Extubation Failure & Delay in Brain-Injured Patients

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“Coma” – reason for initiation of ventilation in 17% of patients

- Independently associated with mortality
- Odds ratio 2.98 (2.44-3.63), p<0.001
A patient is day 4 post traumatic brain injury

- Intubated and ventilated - passed a SBT and now on PS 6, PEEP 5, FiO₂ 0.4
- His level of consciousness remains depressed (localises to pain, no eye opening, intubated – 6T)
Clinical Scenario

- A patient is day 4 post TBI
  - Intubated and ventilated - passed a SBT and now on PS 6, PEEP 5, FiO₂ 0.4
  - His level of consciousness remains depressed (localises to pain, no eye opening, intubated – 6T)

- Should you extubate?
- Wait (for improvement) and then extubate?
- Tracheostomy now?
Comparison of three methods of gradual withdrawal from ventilatory support during weaning from mechanical ventilation

L Brochard, A Rauss, S Benito, G Conti, J Mancebo, N Rekik, A Gasparetto and F Lemaire
Medical Intensive Care Unit, Hopital Henri Mondor, Creteil, France.

A COMPARISON OF FOUR METHODS OF WEANING PATIENTS FROM MECHANICAL VENTILATION

Andrés Esteban, M.D., Ph.D., Fernando Frutos, M.D., Martin J. Tobin, M.D., Inmaculada Alía, M.D., José F. Solsona, M.D., Inmaculada Valverdú, M.D., Rafael Fernández, M.D., Miguel A. de la Cal, M.D., Salvador Benito, M.D., Ph.D., Roser Tomás, M.D., Demetrio Carriecho, M.D., Santiago Macías, M.D., and Jesús Blanco, M.D., for the Spanish Lung Failure Collaborative Group*
Clinical Characteristics, Respiratory Functional Parameters, and Outcome of a Two-Hour T-Piece Trial in Patients Weaning from Mechanical Ventilation

IMMA VALLVERDÚ, NURIA CALAF, MIREIA SUBIRANA, ALVAR NET, SALVADOR BENITO, and JORDI MANCEBO


Intensive Care Unit, Hospital Santa Creu i Sant Pau, Barcelona, Spain

![Diagram showing outcomes for COPD and ARF patients](image)
Clinical Characteristics, Respiratory Functional Parameters, and Outcome of a Two-Hour T-Piece Trial in Patients Weaning from Mechanical Ventilation

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![Bar chart showing outcomes in COPD, Neurologic, and ARF patients.](image)
Removal from ventilatory support is a two-step process:
1. Determine capability for unassisted breathing
2. Determine capability to tolerate removal of endotracheal tube

Both delayed extubation and extubation failure are associated with increased morbidity & mortality.
Adil Salam
Lisa Tilluckdharry
Yaw Amoateng-Adjepong
Constantine A. Manthous

Neurologic status, cough, secretions and extubation outcomes

Risk Factors:
- 4 Simple Tasks
- Cough Peak Flow < 60 L/min
- Secretions > 2.5 ml/h

88 MICU Patients Passed SBT
Risk Factors for Extubation Failure in Patients Following a Successful Spontaneous Breathing Trial*

( CHEST 2006; 130:1664–1671 )

Fernando Frutos-Vivar, MD; Niall D. Ferguson, MD, MSc; Andrés Esteban, MD, PhD; Scott K. Epstein, MD, FCCP; Yaseen Arabi, MD, FCCP; Carlos Apezteguía, MD; Marco González, MD; Nicholas S. Hill, MD, FCCP; Stefano Nava, MD; Gabriel D’Empaire, MD; and Antonio Anzueto, MD

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**Rapid breathing shallow index**

- \( \leq 57 \) breaths/min/L
  - 65 / 596 (11%)
  - Pneumonia as reason for mechanical ventilation
    - **NO**
      - 47 / 592 (9.5%)
    - **YES**
      - 18 / 104 (17%)
  - POSITIVE FLUID BALANCE
    - **NO**
      - 20 / 154 (13%)
    - **YES**
      - 36 / 150 (24%)

