Eastern Pulmonary Conference
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Liberation From Mechanical Ventilation: An Update

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Nothing to Disclose

Liberation From Mechanical Ventilation: An Update

Objectives

1. Upon completion of this learning activity, participants should be able to manage structured multi-professional liberation from mechanical ventilation
2. Upon completion of this learning activity, participants should be able to explain key controversies in ventilator liberation

Question

Which of the following statements about protocol-based weaning / liberation is true…

A. Weaning protocols have been shown to reduce time on mechanical ventilation

B. Checking by RNs and RTs with physicians at all decision points is important

C. More complex protocols generally perform better

D. Clinicians who are highly skilled in the technique of weaning are called “weiners”

Question

Which of the following statements about protocol-based weaning / liberation is true…

>> A. Weaning protocols have been shown to reduce time on mechanical ventilation

B. Checking by RNs and RTs with physicians at all decision points is important

C. More complex protocols generally perform better

D. Clinicians who are highly skilled in the technique of weaning are called “weiners”

“Weaning” From Mechanical Ventilation

The process of substituting unassisted ventilation for mechanical ventilatory support

Liberation

- Simple discontinuation of ventilation & airway
- Removal of ventilator: requires adequate ventilation, oxygenation
- Removal of airway: requires airway maintained & protected, secretion clearance

Major Issues in Vent Liberation

- Variability: patients, causes of respiratory failure, weaning practice
- Goals: apply evidence-based practice, improve consistency, apply interdisciplinary expertise, streamline the process
- Components: ventilation, oxygenation, airway, medical conditions
- Avoid unintended delay from restrictive criteria

Ventilator Liberation

Evidence-based Guideline for Weaning & Discontinuing Ventilatory Support

- Daily screen performed by RN & RT: must pass all
  - Some reversal of cause for ventilatory support
  - Adequate oxygenation ($paO_2/FiO_2 \geq 150\text{-}200$ torr, PEEP $\leq$ 5-8 cmH_2O, $FiO_2 \leq .04\text{-}.05$) ; pH $\geq$ 7.25)
  - Hemodynamically stable; no (or minimal) pressors
  - Can initiate inspiratory effort
- Spontaneous breathing trial
- Airway patency, ability to protect airway

ACCP/SCCM/AARC Task Force. Chest 2001; 120:375S

An Official American Thoracic Society/American College of Chest Physicians Clinical Practice Guideline: Liberation from Mechanical Ventilation in Critically Ill Adults

Rehabilitation Protocols, Ventilator Liberation Protocols, and Cuff Leak Tests

Timothy D. Girard, Waleed Alhazzani, John P. Kress, Daniel R. Ouellette, Gregory A. Schmidt, Jonathon D. Truwit, Suzanne M. Burns, Scott K. Epstein, Andres Esteban, Eddy Fan, Miguel Ferrer, Gilles L. Fraser, Michelle Ng Gong, Catherine L. Hough, Sangeeta Mehta, Rahul Nanchal, Sheena Patel, Amy J. Pawlik, William D. Schweickert, Curtis N. Sessler, Thomas Strøm, Kevin C. Wilson, and Peter E. Morris; on behalf of the ATS/CHEST *Ad Hoc* Committee on Liberation from Mechanical Ventilation in Adults

This official clinical practice guideline of the American Thoracic Society (ATS) and the American College of Chest Physicians (CHEST) was approved by the ATS Board of Directors, December 2016, and by the CHEST Board of Regents, October 2016

Liberation From Mechanical Ventilation in Critically Ill Adults: An Official American College of Chest Physicians/American Thoracic Society Clinical Practice Guideline

Inspiratory Pressure Augmentation During Spontaneous Breathing Trials, Protocols Minimizing Sedation, and Noninvasive Ventilation Immediately After Extubation

Daniel R. Ouellette, MD, FCCP; Sheena Patel, MPH; Timothy D. Girard, MD; Peter E. Morris, MD, FCCP; Gregory A. Schmidt, MD, FCCP; Jonathon D. Truwit, MD, FCCP; Waleed Alhazzani, MD; Suzanne M. Burns, RN, MSN, ACNP, RRT; Scott K. Epstein, MD, FCCP; Andres Esteban, MD, PhD; Eddy Fan, MD, PhD; Miguel Ferrer, MD, PhD; Gilles L. Fraser, PharmD; Michelle Ng Gong, MD; Catherine L. Hough, MD; Sangeeta Mehta, MD; Rahul Nanchal, MD, FCCP; Amy J. Pawlik, DPT; William D. Schweickert, MD; Curtis N. Sessler, MD, FCCP; Thomas Strøm, MD; and John P. Kress, MD, FCCP

TABLE 2] Summary of Recommendations

Recommendation	Strength of Recommendation	Certainty of Evidence (ie, Quality of Evidence)
1. For acutely hospitalized patients ventilated more than 24 h, we suggest that the initial SBT be conducted with inspiratory pressure augmentation (5-8 cm H_2O) rather than without (T-piece or CPAP)	Conditional	Moderate certainty in the evidence
2. For acutely hospitalized patients ventilated for more than 24 h, we suggest protocols attempting to minimize sedation	Conditional	Low certainty in the evidence
3. For patients at high risk for extubation failure who have been receiving mechanical ventilation for more than 24 h and who have passed am SBT, we recommend extubation to preventive NIV	Strong	Moderate certainty in the evidence
4. For acutely hospitalized patients who have been mechanically ventilated for > 24 h, we suggest protocolized rehabilitation directed toward early mobilization	Conditional	Low certainty in the evidence
5. We suggest managing acutely hospitalized patients who have been mechanically ventilated for > 24 h with a ventilator liberation protocol	Conditional	Low certainty in the evidence
6a. We suggest performing a CLT in mechanically ventilated adults who meet extubation criteria and are deemed at high risk for PES	Conditional	Very low certainty in the evidence
6b. For adults who have failed a CLT but are otherwise ready for extubation, we suggest administering systemic steroids at least 4 h before extubation; a repeated CLT is not required	Conditional	Moderate certainty in the evidence

More detailed discussions of questions 1-3 appear in Ouellette et al[3] and of questions 4-6 appear in Girard et al.[4] CLT = cuff leak test; NIV = noninvasive ventilation; PES = postextubation stridor; SBT = spontaneous breathing trial.

