAP is set independently of EPAP (eg.12/6 offers a pressure gradient of 6)

Patient Management on BiPAP

- Optimize FRC by increasing EPAP, optimize Vt by increasing IPAP

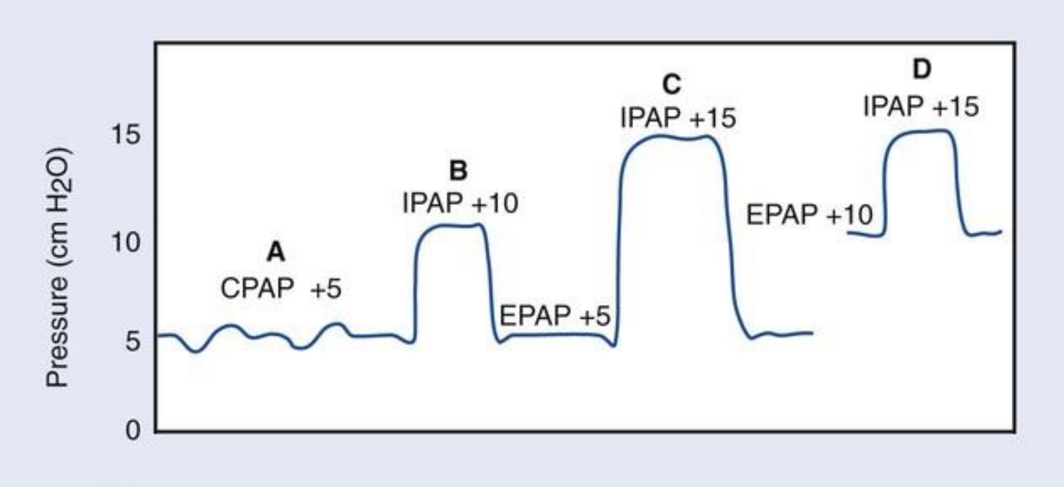
  Example: 12/6 → 14/7 → 16/8 → 18/8 → 18/10 → 20/10 → 20/12

  - consider intubation at higher pressures
    - discuss with PICU

- Optimize airway patency
  - positioning/frequent check for mask leak
  - airway suctioning (oropharyngeal, nasopharyngeal),
  - medications such as salbutamol
  - prone positioning

- Optimize patient comfort
  - sedation my be required
  - optimize settings for patient comfort/confirm each breath is triggered and delivered

Titration of Pressures



Basic Ventilator Initial Settings

Infants and children are NOT ventilated like neonates

Vt	6-8mL/kg
RR	15-30
Ti	0.6-1.2
PEEP	5-10
Target MV	100-200mL/min/kg
IBW is generally reflected by actual body weight	

Quick Settings

	Newborn <1mo	Infant 1mo to 1yo	Toddler 1 to 3yo	Child 3 to 10yo	Adolescent >10yo
Target MV	200mL/min/kg	175mL/min/kg	150mL/min/kg	125mL/min/kg	100mL/min/kg
Vt	7mL/kg	7mL/kg	7mL/kg	7mL/kg	7mL/kg
RR	30	25	22	18-20	15
Ti	0.5-0.6	0.6-0.7	0.7-0.8	0.8-1.0	0.8-1.0

If using lower Vt for lung protection, increase RR to maintain MV

Pay attention to I:E ratio if increasing RR

Basic Ventilator Strategies

- Normal lungs/acute lung injury
  - lung protective

- Obstructive lung disease
  - minimize gas trapping

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What Pressure Settings do I start with?

- Depends on the primary disease process
  - normal lungs
  - airspace disease
  - obstructive disease

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Normal Lungs – Basic Approach

- Paralyzed vs spontaneously breathing?
- TV 6-8 mls/kg
- PEEP 5-6cm H_2O
- I time/RR age dependent
  - paralyzed (see table)
  - spontaneously breathing – determined by the patient
- Reassess patient

