Use of Cough Augmentation Techniques in the Critically Ill

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What I would like to cover....

• Why is cough important in the critically ill?
• What techniques are available?
• What is the evidence in the non critically ill?
• What is the evidence in the critically ill?
• Who is using it in the ICU?
  – a Canadian perspective

Why is cough important in the critically ill?
Secretion retention is a problem!

- Infection/ventilation = increased mucus volume and tenacity
- Immobilization = atelectasis
- Altered mucus system
- Regional lung mechanics
- Expiratory muscle weakness
- Impaired cough = decreased ability to expel
- Ineffective humidification
- Altered fluid mechanics

Cough strength may be a predictor of extubation outcome.

Cough PEF ≤ 60 L/min
69% sensitivity/74% specificity for predicting extubation outcome

PEF range 30-180 L/min

Voluntary Is Better Than Involuntary Cough Peak Flow for Predicting Re-Intubation After Scheduled Extubation in Cooperative Subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Restricted Extubation ≤ 72h</th>
<th>Restricted Extubation &gt; 72h</th>
<th>Restricted Extubation ≤ 72h</th>
<th>Restricted Extubation &gt; 72h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineffective cough</td>
<td>5.03 (1.60-14.41)</td>
<td>5.39 (1.28-22.00)</td>
<td>NS</td>
<td>0.003</td>
</tr>
<tr>
<td>Duration of Mechanical Ventilation before extubation &gt; 72h</td>
<td>2.67 (1.11-6.21)</td>
<td>3.38 (1.54-7.40)</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>Severe Isolated Left Ventricular Dysfunction</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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</table>

AUC V-CPF = 0.74
IV-CPF = 0.63

PEF ≥ 60 L/min
What techniques are available?

Mechanical insufflation-exsufflation for people with neuromuscular disorders (Review)

- Included prospective RCTs, quasi RCTs & randomized cross over trials
- 5 trials eligible
- Total of 105 patients
- Qualitative synthesis only

All used face-mask interface
Insufflation/exsufflation pressures ranged from +15 to 40 cmH₂O
Compared to alternate cough aug. strategy

All reported short term outcomes only:
peak cough expiratory flow
physiological variables
treatment time
Subjective measures such as comfort, breathlessness, mood, secretion production

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What is the evidence in the non-critically ill?

Mechanical insufflation-exsufflation for people with neuromuscular disorders (Review)

- All used face-mask interface
- Insufflation/exsufflation pressures ranged from +15 to 40 cmH₂O
- Compared to alternate cough aug. strategy
- All reported short term outcomes only:
  - peak cough expiratory flow
  - physiological variables
  - treatment time
  - Subjective measures such as comfort, breathlessness, mood, secretion production

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KEY FINDINGS

- MI-E may improve cough PEF (3 studies) compared to unassisted cough
- No clear evidence MI-E improves cough PEF more than other techniques
- May ↓ treatment time
- Well tolerated (comfort VAS)
At risk and using NIV

Education and preventative airway clearance must precede ventilation (consensus)

In absence of contraindications, LVR should be introduced with measurement of PCFs and MIC in those with PCF <270 L/min (1C recommendation)

MAC recommended alone or with LVR to PCF >270 L/min

In absence of contraindications, Mль-E should be used for patients unable to achieve PCFs >270 L/min with LVR and/or MAC, particularly during respiratory infection (1C recommendation)

Effects of manually assisted coughing on respiratory mechanics in patients requiring full ventilatory support

Observational study of manually assisted cough in 16 ventilated post-surgery ICU patients

MAIN FINDING: 0/16 patients experienced:
- Hemodynamic compromise
- Bradycardia
- Hypoxemia
- Bronchospasm

Effects of manually assisted cough combined with postural drainage, saline instillation, and suctioning in critically ill patients during high-frequency oscillatory ventilation:

- Mark Nonnemacher, MD, MSc, Marjory van den Berg, RN, and Luigi Comparsa, MD

What is the evidence in the critically ill?

Woman campaigns to have ‘cough’ machine on market

Criteria for Extubation and Tracheostomy Tube Removal for Patients With Ventilatory Failure

A Different Approach to Weaning

49 ventilated patients (neuromuscular impairment/SCI/COPD)

Medically stable, cognitively intact; no narcotics/sedatives, PaO2 >60

Switch to portable volume ventilator

Wean from O2 using ventilator assist and Mль-E

Switch to fenestrated cuffed tube

Cap tube and train to use mouth piece/nasal IPPV

Extubate/decanunculate + Mль-E (+30 to +50/30 to -50) for cough and O2 desaturations

Wean from ventilatory assist by taking fewer assisted insufflations
### Criteria for Extubation and Tracheostomy Tube Removal for Patients With Ventilatory Failure

