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Lung Volume Recruitment – Manual and Mechanical (Modified Manual Lung Volume Recruitment (MMLVR) and Mechanical Insufflation - Exsufflation (MI-E))		CLIN -103	Page 1 of 16
AUTHORIZATION:		SITES	
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ADDITIONAL AUTHORIZATIONS:		May 21, 2008	

REASON FOR POLICY

Lung Volume Recruitment (LVR) such as Modified Manual Lung Volume Recruitment (MMLVR) and Mechanical Insufflation - Exsufflation (MI-E) can increase lung volume and lung/ribcage suppleness, improve cough efficiency and prevent infections. This policy will establish minimum standards for the safe and effective use of MMLVR and MI-E within the Calgary Health Region (CHR).

POLICY STATEMENT

- MMLVR and MI-E will only be performed by competent individuals who have undergone CHR education and training.
- A physician's order is required to perform LVR (MMLVR and MI-E).
- LVR (MMLVR and MI-E) can be performed in care sites across the Region, including but not limited to, acute care centers, clinics, rehabilitation centers, continuing care centers and patients'/clients' homes
- If LVR (MMLVR or MI-E) is performed in a patient/client's home they must be assessed by Homecare Respiratory Therapist (RRT) or Physiotherapist (PT).
- LVR (MMLVR and MI-E) **cannot** be performed through an endotracheal tube.

POINTS OF EMPHASIS

- LVR (MMLVR) is used for the purpose of improving vital capacity (VC) and peak expiratory cough flow (PCF) in patients/clients with impaired respiratory function. (Please see [Appendix 'A1'](#) for Indications and Contraindications of LVR MMLVR)
- LVR (MI-E) is used for the purpose of assisting the removal of retained secretions in patients/clients with impaired secretion clearance and ineffective cough, including but not limited to, spinal cord injury, neuromuscular disease and syringomyelia. (Please see [Appendix 'B'](#) for Indications and Contraindications of LVR MI-E)
- LVR will only be performed on patients/clients who are alert, cooperative and able to communicate.
- LVR is most effective when performed in conjunction with appropriate chest therapy.
- When performed through a tracheostomy, LVR MI-E may lead to obstruction of tracheostomy tube. Caution should be exercised when performing LVR MI-E with an artificial airway. Post procedure assessment of tracheostomy tube patency is vital.
- To avoid hyperventilation do not perform LVR procedures more frequently than every 10 minutes.

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- LVR can be performed in conjunction with an assisted cough maneuver (see [Appendix 'A2'](#)).
- If LVR is to be performed by a patient/client's family or caregiver, family members or caregivers must receive appropriate education and training beforehand. Education of privately hired caregivers will be the responsibility of the family.
- Individuals performing LVR must apply an appropriate level of Personal Protective Equipment (PPE) to reduce exposure to droplets.

APPLICABILITY

This policy and procedure applies to all Registered Respiratory Therapists and Respiratory Therapy Students in the Respiratory Services Department of the Calgary Health Region

DEFINITIONS

Assisted Cough Maneuver:

The application of a rapid abdominal thrust or lateral costal compression using various hand placements after an adequate spontaneous inspiration or maximal insufflation. Also known as a 'quad cough' (see [Appendix 'A2'](#) for procedure, indications, contraindications and complications).

Glossopharyngeal Breathing (GPB):

A method of breathing, which consists of a stroke like action of the tongue along with constricting action of the pharynx pumping air through the larynx into the lungs.

Maximum Forced Expiratory Flow (Max_{FEF}):

The maximum flow rate measure during a forced vital capacity (VC) maneuver.

Maximum Insufflation Capacity (MIC):

The maximum volume of air stacked within the patient's/client's lungs beyond spontaneous vital capacity. MIC is obtained by having the patient/client take a deep breath, holding it and then breath stacking using a MMLVR bagging unit.

Peak Cough Flow (PCF):

The velocity of air expelled from the lungs after a cough maneuver as measured by a peak flow meter. A minimum PCF of 160 L/min is required for effective secretion removal. PCF can be measured using a simple peak flowmeter or calculated by multiplying the Forced Expiratory Flow (FEF) X 60.

Vital Capacity (VC):

The maximum amount of air that can be exhaled after a maximum inhalation.

