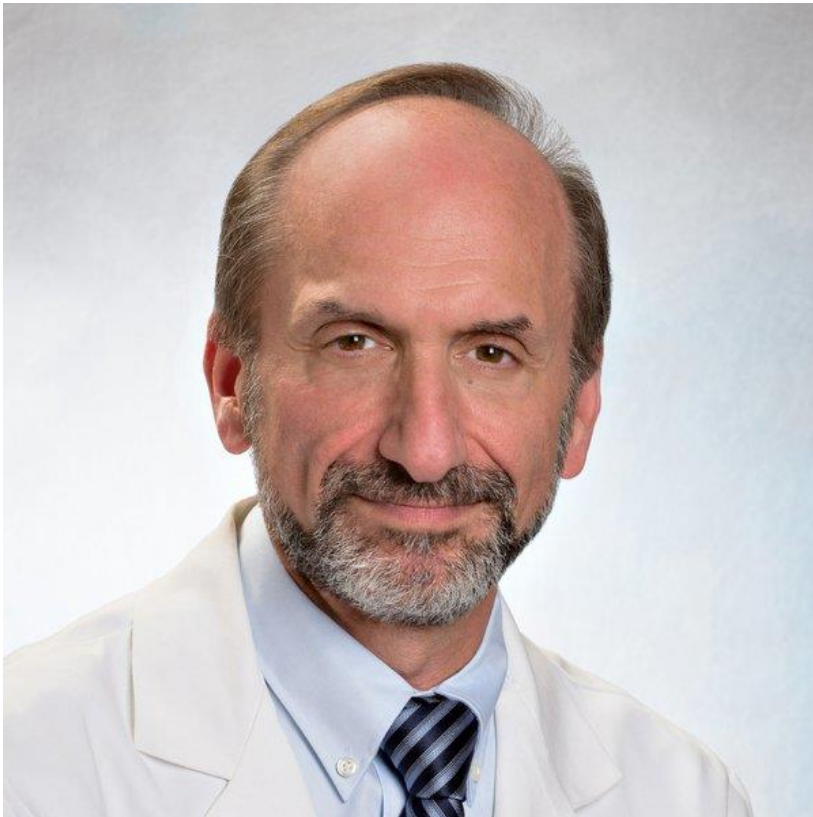


Critical Care: Additional Clinical Pearls and Take-Home Messages

Gerald Weinhouse, MD

Gerald L. Weinhouse, MD



- UMDNJ-New Jersey Medical School
- Medicine Residency at Boston City Hospital
- Pulmonary/Critical Care fellowship at University of Pennsylvania
- Assistant Professor of Medicine at HMS
 - Clinical and research interest in sleep and delirium in the critically ill.

Disclosures

- No financial disclosures

Learning objectives

- Reinforce core principles of critical care management from some of the other lectures
- Cover a few important principles not covered in the other lectures

ABCDEF Bundle Elements



Assess, prevent and manage Pain



Both SAT and SBT



Choice of Analgesia and Sedation



Delirium: Assess, Prevent and Manage



Early Mobility and Exercise



Family Engagement and Empowerment

Pain—Pharmacologic management

- Assessments by validated pain scales
- Opioids are the mainstay; however...
 - Adjuncts are recommended to decrease pain and opioid consumption, ie acetaminophen, low-dose ketamine, neuropathic pain medications.
 - Not recommended for routine use:
 - IV Lidocaine
 - COX-1 selective NSAID's

Pain—non-pharmacologic management

- Suggested:
 - Massage
 - Music
- Not-suggested:
 - Hypnosis
 - Cybertherapy (virtual reality)
- **Protocol** (vs no protocol (usual care)): use of a validated protocol improves pain scores, shortens length of stay, lessens mortality and use of sedative, increases use of nonopioid analgesia.



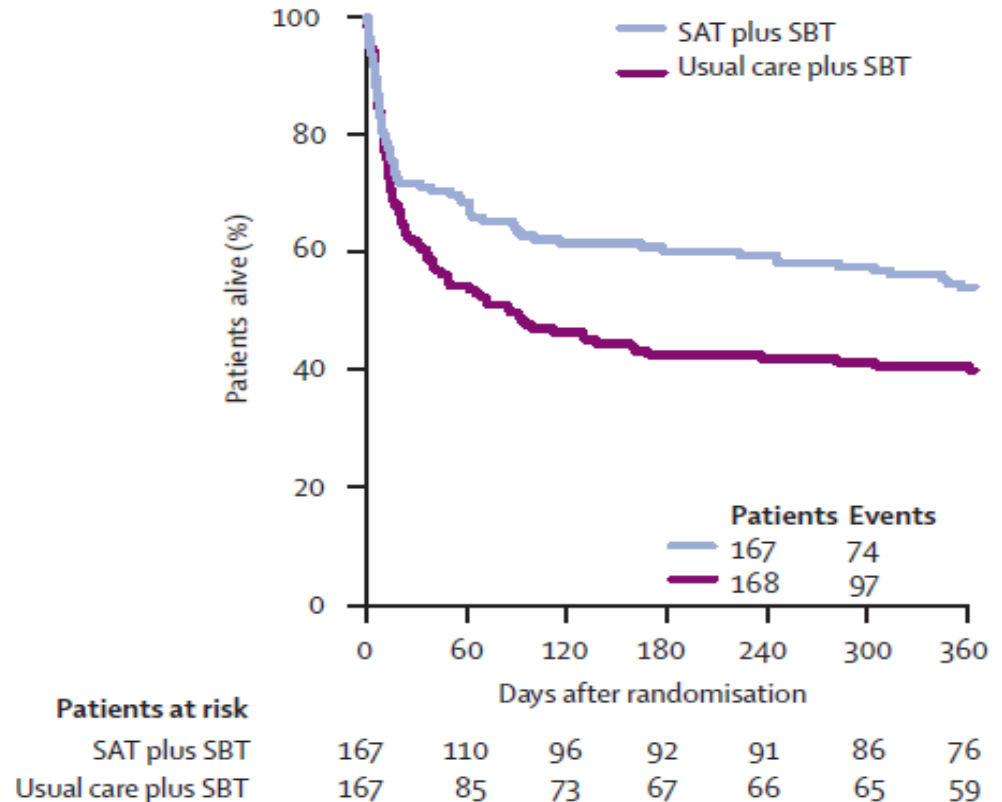
Agitation/Sedation

- **Light** vs deep sedation in mechanically ventilated critically ill patients
 - Shorter time to extubation; fewer tracheostomies

