Ventilator Discontinuation:
The evidence base and "best practice"

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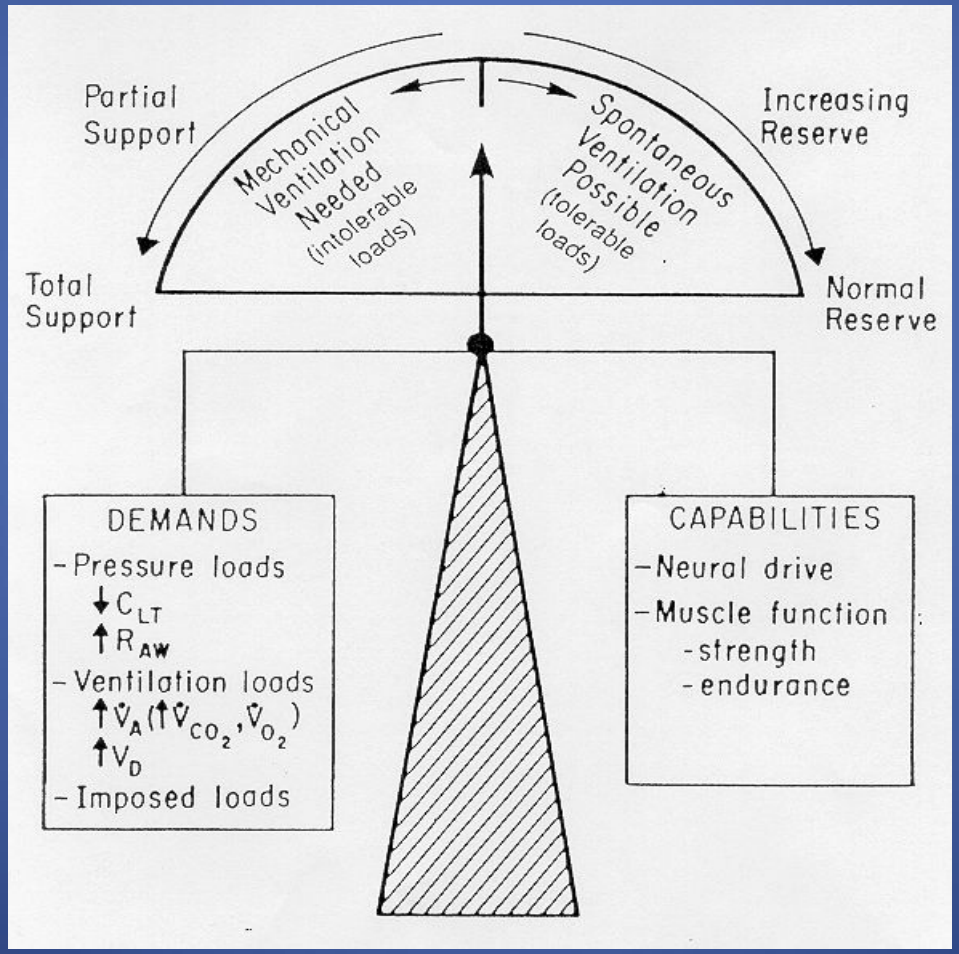
Ventilator dependency reflects an imbalance in loads/capacities



Ventilator dependency can also be iatrogenic

- Failure to recognize discontinuation potential
- Imposed loading:
  - insufficient support
  - insensitive/unresponsive triggers
  - flow dys-synchrony
  - cycle dys-synchrony
- Inefficient weaning “rules”
- Unnecessary sedation:
  - Kollef et al (1999) demonstrated sedation protocols reduce ventilator time

The Ventilator Discontinuation Process - EBM Projects

- AHCPR - McMaster comprehensive evidence based review
  - 5000 papers screened
  - Over 150 quality trials systematically analyzed
  - Published Nov 1999