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APPENDIX A Lung Volume Recruitment (MMLVR)

EQUIPMENT

- 1 - disposable Bagging Unit (reservoir removed and oxygen tubing removed) clearly labeled "Not for CPR".
- 1 - set of nose clips (optional)
- 2 - one-way-valve connectors (remove leaf valve from device closest to patient)
- 1 - connector
- 4 - pieces of 6-inch corrugated tubing
- 1 - mouthpiece, mask or tracheostomy 15mm adaptor

PROCEDURE

1. Verify Physician's order. (Note: the initial order will be directed to RRT and/or PT as an "LVR Manual and Mechanical Assess and Treat" order.)
2. Determine patient/client eligibility for LVR (MMLVR) (see [Appendix 'A1'](#)).
3. Assemble and test the equipment (see [Appendix 'A3'](#)).
4. Explain the procedure to the patient/client.
5. Establish with the patient/client the signal they will use to indicate when MIC is reached or they wish to stop.
6. Ask the patient to take a deep breath and hold it, apply the mask/mouthpiece and ask the patient/client to continue to inhale.
 - 6.1. If using a mouthpiece, ask the patient/client to place their lips tightly around the mouthpiece to prevent an air leak. You may need to use a nose clip initially until the patient/client is proficient with MMLVR.
 - 6.2. If using a mask, have the patient/client hold the mask firmly on their face to prevent air leak. If patient/client is unable to hold the mask on their face a caregiver will hold the mask on the face.
 - 6.3. If performing MMLVR through a tracheostomy tube, ensure the patient has a cuff-less tube or that the cuff is deflated. (Note: If the patient tolerates corking, it is preferable to cork the patient and perform procedure through the upper airway.)
7. Cue patient to inhale again to stack breaths. Squeeze bag in synchrony with patient/client's inhalation. Patient must not exhale between each breath. Continue to stack breaths 3 – 5 times as tolerated by patient. (Note: The patient/client may feel a stretch in the chest or slight discomfort when MIC is reached.)
8. Once the patient/client's lungs are full or the patient/client signals MIC is reached, remove the mouthpiece, mask, or connector from the patient/client and ask the patient/client to continue holding their breath for 3 – 5 seconds and then slowly exhale.
 - 8.1. If secretions are present, instead of slowly exhaling, ask the patient/client to produce a strong cough/huff or include an assisted cough maneuver when indicated (See [Appendix 'A2'](#)).
9. Repeat steps 6 thru 8, 3 – 5 times.

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Appendix A1 Indications and Contraindications for LVR MMLVR

1. Clinical Indications

A patient/client who is alert, cooperative and able to communicate and:

- a. has an established diagnosis of a neuromuscular or mechanical disorder that limits thoracic expansion, including but not limited to, spinal cord injuries, amyotrophic lateral sclerosis (ALS), muscular dystrophy, progressive multiple sclerosis (MS), Guillain-Barré syndrome (GBS), post polio syndrome, syringomyelia, and kyphoscoliosis.
- b. may be unable to mobilize and expectorate secretions,
- c. has a VC less than 70% predicted or anticipate a continued decline in VC.

2. Absolute Contraindications:

- a. hemoptysis,
- b. untreated or recent pneumothorax, bullous emphysema, severe COPD
- c. asthma,
- d. recent cardio-thoracic surgery,
- e. increased intracranial pressure (ICP),
- f. intracranial drains,
- g. nausea,
- h. impaired consciousness/inability to communicate.

3. Relative Contraindications:

- a. immediately following meals.
- b. rib fractures,
- c. hemodynamic instability,
- d. pregnancy,
- e. history of pneumothorax,
- f. presence of a large pleural effusion,
- g. patient unable to breath stack.

4. Precautions:

- a. Patients/clients known to have cardiac instability should be monitored for arrhythmias, SpO₂, dyspnea, vital signs and symptoms
- b. Patients/clients with long standing thoracic cage restriction who may have severely reduced thoracic compliance will require slow incremental insufflations during the initial MMLVR introductory period.

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Appendix A2 Assisted Cough Maneuver

Indication is to aid patient/client with weak and/or paralyzed muscles to clear secretions. Assess strength of cough to decide on the amount of assistance and technique required for an effective cough.

Contraindications to Lateral Costal (Technique 3) and Forearm Assisted Cough

- osteoporosis ribs/spine
- kyphoscoliosis
- rib/thoracic pathology such as fractures,
- bruising and metastasis

Complications of Assisted Cough Maneuver

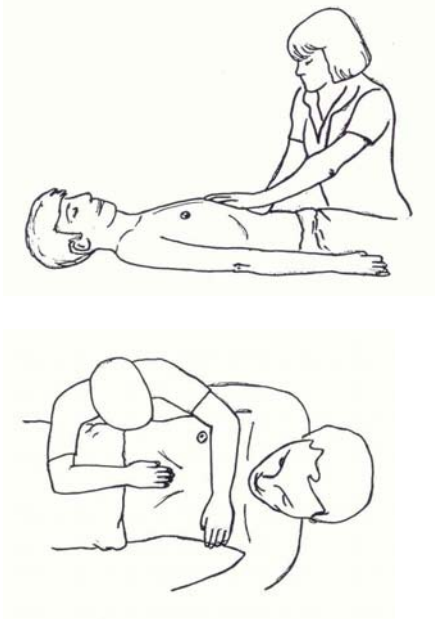
- reduced coronary perfusion
- regurgitation
- incontinence
- fatigue
- rib or costochondral junction fracture
- headache
- bronchospasm
- muscular damage or discomfort
- cough paroxysms
- chest pain

