MANUAL VENTILATION AND MANUAL HYPERINFLATION
PRE-READING AND COMPETENCIES

Title; Manual ventilation and manual hyperinflation competency	
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THEORY OF MANUAL VENTILATION (MV)

DEFINITION

Manual ventilation is often referred to as 'hand bagging' and involves lung inflation by means of a self inflating/ resuscitation bag maintaining normal tidal volume, minute volume and airway pressure driven by 15L O2 therapy.

INDICATIONS

Ventilator failure
Change of ventilator tubing
Cardio pulmonary resuscitation
Patient requires to be transferred to another bed space within the ward.

CAUTIONS

Although manual ventilation should mimic the ventilator there is no means of monitoring exact tidal volume. Prior to procedure, **consult with medical staff** if any of the following apply.

Cardiovascular instability

MV can cause an increase in intrathoracic pressure, which compresses the great veins leading to a reduction in venous return and subsequent reduction in cardiac output and blood pressure.
Caution must therefore be observed where the patient is hypotensive / hypovolaemic as this may cause a marked reduction in blood pressure.
Due to a reduction in blood pressure and cardiac output, MV may also exacerbate dysrhythmias in susceptible patients.

Unstable ICP (>20mmHg)

If manual ventilation is appropriate, end tidal CO2 must be monitored during intervention.

Surgical emphysema

Patients with surgical emphysema may have underlying pneumothorax or a displaced tracheostomy tube. Please always consult medical staff before commencing MV.

High airway pressures (>40mmHg)

Patients may have high airway pressures due to bronchospasm, COPD persistent pulmonary hypertension, asthma or emphysema. MV may further increase airway pressures placing patients at risk of barotrauma or pneumothorax. Wheeze should be treated appropriately and a prescribed bronchodilator administered prior to MV.

Acute haemoptysis
Care should be exercised if this is of unknown origin. Coagulation results should be reviewed prior to MV.

PEEP >10mmHg
Caution should be taken when PEEP >10mmHg as disconnection from the ventilator may then result in small airways collapse and subsequent desaturation.

Hypercapnia
MV can reduce respiratory drive by blowing off CO2 therefore care must be taken in patients with COPD or patient's dependant on hypoxic drive.

Rib fractures
MV can cause severe pain, potential lung contusions and pneumothorax in patients with rib fractures.

Bronchopleural Fistula (a communication between the pleural space and the bronchial tree)/ Lung Abscess
MV can deliver high positive pressure and patients with bronchopleural fistula or lung abscesses are at increased risk of tension pneumothorax.

Oesophagogastrectomy
Ivor Lewis oesophagogastrectomy is a complex surgery requiring an anastomosis between the oesophagus and stomach or small bowel. A new anastomosis is a fragile connection and care should be taken to prevent high pressures which can lead to an anastomotic leak.

ABSOLUTE CONTRAINDICATIONS

Undrained Pneumothorax:
MV can cause tension pneumothorax. In the presence of a pneumothorax or haemothorax, manual ventilation should only be carried out if there is a **correctly functioning** intercostal chest drain in place. A correctly functioning intercostal chest drain should be swinging, draining and or bubbling i.e. there should be a patent route to allow air, fluid or blood to escape.

Blocked/misplaced tracheostomy-
MV should not be delivered to patients with a suspected blocked or displaced tracheostomy. The Mapleson C circuit should only be attached to the tracheostomy tube if the expiratory valve is open and end tidal CO_2 is measured but manual ventilation breaths **MUST NOT** be given until correct tracheostomy position has been verified. This prevents the risk of surgical emphysema and further airway obstruction. In the event of a blocked or displaced tracheostomy, please follow the tracheostomy/Laryngectomy emergency algorithm found on NHS Lothian intranet: Directory/critical care/airway/tracheostomy and laryngectomy.

COMPLICATIONS ASSOCIATED WITH MV

The following are the most common complications that can result from manual ventilation.

If any complication arises from MV **STOP** and place patient back on ventilator.

Cardiovascular instability
As previously discussed.

Pneumothorax
As previously discussed.

ICP instability
CO_2 retention (under ventilation) causes cerebral vasodilatation which adversely increases intracranial pressure (ICP).
Additionally, excessive CO_2 elimination (overventiltion) may cause cerebral vasoconstriction which results in a reduction in cerebral blood flow and reduction in ICP. Whilst a reduction in ICP will benefit the patient, a reduction in cerebral perfusion pressure (CCP) will not, and can potentially place the patient at risk of an ischaemic stroke.