Schmidt et al CHEST 2017; 151:160-65

Protocolized Weaning

We suggest managing acutely hospitalized patients who have been mechanically ventilated for > 24hr with a ventilator liberation protocol

Weak recommendation, moderate quality of evidence

Shorter duration MV by 25 hrs (12.5-35.5h)

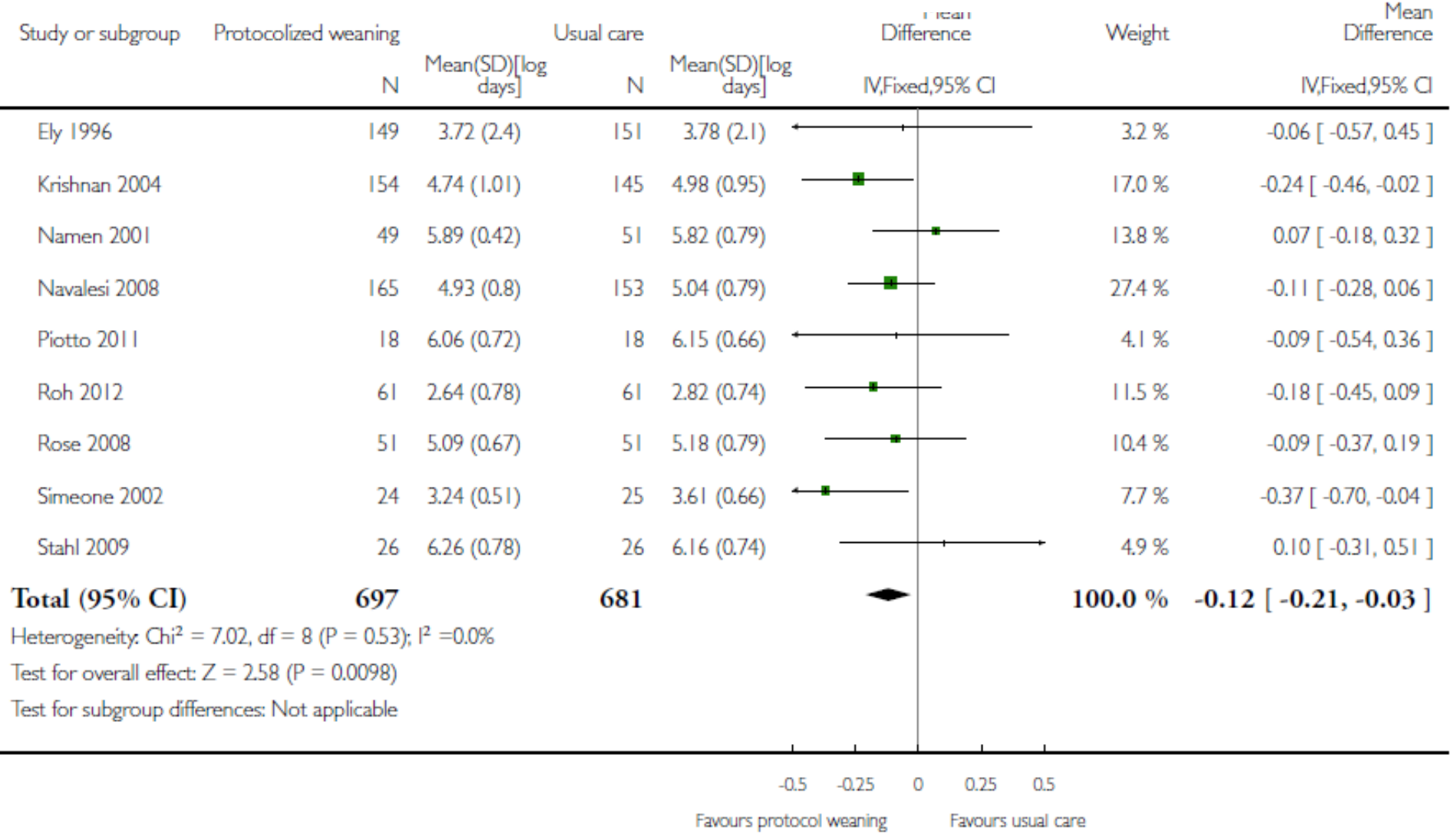
Shorter ICU LOS by 0.96 d (0.24-1.7d)

No difference in mortality

No difference in reintubation

Girard et al AJRCCM 2017
Blackburn et al. Cochrane 2014

Effect of Protocolized Weaning on ICU LOS



Girard et al AJRCCM 2017Blackburn et al. Cochrane 2014

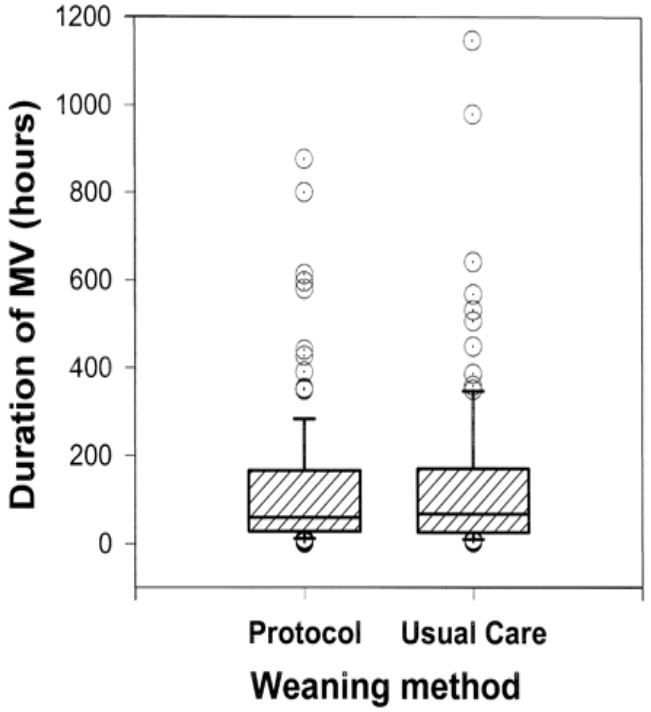
Common Components of Weaning Protocols

Parameter	Measures
Medical stability	shock, pressors, pH
Mental status	i.v. sedatives, sedation scale
Oxygenation	FiO2, PEEP, PaO2:FiO2
Lung mechanics	RSBI (SBI), pH
Endurance	SBT
Airway patency	Cuff-leak test
Miscellaneous	Condition improving, cough, sputum

Prospective Trial of Protocol to Discontinue Ventilation: Results

No difference in successful discontinuation (PW: 74.7%, UC: 75.2%, p = 0.92

Duration of MV similar (PW: 60h, UC 68h, p = 0.61)



Krishnan et al. Am J Respir Crit Care Med 2004; 169:673-8

Prospective Trial of Protocol to Discontinue Ventilation: Results

Conservative protocol criteria may have slowed weaning

PEEP > 5 cmH2O - stop

f/Vt > 106 – stop

FiO2 > 0.5 – stop

Wean screen prohibited by physician

SpO2 < 92%

Reasons for weaning failure not stated

Krishnan et al. Am J Respir Crit Care Med 2004; 169:673-8

Weaning Slower with RSBI?