Agitation/Sedation

Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial) a randomised controlled trial

Timothy D Girard, John P Kress, Barry D Fuchs, Jason W W Thomason, William D Schweickert, Brenda T Pun, Darren B Taichman, Jan G Dun
Anne S Pohlman, Paul A Kinniry, James C Jackson, Angelo E Canonico, Richard W Light, Ayumi K Shintani, Jennifer L Thompson, Sharon M
Jesse B Hall, Robert S Dittus, Gordon R Bernard, E Wesley Ely



Daily sedative interruption = nurse-driven protocolized targeted sedation

Choice of analgesia/sedation:

Pharmacology

- Propofol or dexmedetomidine
> Benzodiazepines
- **Propofol = Dexmedetomidine**

Monitoring

- Bispectral index (BIS) for deep sedation or neuromuscular blockade

Other

- Restraints: case by case risk/benefit assessment

Delirium

Modifiable risk factors (strong evidence)

- Benzodiazepine use
- Blood transfusions

Non-Modifiable risk factors

- Age
- Dementia
- Prior coma
- Pre-ICU emergency or trauma
- High APACHE score

Delirium

- Regular assessment with a validated assessment tool is recommended

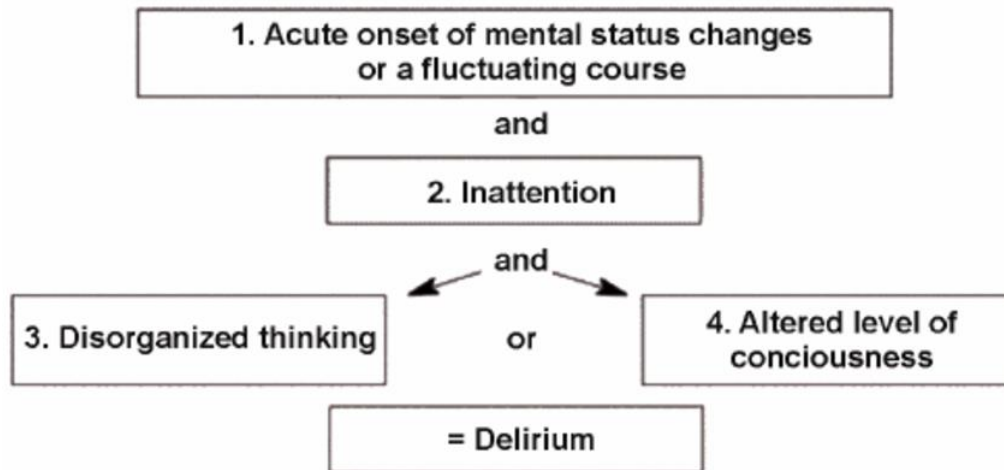


Table 1

Intensive Care Delirium Screening Checklist.¹

Delirium is considered to be present when the score on the following 8 items, assessed each nursing shift, is 4 or higher.

1. Altered level of consciousness: coma (no response) or stupor (no response to loud voice and pain).

- No response: **No score assigned**
- Response only to intense and repeated stimulation: **No score assigned**

No score assigned

- Response to mild or moderate stimulation: **1 point**
- Normal wakefulness or sleep with easy arousal: **0 point**
- Exaggerated response to normal stimulation: **1 point**

2. Inattention: difficulty following conversation or instructions; easy distraction: **1 point**

3. Disorientation: any obvious mistake in time, place, or person: **1 point**

4. Hallucination, delusion, or psychosis: **1 point**

5. Hyperactivity requiring sedation or restraints, or clinically important psychomotor slowing: **1 point**

6. Inappropriate speech or mood: **1 point**

7. Sleep/wake cycle disturbance: frequent spontaneous awakening; sleeping less than 4 hrs/night: **1 point**

8. Marked fluctuation in symptoms or in the manifestations of any of the above items from shift to shift: **1 point**

Delirium

Is associated with:

- Cognitive impairment at 3 and 12 months post-discharge
- May be associated with longer hospital stay

Has not been consistently associated with:

- PTSD
- ICU length of stay
- Depression
- Functional dependence
- Mortality
- Discharge disposition to place other than home

Delirium--Pharmacology

- Prevention?
 - ***Not recommended*** (haloperidol, atypical antipsychotic, dexmedetomidine, statins, ketamine)
- Treatment?
 - ***No pharmacologic treatment is recommended*** for the routine treatment of delirium or subsyndromal delirium except for the mechanically ventilated patient where agitation is interfering with weaning/extubation (dexmedetomidine)

Delirium—Treatment

- Recommended:
 - Multi-component, non-pharmacologic intervention focused on risk reduction
 - Improve sleep
 - Improve wakefulness (reduce sedation)
 - Reduce immobility
 - Reduce visual/hearing impairment

Immobility (Rehabilitation/Mobilization)

- Highlighted in the 2013 PAD guidelines as beneficial as part of a delirium management strategy
- A set of interventions designed to optimize functioning and reduce disability.
- Rehabilitation or mobilization is recommended for critically ill adults.