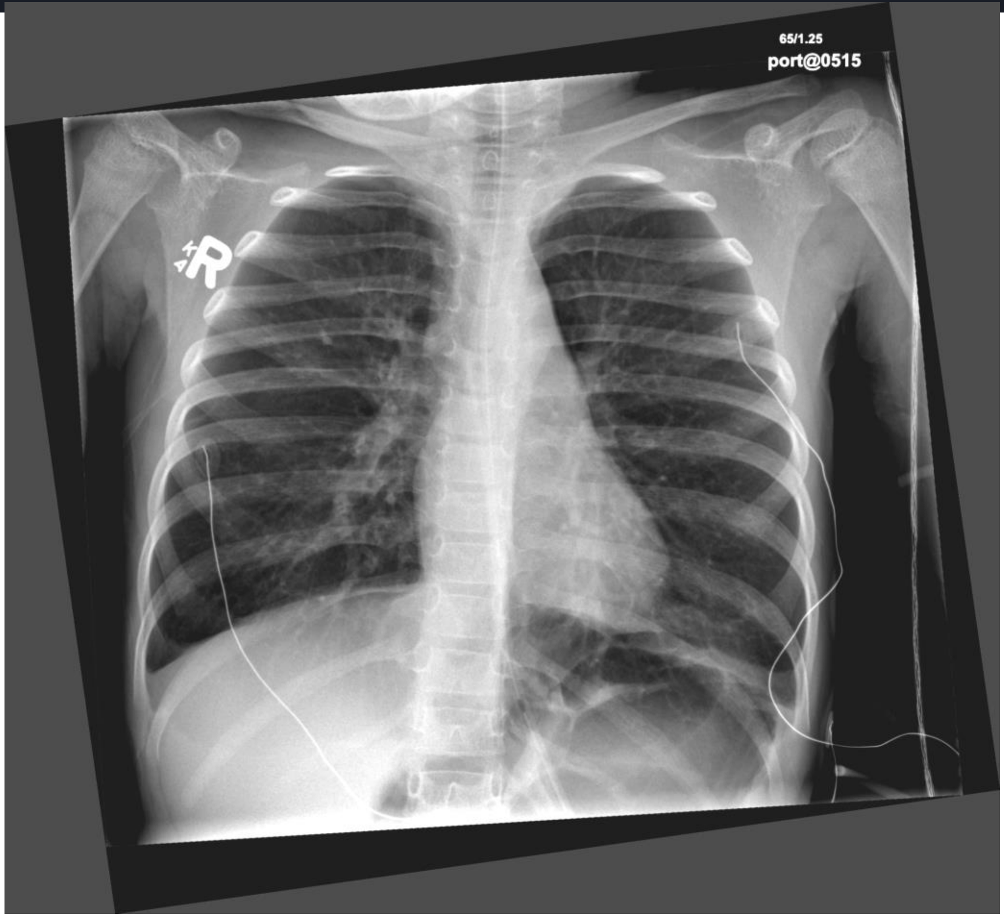
Acute Lung Disease – Basic Approach

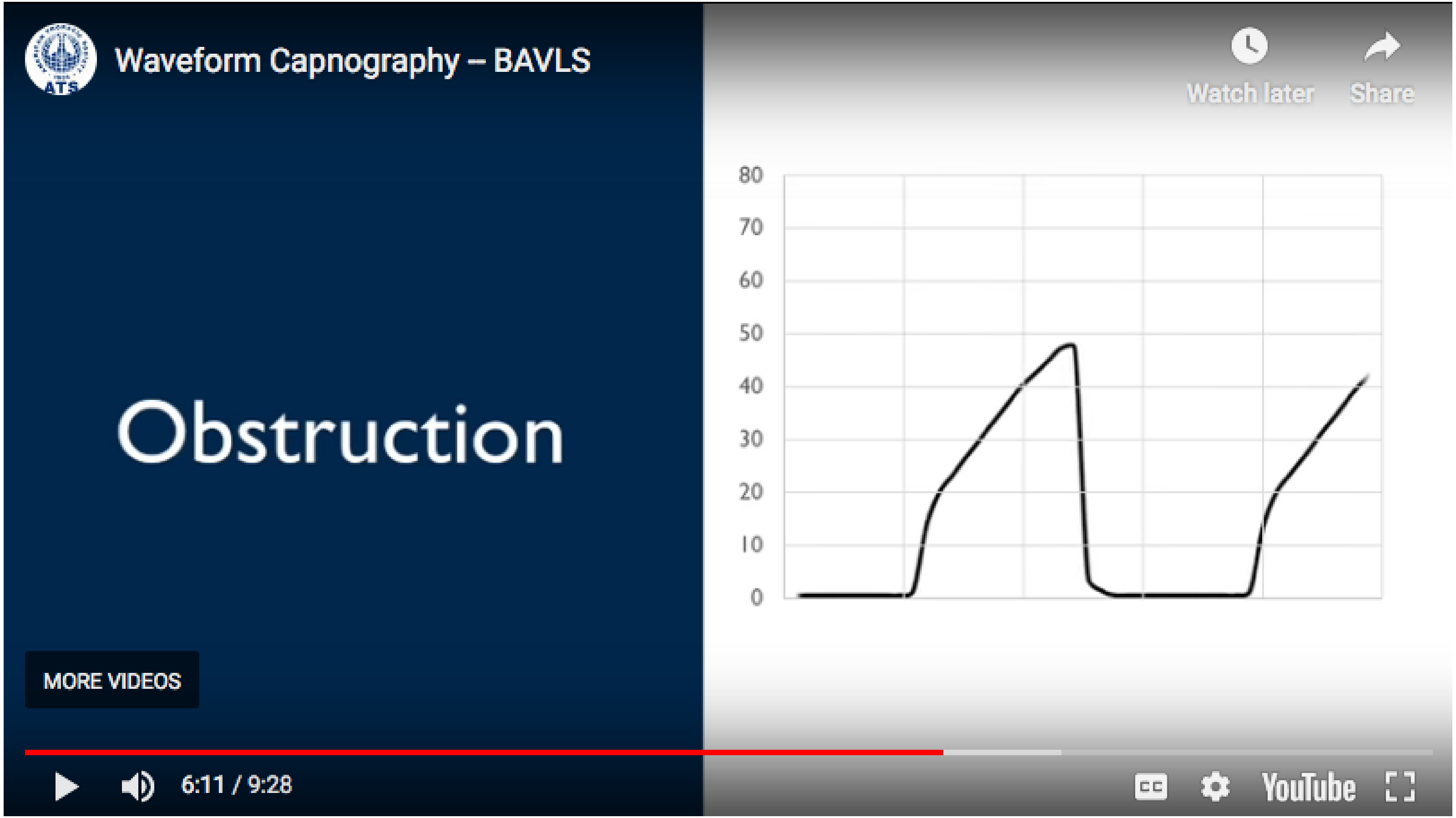
- Paralyzed vs spontaneously breathing?
- TV 5-6 mls/kg
- PEEP 6-8cm H_2O
  - may increase to 10cm H_2O depends on saturations
- I time/RR age dependent
  - paralyzed (see table)
  - spontaneously breathing – determined by the patient
- Reassess patient