- RCT comparing wean screen with or without testing RSBI (f/Vt < 105)

Parameter		+ f/Vt	no f/Vt	p
N		153	151	
MV	duration	6d	6d	ns
Weaning duration		*3d*	*2d*	*.04*

Tanios et al. Crit Care Med 2006; 34

Oxygenation Criteria: Most Common Reason to Fail a Weaning Protocol

Reasons for failing criteria for patients who achieved ventilator independence without ever meeting criteria

- **PaO2/FiO2 < 180 mm Hg** **49%**
- Neurologically impaired 18%
- Inadequate spont resp effort 11%

Walsh et al. Brit J Anesth 2004 92:793-9

Minimize Sedation

For acutely hospitalized patients ventilated for > 24hr, we suggest protocols attempting to minimize sedation

Weak recommendation, low quality of evidence

Shorter duration MV by 1 d (0.14-2.14)

Shorter ICU LOS by 1.78 d (0.41-3.41d)

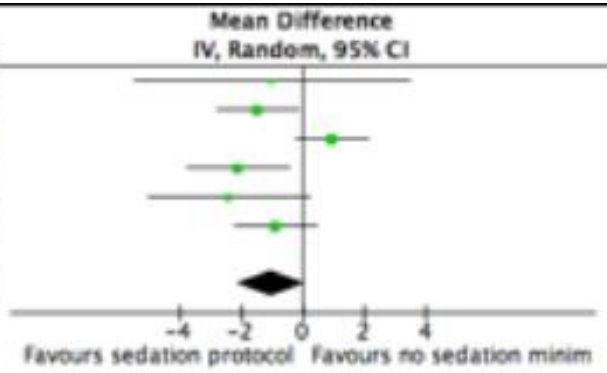
No difference in mortality

Ouellette et al CHEST 2017

Effect of Minimizing Sedation on Duration of Mechanical Ventilation & ICU LOS

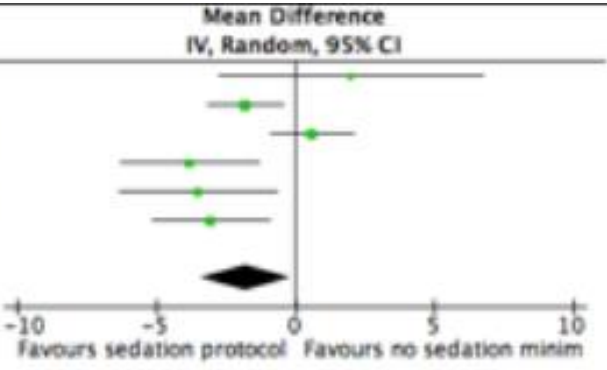
Study or Subgroup	Protocolized Sedation Mean	SD	Total	No Sedation Minimization Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Anifantaki 2009	7.7	13.5	49	8.7	8.35	48	5.3%	-1.00 [-5.46, 3.46]
Brook 1999	3.71	5.57	162	5.17	6.4	159	21.3%	-1.46 [-2.77, -0.15]
Bucknall 2008	4.83	6.1	153	3.89	4.3	159	22.5%	0.94 [-0.24, 2.12]
Girard 2008	7.1	7	167	9.2	8.4	168	18.2%	-2.10 [-3.76, -0.44]
Kress 2000	4.9	4.52	68	7.3	9.41	60	11.6%	-2.40 [-5.01, 0.21]
Mansouri 2013	0.79	1.8	96	1.67	6.7	105	21.1%	-0.88 [-2.21, 0.45]
Total (95% CI)			**695**			**699**	**100.0%**	**-1.00 [-2.14, 0.14]**

Heterogeneity: $Tau^2 = 1.14$; $Chi^2 = 13.20$, $df = 5$ ($P = 0.02$); $I^2 = 62\%$
Test for overall effect: $Z = 1.72$ ($P = 0.09$)



Study or Subgroup	Protocolized Sedation Mean	SD	Total	No Sedation Minimization Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Anifantaki 2009	14	13.5	49	12	10.17	48	8.1%	2.00 [-2.75, 6.75]
Brook 1999	5.7	5.9	162	7.5	6.5	159	21.9%	-1.80 [-3.16, -0.44]
Bucknall 2008	6.6	7.2	153	6	6.2	159	21.2%	0.60 [-0.89, 2.09]
Girard 2008	9.1	9.4	167	12.9	13.48	168	16.2%	-3.80 [-6.29, -1.31]
Kress 2000	6.4	6	68	9.9	9.7	60	14.5%	-3.50 [-6.34, -0.66]
Mansouri 2013	4.04	4.15	96	7.08	10.12	105	18.1%	-3.04 [-5.15, -0.93]
Total (95% CI)			**695**			**699**	**100.0%**	**-1.78 [-3.41, -0.14]**

Heterogeneity: $Tau^2 = 2.71$; $Chi^2 = 17.11$, $df = 5$ ($P = 0.004$); $I^2 = 71\%$
Test for overall effect: $Z = 2.13$ ($P = 0.03$)