Contraindications to Abdominal Assisted Cough

- Pregnancy
- Abdominal aortic aneurysm
- Recent abdominal surgery
- Acute upper gastrointestinal bleed
- Paralytic Ileus
- Hiatal Hernia
- Open Abdomen
- Abdominal anomaly

Precaution to Abdominal Assisted Cough

- IVC Filter
- Insertion of new abdominal feeding tube (<48hours)



Technique 1

Similar to the Heimlich Maneuver Patient Position: Supine or sitting with Head of Bed (HOB) at desired angle. Assister Hand Position: Standing beside patient (or straddling patient) place heel of 1 hand over abdomen midline 2” below bottom of breast bone, place second hand on top and interlock fingers.

Action: Patient - takes deep breath and tries to cough. Assister – at beginning of cough pushes in and up evenly, firmly and quickly

Technique 2

Forearm and Hand Patient Position: Supine or sitting with HOB at desired angle. Assister Hand Position: Standing beside patient and place upper arm’s forearm across upper chest and lower hand over abdomen fingers facing patient’s chin

Action: Patient - takes deep breath and tries to cough. Assister – at beginning of cough pushes down with forearm and in and up with lower hand evenly, firmly and quickly.

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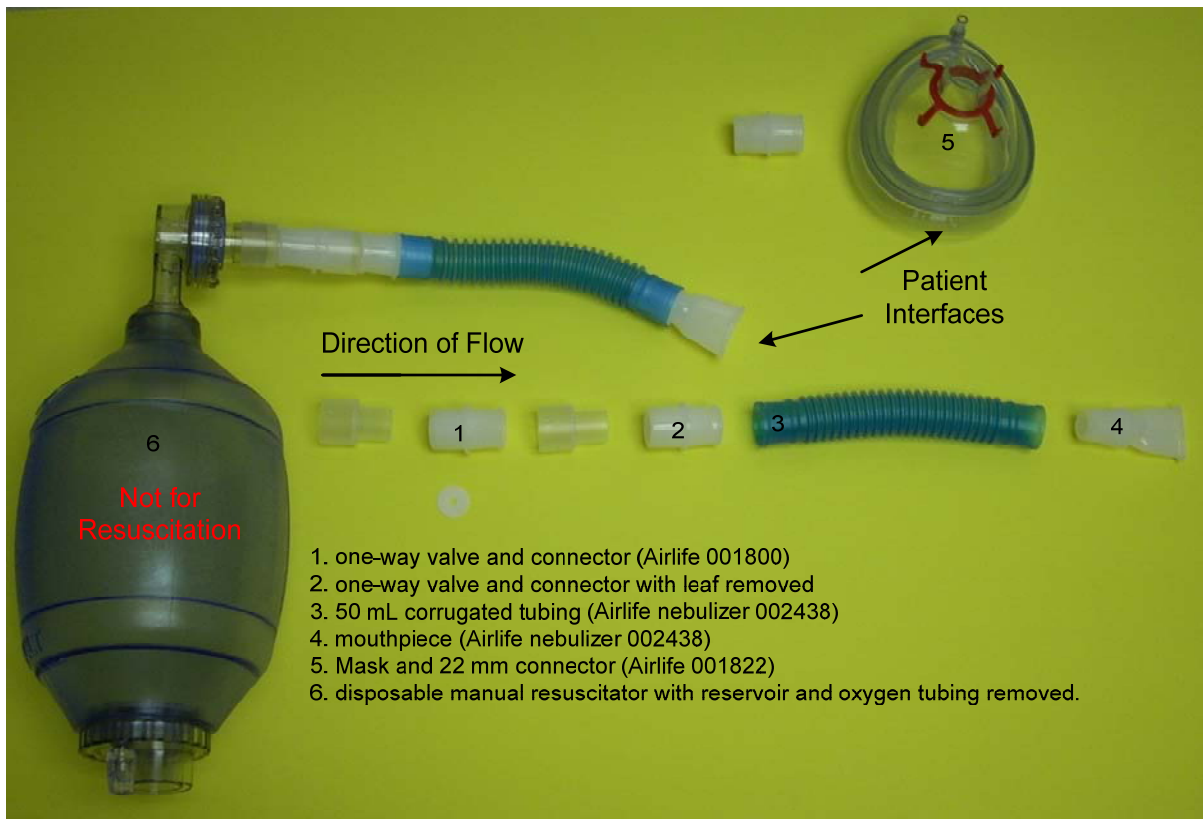
Technique 3

Hands on lateral ribs

Patient Position: Supine or sitting with HOB at desired angle. Assister Hand Position: Standing beside patient place hands on side of patient's lower rib cage.

