Chest Physiotherapy and Airway Clearance in Pediatrics

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I have no real or perceived conflict of interest that relates to this presentation. Any use of brand names is not in any way meant to be an endorsement of a specific product, but to merely illustrate a point of emphasis.
Objectives

Learning objectives for this presentation:
• Discuss different forms of airway clearance therapies (ACTs)
• Review the literature related to the use of ACTs in pediatric lung disease
• Discuss ways to embrace judicious use of ACTs in patients using evidence-based approaches
Airway Clearance Techniques (ACTs) are used in variety of settings for a variety of clinical ailments:

1) evidence of retained pulmonary secretions
2) weak or ineffective cough
3) focal lung opacity on chest x-ray consistent with mucous plugging and/or atelectasis and
4) intrapulmonary shunt requiring oxygen
Chest Physiotherapy

Postural drainage is a technique for loosening mucus in the airway so that it may be coughed out.

Tapping is performed in certain areas with the patient in different positions.

Postural Drainage

http://www.cfbarbados.org/content/treatment
Chest Physiotherapy
Vibrate Your Body And Make it Well

You have no right to be sick. Pain, suffering and disease are unnatural, they are wrong. It is your duty to be well. Don't try to stand pain—CURE IT! No matter how old you are, even if others have told you that your case was hopeless, you can still be cured. The White Cross Electric Vibrator is putting up a fight against the century of disease. It is putting up a fight against the disease that has made you feel so weak, so helpless. It is putting up a fight against the disease that has made you feel so weak, so helpless. It is putting up a fight against the disease that has made you feel so weak, so helpless. It is putting up a fight against the disease that has made you feel so weak, so helpless.

FREE BOOK
"Health and Beauty"

SEND TODAY for the instructive free book, "Health and Beauty." This book will show you how to make the body in health and disease as perfect as possible, no matter how many years you have lived. It tells you how to get well and stay well, and how to live and work and play and have fun. This book was not written for surgeons and physicians, but for all. It tells you how you can put your body in perfect health.

Vibrating Chair Free

With your White Cross Electric Vibrator, you can transform any ordinary household chair into a Vibrating Chair, again on easy terms. It is a great step forward in the fight against disease. It is a great step forward in the fight against disease. It is a great step forward in the fight against disease. It is a great step forward in the fight against disease.

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DON'T DELAY A MINUTE. Whether you feel sick or well, you should read this book. You can't afford to wait. You must do it now, and it's easy. When you do it now, you'll be able to read it later. Even today when you feel well, you'll be able to read it later. Even today when you feel well, you'll be able to read it later. Even today when you feel well, you'll be able to read it later. Even today when you feel well, you'll be able to read it later.

SEND NO MONEY, just your name and address to the coupon. But write today.

LINDSTROM, SMITH CO. 283 N. LaSalle Street CHICAGO
Other Airway Clearance Options: ACTs

- Therapy Vest
- Nasotracheal Sx
- Hand-Held Airway Clearance
- Cough Assist
ACTs cont’d

Incentive Spirometry

Ambulation

Breathing games
ACTs have only been shown to be effective in children with CF, Bronchiectasis and neuromuscular weakness.

Lack of definitive data for ACT for common forms of pediatric respiratory failure:
- Pneumonia (may cause patients' condition to worsen)
- Bronchiolitis, asthma, pleural effusion
- Prevention of atelectasis
Bronchiolitis

- Systematic review to determine efficacy of CPT in infants with acute viral bronchiolitis <2 years old
- Reviewed improvement in disease severity, LOS, and oxygen use
- Nine clinical trials including 891 participants were included comparing CPT with no intervention
- CPT was not found to improve the severity of the disease, respiratory parameters, or reduce length of hospital stay or oxygen requirements in infants

Roqué i Figuls Chest physiotherapy for acute bronchiolitis in paediatric patients between 0 and 24 months old. Cochrane Database Syst Rev. 2012
Therapies NOT routinely recommended

- Albuterol
- Racemic Epinephrine
- Hypertonic Saline
- Combination Medications
- Corticosteroids
- **Chest Physiotherapy**
- Singulair

Thought to assist in clearance of secretions and decrease ventilatory effort.