Ouellette et al CHEST 2017

Wake up and breathe*

Curtis N. Sessler, MD, FCCM

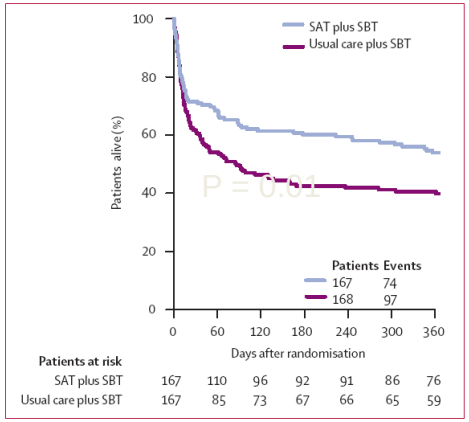
Crit Care Med 2004 Vol. 32, No. 6

Daily “Spontaneous Awakening (SAT)”+ Spontaneous Breathing Trial

Intervention (SAT) group

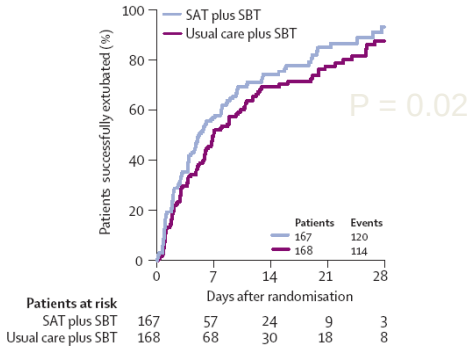
Less benzodiazepine

More unplanned extubation

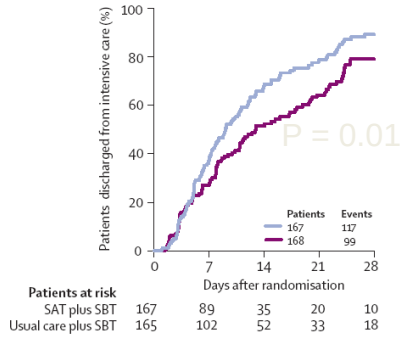


Alive

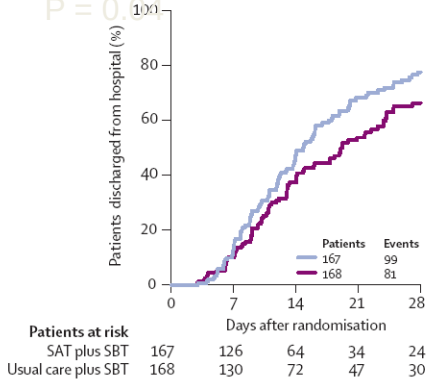
Extubated



Discharged from ICU



Hospital discharge



Girard et al. Lancet 2008; 371:126-34

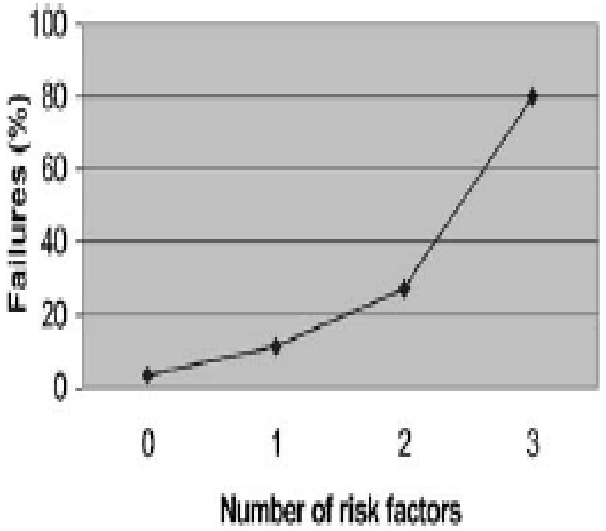
Mental Status, Sputum Volume & Cough Strength in Weaning

Prospective observational study of 88 patients who passed 30-60min SBT

3 Risk factors for failure

- Poor cough (peak flow < 60 lpm)
- Heavy endotracheal secretions (> 2.5ml/h)
- Unable to do all 4 tasks (open eyes, follow with eyes, grasp hand, stick out tongue)

If 2/3 present, 71% sensitive, 81% specific for failure (72h)



Salam et al. Intensive Care Med 2004; 30:1334-9

Early Mobilization

For acutely hospitalized patients who have been mechanically ventilated for > 24hr, we suggest protocolized rehabilitation directed towards early mobilization

Weak recommendation, low quality of evidence

Shorter duration MV by 2.7 d (1.19-4.21)

More likely to walk at hosp d/c (64% vs 41%)

No difference in ICU LOS

No difference in mortality

Girard et al AJRCCM 2017

Ventilator Liberation

Evidence-based Guideline for Weaning & Discontinuing Ventilatory Support

- Daily screen performed by RN & RT: must pass all
  - Some reversal of cause for ventilatory support
  - Hemodynamically stable; no (or minimal) pressors
  - Can initiate inspiratory effort
  - Adequate oxygenation ($paO_2/FiO_2 \geq 150\text{-}200$ torr, $PEEP \leq 5\text{-}8$ cmH_2O, $FiO_2 \leq .04\text{-}.05$) ; $pH \geq 7.25$)
- **Spontaneous breathing trial**
- Airway patency, ability to protect airway

ACCP/SCCM/AARC Task Force. Chest 2001; 120:375S

Spontaneous Breathing Trial: The Pivotal Test

Test of breathing for 30-120 min with minimal vent support

Variables in SBT

- **Ventilatory support**: T-tube or CPAP vs inspiratory pressure augmentation - PSV, automatic tube compensation
- **Duration of SBT**: 30min, 60min, 120min
- **Termination criteria**: RR > 35 bpm x > 5 min, SaO2 < 90%, HR > 140 bpm or sustained HR change > 20% higher or lower, SBP > 180 or < 90 mmHg, increased anxiety or diaphoresis

Inspiratory Support During SBT

For acutely hospitalized patients who have been ventilated for > 24hr, we suggest that the initial SBT be conducted with inspiratory pressure augmentation (5-8 cm H2O) rather than without (t-piece or CPAP)

Weak recommendation, moderate quality of evidence

More likely successful SBT (84.6% vs 76.7%)

More likely successful extubation (75.4% vs 68.9%)

Ouellette et al. CHEST 2017

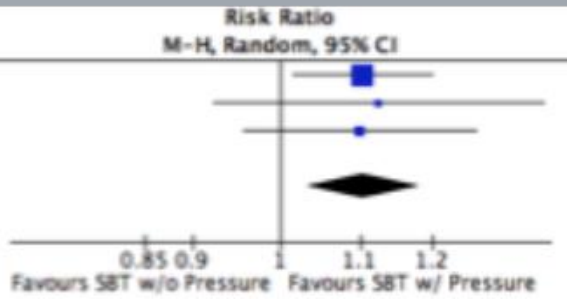
Analysis of RCTs Comparing SBT With & Without Inspiratory Support

CHEST
AMERICAN COLLEGE of CHEST PHYSICIANS

Successful SBT

Study or Subgroup	SBT with Pressure Events	Total	SBT without Pressure Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Esteban 1997	205	238	192	246	65.1%	1.10 [1.02, 1.20]
Haberthur 2002	54	60	24	30	11.6%	1.13 [0.92, 1.37]
Matic 2004	120	150	80	110	23.3%	1.10 [0.96, 1.26]
Total (95% CI)		**448**		**386**	**100.0%**	**1.11 [1.03, 1.18]**
Total events	379		296			

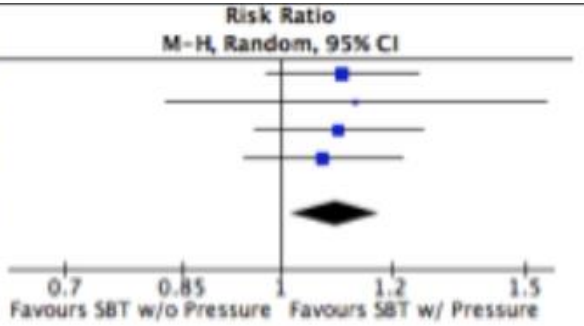
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.04$, df = 2 (P = 0.98); $I^2 = 0\%$
Test for overall effect: Z = 2.91 (P = 0.004)



Extubation Success

Study or Subgroup	SBT with Pressure Events	Total	SBT without Pressure Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Esteban 1997	167	238	156	246	34.5%	1.11 [0.98, 1.26]
Haberthur 2002	43	60	19	30	5.5%	1.13 [0.83, 1.55]
Matic 2004	120	150	80	110	28.1%	1.10 [0.96, 1.26]
Zhang 2014	78	93	90	115	31.8%	1.07 [0.94, 1.22]
Total (95% CI)		**541**		**501**	**100.0%**	**1.09 [1.02, 1.18]**
Total events	408		345			

