

Date: November 22, 2011

Title: Recruitment Maneuvers for Acute Lung Injury

Clinical Question:

- | | |
|------------------|---|
| P (Population) | Among newborn infants through adults with artificial airways that are mechanically ventilated |
| I (Intervention) | do recruitment maneuvers |
| C (Comparison) | compared to conventional mechanical ventilation |
| O (Outcome) | lead to improvement of acute lung injury and/or atelectasis? |

Target Population:

Newborn infants through adults who are mechanically ventilated with acute lung injury and/or atelectasis. Exclusion criteria include patients with increased intracranial pressure, pneumothorax and hemodynamic instability.

Recommendation:

It is recommended that recruitment maneuvers be used with mechanically ventilated patients diagnosed with acute lung injury to improve acute lung injury and decrease atelectasis (*Lapinsky 2004[1b], Badet 2009[2a], Marchenkov 2010[2a], Meade 2008[2a], Scohy 2009[2a], Tusman 2003[2a], Iannuzzi 2010[2b], Maa 2005[2b], Boriosi 2011[3a], Duff 2007[3a], Povoia 2004[3a], Toth 2007[3a], Hodgson 2011[4a], Dernaika 2007[5a], Kacmarek 2011[5a], Papadacos 2010[5a], Stiller 2000[5a], Principi 2011[5b]*).

Note: Potential risks for use of RM are transient hypotension, decreased venous return and barotrauma (*Lapinsky 2004[1b], Marchenkov 2010[2a], Iannuzzi 2010[2b], Duff 2007[3a], Hodgson 2011[4a], Dernaika 2007[5a], Kacmarek 2011 [5a]*).

Definitions:

Recruitment maneuvers (RM): an intervention to increase the number of alveoli participating in gas exchange by increasing the trans-pulmonary pressure via ventilator or flow inflation bag.

Acute lung injury (ALI): an acute lung disease with bilateral pulmonary infiltrate documented on a chest radiograph consistent with the presence of pulmonary edema, no evidence of left atrial hypertension and if measured a pulmonary wedge pressure of ≤ 18 mmHg. Oxygen criteria to include the ratio of arterial oxygen to the fraction of inspired oxygen ($\text{PaO}_2/\text{FiO}_2$) to be ≤ 300 mmHg and ≤ 200 mmHg for respiratory distress syndrome (*Bernard 1994[5a]*).

Atelectasis: an abnormal condition characterized by the collapse of lung tissue, preventing the exchange of carbon dioxide and oxygen with the pulmonary capillary blood (*Egan 1995[5a]*).

Conventional Mechanical Ventilation: a conservative method to mechanically replace or assist spontaneous breathing.

Discussion/Summary of Evidence Related to the Recommendation:

Managing patients with acute lung injury (ALI) and/or acute atelectasis is continually evolving and recruitment maneuvers have become an area of interest in the clinical setting. The use of RM has been shown to improve atelectasis among patients who received therapy compared to patients who did not receive therapy (*Tusman*

2003[2a], Maa 2005[2b]). Management of adult and pediatric patients utilizing RM showed an increase in oxygenation post RM (Badet 2009[2a], Marchenkov 2010[2a], Meade2008[2a], Scohy 2009[2a], Iannuzzi2010[2b], Boriosi 2011[3a], Toth 2007[3a]). Studies have shown an increase in pulmonary compliance after receiving RM therapy (Scohy 2009[2a], Povoia 2004[3a], Hodgson 2011[4a]). Interventions that result in a decrease in the duration of mechanical ventilation thus decreasing length of stay (LOS) in the intensive care unit can overall lead to a shortened hospital admission and lead to significant reductions in total costs (Maa 2005[2b], Stiller 2000[5a]). Overall, RM's have been shown to be a safe and effective modality in adult and pediatric populations (Boriosi 2011[3a], Duff 2007[3a], Povoia 2004[3a] and Hodgson 2011[4a]). Controversy remains among experts about what outcomes are important to measure such as atelectasis, number of ventilator days and mortality (Dernaika 2007[5a], Papadakos 2010[5a], Principi 2011 [5b]).

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Supporting Information

Background/Purpose of BEST Development:

Increasing demand by physicians and bedside clinicians to utilize evidenced based ventilator strategies to treat conditions such as atelectasis and ALI prompted this search. Evidence was needed to develop a safe, effective and consistent modality to treat the pediatric and adult populations. Currently, Cincinnati Children's Hospital Medical Center does not have a standardized RM procedure. In addition, current RM practices vary between clinicians and/or patient units. Recruitment maneuvers promote alveolar recruitment and may consist of intermittent sighs, sustained inflation holds and increasing PEEP. Recruitment maneuvers can be performed by manual inflation bag or manipulation of a ventilator. Typically RM is performed by using pressure control ventilation (PCV) (Marchenkov 2010 [2a], Meade 2008 [2a], Schohy 2009 [2a], Tusman 2003 [2a], Hodgson 2011 [4a]) or performing a sustained inflation (SI) (Iannuzzi 2010 [2b], Duff 2007 [3a]). Utilizing PCV has the benefit of keeping the plateau pressure constant. Therefore a known plateau pressure is delivered consistently. SI is giving the patient a prolonged positive pressure breath usually between 30-40 cmH₂O and for 10-30 seconds. Lung recruitment maneuvers may be used to open non-aerated lung fields, to determine the most appropriate positive end expiratory pressure and to utilize

after interventions which may collapse alveoli, such as suctioning and disconnection from the ventilator (Lapinsky 2004 [1b]).

Applicability Issues:

Potential applicability issues for implementation of RM are development of a standardized procedure (including frequency and method) for each patient population, development of an order set and documentation and staff education.