Reduction in respiratory drive
This may occur post MV as it may reduce CO_2 or increase oxygenation which can inhibit respiratory drive for a short time. Temporary reduction of minute volumes may occur on return to the ventilator.

Vagal stimulation
MV may lead to bradycardia due to stimulation of the vagus nerve from an increase in intrathoracic pressure.

High airway pressures
MV may increase airway pressures if an increase in tidal volume is given.

Dependence on high PEEP
If the patient has a PEEP of 10cmH2O or more, it may be necessary to use a manometer in the circuit to maintain the correct amount of PEEP during the MV.

PROCEDURE FOR MANUAL VENTILATION

Equipment required

1) Rebreathing bag such as Mapleson C circuit (disposable) with reservoir bag and control valve, or a self inflating resuscitation bag. Check connections.
2) Oxygen flow meter connected to oxygen outlet
3) Pressure manometer (to measure inflation pressure if PEEP is greater then 10 cmH2O)
4) Oxygen tubing (to attach to pressure manometer)
5) Bacterial filter/HME
6) $EtCO_2$ line attached to circuit
7) Suction (closed or single use catheter)
8) Artificial lung for ventilator tubing

Procedure	**Rationale**
1) Wash/gel hands as appropriate, use personal protective equipment – gloves, apron, goggles, and mask.	To reduce risk of cross infection and for personal protection.
2) Assess patient and make a general observation of condition. (I.e. history, CVS and neurological status, ventilation mode and settings, blood gases, SaO_2, peak airway pressures, prescribed medications, auscultation and palpation.	To ensure suitability for MV.
3) Explain procedure to patient regardless of conscious level.	To gain informed consent in conscious patients and for patient reassurance.
4) Ensure patient is positioned appropriately. High upright position (chair or bed) or lung to be treated is uppermost if patient is lying in bed.	Optimises ventilation to the affected lung.
5) Ensure adequate analgesia	To maintain patient comfort and tolerance during the procedure
6) Test bagging circuit Check exhalation valve is working (i.e. adjust valve to check for pressure release function and check gas flow with valve in on position, familiarise with open and closed directions)	Preparation for safe procedure
7) Connect spare oxygen tubing from HME to pressure manometer (if using)	To prepare pressure manometer for observation of pressures during MV.
8) Turn flow rate of O2 up to 15litres/min	To allow sufficient volume to fill the bag
9) Silence the ventilator alarm and use the pre-oxygenation facility.	Prevents patient anxiety and pre-oxygenates patients who may require this.

10) Disconnect patient from ventilator and attach the rebreath bag with HME to the patient's closed suction or catheter mount. Place artificial lung onto ventilator tubing	Preparation for MV.
11) Monitor patient's observations continuously	Ensure patient safety
12) Adjust the valve in accordance with the resistance felt. If a manometer is in use, circuit pressures should be the same as the peak inspiratory pressure measured on the ventilator.	To allow adequate chest inflation.
13) Deliver gas to patient by squeezing bag within pressure limits as described as above. Observe chest expansion.	To allow the operator to gain a feel of the patient's lung compliance and assess lung expansion.
14) Release bag, watching patient and vital signs.	Assess for distress or variation to vital signs.
15) A respiratory rate of 12 breaths/min or respiratory rate in line with ventilator settings should be delivered to most patients. When the patient is breathing spontaneously, **M.V. breaths should be timed to coincide with the patient's own breaths.**	To maintain respiratory rate, synchronisation and patient comfort.
16) If suction is required, the valve should be opened fully	To prevent the patient coughing against a resistance.
17) If the patient is coughing the expiratory pressure valve should also be released	Reduces the build up of pressure within the lungs and reduce risk of barotrauma.
18) On reconnection to the ventilator, all vital signs should be re-checked. Check that the ventilator is switched on and the patient is breathing.	Reestablish ventilator support. Patient safety.
19) If the patient is not triggering breaths – change to SIMV mode and consult with medical staff.	To maintain adequate ventilation

ASSESSMENT OF COMPETENCE
Manual Ventilation

This competency will assess the following areas:

- Knowledge of definition of manual ventilation
- Knowledge of contraindications & risks of manual ventilation
- Demonstration of manual ventilation