Immobility

- Ok to begin rehab/mobilization if stability even if stability is achieved with vasoactive infusions or mechanical ventilation.
- Rehab can be done in or out of bed

Ok if:

HR 60-130/min

SBP 90-180 mmHg

DBP 60-100 mmHg

RR 5-40/min

SpO₂ > or = 88%

FiO₂ < 0.6 and PEEP < 10 mmHg

Airway is secured

Sleep



- Why is sleep now part of the PAD-IS guidelines?
 - Sleep is considered a potentially modifiable risk factor influencing recovery in critically ill adults.
 - Whether it is a primary cause of some poor outcomes or represents collateral damage from brain failure in critical illness can be debated.

Sleep

Non-pharmacologic intervention

Mechanical ventilation
(ACV > PSV)

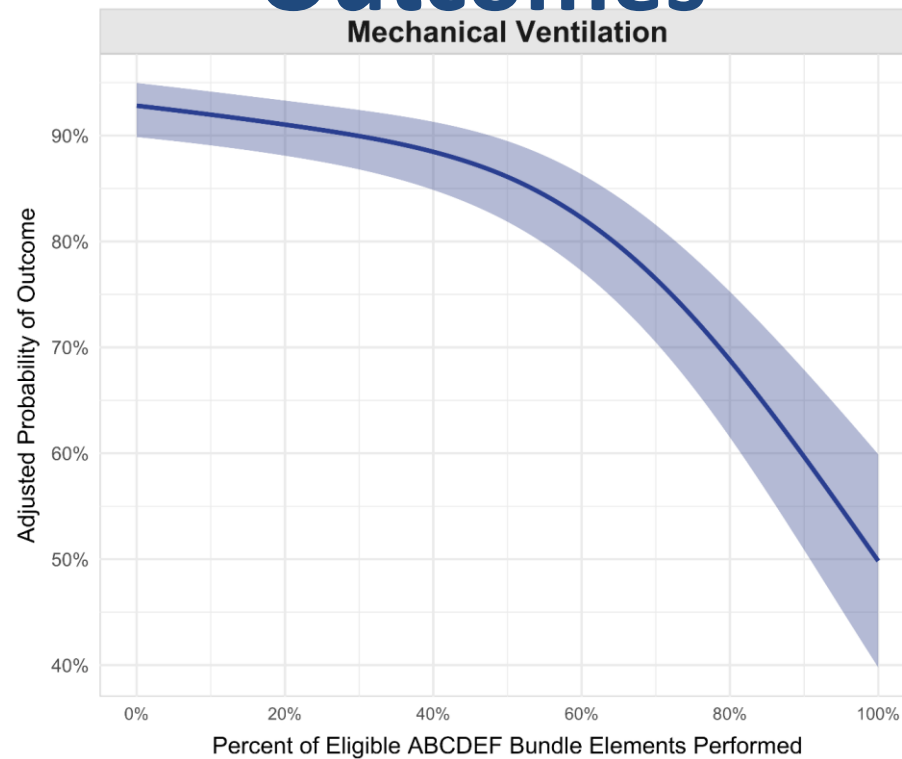
~~Aromatherapy,
acupressure, music~~

Noise and light reduction

Caring for Critically Ill Patients with the ABCDEF Bundle: Results of the ICU Liberation Collaborative in Over 15,000 Adults

Brenda T. Pun, DNP, RN, FCCM¹; Michele C. Balas, PhD, RN, CCRN-K, FCCM, FAAN^{2,3}; Mary Ann Barnes-Daly, MS, RN, CCRN-K, DC⁴; Jennifer L. Thompson, MPH⁵; J. Matthew Aldrich, MD⁶; Juliana Barr, MD, FCCM^{7,8}; Diane Byrum MSN, RN, CCRN-K, CCNS, FCCM⁹; Shannon S. Carson, MD¹⁰; John W. Devlin, PharmD, FCCM¹¹; Heidi J. Engel, PT, DPT¹²; Cheryl L. Esbrook, OTR/L, BCPR¹³; Ken D. Hargett, MHA, FAARC, FCCM¹⁴; Lori Harmon, RRT, MBA, CPHQ¹⁵; Christina Hielsberg, MA¹⁵; James C. Jackson, PsyD¹; Tamra L. Kelly, BS, RRT, MHA⁴; Vishakha Kumar, MD, MBA¹⁵; Lawson Millner, RRT¹⁶; Alexandra Morse, PharmD⁴; Christiane S. Perme, PT, CCS, FCCM¹⁴; Patricia J. Posa, BSN, MSA, CCRN-K¹⁷; Kathleen A. Puntillo, PhD, RN, FCCM, FAAN¹⁸; William D. Schweickert, MD¹⁹; Joanna L. Stollings, PharmD, FCCM²⁰; Alai Tan, PhD²; Lucy D'Agostino McGowan, PhD²¹; E. Wesley Ely, MD, MPH, FCCM^{1,22}