**Chest physiotherapy does not improve respiratory score, length of stay, or O₂ requirement, and is not recommended for routine use in bronchiolitis [LOE: M] (1, Perotta 2008).**

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**Evaluate for one-time trial of albuterol**

Consider for patients with RS or 9-12 AFTER suction OR patients at increased risk for asthma (>12 months old with wheeze, plus history of atopy or recurrent wheezing OR strong family history of atopy or asthma).

Patient considered albuterol responsive if respiratory score improves by 2 or more

- Does not meet criteria, or no response to albuterol

**Respiratory score** *(SCORE, SUCTION, SCORE)*
Are ACTs a useful option with pneumonia?
Pneumonia

- RCT with children (29 d to 12 y old) hospitalized with acute pneumonia, and compared twice-daily CPT and standard pneumonia therapy (n = 51) to standard treatment alone (n = 47)
  - The CPT group had a longer median duration of coughing (5.0 d vs 4.0 d, P = 0.04) and longer duration of rhonchi (median 2.0 d vs 0.5 d, P = 0.03) than the medical treatment only group

Paloudo, Thorax, 2008
The Use of Chest Physiotherapy

- Chest physiotherapy (CPT) had no effect on length of hospital stay, fever, or radiographic findings. Some suggestion that CPT is counterproductive, with longer fever lengths. A supported sitting position may help to expand the lungs and improve respiratory symptoms in a child with respiratory distress.

- It is recommended that therapies directed toward airway clearance, such as postural drainage and CPT not be used for the patients with uncomplicated pneumonia.

- Early mobilization (movement out of bed with change from horizontal to upright positioning for at least 20 minutes in the first 24 hours of stay and subsequent increasing activity each additional day) alone may be more effective than usual care at reducing the mean length of stay. Bottle blowing plus encouragement to sit up 10 times a day and early mobilization may decrease length of stays.

[LOE: ☢☢☢ Low quality] (Gilchrist, 2008)
• Randomized Placebo Controlled Trial
• 38 children aged 6 to 13 years with severe asthma
  • 19 children received chest physical therapy (PT) and 19 children received placebo visits
• Lung function at the end of the study was similar in both groups

Asher I et al., Pediatr Pulmonol, 1990
Can ACT resolve acute lobar atelectasis during mechanical ventilation?

- Larger ventilated patients (Templeton M et al., Intensive Care Med, 2007)
  - CPT may be useful for acute lobar or segmental atelectasis based on radiographic evidence
- Neonates-post-extubation (Flenady et al., Cochrane 2002)
  - No benefit to peri-extubation CPT
  - No decrease in post-extubation lobar collapse
  - Lower re-intubation rate in babies treated with CPT
Can CPT and other ACTs prevent atelectasis?
Cardiac Transplant

Room Air HHFNC 4-6 L/min


CXR from 4/16/15. CPT provided TID. Radiologist noted “lungs are somewhat overinflated mild shadowing in infrahilar areas”
Tricuspid Atresia
Room Air HFNC 5 L/min for 72 hours

4/14 “Mild Perihilar haziness suggestive of edema”
Receiving CPT TID to RUL
RT attempted to get this DC’d
MD: “well, I guess you are going to have to do it anyway.”
RT: “how about increasing PEEP”?  

4/16/15 Radiologist noted “No lobar consolidation”
CPT reordered for “Right sided lobar collapse.”
4/14/15 Ordered for “left hemidiaphragm paresis” and then order changed to “lobar atelectasis”

4/16/15 0610 CPT Q4 for 72 hours
Radiologist noted “mild increase in RUL opacity”
Cost to patient: $6,300.00
RT time: 6 hours at the bedside
Chest Physiotherapy Fails to Prevent Postoperative Atelectasis in Children After Cardiac Surgery