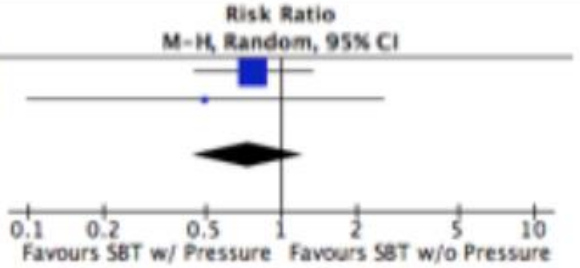
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.18$, df = 3 (P = 0.98); $I^2 = 0\%$
Test for overall effect: Z = 2.40 (P = 0.02)



Short-Term Mortality

Study or Subgroup	SBT with Pressure Events	Total	SBT without Pressure Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Esteban 1997	21	238	28	246	90.1%	0.78 [0.45, 1.33]
Matic 2004	2	30	4	30	9.9%	0.50 [0.10, 2.53]
Total (95% CI)		**268**		**276**	**100.0%**	**0.74 [0.45, 1.24]**
Total events	23		32			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.25$, df = 1 (P = 0.61); $I^2 = 0\%$
Test for overall effect: Z = 1.15 (P = 0.25)



Ouellette et al. CHEST 2017 Online supplement

Automatic Tube Compensation ("Tube Comp"): Smart PSV?

Spontaneous breaths are supported with pressure calculated to overcome resistance of breathing through the ET or Trach tube

