

## Weaning From Mechanical Ventilation

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### Learning Objectives

- ◆ Discuss issues related to readiness for weaning from mechanical ventilation.
- ◆ Compare ventilator weaning strategies with respect to efficiency and safety.
- ◆ Describe underlying causes for failure to wean from ventilation

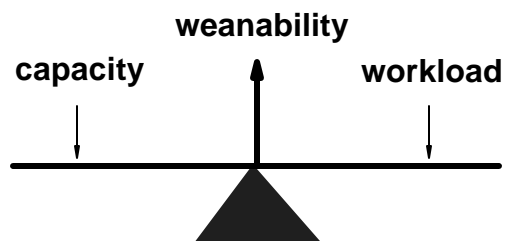
## Weaning Readiness

### Types of Ventilator Discontinuance

- Rapid and routine discontinuance
  - ◆ post-op
  - ◆ overdose
  - ◆ acute illnesses
- Weaning- gradual reduction of support
  - ◆ chronic or severe illnesses
  - ◆ severe trauma
- Ventilator dependent patients

### Causes of Ventilator Dependence

Function of balance between ventilation workload and capacity



### Causes of Ventilator Dependence

- Ventilatory workload exceeds capacity
  - ◆ increased workload
    - increased resistance
    - decreased compliance
    - increased deadspace
  - ◆ decreased capacity
    - impaired neurologic function
    - impaired muscular function

### Causes of Ventilator Dependence

- When should weaning commence?
  - ◆ evaluation for weanability should commence with decision to intubate, ventilate
  - ◆ test for reduced support as soon as determined safe
  - ◆ reduce support as determined safe

### Determinants of Readiness

- Primary factor- improvement or reversal of process that caused commitment to ventilation.

### Determinants of Readiness

- General clinical determinants
  - ◆ APACHE II score (acute physiology and chronic health evaluation)
  - ◆ Cardiovascular stability
  - ◆ Chest radiograph
  - ◆ Cough
  - ◆ Sputum production
  - ◆ Mental status

### Determinants of Readiness

- Oxygenation
  - ◆ PaO<sub>2</sub> > 60
  - ◆ FIO<sub>2</sub> < 0.6
  - ◆ P(a/A)O<sub>2</sub> > .35
  - ◆ P(A-a)O<sub>2</sub> < 350 on FIO<sub>2</sub> = 1.0
  - ◆ PaO<sub>2</sub>/FIO<sub>2</sub> > 200
  - ◆ SvO<sub>2</sub> > 60%

### Determinants of Readiness

- Weaning parameters
  - ◆ VC > 20 ml/kg or TV \* 3
  - ◆ TV > VDAN \* 2
  - ◆ PIMAX @ 20 sec > 20 cm H<sub>2</sub>O
  - ◆ PEMAX > 20 cm H<sub>2</sub>O
  - ◆ f < 38/min\*
  - ◆ PI/PIMAX < 0.3PIMAX\*
  - ◆ RSBI (f/TV) < 100\*- - propofol increases value

\*best predictors

### Determinants Of Readiness

- ▲ CROP weaning index
  - ◆ components
    - compliance (C<sub>dyn</sub>)
    - rate
    - oxygenation (PAO<sub>2</sub>/PaO<sub>2</sub>)
    - pressure (P<sub>I</sub>max)

### Determinants Of Readiness

#### ▲ CROP weaning index

- ◆ CROP - compliance, rate, oxygenation, pressure =

$$(C_{dyn} * P_{imax} * [PaO_2 / PAO_2]) / f$$

- ◆ good predictor if adjusted for weight

### Determinants of Readiness

#### ➤ Workload evaluation

- ◆ accessory muscle usage
- ◆ retractions
- ◆ paradoxical abdominal motion
- ◆ Electronic evaluation- measure workload

### Determinants of Readiness

#### ➤ WHEANS NOT (Ely, 2000)

- ◆ wheezes
- ◆ heart disease
- ◆ electrolytes
- ◆ anxiety
- ◆ neuromuscular disease
- ◆ sepsis
- ◆ nutrition
- ◆ opiates
- ◆ thyroid disease

## Weaning Strategies

### Optimize Patient Condition

- Acid-base, electrolyte balance
- Caloric balance
- Anemia
- Infection

### Optimize Patient Condition

- Pain
- Sleep
- Depression
- Communication
- Decrease FIO<sub>2</sub> to 0.4
- Decrease PEEP to ≤5 cm H<sub>2</sub>O

### Strategies

- Rapid ventilator discontinuance
  - ◆ Criteria
    - less than 72 hours on ventilator
    - no underlying cardiovascular problems
    - good parameters

### Strategies

- Rapid ventilator discontinuance
  - ◆ Procedure
    - evaluate
    - t-tube trial- 30 minutes
    - blood gas
    - extubate

### Strategies

- T-tube trials
- SIMV
- PSV
- CPAP
- Adaptive support ventilation
- Automatic tube compensation
- Weaning protocols

### Strategies

- T-tube trials- advantages
  - ◆ rapid
  - ◆ provides exercise of ventilatory muscles
  - ◆ requires minimal technology

### Strategies

- T-tube trials- disadvantages
  - ◆ more staff time
  - ◆ lack of alarms
  - ◆ imposed WOB from ETT

### Strategies

- SIMV- advantages
  - ◆ less staff time
  - ◆ presence of alarms
  - ◆ can incorporate PSV & CPAP
  - ◆ psychological support-ventilator remains in place

### Strategies

- SIMV- disadvantages
  - ◆ slower
  - ◆ some circuits increase WOB

### Strategies

- PSV- advantages
  - ◆ compensates for imposed WOB
  - ◆ may be faster than T-piece
  - ◆ can be combined with SIMV, CPAP
  - ◆ flow pattern- physiologic, comfortable
  - ◆ permits variability of patient workload

### Strategies

- PSV- disadvantages
  - ◆ high mean airway pressures may be misleading for extubatability
  - ◆ flow cycling problematic with system leaks
  - ◆ low tidal volumes may cause atelectasis- overcome by newer versions?