H. DAVID REINES, M.D., ROBERT M. SADE, M.D., BARBARA F. BRADFORD, M.D., JOHN MARSHALL, R.R.T.

**Table 3. Results: CPT vs. NCPT**

<table>
<thead>
<tr>
<th></th>
<th>CPT*</th>
<th>NCPT†</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest postoperative temperature (°C)</td>
<td>38.5 ± 0.1</td>
<td>38.4 ± 0.1</td>
<td>NS</td>
</tr>
<tr>
<td>Daily peak sleeping respiratory rate (min⁻¹)</td>
<td>30 ± 2</td>
<td>29 ± 2</td>
<td>NS</td>
</tr>
<tr>
<td>Atelectasis: highest postop grade</td>
<td>3.2 ± 0.2</td>
<td>2.8 ± 0.2</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Highest postop–preop grade</td>
<td>2.1 ± 0.2</td>
<td>1.5 ± 0.2</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>No. pts developing atelectasis</td>
<td>13/19 (68.4%)</td>
<td>8/25 (32.0%)</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

* CPT: chest physiotherapy.
† NCTP: no chest physiotherapy.
Can ACT **prevent** lobar atelectasis or VAP?

- Mechanically ventilated adult patients (*Chen YC, J Clin Med Assoc, 2009*)
  - No differences in VAP between CPT and no intervention
ACT in pleural effusion
Systematic Review

- Included 24 RCTs, seven crossover RCTs, and one prospective cohort study in adults and patients (n=2,453)
- Patients with CF and neuromuscular disease were excluded
- Based on these data, this review found no evidence from RCTs to support the use of CPT or any other form of ACT in adults or pediatrics to:
  - improve oxygenation, reduce length of time on the ventilator, reduce stay in the ICU, resolve atelectasis/consolidation, and/or improve respiratory mechanics versus usual care in this population

Andrews et al., Resp Care, 2013
Airway clearance therapy (ACT) is used in a variety of settings for a variety of ailments. These guidelines were developed from a systematic review with the purpose of determining whether the use of nonpharmacologic ACT improves oxygenation, reduces length of time on the ventilator, reduces stay in the ICU, resolves atelectasis/consolidation, and/or improves respiratory mechanics, versus usual care in 3 populations. For hospitalized, adult and pediatric patients without cystic fibrosis, 1) chest physiotherapy (CPT) is not recommended for the routine treatment of uncomplicated pneumonia; 2) ACT is not recommended for routine use in patients with COPD; 3) ACT may be considered in patients with COPD with symptomatic secretion retention, guided by patient preference, toleration, and effectiveness of therapy; 4) ACT is not recommended if the patient is able to mobilize secretions with cough, but instruction in effective cough technique may be useful. For adult and pediatric patients with neuromuscular disease, respiratory muscle weakness, or impaired cough, 1) cough assist techniques should be used in patients with neuromuscular disease, particularly when peak cough flow is < 270 L/min; CPT, positive expiratory pressure, intrapulmonary percussive ventilation, and high-frequency chest wall compression cannot be recommended, due to insufficient evidence. For postoperative adult and pediatric patients, 1) incentive spirometry is not recommended for routine, prophylactic use in postoperative patients, 2) early mobility and ambulation is recommended to reduce postoperative complications and promote airway clearance, 3) ACT is not recommended for routine postoperative care. The lack of available high-level evidence related to ACT should prompt the design and completion of properly designed studies to determine the appropriate role for these therapies. Key words: airway clearance therapy; ACT; chest physiotherapy; CPT; atelectasis; secretion clearance; percussion. [Respir Care 2013;58(12):2187–2193. © 2013 Daedalus Enterprises]
Evidence Based Review-Pediatrics

Quality of Evidence Related to ACT Effectiveness

HIGH
- Cystic Fibrosis
- Bronchiectasis
- Chronic Bronchitis

HIGH - MODERATE
- Neonates: Post Extubation

MODERATE
- Neuromuscular Disease
- Atelectasis/Infiltrate during Mechanical Ventilation

LOW
- Asthma
- Bronchiolitis
- Pneumonia
- Pleural Effusion
- Preventing Atelectasis

Adapted from: Walsh BK, et al. Respir Care 2011.