Action: Patient - takes deep breath and tries to cough.
 Assister – at beginning of cough pushes hands down and in firmly and quickly.

Appendix A3 How to Obtain Modified Bagging Unit



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Appendix A4 Cleaning/Assembly/Testing of Equipment used for MMLVR

This procedure is for use in the home environment on a weekly basis.

Cleaning:

1. **Mouthpiece/Mask/Corrugated Tubing, One-Way Valves and Nose Clips** – Clean with warm soapy water, rinse well, and allow to air dry.
2. **Bagging Unit** – Clean exterior with damp cloth. Interior of bagging unit should remain clean as one-way valve isolates bagging unit from patient/client.

Testing of Equipment:

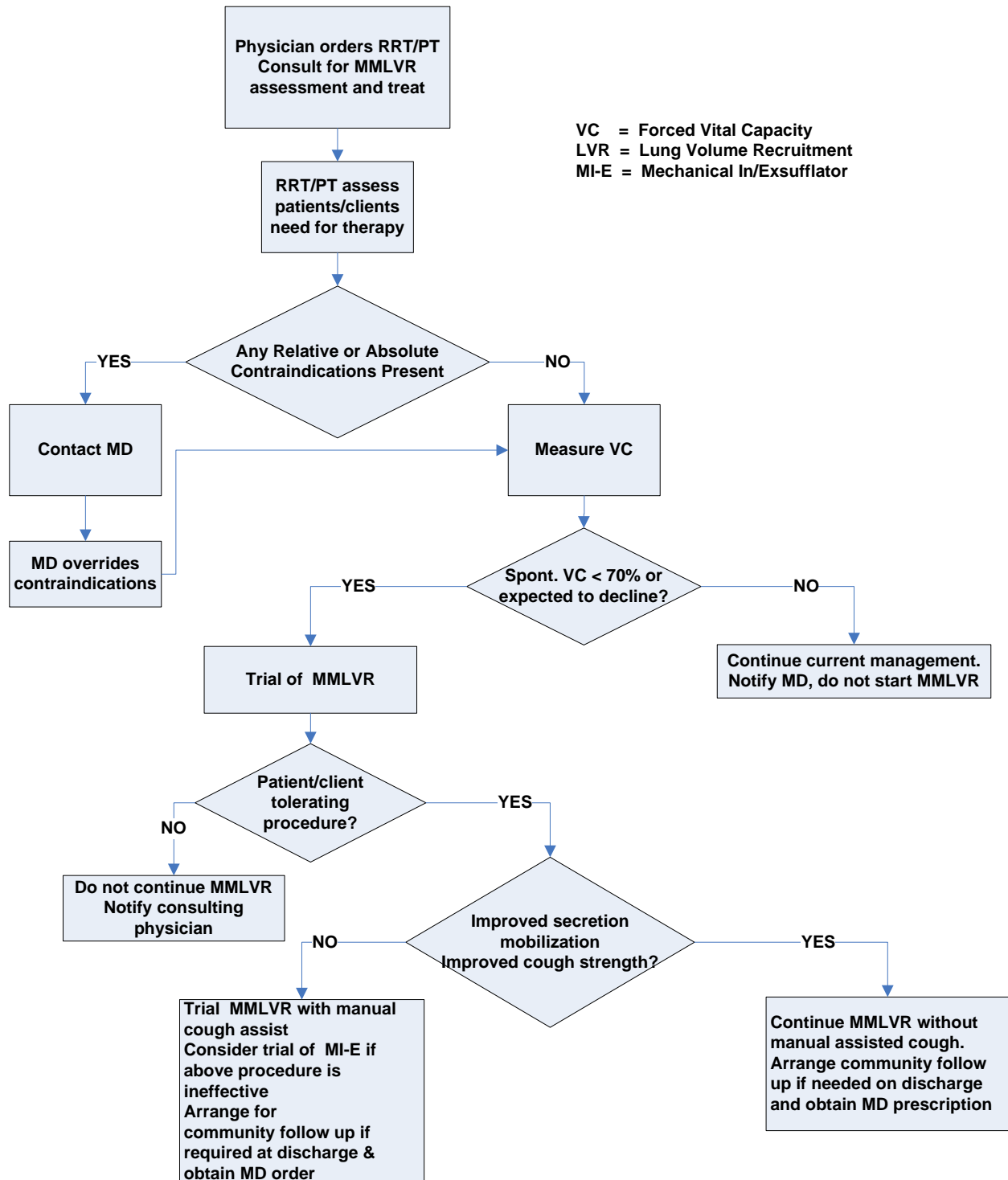
The bagging unit should be tested prior to each use to ensure alignment of the 1-way valve and proper functioning of the unit. To test the unit:

1. Occlude patient/client connector of bagging unit, squeeze bagging unit, resistance should be felt; no air should leak from bagging unit.
2. With patient/client connector of bagging unit open, squeeze the bagging unit, the bagging unit should re-inflate quickly.

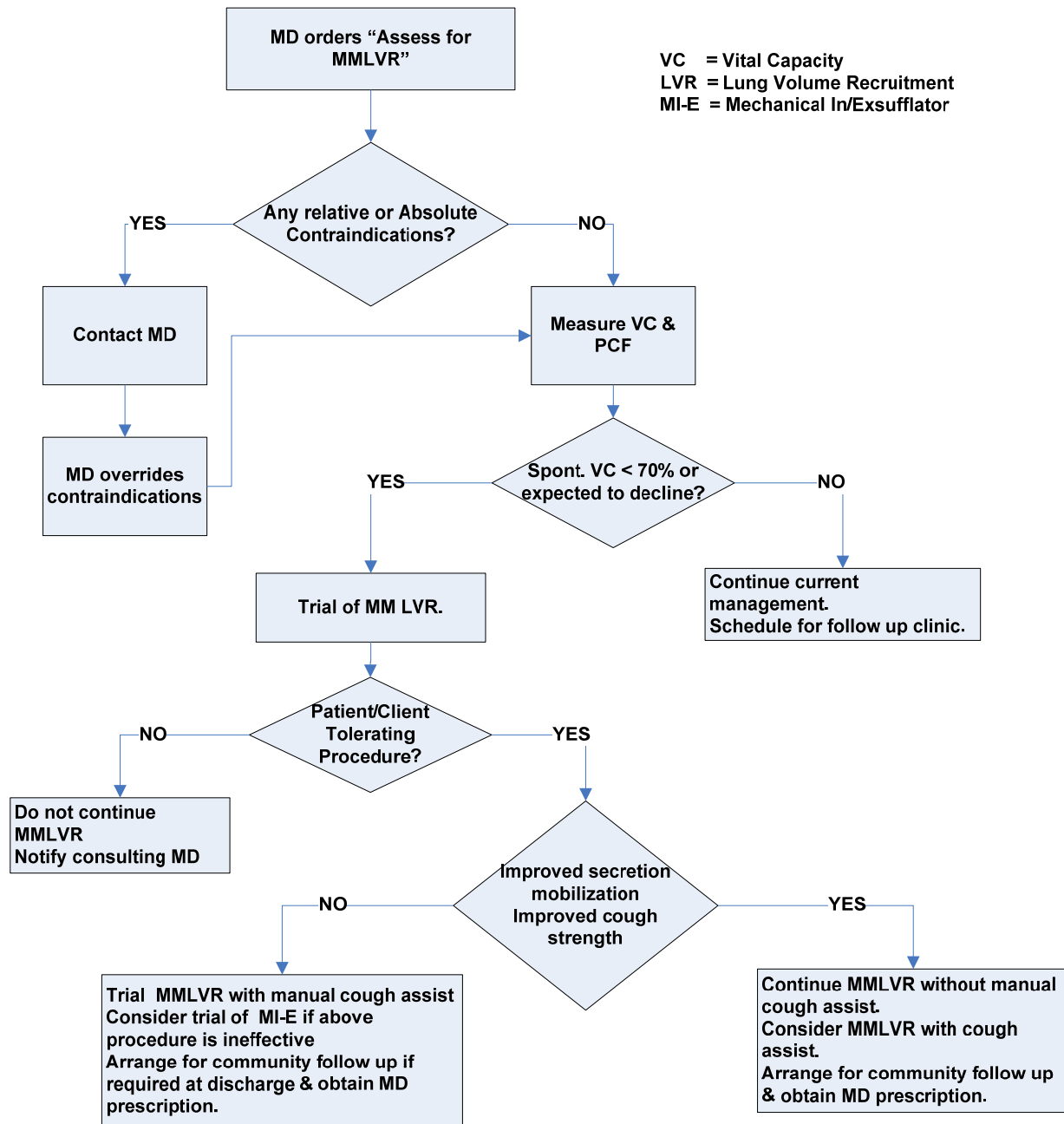
Assembly:

1. Reassemble the unit by connecting the corrugated tubing to the patient/client connector, place one way valves in-line and then connect mouth-piece (See picture in [Appendix A3](#)).