### Strategies

- CPAP- advantages
  - ◆ prevents atelectasis- emulates epiglottic closure
  - ◆ combinable with SIMV, PSV
  - ◆ same as T-tube with respect to outcomes

### Strategies

- Adaptive support ventilation- automatic weaning
- Automatic tube compensation- electronic extubation

### Strategies

- Extubation with standby bipap
  - ◆ for patients with borderline parameters
  - ◆ for patients likely to become ventilator- dependent

### Strategies

- Weaning protocols
  - ◆ Use combinations of techniques
  - ◆ Research results- faster extubation

### Weaning Protocol (Ely, 2000)

- Daily screening (DS)
- Spontaneous breathing trial (SBT)
- Continuation of ventilation or extubation

### Weaning Protocol (Ely, 2000)

- Daily screening test- 2 min test
  - ◆ patient coughs when suction catheter inserted
  - ◆ intact gag reflex
  - ◆ patient not receiving continuous infusions of vasopressors or sedatives
  - ◆  $\text{PaO}_2/\text{FIO}_2 \geq 200$  torr
  - ◆  $f/\text{TV} \leq 105$
  - ◆ PEEP  $\leq 5$  cm H<sub>2</sub>O

### Weaning Protocol (Ely, 2000)

- Spontaneous breathing trial
  - ◆ recommended by RT
  - ◆ ordered by MD
  - ◆ 120 minutes flowby without PS
  - ◆ monitoring by RN

### Weaning Protocol (Ely, 2000)

- Termination of SBT
  - ◆ successful after 120 min ==> 90% chance of staying off MV for 48 hours
- Termination of SBT
  - ◆  $f > 30$  for 5 min
  - ◆  $\text{SpO}_2 < 90\%$  for 30 sec
  - ◆ 20% change in HR for  $> 5$  min
  - ◆  $\text{P}_{\text{sys}} > 180$  or  $< 90$  for 1 min
  - ◆ anxiety, agitation or diaphoresis for 5 min

**Failure to Wean**

### Causes of Weaning Failure

- Ventilatory demand exceeds capacity
- Underlying disease(s) unresolved- patient not ready
- Inappropriate pulmonary toilet- humidification
- Inadequate management of pulmonary mechanics
  - ◆ bronchodilators
  - ◆ PEEP

### Causes of Weaning Failure

- Cardiovascular instability- i.e. CHF
- Muscular atrophy
- Poor nutrition
- CNS depressants
- Anemia
- Psychological dependence

### Extubation Failure

- Associated with increased mortality
- Causes
  - ◆ Upper airway obstruction- edema
  - ◆ Excessive secretions
  - ◆ Inability to swallow
  - ◆ Cardiac failure or ischemia
  - ◆ Encephalopathy
  - ◆ Respiratory failure- load exceeds capacity

### Summary & Review

- Weaning readiness
  - ◆ general status
  - ◆ oxygenation
  - ◆ ventilatory parameters
  - ◆ evaluation of workload

### Summary & Review

- Weaning techniques
  - ◆ T-tube
  - ◆ SIMV
  - ◆ PSV
  - ◆ CPAP
  - ◆ ASV, ATC
  - ◆ Standby NIPPV (Bipap)
  - ◆ Protocols

### Summary & Review

- Weaning failure
  - ◆ Unreadiness to wean
  - ◆ Ventilatory demand exceeds capacity
  - ◆ Inappropriate respiratory care
  - ◆ Cardiovascular instability- i.e. CHF

## **Summary & Review**

- **Weaning failure**
- ◆ **Muscular atrophy**
- ◆ **Poor nutrition**
- ◆ **CNS depressants**
- ◆ **Anemia**
- ◆ **Psychological dependence**

## **References**

- Meade MO, Guyatt G, Cook DJ. Weaning from mechanical ventilation: the evidence from clinical research. *Respir Care* 2001;46:1408.
- Manthous A (Ed). Liberation from mechanical ventilation, part I. *Respiratory Clinics of North America* 2000;6(2).
- Manthous A (Ed). Liberation from mechanical ventilation, part II. *Respiratory Clinics of North America* 2000;6(3).
- Affessa B, Hogans L, Murphy R. Predicting 3-Day and 7-Day Outcomes of Weaning From Mechanical Ventilation. *Chest*. 1999;116:456-461.  
Tobin et al, *NEJM* 1991; 324: 1445-50
- Khamiees, et al. Propofol infusion is associated with a higher rapid shallow breathing index in patients preparing to wean from mechanical ventilation. *Respir Care* 2001;47:150.

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