Andrews et al., Resp Care, 2013
Risks Associated with ACT

- Gastroesophageal reflux (Button BM, Pediatr Res 1994)
- Decreased oxygenation and increased oxygenation requirements (Hough JL, Cochrane, 2008)
- Increased intracranial pressure and intracranial bleeding (Harding JE, J Pediatr, 1998)
- Longer duration of fever (Britton S, BMJ, 1985)
- Increased vomiting and respiratory instability (Roque et al., Cochrane, 2012)
- Increased SOB, arrhythmia, bronchospasm, thoracic hematoma (Andrews J, Resp Care, 2013)
Photo courtesy of Seattle Children’s Hospital RT Dept with permission
Problem: RT Staffing Crisis

Dayshift RT FTE

1/3/2009
2/3/2009
3/3/2009
4/10/2009
5/17/2009
6/27/2009
8/3/2009
9/7/2009
10/16/2009
12/11/2009
1/24/2010
2/26/2010
3/30/2010
5/2/2010
6/3/2010
7/5/2010
8/6/2010
9/8/2010
10/11/2010
11/12/2010
12/23/2010
1/15/2011
2/20/2011
3/25/2011
4/26/2011
5/31/2011
7/4/2011
8/5/2011
9/8/2011
10/14/2011
11/20/2011
12/23/2011
2/3/2012
3/18/2012
4/28/2012
6/2/2012
7/13/2012
8/19/2012
9/25/2012
11/13/2012
12/25/2012
1/29/2013
3/3/2013
4/10/2013
5/17/2013
6/27/2013
8/3/2013
9/7/2013
10/16/2013
12/11/2013
1/24/2014
3/12/2014
4/16/2014
5/24/2014
7/29/2014
Allocation of RT resources: Airway Clearance

<table>
<thead>
<tr>
<th>Year</th>
<th># Chest Physiotherapy Charges</th>
</tr>
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<tbody>
<tr>
<td>2011</td>
<td>$548,310</td>
</tr>
<tr>
<td>2012</td>
<td>$908,670</td>
</tr>
<tr>
<td>2013</td>
<td>$1,017,660</td>
</tr>
<tr>
<td>2014</td>
<td>$1,431,150</td>
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### Orders for Signature

<table>
<thead>
<tr>
<th>Order Name</th>
<th>Status</th>
<th>Start</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resp Therapy</td>
<td></td>
<td>7/29/2014 11:57 for 3 day(s), Requested date/time: 7/29/2014 11:57</td>
<td></td>
</tr>
</tbody>
</table>

### Details for Chest Physiotherapy

**Order details**
- **Frequency**
- Duration [3]
- Duration unit [day(s)]
- Type of therapy
- Reason for therapy
- Other (enter free-text reason)
- Lung field
- While awake

**Detail values**
- Bronchiectasis
- Chronic bronchitis
- Cystic fibrosis
- Lobar atelectasis
- Other-
“prevention of lobar atelectasis, diffuse pneumonia, increased work of breathing, inability to clear secretions, obstruction of V-P shunt and pleural effusion, complete lung opacification while on extracorporeal life support, wheezing, microaspiration, comfort (soothing), decreased breath sounds, no abdominal domain, poor pulmonary compliance, bronchiolitis, excessive nasal and/or oral pooling, junky breath sounds, post-operative fever and paroxysmal cough.”
Goal

• We proposed a therapist-driven protocol that allows RTs to provide appropriate and judicious ACT care to patients
  – Less risk to the patient
  – Less expense to payers
  – Less strain on RT resources
  – Improved job satisfaction for RTs
All Patients, All Diseases: All Airway Clearance Therapies

Patients with moderate-high level evidence for ACT use: **67% increase**

Patients with low level evidence for ACT use: **65% increase**
Total Tx's per Patient Day - Group A
Patients with Bronchiolitis, Pneumonia, Pleural Effusion, Asthma as Primary or Secondary Diagnoses
Tx's per Patient Day
Patients without Pneumonia, Bronchitis, Bronchiolitis or Asthma as Primary or Secondary Dx
Airway Clearance RT Consult Algorithm
(Expires within 72 hours; frequency, response, and adjustments to therapy are an ongoing process)

1. Continue at Baseline Frequency
2. If Clinical Condition Warrants, Increase Frequency ≥ Baseline
3. Assess Readiness to Wean
4. Frequency to Baseline ≥ Q24hrs
5. Suggest Potential Changes to Regimen (if indicated).