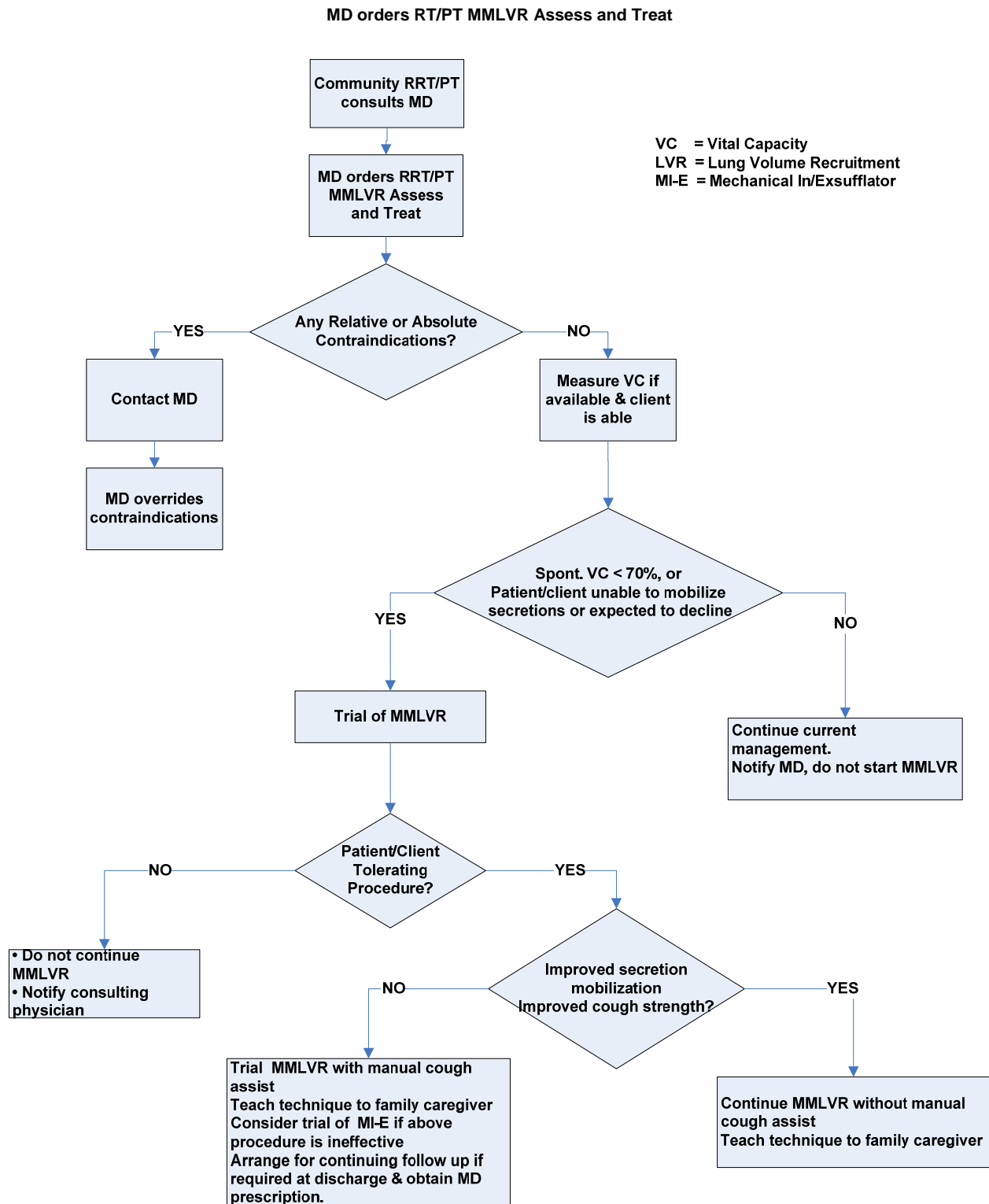
Appendix A5 Acute Care Modified Manual Lung Volume Recruitment Algorithm



Appendix A6 Clinics Modified Manual Lung Volume Recruitment Algorithm



Appendix A7 Community Modified Manual Lung Volume Recruitment Algorithm



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APPENDIX B Lung Volume Recruitment (MI-E)

Points of Emphasis (MI-E)