The Ventilator Discontinuation Process - EBM Projects

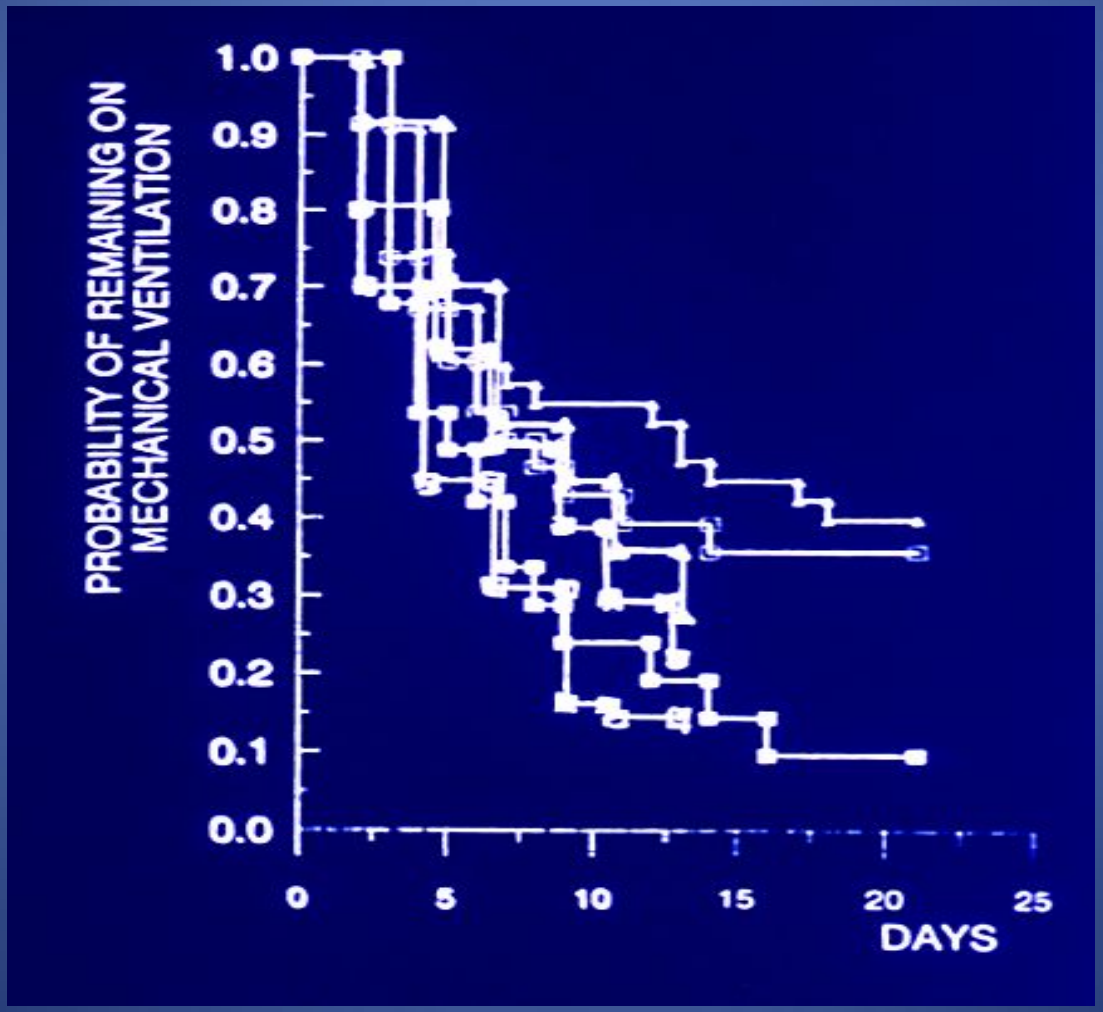
- ACCP/SCCM/AARC Task Force
  - Organized May 1999
  - Used McMaster report + own research + consensus to “fill in the gaps”
  - Developed 12 evidence based guidelines published in Chest Supplement December 2001