Obstructive Lung Disease – Basic Approach

- NIV best initial option
  - BiPAP
- Targets
  - avoid worsening gas trapping / offset intrinsic PEEP
  - unload respiratory muscles / reduce resistance to exhalation
- Settings
  - TV < 8mls/kg
  - Long E time/short I time (patient age dependent/set by patient while spontaneously breathing)
    - Observe patient trigger
  - EPAP set to match intrinsic PEEP in spontaneously breathing patient
  - FiO_2 to maintain sats > 92%

Airway Obstruction Strategy




Waveform Capnography – BAVLS
Obstruction
Watch later
Share
80
70
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50
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10
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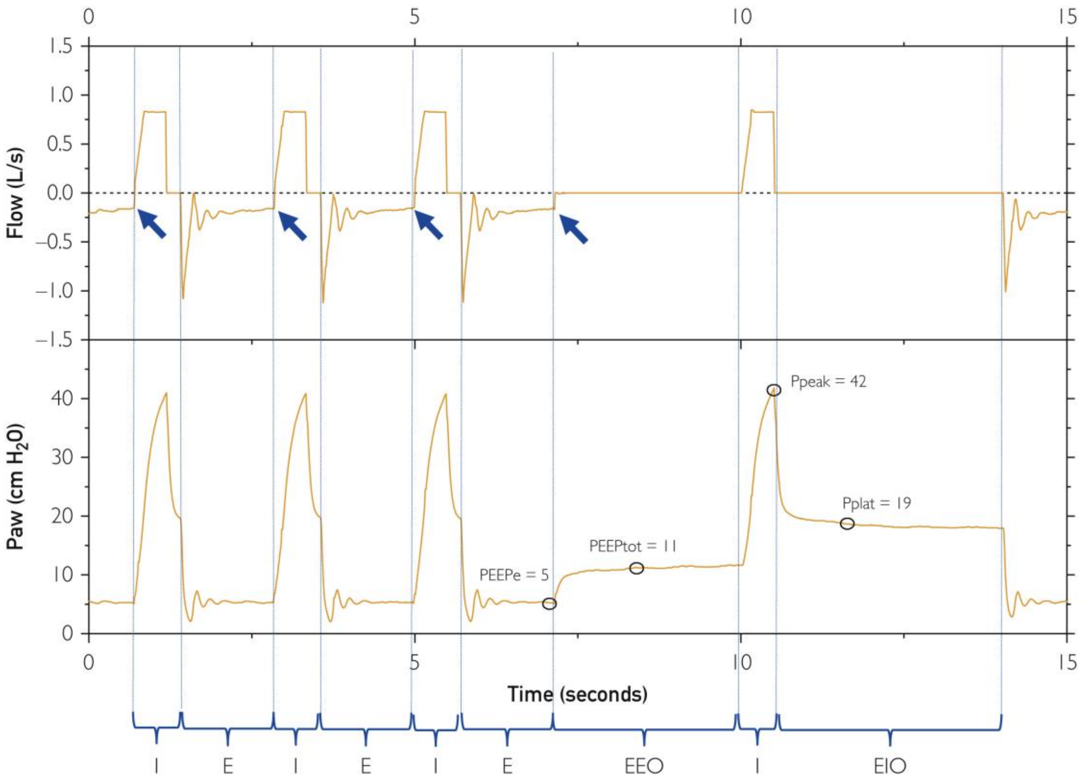
MORE VIDEOS
6:11 / 9:28
YouTube