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Reintubation rate (%)
• Randomized trial of RT-driven daily SBT protocol (similar to 1996 NEJM paper) in 100 mixed neurosurgical patients
• 98/100 patients had an extubation attempt
  ◦ 38 (39%) failed - ? timing
• 30% tracheostomy rate
Predictors of Successful Extubation in Neurosurgical Patients

ANDREW M. NAMEN, E. WESLEY ELY, STEPHEN B. TATTER, L. DOUGLAS CASE, MICHAEL A. LUCIA, ALLEN SMITH, SCOTT LANDRY, JOHN A. WILSON, STEVEN S. GLAZIER, CHARLES L. BRANCH, DAVID L. KELLY, DAVID L. BOWTON, and EDWARD F. HAPONIK


% of All Extubations

<table>
<thead>
<tr>
<th>Glasgow Coma Scale</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>10</td>
<td>25</td>
<td>33</td>
<td>67</td>
<td>50</td>
<td>92</td>
<td>75</td>
<td>79</td>
<td>70</td>
</tr>
<tr>
<td>%</td>
<td>10</td>
<td>25</td>
<td>33</td>
<td>67</td>
<td>50</td>
<td>92</td>
<td>75</td>
<td>79</td>
<td>70</td>
</tr>
</tbody>
</table>
Randomized trial of RT-driven daily SBT protocol (similar to 1996 NEJM paper) in 100 mixed neurosurgical patients

- 98/100 patients had an extubation attempt
  - 38 (39%) failed - ? timing
- 30% tracheostomy rate
- 44 total extubation failures (44/117 - 38%) - followed by reintubation in half, others withdrawal of LST
136 patients with isolated brain injuries

- 78 TBI
- 26 SAH
- 24 Stroke
- 8 Other

Exclusions:

Chest trauma (30); Abdo Inj/Surg (17);
Impending brain death (12);
Parameters not met before death/extubation (15);
Parameters met but died or trach before extubation (10);
ALI (2); MODS (1)
# Implications of Extubation Delay in Brain-Injured Patients Meeting Standard Weaning Criteria

**WILLIAM M. COPLIN, DAVID J. PIERSON, KATHY D. COOLEY, DAVID W. NEWELL, and GORDON D. RUBENFELD**

Division of Pulmonary and Critical Care Medicine and the Departments of Neurology, Neurological Surgery, and Respiratory Care, Harborview Medical Center, University of Washington, Seattle, Washington


## CRITERIA USED TO DETERMINE READINESS FOR DISCONTINUATION OF VENTILATORY SUPPORT

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurologic status</td>
<td>Physical examination not deteriorating</td>
</tr>
<tr>
<td></td>
<td>ICP &lt; 20 mm Hg (when ICP measured)</td>
</tr>
<tr>
<td></td>
<td>CPP ≥ 60 mm Hg (when ICP measured)</td>
</tr>
<tr>
<td>Cardiovascular status</td>
<td>Systolic BP &gt; 90 and &lt; 160 mm Hg</td>
</tr>
<tr>
<td></td>
<td>HR &gt; 60 and &lt; 125 beats/min</td>
</tr>
<tr>
<td>Arterial oxygenation</td>
<td>$\text{PaO}_2 \geq 80 \text{ mm Hg on } \text{FiO}_2 \leq 0.50$ (on ≤ 5 cm H$_2$O PEEP)</td>
</tr>
<tr>
<td>Spontaneous ventilatory mechanics</td>
<td>$\text{MIP} \geq 20 \text{ cm H}_2\text{O}$</td>
</tr>
<tr>
<td></td>
<td>$\text{RSBI} \left(f/V_t\right) \leq 105$</td>
</tr>
<tr>
<td></td>
<td>Spontaneous $V_e \leq 12 \text{ L/min}$</td>
</tr>
<tr>
<td></td>
<td>Spontaneous $V_e \geq 80%$ of ventilator spontaneous $V_e$</td>
</tr>
<tr>
<td>Absence of specific indication for mechanical ventilation</td>
<td>Surgery requiring general anesthesia not planned within 72 h</td>
</tr>
<tr>
<td></td>
<td>No deliberate hyperventilation</td>
</tr>
<tr>
<td></td>
<td>Cervical-spine status cleared</td>
</tr>
</tbody>
</table>