McMaster EBM Review - significant LRs

Parameter	Number of studies	Threshold values	Range of positive LRs
A. Measured on ventilator			
Minute ventilation	20	10-15 L/min	.81 to 2.37
Negative insp force	10	-20 to -30 cm H2O	.23 to 2.45*
Pi max	16	-15 to -30 cm H2O	.98 to 3.01
P0.1/MIP	4	.30	2.14 to 25.3
CROP	2	13	1.05 to 19.74
B. Measured during a 1-2 minute period of spontaneous breathing			
Respiratory rate	24	30 to 38	1.00 to 3.89
Tidal volume	18	325-408 ml (4-6 ml/kg)	.71 to 3.83
Resp rate/tidal volume (f/Vt ratio)	20	60 to 105 /L	.84 to 4.67

Although statistically significant, LRs not high enough to drive decisions in isolation

No strategy has been shown to be faster than daily SBTs with an "integrated " assessment



ACCP/SCCM/AARC EBM Guidelines

- Criteria for considering vent discontinuation:
  - stability/reversal of respiratory failure
  - P/F > 150-200, PEEP < 5-8, FiO2 < 0.4-0.5, pH > 7.25
  - hemodynamic stability (no pressors/inotropes)
  - capable of reliable insp efforts

ACCP/SCCM/AARC EBM Guidelines

- SBT is most effective way of assessing d/c potential:
  - 5 cm H2O PS, 5 cm H2O CPAP, ATC, T-piece
    - T-piece closest to mimicking extubation
  - "Integrated assessment"
    - Vent pattern – especially change
    - Gas exchange – especially change
    - Hemodynamics – especially change
    - "Comfort"
  - 30-120 min - 1st 1-5 minutes needs close monitoring

ET tube removal requires ability to protect airway

- Cough is essential
  - Cough velocity (>1 l/sec)
  - White card test
  - Suctioning frequency
- Less important:
  - Gag reflex present
  - Cuff leak
  - Alertness – GCS 8 adequate
- Expected extubation failures: 10-15%

Routine daily SBTs shortens weaning

NEJM 1996;335:1864

Parameter	Intervention (149 Patients)	Control (151 Patients)	*P* value
APACHE II score	19.8	17.9	0.01
Weaning days	1	3	0.0001
Ventilator days	4.5	6	0.003
Reintubation (%)	6 (4)	15 (10)	0.04
Mechanical ventilation >21 days (%)	9 (6)	20 (13)	0.04
Any complication (%)	30 (20)	62 (41)	0.001
Total ICU costs	$15,740	$20,890	0.03

ACCP/SCCM/AARC EBM Guidelines

- For patients who fail the SBT:
  - Search for reversible causes

In between the daily SBT:

- Address the reversible aspects of load/capabilities imbalance:
  - Loads:
    - improve mechanics (edema, airways)
    - metabolic demands
  - Capabilities
    - nutrients/electrolytes
    - provide adequate DO2 to vent muscles (CO*,Hb)
    - adrenal function
    - *SEDATION STRATEGIES* – SAT vs targeted protocols?

**removal of intrathoracic pressure may precipitate heart failure*

ACCP/SCCM/AARC EBM Guidelines

- For patients who fail the SBT:
  - Search for reversible causes
  - Repeat SBTs q 24 hrs in those maintaining clinical stability
    - In between, provide *stable* and comfortable assisted ventilation
    - Little data demonstrating gradual support reduction reduces VLOS – likely wastes resources and risks fatigue

In between daily SBTs

- Properly load the muscles:
  - "Normalize" amount of load
    - avoid atrophy, avoid fatigue
  - "Optimize" comfort with synchronous flow delivery throughout the breath
    - sensitive/responsive triggering
    - responsive (variable) flow with EVERY breath
    - proper breath termination (cycling)
- Maintain this level without change until next SBT
  - "Weaning" this level has never been shown to improve outcomes

Practical aspects of “normalized”, comfortable loading

- Triggering - max sensitivity, “balance” PEEPi with applied PEEP
- Pressure/flow targets
  - Variable flow easier to synchronize with effort - therefore pressure targeted modes (PS, PA) best
  - Operational pressure range 10-25 cm H2O - start at 15 and titrate to breathing pattern, comfort
- Cycling - PS uses flow, PA uses time - adjust to comfortable I:E

Newer approaches to improving synchrony

- Proportional assist ventilation
  - Pressure and flow driven by sensed pt flow
- Neurally adjusted ventilator assistance
  - Pressure and flow driven by diaphragm EMG

All have theoretical appeal and have been shown to support patient effort – However, no meaningful outcome data

ACCP/SCCM/AARC EBM Guidelines

- For patients who fail the SBT:
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    - Stable comfortable support – no need to “wean”

ACCP/SCCM/AARC EBM Guidelines

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Is this what is happening?