Expiratory Flow Obstruction



Asthma Emergencies

- Can't ventilate
  - disconnect to manual ventilator with 100% oxygen
  - gentle manual breaths with long expiratory time to allow lung decompression
- Hypotension
  - as for "can't ventilate"
  - give fluid bolus
  - exclude/treat tension pneumothorax
  - bolus IV adrenaline 10mics/kg
- Worsening hypoxemia
  - 100% oxygen/minimize PEEP/minimize gas trapping

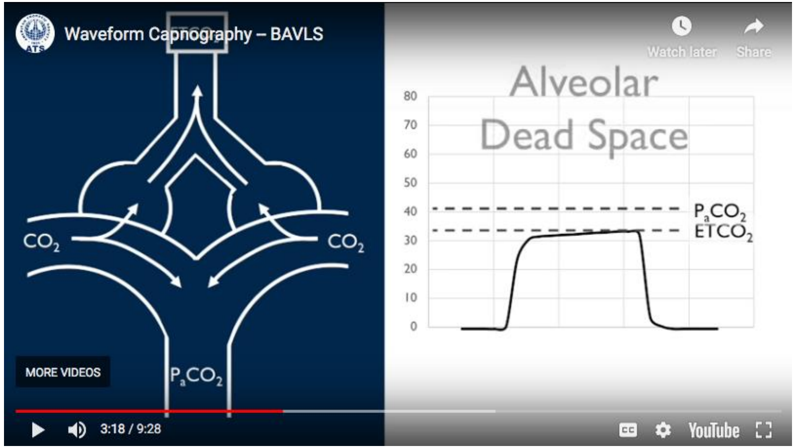
Managing the Patient on MV

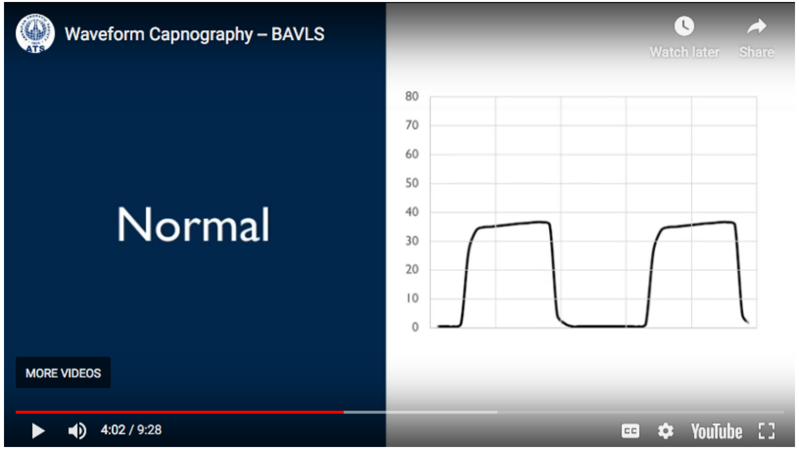
- Sedation/analgesia +/- paralysis
- NG to drain the stomach/provide nutrition
  - D5NS routine 75% maintenance until nutrition initiated
  - provide nutrition
- Patient positioning to reduce pressure sores
  - prone positioning for acute lung injury

Monitoring the Patient on MV

- Clinical exam
  - chest rise equal bilaterally
  - patient - ventilator synchrony
- CXR
  - confirm ETT above carina
  - understand disease process
  - identify air leak
- Monitors
  - saturation
  - $ETCO_2$/transcutaneous CO_2
  - BP/heart rate
  - ventilator waveforms – know the basics
  - intermittent blood gases
    - capillary/venous/arterial

Capnography





Troubleshooting Patient with Hypoxemia

- **D**isplacement
- **O**bstruction
- **P**neumothorax
- **E**quipment

Troubleshooting Acute Hypoxemia on Ventilator

- Disconnect from ventilator
  - attach to manual ventilator and manually ventilate with 100% high flow oxygen
  - check $ETCO_2$
- Assess patient using MASH
  - chest **Movement** with bagging
  - **A**rterial saturations?
  - **S**kin color?
  - **H**emodynamic stability?
- Difficult to bag?
  - tube or patient?
    - suction down ETT
    - directly check ETT placement through the cords
    - CXR

BCEHS BC Emergency Health Services
Provincial Health Services Authority

BC Children's Hospital

CHILD HEALTH BC
LEAD BENEFACTOR save on foods

Provincial Health Services Authority

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