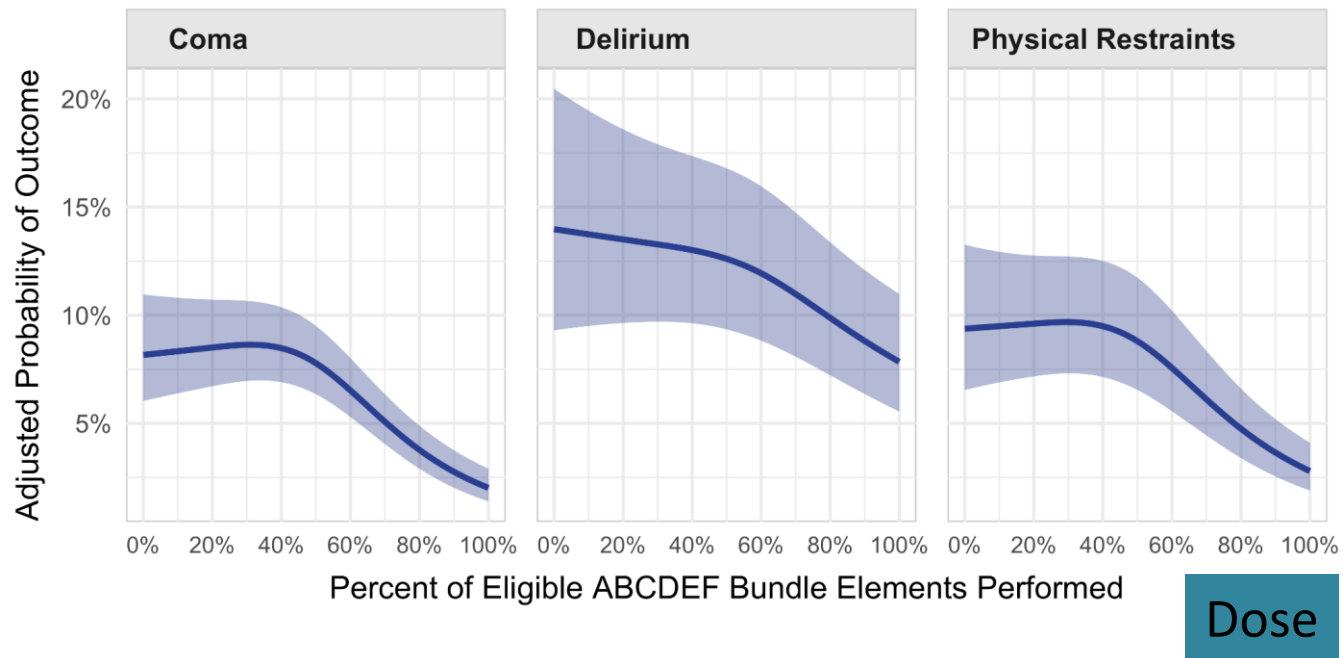
Results: Symptom-Related Outcomes



Dose

Pun B, et al. *Crit Care Med.* 2019; 47:3-14

Results: Symptom-Related Outcomes



Pun B, et al. *Crit Care Med.* 2019; 47:3-14

Surviving but not thriving:

The burden of Post-Intensive Care Syndrome

Neuropsychological Sequelae and Impaired Health Status in Survivors of Severe Acute Respiratory Distress Syndrome

RAMONA O. HOPKINS, LINDELL K. WEAVER, DONNA POPE, JAMES F. ORME, Jr.,
ERIN D. BIGLER, and VALERIE LARSON-LOHR

- Emphasized that lung function could return to near normal
- Survivors instead limited by weakness, and cognitive dysfunction

Anecdotal Evidence – Lay press

HEALTH

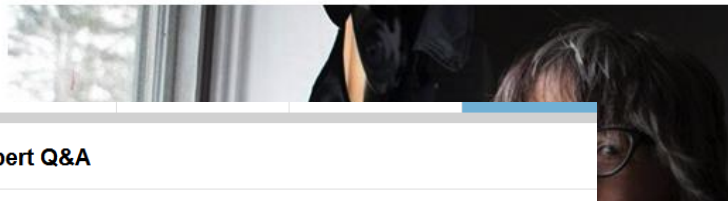
Flashbacks plague former ICU patients

By Dr. Daniela J. Lamas | GLOBE CORRESPONDENT | APRIL 08, 2013

ARTICLE

COMMENTS (3)

SUBSCRIBE



Expert Q&A

updated 1:46 p.m. EST, Tue December 1, 2009

How can I get help for PTSD induced by an ICU stay?

Asked by Celia C, Denver, Colorado
Following a two-month ICU stay five years ago, I was told that I had many symptoms of PTSD. The near-death experience would have been enough to shake me up alone, but when I wound up with ICU delirium ... I don't know how long it lasted, it felt like years, and the hallucinations were worse than all of the surgeries and physical therapy out

MIND | JULY 22, 2013, 5:41 PM | 205 Comments

Nightmares After the I.C.U.

By JAN HOFFMAN



Post-Intensive Care Syndrome

“New or worsening impairments in physical, cognitive, or mental health status arising after critical illness and persisting beyond acute care hospitalization”

Estimates: 50% (of the 4.8 million annual ICU survivors) will experience at least one symptom.

Brain ICU cohort

- Adults admitted to medical/surgical ICUs with respiratory failure, cardiogenic shock, or septic shock.
- **Excluded** individuals mechanically ventilated at any time two months before the current ICU admission, spent >5 days in an ICU during the month before the current ICU admission, or spent >72 hours with organ dysfunction in the current ICU admission
- And individuals with significant preexisting cognitive impairment identified
- And individuals at high risk for preexisting cognitive deficits due to neurodegenerative dz, recent cardiac surgery or suspected anoxic injury
- **821 patients enrolled, then evaluated at 3 and 12 months**

Depression

	3 months	12 months
No prior depression	30%	29%
Prior history of depression	37%	33%