- LVR MI-E is best performed in the sitting or semi-recumbent position however, it can be done in the supine position if required.
- Cervical spine stabilization must be assessed and the head and neck must always be supported if an assisted cough maneuver is performed in conjunction with exsufflation.
- A jaw thrust may be required to maintain airway patency in patients with significant bulbar muscle weakness
- LVR MI-E sessions are performed as per assessed need, to a *maximum* of every 10 minutes to avoid hyperventilation.
- LVR MI-E is ideally done in the morning upon awakening, before meals and at bedtime.
- Inspiratory and expiratory pressures of ± 20 to 30 cmH₂O can be used to start. If the secretions are not being mobilized, increase the amount of expiratory pressure until they are cleared. Incremental changes of ± 5 cmH₂O can be tried. Minimum effective pressures are usually ± 30 cmH₂O with the most clinical effective pressures being ± 40 to a maximum of ± 50 cmH₂O.
- Insufflation/exsufflation pressures are usually the same unless one wishes to minimize stretch to the intercostals muscles.
- For patients/clients previously using LVR MMLVR; treatments should continue on a daily basis, minimum twice a day. This ensures the patient/client will be able to resume LVR MMLVR once the LVR MI-E is discontinued.
- Patients/clients requiring supplemental oxygen can be oxygenated between MI-E treatments.

EQUIPMENT

- 1 - Mechanical Insufflator-Exsufflator
- 1 - 5- foot large bore disposable tubing
- 10 - 6-inch pieces of corrugated tubing with 15 mm connector for tracheostomy patients/clients.
- 1 - bacteria filter
- 1 - transparent resuscitation mask or
- 1 - tracheostomy tube connector or
- 1 - mouthpiece and nose clip (used if patient/client does not tolerate mask
- 1 - suction source with Yankauer or tracheal suction catheter (consider use of in-line catheter)

PROCEDURE

1. Verify Physician's order. Note: the initial order will be directed to RT and/or PT as an "MI-E Assess and Treat" order.
 - 1.1. Determine patient/client's eligibility for MI-E (see [Appendix 'B1'](#))
 - 1.2. Explain the procedure to the patient/client.
2. Set up equipment (see [Appendix 'B2'](#)):
 - 2.1. Attach Yankauer or suction catheter to suction
 - 2.2. Attach the breathing circuit to the MI-E machine

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- 2.3. If you have an automatic machine, place the machine on manual mode.
3. Ensure MI-E machine is cycling and returning to neutral (see [Appendix 'B3'](#)).
4. Set the inhalation and exhalation pressures (see [Appendix 'B4'](#))
5. Start with the pressure to +/-20-30 cmH₂O; this will familiarize the patient/client with the feel of mechanical insufflation - exsufflation.
6. Adjust pressures as required to meet patient needs and tolerance.

Procedure performed with a mouthpiece or mask:

7. Verify pressure settings before starting each treatment. **(Note: As this machine provides positive pressure, all the risks associated with positive pressure ventilation apply to this therapy.)**
8. Attach the appropriate patient/client interface to the breathing circuit. **(Note: a full facemask is the preferred interface.)**
9. Apply the interface to the patient/client.
10. Instruct the patient/client to inhale while shifting the manual control lever to the inhale position and hold for 2 to 3 seconds (count time out loud).
11. Rapidly shift the manual control lever to the exhale position to induce a cough, holding it there for 1 to 2 seconds. **(Note: encourage the patient/client to cough on exhalation phase. A manual assisted cough maneuver may be added where indicated at the onset of exhalation. Count time out loud.)**
12. Repeat this inhale/exhale cycle 4 to 5 times as tolerated by the patient/client. **(Note: Allow the patient/client to rest for 20 to 30 seconds after each cycle of 4 to 5 breaths.)**
13. If the patient/client coughs up secretions during any of the inhale/exhale cycles, remove the interface and clear the secretions before initiating any additional cycles.
14. The entire procedure (4-5 inhale/exhale cycles) can be repeated 4-6 times during a treatment session.
15. No oxygen is to be entrained into the MI-E machine; patients/clients requiring high levels of oxygen may require pre-oxygenation or may require re-oxygenation between cycles. **(Note oxygen can not be entrained into the circuit as this is a fire risk)**

Procedure performed through a Tracheostomy:

7. Assemble 10 – six inch pieces of corrugated tubing with 15 mm ID connectors
8. Attach flex tubing to machine and then to the patient.
9. Perform the inhale/exhale cycles as with a mouthpiece or mask.
10. If flex tube fills with secretions, discard it and replace with new 6 – inch flex tube/15 mm ID connector (may need to use higher pressures due to reduced diameter of the artificial airways).
11. A cuffed tube is preferred and should be inflated when performing the in-exsufflation. The in-exsufflator is connected directly to the tracheostomy tube.
12. In-exsufflation may be delivered on a patient/client with a cuffless tracheostomy tube. Cork the tube and apply the in-exsufflation via a mouth piece or mask. The patient/client must tolerate corking for the procedure and have excellent control of the upper airway.
13. Ensure to check the patency of the tracheostomy tube post procedure and restore cuff inflation to pre-treatment state (if applicable).