Yes

Encourage Cough:
Oral or Tracheal Suction

Radiographic Evidence < 72 hours

Provide Incentive Spirometry,
Breathing Games, or Ambulation

Yes

Quality of Evidence Related to ACT Effectiveness

HIGH
Cystic Fibrosis
Bronchiectasis
Chronic Bronchitis

HIGH - MODERATE
Neonates: Post Exubation

MODERATE
Neuromuscular Disease
Atelectasis/Infiltrate during Mechanical Ventilation

LOW
Asthma
Bronchiolitis
Pneumonia
Pleural Effusion
Preventing Atelectasis

Adapted from: Walsh BK, et al. Respir Care 2011.

Treatment Effective?

No

RT to provide Mechanical Insufflation or Acapella Therapy

Yes

Continue Therapy for 72hrs & Reassess

Neonates: Manual Percussor (side lying)
Toddlers: Manual Percussor or Large Vibrator
Adolescents: Acapella, Hand Clapping, Large Vibrator, or Therapy Vest
### Step 1: MD orders RT Airway Clearance Consult

<table>
<thead>
<tr>
<th>Order Name</th>
<th>Status</th>
<th>Start</th>
<th>Details</th>
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<tbody>
<tr>
<td>PICU-F5; FA.5.202-P; 1 x79402 Account Number: 30137916 Admit: 2/23/2015 14:14:00 PST</td>
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</tr>
</tbody>
</table>

#### Details for RT Airway Clearance Protocol Consult

**Order details**
- **Reason for consult**
- **Contact name**
- **Contact phone number**
- **Special instructions**
- **Requested date/time**: 6/16/2015 12:24

**Detail values**
- Patient uses chronic form of therapy
- Ineffective secretion clearance
- Lobar atelectasis
- Risk for atelectasis
Step 2: Assess and Treat

![Image of a healthcare management system interface]

- **Component**: Ordersets
  - Last modified: 06/16/15
  - Clinical owner: Rob Dibiasi

- **Resp Therapy**
  - Chest Physiotherapy
  - Acapella Treatment
  - Percussion Vest
  - In-exsufflator

*Seattle Children's Hospital - Research - Foundation*
Step 3: Entering the Power Plan per Protocol on behalf of the ordering provider
Study Design: Ongoing Metrics

Pre-Protocol 2/5/2012 - 6/30/2015
- All patients billed for Airway Clearance Procedures
  - Excluded CF Patients
    - CPT Only
    - Other ACT

Post-Protocol 7/1/2016 - 1/31/2016
- All patients billed for Airway Clearance Procedures
  - Excluded CF Patients
    - CPT Only
    - Other ACT

Metrics:
- Tx’s per Pt Day
- Tx’s per Calendar Day
- Revenue per Pt Day*
- Revenue per Calendar Day*

* Revenue data were inflation adjusted to keep all data in constant 2012 dollars
44% reduction Tx/PPD
39% reduction in revenue
4% increase in Tx/PPD
17% increase in revenue
Sudden Clinical Deteriorations
Among Non-CF Patients Receiving CPT or ACT
Before and After Protocol Implementation

<table>
<thead>
<tr>
<th>COUNT OF ENCOUNTERS</th>
<th>PRE</th>
<th>POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCD? NO</td>
<td>2646</td>
<td>392</td>
</tr>
<tr>
<td>SCD? YES</td>
<td>122</td>
<td>13</td>
</tr>
<tr>
<td>RATE</td>
<td>4.6%</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

There was no significant difference in SCDs between PRE and POST Airway Clearance Consult, $P=0.264$ (Chi-Square)
Shared Learnings

• Developing a hospital-wide RT Driven Protocol (clinical standard work) is not EASY work
• Clinical Standard Work can result in significant cost savings and potentially lower risk to the patient
• Must engage/include key stakeholders from multiple disciplines
  • Share evidence-based data and publications
  • Solicit input from RN, MD, RT leadership
  • Work with IS to develop an appropriate order set
• Ongoing assessment of metrics is necessary to evaluate the success of our efforts
Conclusion

• The effectiveness of airway clearance therapy lacks definitive data in different pediatric populations
• CPT may do more harm than good in some patients and clinicians should weigh risk vs benefit with tx
  • Bronchiolitis, post-op, pneumonia, prevention of atelectasis
• Educating clinicians and patients on ACTs is essential
• Not all patients can be managed with a standardized ACT protocol and care may need to be modified or individualized