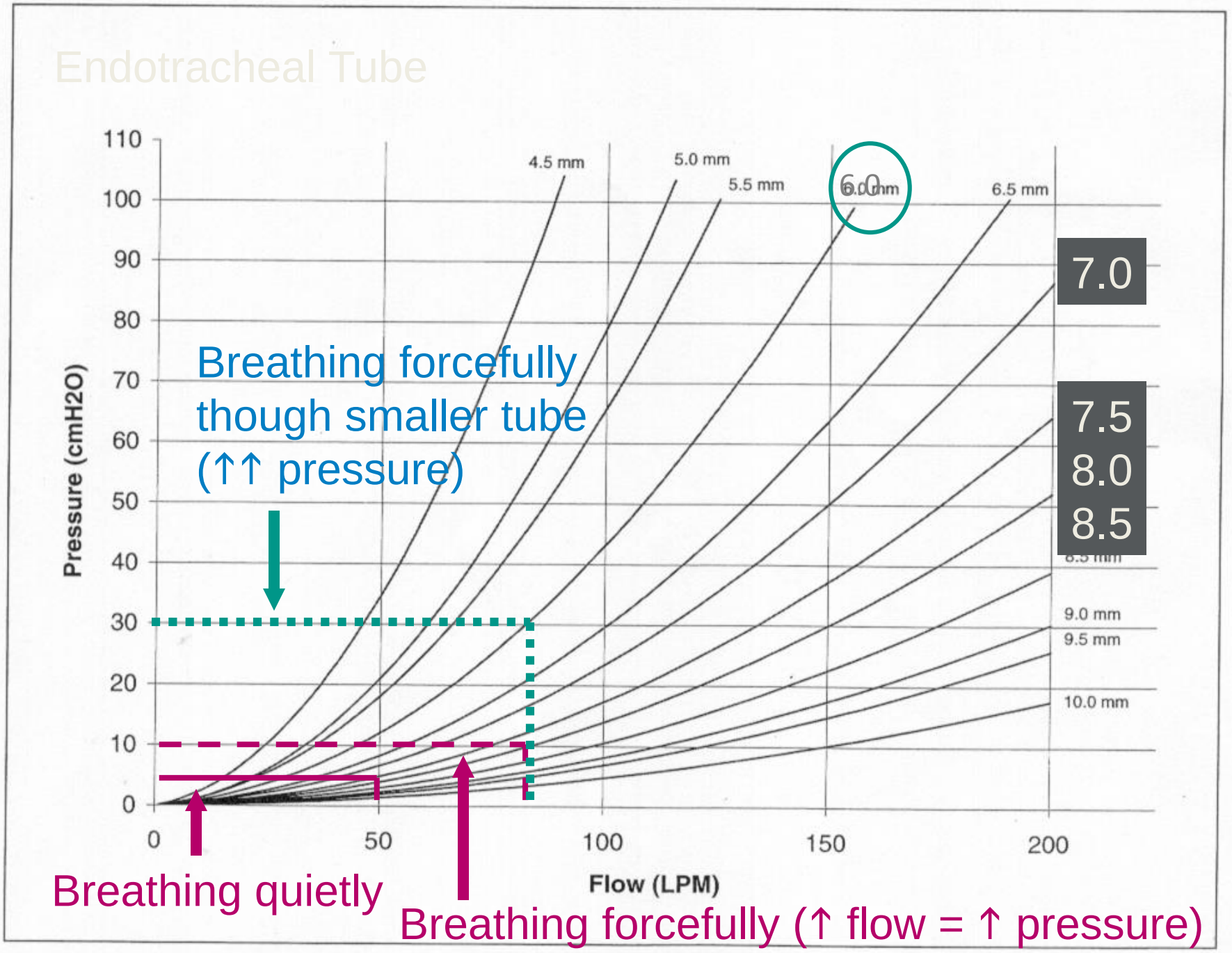
- Resistance α length, 1/radius^4, flow

Pressure calculated every 5ms based upon

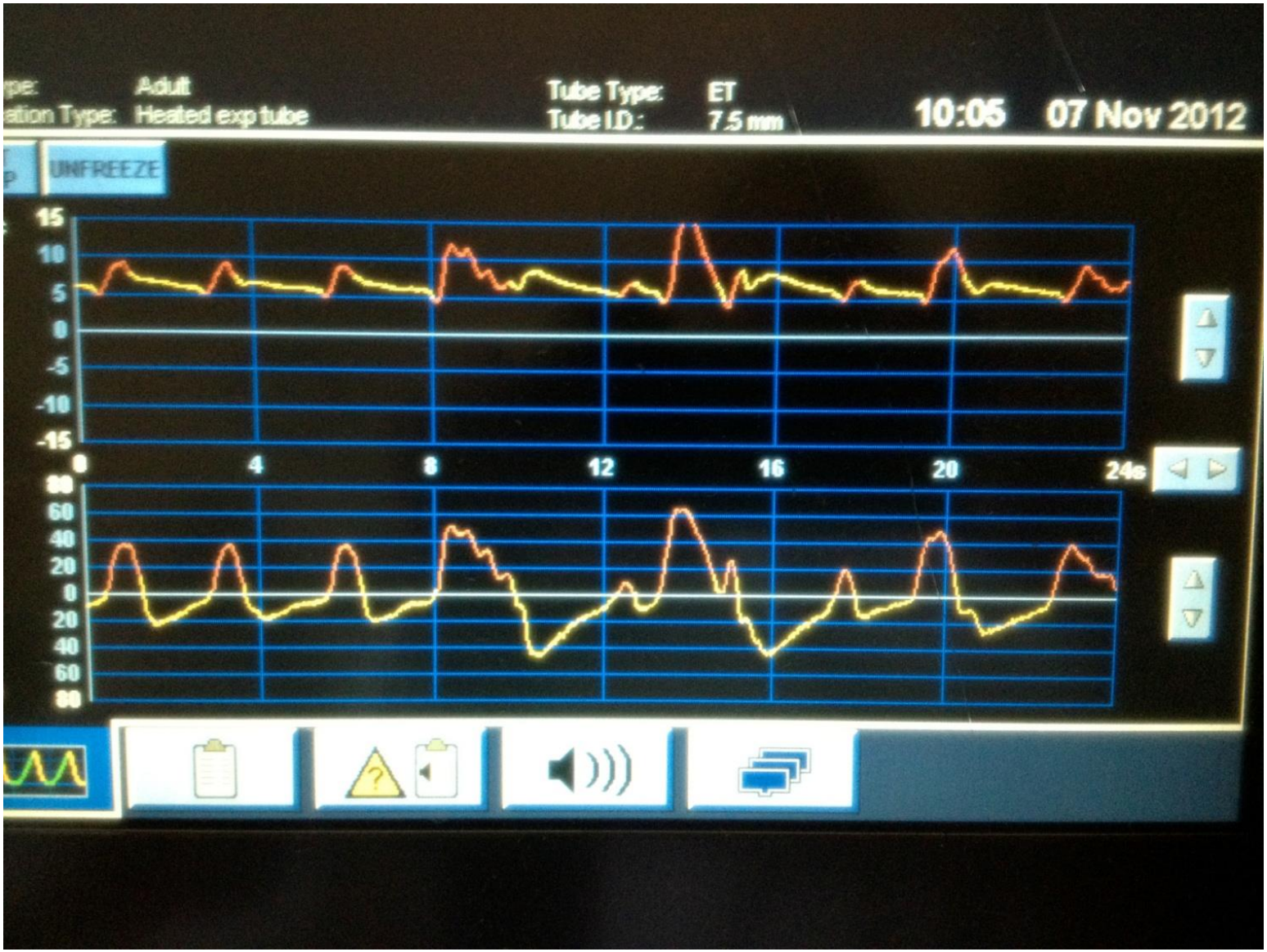
- Tube type (length): ET tube vs trach tube
- Inside diameter of tube
- Inspiratory flow rate (which is constantly changing

Good mode for spontaneous breathing trial

Figure 1. Target pressure - at 100 % support - at the wye for ET tube sizes: 4.5 mm to 10.0 mm



Automatic Tube Compensation



Automatic Tube Compensation During Spontaneous Breathing Trial

RCT of 99 ventilated (> 24h) patients

1hr SBT using CPAP with ATC (n=51)

1hr SBT using CPAP (n=48)

Parameter	ATC	CPAP	p
Complete SBT	96%	85%	.08
Extubated >48h	86%	76%	.28
Success	82%	65%	.04

Cohen et al. Crit Care Med 2006; 34:682-6

Ventilator Liberation

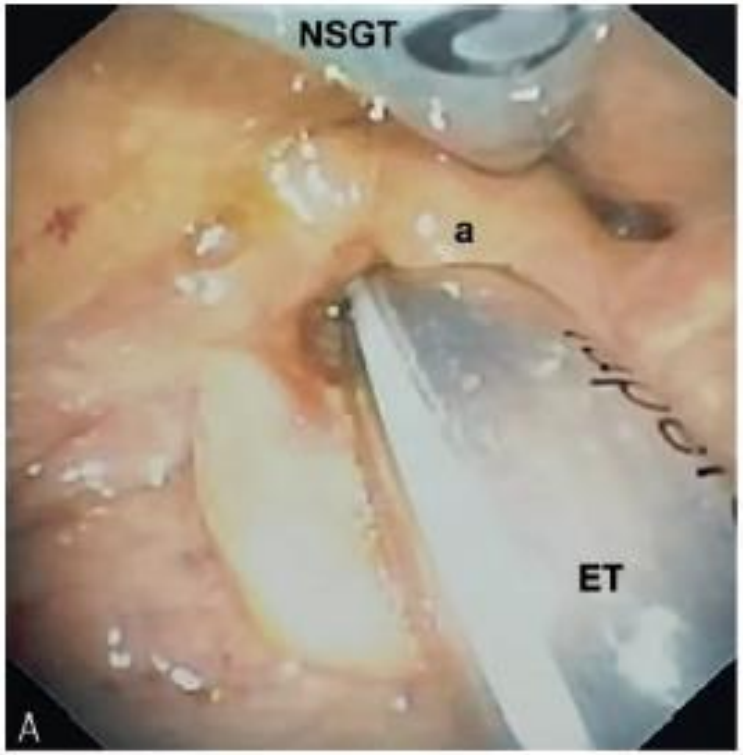
Evidence-based Guideline for Weaning & Discontinuing Ventilatory Support

- Daily screen performed by RN & RT: must pass all
  - Some reversal of cause for ventilatory support
  - Adequate oxygenation ($paO_2/FiO_2 \geq 150\text{-}200$ torr, PEEP $\leq$ 5-8 cmH_2O, $FiO_2 \leq .04\text{-}.05$) ; pH $\geq$ 7.25)
  - Hemodynamically stable; no (or minimal) pressors
  - Can initiate inspiratory effort
- Spontaneous breathing trial
- **Airway patency, ability to protect airway**

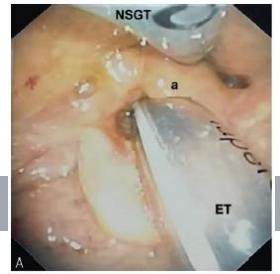
ACCP/SCCM/AARC Task Force. Chest 2001; 120:375S

Post-Extubation Stridor (PES)

- Endotracheal intubation causes damage to the airway, including laryngeal edema, ulcerations, vocal cord damage
  - Airway damage is generally reversible, but can produce airway narrowing, respiratory distress, re-intubation



Post-Extubation Stridor (PES)



- Endotracheal intubation causes damage to the airway, including laryngeal edema, ulcerations, vocal cord damage
  - Airway damage is generally reversible, but can produce airway narrowing, respiratory distress, re-intubation
- Published incidence of PES varies widely (0.6 – 36.8%) with a pooled incidence of 6.8% *Zhou et al J Evid Based Med 2011*
- The incidence of reintubation due to laryngeal edema is estimated to be 3.5% (range 0-10.5%)
- Reintubation is associated with ↑ morbidity and mortality
- Prophylactic corticosteroids reduces PES and reintubation
- Concern for risk of PES can delay extubation

Who Gets Stridor After Extubation?