2174 Successfully Discontinued (> 12 hrs support)

- 55% simple
  - 82% SBTs only, “wean”* 18%
- 39% complex (3 SBT)
  - 47% SBTs, “wean”* 53% at first
  - then “wean”* 71%/SBTs 29%
- 6% prolonged (> 7)
  - 38% SBTs, 62% “wean”* at first
  - then “wean”* 80%/SBTs 20%

*62-71% PSV, 26-29% SIMV

AJRCCM 2011;

Can weaning be automated?

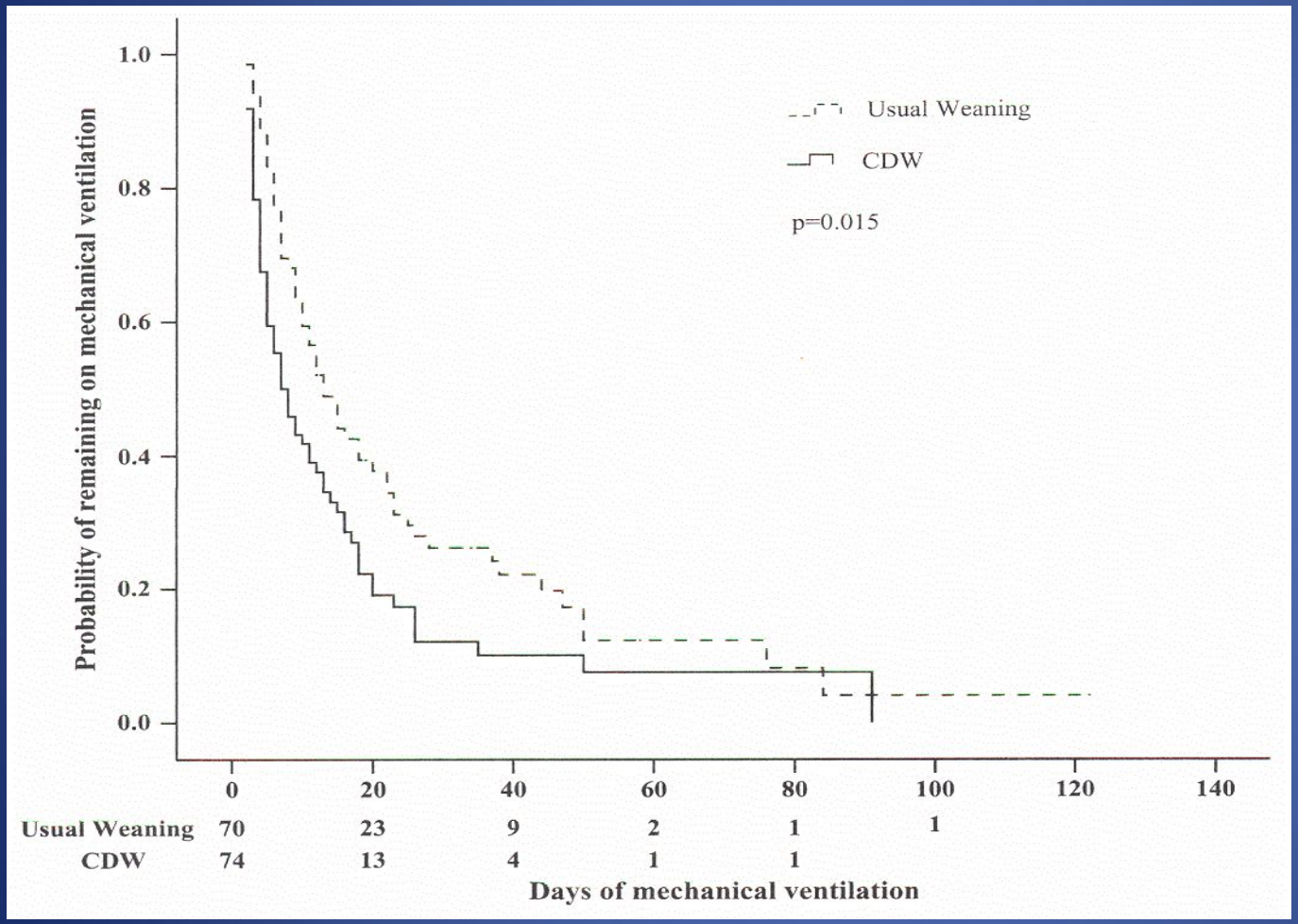
- Assumes that gradual support reductions help – evidence supporting this is weak