Outcome or Process Measures:

Organization Goal	Potential Impact	Measure
Safety	Improved time to resolution of atelectasis	Heart rate, respiratory rate, blood pressure, chest x-ray, blood gas
Satisfaction	Improved satisfaction of Patient, families, and staff	Satisfaction surveys
Flow	Decreased use of traditional therapies, decreased ventilator days, shortened length of intensive care unit (ICU) stay	Number of ventilator days, ICU length of stay
Cost	Decreased ventilator costs, length of ICU stay, and costs of traditional therapies	Ventilator cost and days, ICU length of stay, cost of traditional therapy

Search Strategy:

Keywords: Recruitment maneuver, pediatric, acute lung injury, mechanically ventilated, open lung technique, atelectasis, intubated, artificial airway

Databases: Medline/PubMed, MD consult, and Google Scholar

Filters: none

Date range searched: 2000-2011

Relevant CCHMC Evidence-Based Documents:

BESr # 109-Recruitment Maneuvers vs. Chest Physiotherapy for the Mechanically Ventilated Patient

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Conflicts of Interest were declared for each team member:

- No financial conflicts of interest were found.
 The following financial conflicts of interest were disclosed:

Note: Full tables of evidence grading system available in separate document:

- [Table of Evidence Levels of Individual Studies by Domain, Study Design, & Quality](#) (abbreviated table below)
- [Grading a Body of Evidence to Answer a Clinical Question](#)
- [Judging the Strength of a Recommendation](#) (abbreviated table below)

Table of Evidence Levels (see note above)

Quality level	Definition
1a [†] or 1b [†]	Systematic review, meta-analysis, or meta-synthesis of multiple studies
2a or 2b	Best study design for domain
3a or 3b	Fair study design for domain
4a or 4b	Weak study design for domain
5a or 5b	General review, expert opinion, case report, consensus report, or guideline
5	Local Consensus

†a = good quality study; b = lesser quality study

Table of Recommendation Strength (see note above)

Strength	Definition
It is strongly recommended that... It is strongly recommended that... not...	There is consensus that benefits clearly outweigh risks and burdens (or visa-versa for negative recommendations).
It is recommended that... It is recommended that... not...	There is consensus that benefits are closely balanced with risks and burdens.
There is insufficient evidence and a lack of consensus to make a recommendation...	

Dimensions for Judging the Strength of the Recommendation

Reflecting on your answers to the dimensions below and given that more answers to the left of the scales indicates support for a stronger recommendation, complete one of the sentences above to judge the strength of this recommendation.

(Note that for negative recommendations, the left/right logic may be reversed for one or more dimensions.)

1. Grade of the Body of Evidence	<input type="checkbox"/> High	<input checked="" type="checkbox"/> Moderate	<input type="checkbox"/> Low
2. Safety / Harm (Side Effects and Risks)	<input type="checkbox"/> Minimal	<input checked="" type="checkbox"/> Moderate	<input type="checkbox"/> Serious
3. Health benefit to patient	<input type="checkbox"/> Significant	<input checked="" type="checkbox"/> Moderate	<input type="checkbox"/> Minimal
4. Burden on patient to adhere to recommendation	<input checked="" type="checkbox"/> Low	Unable to determine	<input type="checkbox"/> High
5. Cost-effectiveness to healthcare system	<input checked="" type="checkbox"/> Cost-effective	<input type="checkbox"/> Inconclusive	<input type="checkbox"/> Not cost-effective
6. Directness of the evidence for this target population	<input type="checkbox"/> Directly relates	<input checked="" type="checkbox"/> Some concern of directness	<input type="checkbox"/> Indirectly relates
7. Impact on morbidity/mortality or quality of life	<input type="checkbox"/> High	<input checked="" type="checkbox"/> Medium	<input type="checkbox"/> Low

Comments on Dimensions (optional):

2. Potential risks for use of RM are transient hypotension, decreased venous return and barotrauma (Lapinsky 2004[1b] Marchenkov 2010[2a], Iannizzi 2010[2b], Duff 2007[3a], Hodgson 2011[4a], Dernaïke 2007[5a], Kacmarek 2011 [5a]).

Copies of this Best Evidence Statement (BEST) and related tools (if applicable, e.g., screening tools, algorithms, etc.) are available online and may be distributed by any organization for the global purpose of improving child health outcomes.

Website address: <http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/best.htm>

Examples of approved uses of the BEST include the following:

- copies may be provided to anyone involved in the organization's process for developing and implementing evidence-based care;
- hyperlinks to the CCHMC website may be placed on the organization's website;
- the BEST may be adopted or adapted for use within the organization, provided that CCHMC receives appropriate attribution on all written or electronic documents; and
- copies may be provided to patients and the clinicians who manage their care.

Notification of CCHMC at EBDMinfo@cchmc.org for any BEST adopted, adapted, implemented, or hyperlinked by the organization is appreciated.

Please cite as: Cincinnati Children's Hospital Medical Center: Best Evidence Statement: Recruitment Maneuvers
<http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/best.htm>, BEST 116, pages 1-6.

This Best Evidence Statement has been reviewed against quality criteria by 2 independent reviewers from the CCHMC Evidence Collaboration.

For more information about CCHMC Best Evidence Statements and the development process, contact the Evidence Collaboration at EBDMinfo@cchmc.org.

Note

This Best Evidence Statement addresses only key points of care for the target population; it is not intended to be a comprehensive practice guideline. These recommendations result from review of literature and practices current at the time of their formulation. This Best Evidence Statement does not preclude using care modalities proven efficacious in studies published subsequent to the current revision of this document. This document is not intended to impose standards of care preventing selective variances from the recommendations to meet the specific and unique requirements of individual patients. Adherence to this Statement is voluntary. The clinician in light of the individual circumstances presented by the patient must make the ultimate judgment regarding the priority of any specific procedure.