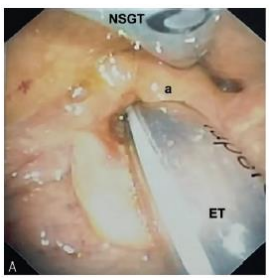
Commonly cited risk factors

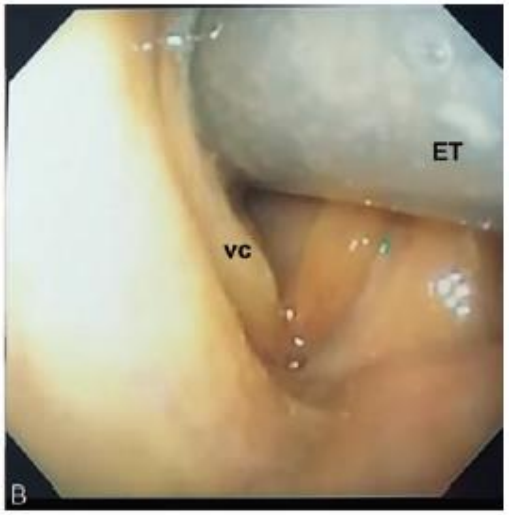
- Longer duration of intubation
- Female gender
- Difficult intubation
- Large tube
- High cuff P

Parameter	No Stridor (99)	Stridor (13)	P value
SAPS II	38	50	< .005
Difficult intubation	7%	54%	< .005
ETT cuff pressure	40 cmH_2O	83 cmH_2O	< .005
Intubation duration	5.5 days	10.9 days	< .005
Prior self-extubation	4%	38%	< .005
Cuff-leak	372 ml	59 ml	< .005
Cuff-leak	56%	9%	< .005
Received steroids	30%	8%	

Jaber et al. Intensive Care Med 2003; 29:69-74

Cuff-Leak Test (CLT)





Easy, fast, cheap

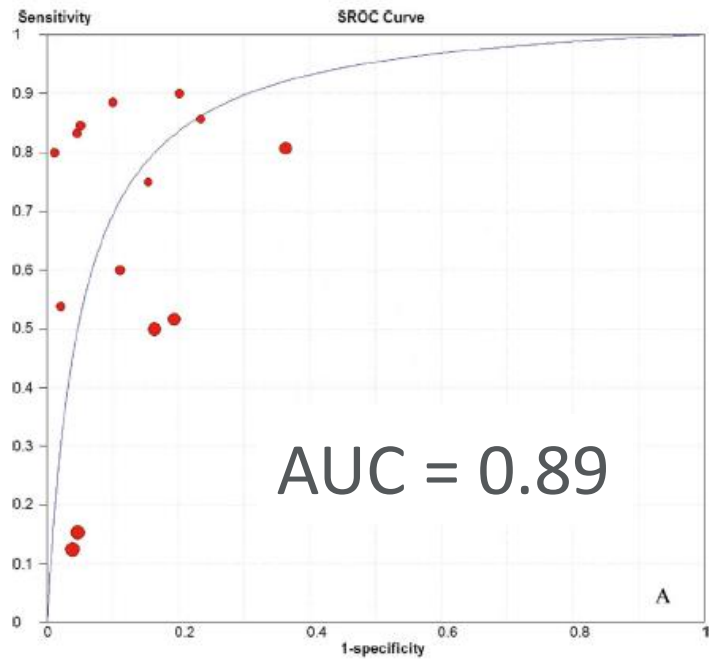
- Place patient on controlled ventilation with Vt = 8-10ml/kg
- Difference between exhaled Vt with cuff inflated and with cuff deflated
  - Measure exhaled Vt
  - Deflate cuff and measure exhaled Vt
  - Subtract Vt-E cuff down from Vt-E cuff up = cuff leak volume
- Correlates with audible leak
- Express as % leak (< 15%) or volume (< 120 ml) = positive test and increased risk of post-extubation stridor

REVIEW

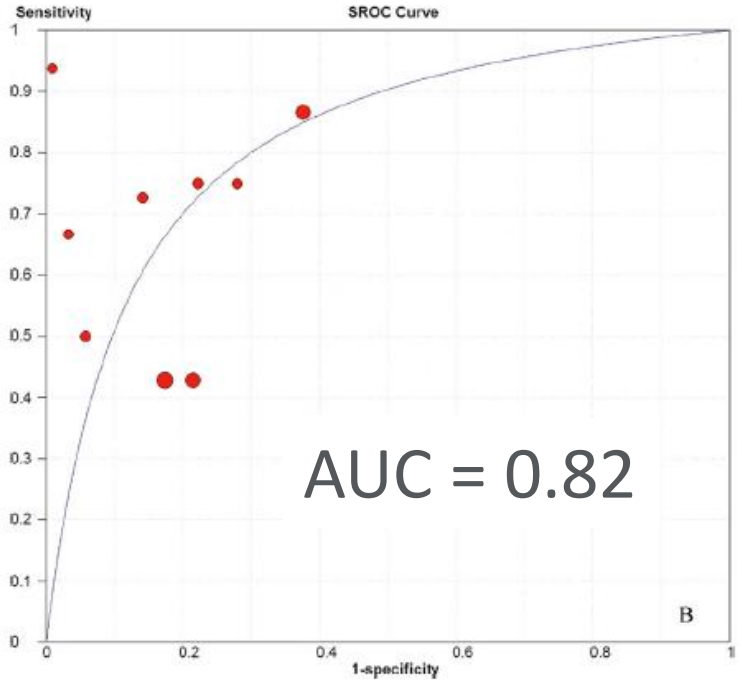
Cuff-leak test for predicting postextubation airway complications: a systematic review

Ting Zhou[1], Hong-Ping Zhang[1], Wei-Wei Chen[1], Ze-Yu Xiong[2], Tao Fan[3], Juan-Juan Fu[4], Lei Wang[1] and Gang Wang[1]

Systematic review of 16 studies (3172 patients) for PES



Postextubation Laryngeal Edema



Reintubation

Cuff Leak Test (CLT)

6a. We suggest performing a CLT in mechanically ventilated adults who meet extubation criteria and are deemed at high risk for PES	Conditional	Very low certainty in the evidence

We suggest performing CLT for MV adults who meet extubation criteria and are deemed to be high risk* for post-extubation stridor (PES)

Weak recommendation, very low quality of evidence

Predicts post-extubation stridor

Predicts reintubation

Can delay extubation

No difference in duration of ventilation

Ouellette et al CHEST 2017
Girard et al AJRCCM 2017

* MV > 6 days, Female, Large ET tube, Traumatic intubation, reintubated after unplanned extubation

Corticosteroids after Failed CLT

6b. For adults who have failed a CLT but are otherwise ready for extubation, we suggest administering systemic steroids at least 4 h before extubation; a repeated CLT is not required	Conditional	Moderate certainty in the evidence

For adults who have failed a CLT but are otherwise ready for extubation, we suggest administering systemic steroids at least 4 h before extubation