**Extubation Delay – >48 hrs**
Implications of Extubation Delay in Brain-Injured Patients Meeting Standard Weaning Criteria

WILLIAM M. COPLIN, DAVID J. PIERSON, KATHY D. COOLEY, DAVID W. NEWELL, and GORDON D. RUBENFELD
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- Reintubation required in 17/99 (17%) prompt vs. 7/37 (19%) of delayed patients
  - 39/49 (80%) of GCS ≤8 and 10/11 (91%) of GCS ≤4 were successfully extubated
  - Spontaneous cough and lower suction frequency associated with successful extubation

- Pneumonia: 21% vs. 38%

- ICU LOS: 3 vs. 8 days

- Mortality: 12% vs. 27%

All favouring the non-delayed group
Implications of Extubation Delay in Brain-Injured Patients Meeting Standard Weaning Criteria

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Am J Respir Crit Care Med Vol 161. pp 1530-1536, 2000

16 pneumonias

A

9 pneumonias

B

10 pneumonias

C

Admission

Meet readiness criteria

Extubated

Endpoint
Ready for Extubation?
Causes & Consequences of Extubation Failure in Neurosurgical ICU Patients

ND Ferguson, JA Lorente, DA Margel, KPW Chan, WL Lee, W Demajo, TE Stewart

AJRCCM 2004 169:A123
Included Patients

2380 Intubated Admissions 1998-2002

2102 Individual Patients

1337 Patients Extubated Prior to Death / Trach

1280 Elective Extubations Included

278 Repeat Admissions

654 Deaths 111 Trachs.

50 Self-extubation 7 Tube exchanges
Timing of Extubation Failure

Survival Functions

Time (hrs)
72 60 48 36 24 12 0

Proportion Remaining Extubated
1.00 0.95 0.90 0.85 0.80

Neuro vs. Med-Surg

p = 0.63 by log rank test
Conclusions

- Extubation failure rates and times are similar between med-surg and neuro patients in our centre

- Causes of extubation failure differ

- Different approaches to identifying extubation readiness may be needed for this patient population
Neurological ICU Extubation Strategy Utilization and Reintubation Outcomes (NEURO) Pilot Study

ND Ferguson, NKJ Adhikari, DC Scales, RA Fowler, M Chapman, AJ Baker, DJ Cook, and MO Meade
for the Canadian Critical Care Trials Group

Interdepartmental Division of Critical Care Medicine,
University of Toronto
Methods

- Prospective observational study enrolling consecutive ventilated brain-injured patients
- 3 University of Toronto hospitals
  - Toronto Western Hospital
  - Sunnybrook Health Science Centre
  - St. Michael’s Hospital
- April – November 2005
- REB approved with waiver for consent
Active Observation for Readiness to Extubate
- GCS ≥ previous day
- Intracranial pressure < 20
- CPP > 60 mm Hg
- PaO$_2$/FiO$_2$ > 200 mm Hg
- PEEP ≤ 5 cmH$_2$O
- Temperature < 38.5 °C
- MAP > 60, no inotropes
- No surgery planned
- No hyperventilation order
- Tolerates minimal ventilatory support

Observation for Clinical Suspicion of Pneumonia
- Temp >38.5°C + WBC >12
- Positive respiratory cultures
- New antibiotics
- Need for FiO$_2$ > 0.5 x 6hrs
- Reintubation
- ICU Readmission

Patients meet criteria for active observation:
- Acute brain injury*
- Mechanical ventilation for ≥ 24 hrs via endotracheal tube
- Age > 16 years
- Not previously in study cohort