**A Different Approach to Weaning**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Success</th>
<th>Failure</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decannulation, n (%)</td>
<td>32 (65)</td>
<td>17 (35)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>43 (18)</td>
<td>39 (18)</td>
<td>0.47</td>
</tr>
<tr>
<td>Mechanical ventilation before decannulation, days</td>
<td>11.2 (15)</td>
<td>5.8 (6.1)</td>
<td>0.09</td>
</tr>
<tr>
<td>Vital capacity, mL</td>
<td>982 (609)</td>
<td>982 (466)</td>
<td>0.59</td>
</tr>
<tr>
<td>Hours of ventilator use per day</td>
<td>16.6 (9.8)</td>
<td>11.1 (9.9)</td>
<td>0.07</td>
</tr>
</tbody>
</table>

All patients with an assisted PCF > 160 L/min were successfully extubated/decannulated
No patient with a PCF < 160 L/min was successful

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### Safety and Effectiveness of Breath Stacking in Management of Persons with Acute Atelectasis

- **BREATH STACKING PROTOCOL**
  - Side-lying with affected lung uppermost
  - 3 mins 100% FiO₂ on vent
  - 3 stacked breaths
    - 1 way valve
    - Max pressure of 40 cmH₂O
  - 10 sec hold at max pressure
  - Abdominal thrust or chest squeeze
  - Repeat for total of 3 cycles

Enrolled 20/40 participants
Main finding: no adverse events

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### Exubation of Patients With Neuromuscular Weakness

**A New Management Paradigm**

- **PROTOCOL**
  - Cough assist (+40/⁻40) to maintain SpO₂ ≥ 95% prior to extubation
  - Extubated to NIV
    - Nasal/oronasal/mouthpiece
    - Assist/control 800-1500mL, FiO₂ 21%
    - LVR, MAC
    - Pts weaned selves by taking fewer IPPV breaths

- **RESULTS**
  - 100% success for CPF ≥ 160 L/min
  - 80% for CPF < 160 L/min
  - Success = no reintubation prior to dx

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### Effects of mechanical insufflation-exsufflation in preventing respiratory failure after extubation: a randomized controlled trial

- **PROTOCOL**
  - Respiratory pause with loss of consciousness
  - Respiratory pause after 24 h

- **RESULTS**
  - Improved ventilation in both groups
  - Decreased need for ventilation
  - Reduced tidal volume
  - Improved oxygenation

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### Enrolled 20/40 participants
Main finding: no adverse events
16 cases (15 children) with NMD and ARF requiring ICU admission.

NIV and MI-E used to prevent intubation.

BiPAP: IPAP 8-10 cmH₂O; EPAP 4.5 cmH₂O

MI-E: titrated up to +40/-40 cmH₂O

Applied when SpO₂ <94%; Need to ↑ IPAP; or ↑ secretions.

Mean time to intubation in 4 cases that failed 17.5 (6.6) hours.

11 adults with NMD and ARF requiring ICU admission (MI-E + physiotherapy)

16 historical controls (physiotherapy only)

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Control</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requiring NPPV, n</td>
<td>8</td>
<td>14</td>
<td>0.370</td>
</tr>
<tr>
<td>Intravenous antibiotics, n</td>
<td>11</td>
<td>13</td>
<td>0.248</td>
</tr>
<tr>
<td>Time on mechanical ventilation, days</td>
<td>9.4 (6.9)</td>
<td>13.5 (11.9)</td>
<td>0.299</td>
</tr>
<tr>
<td>Hospital stay, days</td>
<td>20.5 (20)</td>
<td>19.8 (17)</td>
<td>0.927</td>
</tr>
<tr>
<td>Treatment failure (defined as need for intubation), n</td>
<td>2</td>
<td>10</td>
<td>0.040</td>
</tr>
</tbody>
</table>

Who is using it in the ICU? a Canadian perspective.
Canadian National Survey

**OBJECTIVE**— to describe:
- Use of:
  - MI-E
  - manually assisted cough (MAC)
  - lung volume recruitment (LVR)
- Interfaces
- Settings
- Diagnoses/Indications
- Contraindications
- Complications
- Barriers to use

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**OUR RESULTS**

238 eligible units
157 returned survey
66% response rate

78/157 (50%) used cough augmentation
50/78 (64%) used MI-E
73/78 (93%) used MAC
62/78 (79%) used LVR

MI-E via facemask (77%), tracheostomy (73%), mouth piece (75%)
endotracheal tube less common (32%)
Mean insp pressure 31 cmH2O; exp pressure - 32 cmH2O

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**DIAGNOSES**

**INDICATIONS**

Weaning (NIV)
Weaning (invasive)
Avoid intubation
Avoid reintubation
Secretion clearance
Never
Seldom
Sometimes
Often
Frequently
BARRIERS TO USE

CONCLUSIONS

• We found moderate adoption of cough augmentation techniques
  – particularly for secretion management

• Lack of expertise and knowledge are modifiable barriers
  – Potentially addressed with educational interventions

Thank you for your attention and Questions?

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