Cognitive Impairments

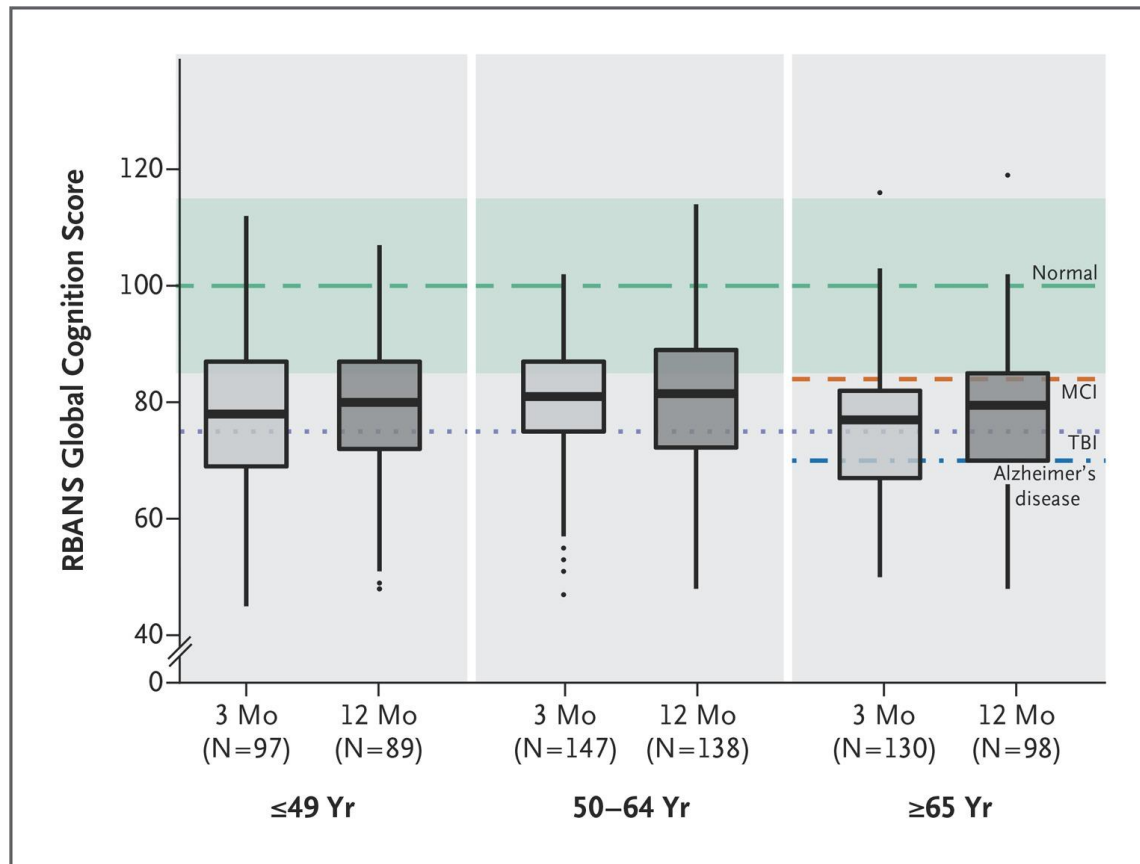
ORIGINAL ARTICLE

Long-Term Cognitive Impairment after Critical Illness

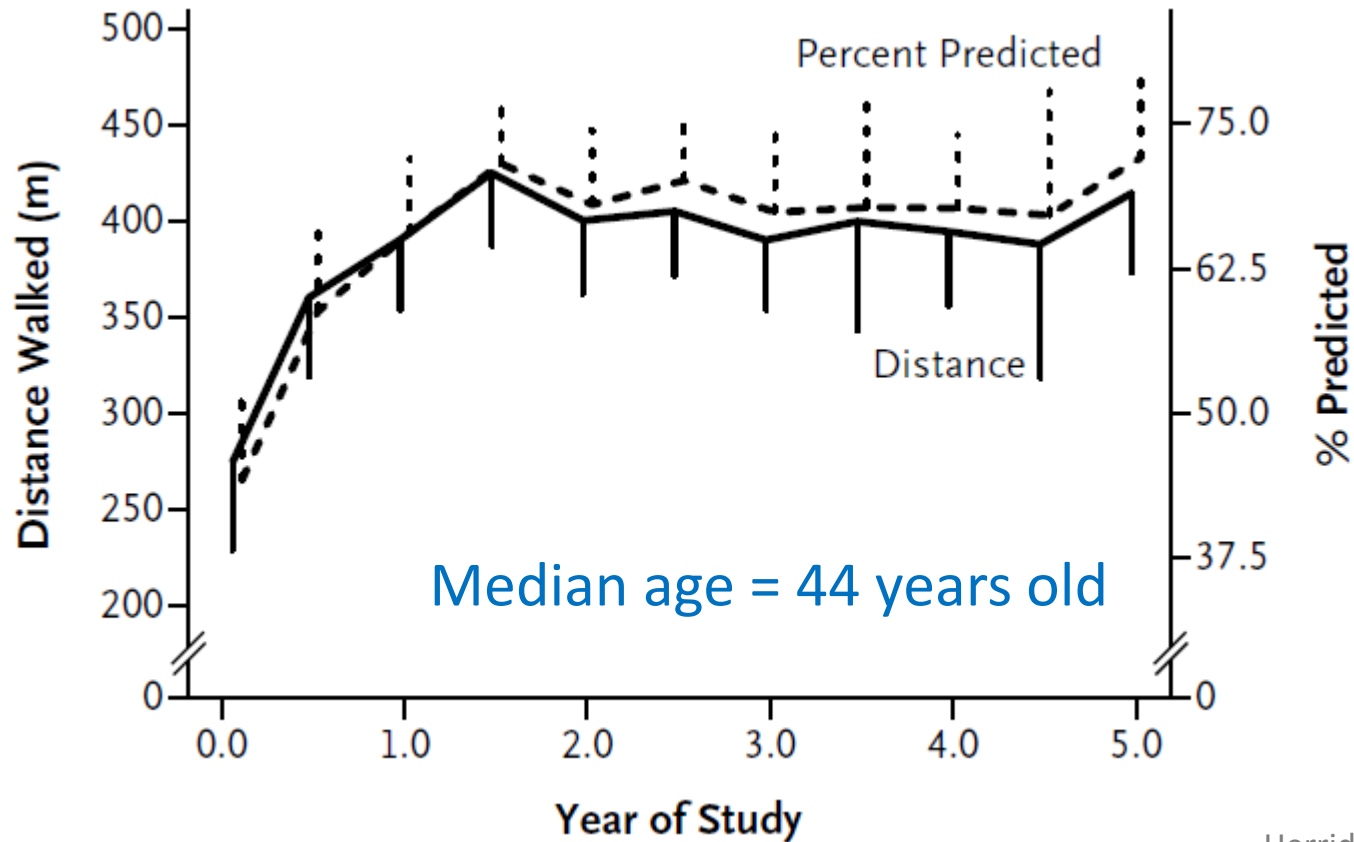
P.P. Pandharipande, T.D. Girard, J.C. Jackson, A. Morandi, J.L. Thompson,
B.T. Pun, N.E. Brummel, C.G. Hughes, E.E. Vasilevskis, A.K. Shintani,
K.G. Moons, S.K. Geevarghese, A. Canonico, R.O. Hopkins, G.R. Bernard,
R.S. Dittus, and E.W. Ely, for the BRAIN-ICU Study Investigators*

NEJM 2013

Global Cognition Scores in Survivors of Critical Illness.