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Appendix B1 Indications and Lung Volume Recruitment (MI-E)

1) Clinical Indications

- a) A patient/client who is alert, cooperative and able to communicate and:
 - i) has an established diagnosis of a neuromuscular or mechanical disorder that limits thoracic expansion, including but not limited to, spinal cord injuries, amyotrophic lateral sclerosis (ALS), muscular dystrophy, progressive multiple sclerosis (MS), Guillain-Barré syndrome (GBS), post polio syndrome, syringomyelia, and kyphoscoliosis.
 - ii) may be unable to mobilize and expectorate secretions,
 - iii) has a VC less than 70% predicted or anticipate a continued decline in VC.

2) Absolute Contraindications:

- a) hemoptysis,
- b) untreated or recent pneumothorax, bullous emphysema, severe COPD,
- c) asthma,
- d) recent cardio-thoracic surgery,
- e) increased intracranial pressure (ICP),
- f) intracranial drains,
- g) nausea,
- h) impaired consciousness/inability to communicate.

3) Relative Contraindications:

- a) immediately following meals,
- b) rib fractures,
- c) hemodynamic instability,
- d) pregnancy,
- e) history of pneumothorax,
- f) presence of a large pleural effusion,
- g) patient unable to breath stack.

4) Precautions:

- a) Patients/clients known to have cardiac instability should be monitored for arrhythmias, SpO₂, dyspnea, vital signs and symptoms
- b) Patients/clients with long standing thoracic cage restriction who may have severely reduced thoracic compliance will require low incremental insufflations during the initial MI-E introductory period.

Lung Volume Recruitment – Manual and Mechanical**(Modified Manual Lung Volume Recruitment (MMLVR) and Mechanical Insufflation - Exsufflation (MI-E))****APPENDIX B2 Initial Set-Up for MI-E**

1. Plug machine into electrical outlet
2. Position the unit within easy reach of the patient, or the operator of the unit.
CAUTION: Position the device so that the air intake ports on the side and rear of the unit are not blocked.
3. Assemble the patient circuit (filter, large bore tubing and patient interface) as follows:
 - a. Attach the bacterial/viral filter to the patient port on the front of panel.
 - b. Attach the 5 foot 22mm ID large bore tubing to the bacterial/viral filter.
 - c. Attach the appropriate patient interface to the large bore tubing.

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APPENDIX B3 Operational Verification

1. Attach patient circuit to the unit and block the end of the hose.
2. Turn the power switch ON.
3. Set the manual/auto switch to manual position (automatic models only).
4. Set the pressure knob fully clockwise (maximum pressure).
5. Cycle the manual control lever from inhale to exhale and observe the pressure gauge to ensure that positive and negative pressure is being applied to the patient circuit.
6. Release the manual control lever from inhale position and observe that the pressure immediately drops to 0 cm H₂O. Repeat for the exhale position. In either case, if the pressure does not drop to zero, the unit should not be used and [Regional Policy 1307](#) should be followed.

APPENDIX B4 Setting and Adjusting the Insufflation/Exsufflation Pressures

1. Turn on the power switch.
2. Set the air flow to full.
3. Attach the patient circuit to the unit and block the end of the breathing circuit.
4. Set the manual/auto switch to manual (automatic models only).
5. Slide the manual control lever to the exhalation phase (to the left). Observe the pressure gauge on the unit and adjust the maximum pressure (negative) using the pressure knob to achieve the correct reading on the gauge.
6. Shift the manual control lever to the inhalation phase (slide to the right). Adjust the pressure reading by turning the inhale pressure knob to achieve the correct reading on the pressure gauge (clockwise to increase pressure and counterclockwise to decrease pressure).
7. Cycle the manual control lever from inhale (positive) to exhale (negative) and back a few times to ensure that the pressure and suction readings are correct.
8. Release the manual control lever to ensure that the pressure immediately returns to 0 cm H₂O. If it does not, do not use the unit and send for maintenance.
9. Inspiratory and expiratory pressures of ± 20 to 30 cmH₂O can be used to start. If the secretions are not being mobilized, increase the amount of expiratory pressure until they are cleared. Incremental changes of ±5 cmH₂O can be tried. Minimum effective pressures are usually ±30 cmH₂O with the most clinical effective pressures being ± 40 to a maximum of ±50 cmH₂O. Insufflation/exsufflation pressures are usually the same unless one wishes to minimize stretch to the intercostals muscles.

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