  Pressure support reductions based on various feedback algorithms
  - VS – target VT
  - Smart Care – target VT, MV, ETCO2

Volume Support (VS, ASV)

- Adjusts pressure to targeted tidal volume
- In theory:
  - As patient recovers, bigger VT, VS drops PS
- In practice:
  - Too high a VT selected – no PS reductions
  - Too low a VT selected – patient overloaded
  - Transient increased efforts from pain/anxiety leads to inappropriate PS reduction
- NO outcome data

SmartCare I



Lellouche, AJRCCM 2006; 174: 894

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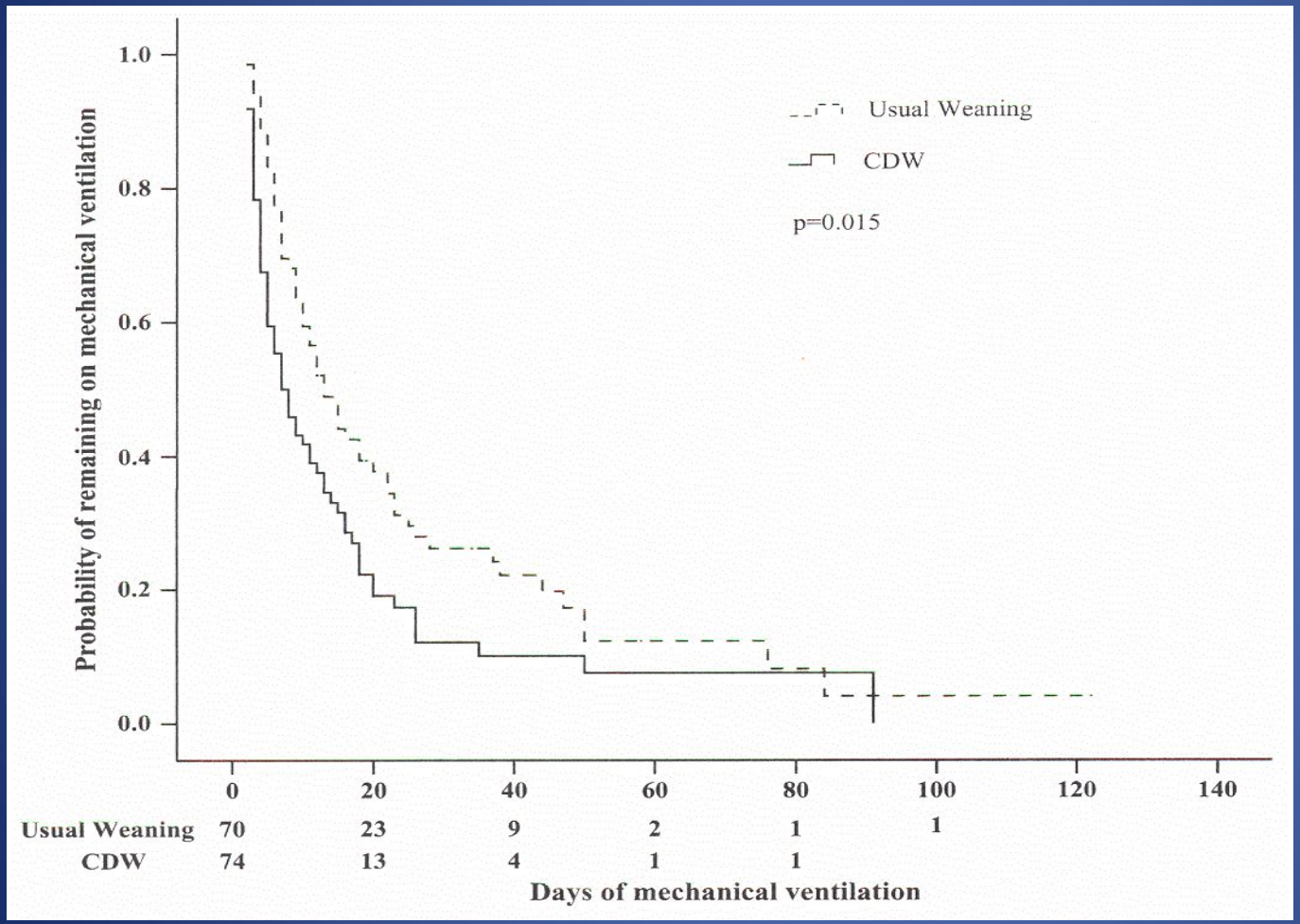
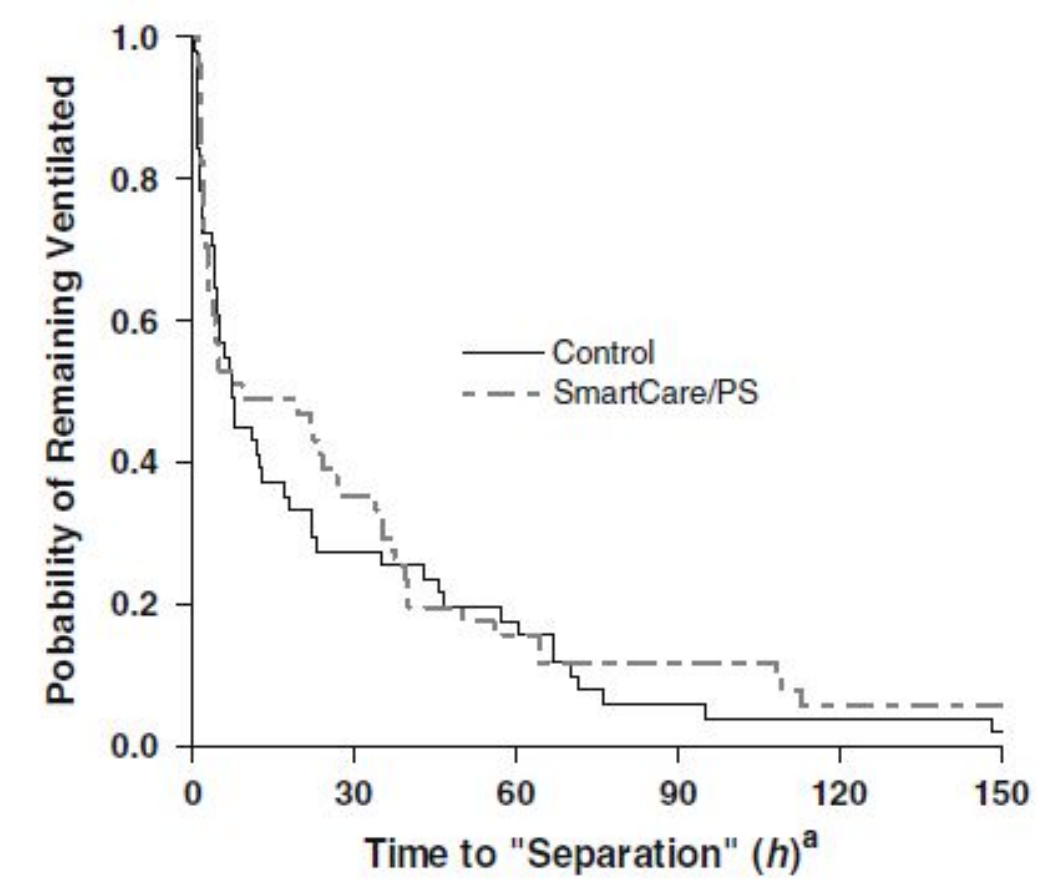