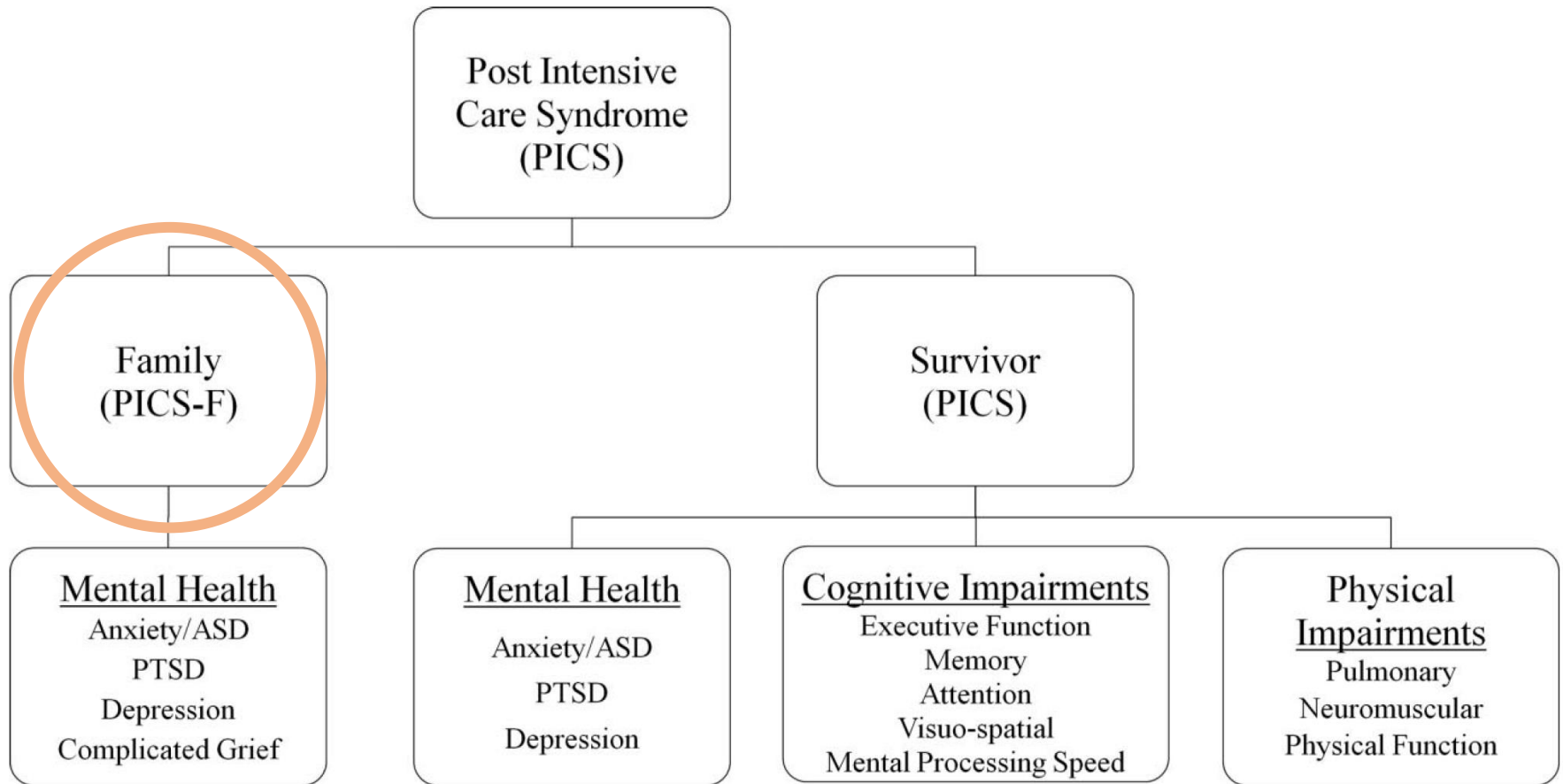


Physical impairments are long lasting



PICS-F

The toll on caregivers



Mechanical Ventilation

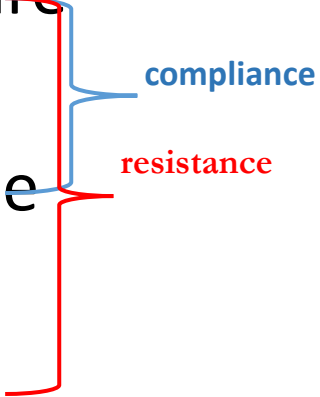
Indications

- Hypoxemia
 - Inability to achieve adequate oxygenation
- Hypercapnea
 - Inability to maintain adequate alveolar ventilation
- Excessive work of breathing
- Inability to protect the airway

Goals

- Maintain adequate oxygenation (pO₂)
- Guarantee adequate alveolar ventilation (pCO₂)
- Avoid harm
- Optimize patient comfort
- Extubate as soon as possible!!!

The Variables

- Pressure
 - Volume
 - Flow
 - Time
- 
- The diagram illustrates the relationships between the variables listed. A blue bracket groups 'Pressure' and 'Volume', with the label 'compliance' in blue text to its right. A red bracket groups 'Volume' and 'Flow', with the label 'resistance' in red text to its right.