Patients meet cohort exclusion criteria:
- Unplanned extubation in ICU
- Death prior to extubation
- Extubation for withdrawal of life-sustaining treatment

Patients meet cohort inclusion criteria:
- Elective extubation or primary tracheostomy

Follow for Outcomes

Abbreviations: GCS=Glasgow coma score; CPP=cerebral perfusion pressure; PaO$_2$=arterial oxygen pressure; FiO$_2$=fraction of inspired oxygen; PEEP=positive end-expiratory pressure; MAP=mean arterial pressure; WBC=white blood cells

NEURO: Neurological ICU Extubation Strategy
Utilization & Reintubation Outcomes

* New subarachnoid haemorrhage, traumatic brain injury, ischemic stroke, intracerebral bleed, subdural haematoma, epidural haematoma, post-craniotomy, global cerebral ischemia, status epilepticus, meningitis, encephalitis, or abscess
## Baseline Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>238</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>51 (36-66)</td>
</tr>
<tr>
<td><strong>Male Sex</strong></td>
<td>155 (65%)</td>
</tr>
<tr>
<td><strong>APACHE II</strong></td>
<td>18 (14-23)</td>
</tr>
<tr>
<td><strong>GCS (max 10T)</strong></td>
<td>5.5 (3-7)</td>
</tr>
<tr>
<td><strong>Location prior to admission</strong></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>140 (59%)</td>
</tr>
<tr>
<td>Other acute hospital</td>
<td>70 (29%)</td>
</tr>
<tr>
<td>Admitting Diagnoses</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Traumatic Brain Injury</td>
<td>65 (27%)</td>
</tr>
<tr>
<td>Subarachnoid Bleed</td>
<td>50 (21%)</td>
</tr>
<tr>
<td>Intracranial Bleed</td>
<td>37 (16%)</td>
</tr>
<tr>
<td>Subdural Bleed</td>
<td>34 (14%)</td>
</tr>
<tr>
<td>Post-craniotomy</td>
<td>16 (7%)</td>
</tr>
<tr>
<td>Extradural Bleed</td>
<td>10 (4%)</td>
</tr>
<tr>
<td>Other / Missing</td>
<td>26 (11%)</td>
</tr>
</tbody>
</table>

87% receiving ongoing ventilation because of neurological issue
Results – Extubation Timing

147 Elective Extubations

Days from Readiness to Extubation: 3.6 (1.3-5.9)
147 Elective Extubations

- 47 (32%) Reintubated
  - 33 within 72 hours
  - Extubation Failure Rate (95%CI): 22 (16-30)%

- Median time to reintubation:
  - 0.63 (0.08 – 2.41) days
## Outcomes

<table>
<thead>
<tr>
<th></th>
<th>ICU Mortality</th>
<th>p-value</th>
<th>Hospital Mortality</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prompt Extubation</td>
<td>2 (3%)</td>
<td>0.62</td>
<td>3 (5%)</td>
<td>0.097</td>
</tr>
<tr>
<td>Delayed Extubation</td>
<td>2 (4%)</td>
<td></td>
<td>7 (13%)</td>
<td></td>
</tr>
<tr>
<td>Extubation Success</td>
<td>1 (1%)</td>
<td>0.004</td>
<td>8 (7%)</td>
<td>0.14</td>
</tr>
<tr>
<td>Extubation Failure</td>
<td>4 (15%)</td>
<td></td>
<td>4 (16%)</td>
<td></td>
</tr>
<tr>
<td>Primary Tracheostomy</td>
<td>8 (20%)</td>
<td>0.75*</td>
<td>9 (24%)</td>
<td>0.64*</td>
</tr>
</tbody>
</table>

* c/w extubation failure
Conclusions

- Extubation failure was common in this group of patients
- Extubation delay did not appear to be associated with adverse outcomes
  - Extubation failure
  - Mortality
- Mortality rates appeared similar between primary tracheostomy and extubation failure
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