Control group used SBTs but may have been done only 50%

Lellouche, AJRCCM 2006; 174: 894

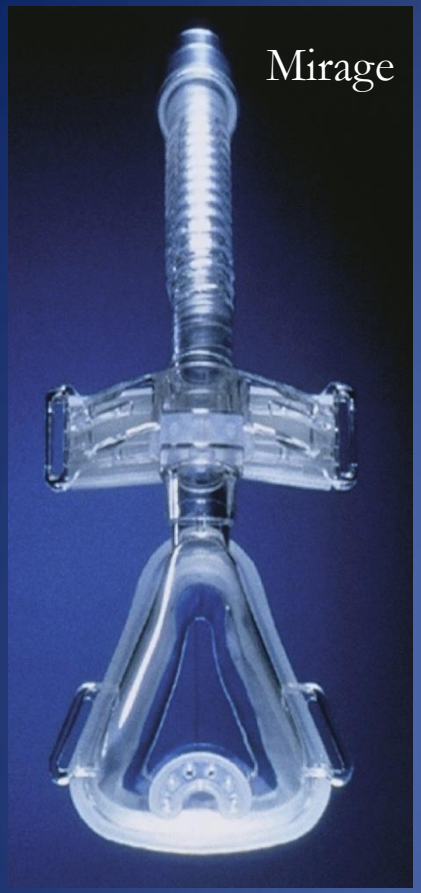
SmartCare II



Int Care Med 2008;34:1788

So is there a role for automatic PS reductions?

- No evidence that says this facilitates muscle recovery
- Patient tolerance to decreasing PS could signal clinicians to initiate SBTs (weaning and weaning success diagnostic, not therapeutic):
  - Rapidly recovering patient (overdose, post op)
  - Slowly recovering after many failed SBTs (PMV population)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GoldSeal


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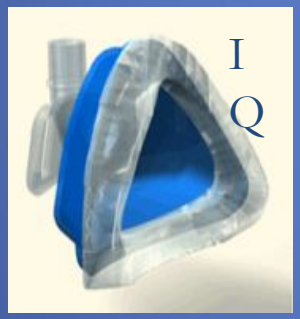
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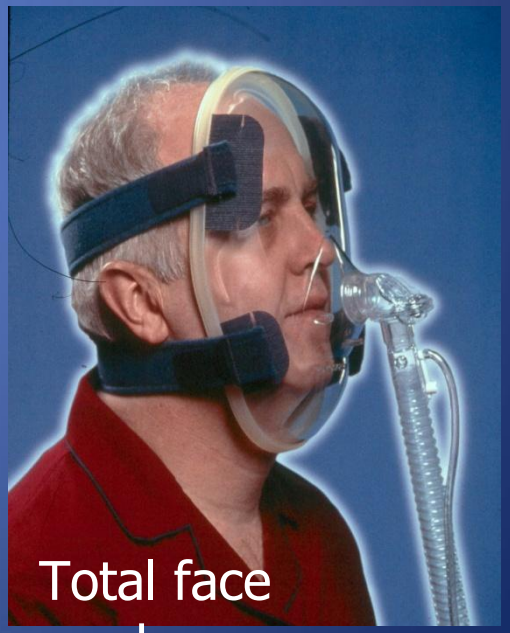
Total face
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Phantom

NIV and Vent Discontinuation:
Two Scenarios

- The failed/borderline SBT but good airway protection
  - Supportive evidence, especially in COPD
- The failed extubation:
  - Supportive evidence in COPD
  - May delay life saving intubation in other forms of ARF

Conclusions

- Ventilator dependency is not only disease induced but can be iatrogenic
- Good evidence supports daily screening and SBTs – success enhanced with sedation protocols
- Successful SBTs need a separate airway protection assessment before extubation
- Failed SBTs need 24 hrs of stable support while causes of ARF further addressed – then SBT
- Automated strategies may have utility in rapidly recovering, or PMV (marker, not cause, of recovery)
- NIV useful in selected patients (mostly COPD)