- Triggering

- Cycling

Understanding Modes of Mechanical Ventilation

Mode Name	Type of Breath	Initiation	Termination (cycling)
AC	Volume	Patient or timer	Volume
PCV	Pressure	Patient or timer	Timer
PSV	Pressure	Patient	Flow Rate

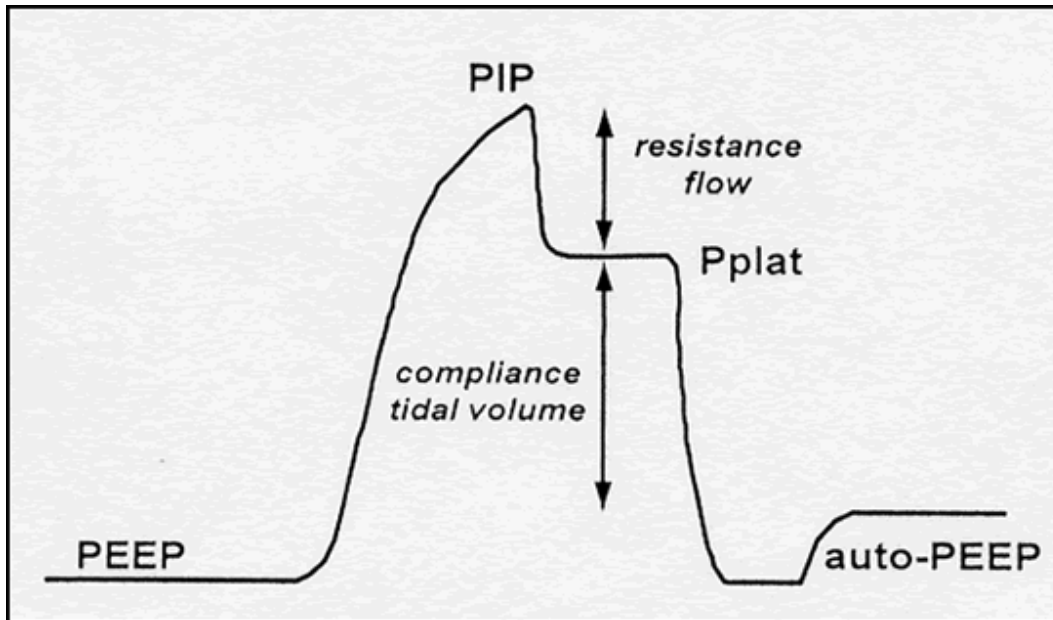
Static Compliance=

$\Delta \text{volume} / \Delta \text{pressure} =$

Tidal volume / plateau-PEEP

$500 / (15 - 5) = 50$

Normal: **50-100 ml / cm H₂O**



Respiratory Mechanics

Elevated Peak Inspiratory Pressure

```
graph TD; A[Elevated Peak Inspiratory Pressure] --> B[Resistance Problem<br/>(large difference between peak and plateau pressure)]; A --> C[Compliance Problem<br/>(small difference between peak and plateau pressure)]; B --> D[Problem with obstruction of the flow of gas into the lung related to the tubes or airway]; C --> E[Problem with the stiffness of the lung];
```

Resistance
Problem
(large difference
between peak and
plateau pressure)

Problem with obstruction of
the flow of gas into the lung
related to the tubes or
airway

Compliance
Problem
(small difference
between peak and
plateau pressure)

Problem with the
stiffness of the
lung

Elevated Peak Airway Pressures

Decreased compliance

Hi peak, hi plateau pressures

Pneumonia

ARDS

Severe CHF

Effusion

Pneumothorax

Right mainstem intubation

Increased resistance

Hi peak, normal plateau pressures

Water/kink of ventilator tubing

Obstructed ETT/secretions

Asthma/bronchospasm

COPD

Complications of Mechanical Ventilation

- Ventilator-induced lung injury
- Ventilator associated pneumonia
- Oxygen toxicity
- Decreased cardiac preload
- Gastric stress ulceration

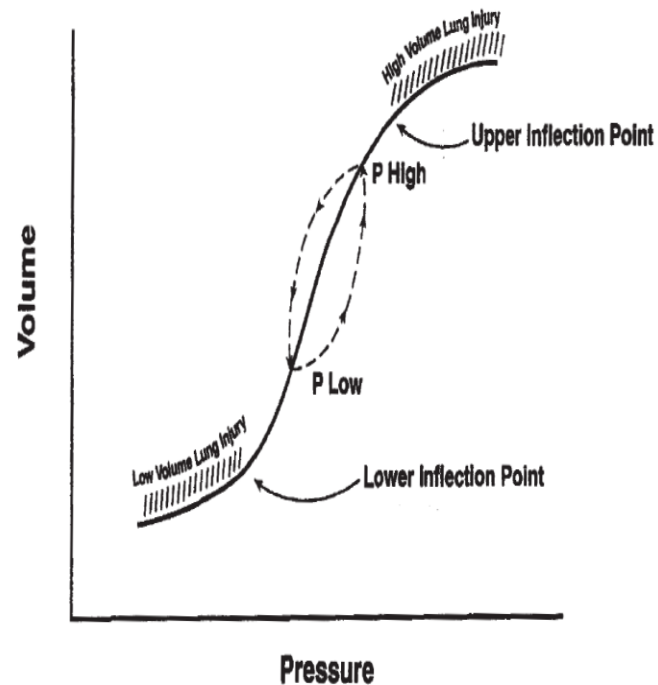
Lung Protective Ventilation: the current standard of care

- **Low tidal volume**

- 6 mL/kg (4-8 mL/kg)
- Maximum plateau pressure <30 cm H₂O
- FiO₂ and PEEP adjusted to keep PaO₂ 55-80 mm Hg

- **PEEP**

- How to best find optimal PEEP remain unclear
- Use PEEP to enable adequate oxygenation by improved alveolar recruitment



Intrinsic or “Auto” PEEP

- Usually only clinically relevant in those with obstructive lung disease (e.g. COPD)
- Can cause:
 - Ventilator dyssynchrony
 - Barotrauma
 - Hypotension