Dose: 20 mg methylprednisolone every 4 h x 4

Consider checking CLT prior to SBT – start steroids if no leak

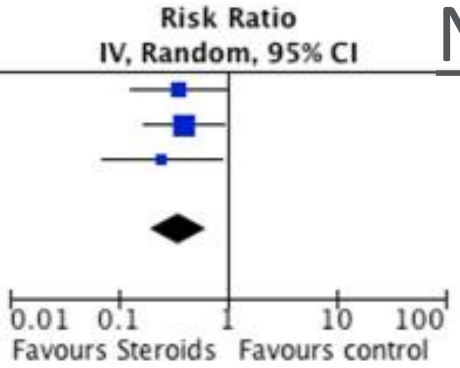
Effects of Steroids on PES and Reintubation after Failed CLT

Corticosteroids reduces post-extubation stridor

Study or Subgroup	Steroids Events	Steroids Total	Placebo Events	Placebo Total	Weight	Risk Ratio IV, Random, 95% CI	Year
Lee 2007	4	40	11	40	30.9%	0.36 [0.13, 1.05]	2007
Cheng 2007	6	38	13	33	48.1%	0.40 [0.17, 0.94]	2007
Cheng 2011	3	42	6	21	21.0%	0.25 [0.07, 0.90]	2011
Total (95% CI)		**120**		**94**	**100.0%**	**0.35 [0.20, 0.63]**	
Total events	13		30				

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.37$, df = 2 (P = 0.83); $I^2 = 0\%$

Test for overall effect: Z = 3.48 (P = 0.0005)



NNT

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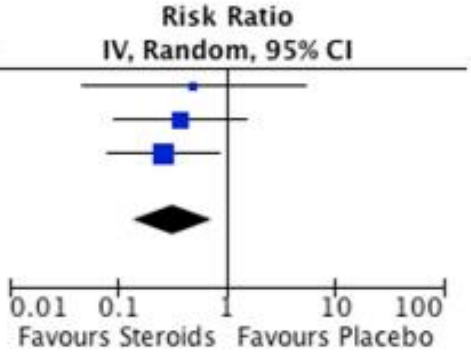
Corticosteroids reduces reintubation

Study or Subgroup	Steroids Events	Steroids Total	Placebo Events	Placebo Total	Weight	Risk Ratio IV, Random, 95% CI	Year
Lee 2007	1	40	2	40	13.0%	0.50 [0.05, 5.30]	2007
Cheng 2007	3	42	4	21	36.9%	0.38 [0.09, 1.52]	2007
Cheng 2011	3	38	10	33	50.1%	0.26 [0.08, 0.87]	2011
Total (95% CI)		**120**		**94**	**100.0%**	**0.32 [0.14, 0.76]**	
Total events	7		16				

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.30$, df = 2 (P = 0.86); $I^2 = 0\%$

Test for overall effect: Z = 2.59 (P = 0.010)



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Girard et al AJRCCM 2017

12-h pretreatment with methylprednisolone versus placebo for prevention of postextubation laryngeal oedema: a randomised double-blind trial

- Multicenter RCT comparing MP 20 mg q4h vs placebo in 761 intubated adults
- Post-extubation laryngeal edema reduced from 22% to 3%
- Re-intubation (all cause) reduced from 8% to 4%
- Reintubation due to post-extubation laryngeal edema reduced from 4% to 0.3%
- No cuff-leak test was performed

Francois et al. Lancet 2007

Extubation to NIV

For patients at high risk for extubation failure* who have been receiving mechanical ventilated for > 24hr and have passed an SBT, we recommend extubation to preventive NIV

Strong recommendation, moderate quality of evidence

Extubation success in high risk patients RR 1.14 (1.05-1.23)

Shorter ICU LOS -2.48 d (-0.93-4.03)

Lower short term mortality RR 0.37 (0.19-0.70)

*Hypercapnic respiratory failure due to COPD, heart failure

Ouellette et al. CHEST 2017

Effect of NIV on Extubation Success, ICU LOS

Study or Subgroup	Extubation to NIV Events	Total	Extubation w/o NIV Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Ferrer 2006	70	79	65	83	32.4%	1.13 [0.99, 1.30]
Ferrer 2009	48	54	42	52	23.4%	1.10 [0.94, 1.30]
Khilnani 2011	17	20	15	20	6.3%	1.13 [0.83, 1.55]
Mohamed 2013	51	60	45	60	19.0%	1.13 [0.95, 1.36]
Nava 2005	44	48	37	49	18.9%	1.21 [1.01, 1.45]
Total (95% CI)		**261**		**264**	**100.0%**	**1.14 [1.05, 1.23]**
Total events	230		204			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.66$, df = 4 (P = 0.96); $I^2 = 0\%$

Test for overall effect: Z = 3.26 (P = 0.001)

Risk Ratio M-H, Random, 95% CI

0.5 0.7 1 1.5 2

Favours no NIV Favours NIV

Study or Subgroup	Extubation to NIV Mean	SD	Total	Extubation w/o NIV Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ferrer 2006	11	8	79	13	11	83	20.3%	-2.00 [-4.95, 0.95]
Ferrer 2009	11	13	54	10	9	52	11.4%	1.00 [-3.24, 5.24]
Mohamed 2013	8.3	3.1	60	11.6	2.6	60	57.9%	-3.30 [-4.32, -2.28]
Nava 2005	8.9	5.7	48	11.6	14.9	49	10.4%	-2.70 [-7.17, 1.77]
Total (95% CI)			**241**			**244**	**100.0%**	**-2.48 [-4.03, -0.93]**

Heterogeneity: $Tau^2 = 0.81$; $Chi^2 = 4.19$, df = 3 (P = 0.24); $I^2 = 28\%$

Test for overall effect: Z = 3.14 (P = 0.002)

Mean Difference IV, Random, 95% CI

-10 -5 0 5 10

Favours NIV Favours no NIV

When in Doubt – Ask the Patient!

Prospective observational study of 211 MV patients who completed SBT

- Patients asked about their confidence in remaining extubated

Confident patients had 90% success

Non-confident patients had 45% success

Extubation success associated with patient prediction OR = 9.2 (3.7-22.4)

Perren et al. Intensive Care Med 2010; 36:2045-52

Troubleshooting Liberation Difficulty

- Unresolved precipitating process
- Reversible airway obstruction
- ET tube resistance
- Excessive secretions
- Respiratory depressant drugs
- Metabolic alkalosis
- Electrolyte imbalance
- Hemodynamic instability
- Ischemic heart disease
- Infection
- Impaired mental status
- Malnutrition / overfeeding
- Unrecognized neuromuscular problem
- Psychological factors

Enhancing Liberation Success

- Implement multi-professional protocols
- Apply evidence-based strategies
- Consider ventilatory & non-ventilatory factors
- Beware overly conservative criteria
- Link multiple interventions ABCDEF-style