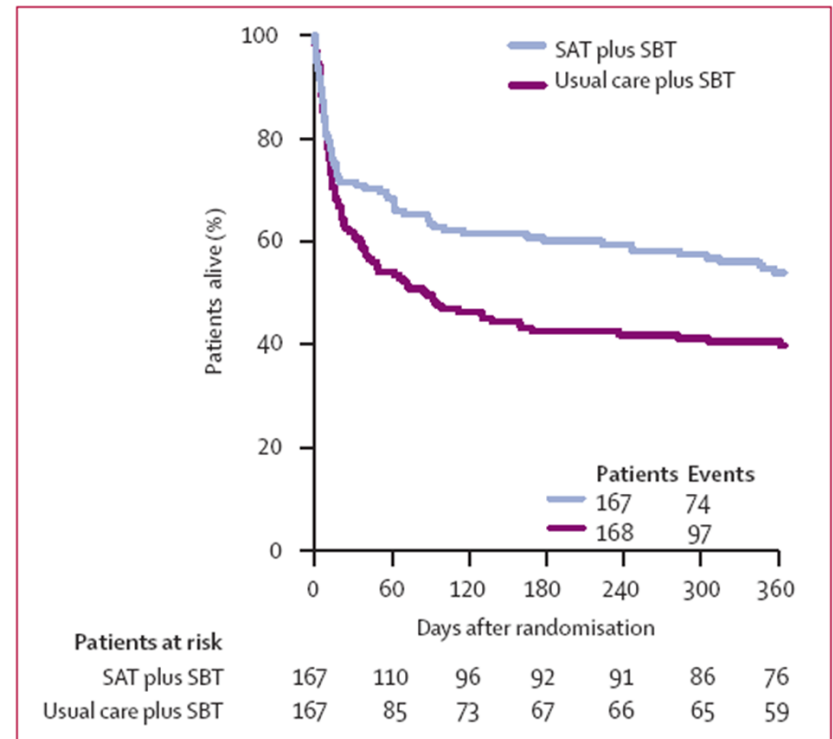
How to treat auto-PEEP

- Decrease minute ventilation
 - Decrease TV
 - Decrease RR
- Increase expiratory time
 - Increase inspiratory flow rate
- Increase extrinsic PEEP to facilitate synchrony

The exit strategy:

Spontaneous awakening trial (SAT) paired with spontaneous breathing trial (SBT)

- Assess patient readiness for extubation
 - Hemodynamically stable
 - Able to protect airway
 - $\text{FiO}_2 < 60\%$
 - $\text{PEEP} < \text{or} = 7.5 \text{ cm H}_2\text{O}$
- Spontaneous breathing trial paired with “sedation vacation”.



Girard et al. Lancet 2009

Indications for **non-invasive** ventilation (NIV)

- Subjective dyspnea and tachypnea
- Accessory muscle use, abdominal paradox
- $\text{pH} < 7.35$ with $\text{PaCO}_2 > 45$ mmHg
- $\text{PaO}_2/\text{FiO}_2 < 200$ mmHg
- Conscious and cooperative*

Contraindications to NIV

- Cardiac or respiratory arrest
- Hemodynamic instability or unstable cardiac arrhythmia
- High aspiration risk
- Severely impaired consciousness or inability to cooperate
- Facial surgery, trauma, or deformity
- Upper airway obstruction
- Recent upper airway or upper GI surgery
- Prolonged duration of ventilatory support anticipated

Potential Benefits of NIV

- Reduce WOB
- Improve gas exchange
- Avoid complications and discomfort associated with invasive ventilation
- Reduce intubation rate
- Facilitate/accelerate extubation
- Reduce LOS
- Decrease cost
- Reduce mortality

Summary for NIV

- Strong evidence for use in acute exacerbation of **COPD** and **cardiogenic pulmonary edema**
- Use in acute hypoxic respiratory failure and immunocompromise remains controversial

NIV vs hi flow nasal cannula

- HFNC may be as good as NIV for acute hypoxemic respiratory failure
- HFNC more comfortable / better tolerated than standard oxygen or NIV
- Both HFNC and NIV may reduce respiratory failure post extubation
- *Frequent reassessment with both modes necessary to avoid delayed intubation*

Sepsis and septic shock

- Early identification
- Source control and early broad spectrum antibiotics
- Early fluid resuscitation, primarily with crystalloids
- Norepinephrine first line vasopressor
- Addition of vasopressin an option to try to limit higher NE doses
- Epinephrine next for refractory, fluid-unresponsive shock
- Limited role for dopamine and neosynephrine
- Novel pressors may be on the horizon

Cardiogenic shock

- Cardiogenic shock is associated with high mortality
- Recognizing and classifying cardiogenic shock can be challenging, but is essential
- Prompt revascularization is the critical therapy for acute MI with shock
- Diverse causes of cardiogenic shock exist beyond acute MI, but are much less studied
- For cardiogenic shock caused by a treatable etiology, prompt etiology-specific therapy is essential
- Supportive measures include inotropes, vasodilators, diuretics and mechanical circulatory support
- Multidisciplinary decision-making facilitates rapid and appropriate initiation of directed supportive therapy

ARDS

- P/F ratio key for prognosis and treatment
- Optimize PEEP
- If $\text{PaO}_2/\text{FiO}_2 < \text{or} = 150$, consider neuromuscular blockade if dyssynchrony
- If $\text{PaO}_2/\text{FiO}_2 < \text{or} = 150$ initiate prone ventilation early. 16 hr prone/8 hr supine
- If very severe or still failing, consider ECMO

Prevention (4-element ICU bundle)

- **DVT prophylaxis**
- **Stress ulcer prophylaxis:** H2 or PPI for high risk patients
- **Elevation head of bed 30°:** A common denominator in ventilator associated complication and HAP is to avoid aspiration. Also, oral care.
- **SAT/SBT**
- Environmental control to prevent delirium, facilitate sleep