Part A.	Assessment criteria	Competent		
1.	Explains the definition of manual ventilation (MV) & indications/ benefits for use.			
2.	Identifies contraindications for manual ventilation			
3.	Identifies complications associated with manual ventilation			
4.	Lists equipment required for manual ventilation			
5.	Explains the considerations required e.g. observations/patient examination prior to MV.			
6.	Reasons for discontinuing treatment			
Part B	**Assessment Criteria**	**1**	**2**	**3**
7.	Demonstrates and describes technique, measures taken to ensure safe practice:			
	Explanation to patient			
	Position patient			
	Wear goggles			
	Connect appropriate bagging circuit to oxygen			
	Test bagging circuit			
	Monitor observations			
	Connect catheter mount to bag			
	Deliver breaths as per ventilator settings			
	Monitor patient during treatment			
	Return patient to ventilator			
	Ensure patient stable			
	Turn off oxygen to bagging circuit			
	Reassess patients respiratory status			

I confirm that has achieved the required competence for manual ventilation.
Signature of Assessor:
Name: *Position:*
Date:

I am satisfied that I am competent in manual ventilation and also undertake to maintain my competency in this area of practice in accordance with the NMC Code (2008)and will demonstrate my ongoing competence to a clinical work-based assessor as required by NHS Lothian.

Signature of Participant:
Name: *Position:*
Date:

THEORY OF MANUAL HYPERINFLATION (MHI)

DEFINITION

Manual hyperinflation is a technique employed to manage mechanically ventilated patients and patients with tracheostomies. It involves a manual inflation technique that delivers a breath 1.5 greater than the tidal volume delivered by the ventilator (hyperinflation) at a rate that matches the respiratory rate on the ventilator or that of the patient.

INDICATIONS

To reinflate areas of atelectasis (loss of lung volume)
To mobilise pulmonary secretions and assist clearance
Improve lung compliance
To promote or stimulate cough
To pre-oxygenate prior to rapid sequence intubation

CAUTIONS AND CONTRAINDICATIONS

See manual ventilation section.

COMPLICATIONS ASSOCIATED WITH MHI

See manual ventilation section.

If any complication arises from MHI **STOP** and place patient back on ventilator.

PROCEDURE FOR MANUAL HYPERINFLATION

Equipment required

1) Rebreathing bag such as Mapleson C circuit (disposable) with reservoir bag and control valve. Check connections.
2) Oxygen flow meter connected to oxygen outlet
3) Pressure manometer- to measure inflation pressure If PEEP is greater than 10 cmH2O
4) Oxygen tubing- (to connect to pressure manometer)
5) Bacterial filter/HME
6) EtCO2 line attached to circuit
7) Suction (closed or single use catheter)
8) Artificial lung for ventilator tubing

Procedure	Rationale
1) Wash/gel hands as appropriate, use personal protective equipment – gloves, apron, goggles, and mask.	To reduce risk of cross infection and personal protection.
2) Assess patient and make a general observation of condition. (I.e. history, CVS and neurological status, ventilation mode and settings, blood gases, SaO_2, peak airway pressures, prescribed medications, auscultation and palpation.	To ensure suitability for M.V.
3) Explain procedure to patient regardless of conscious level.	To gain informed consent in conscious patients and for patient reassurance.
4) Ensure patient is positioned appropriately. High upright position (chair or bed) or lung to be treated is uppermost if patient is lying in bed	Optimises ventilation to the affected lung.
5) Ensure adequate analgesia	To maintain comfort and tolerance during the procedure
6) Test bagging circuit Check exhalation valve is working (i.e. adjust valve to check for pressure release function and check gas flow with valve in on position, familiarise with open and closed directions)	Preparation for safe procedure
7) Connect spare oxygen tubing from HME to pressure manometer (if using)	To prepare pressure manometer for observation of pressures during MV.
8) Turn flow rate of O2 up to 15litres/min	To allow sufficient volume to fill the bag
9) Silence the ventilator alarm and use the pre-oxygenation facility.	Prevents patient anxiety and pre-oxygenates patients who may require this.
10) Disconnect patient from ventilator and attach the rebreath bag with HME to the patient's closed suction or catheter mount. Place artificial lung onto ventilator tubing	Preparation for MHI.
11) Monitor patient's observations continuously	Ensure patient safety
12) Adjust the valve in accordance with the resistance felt	To allow adequate chest inflation.
13) Initially deliver a tidal volume breath (watching the patient's chest expansion).	To allow the operator to gain a feel of the patient's lung compliance and assess lung expansion.

14) Perform MHI breaths. MHI breaths should be held for no more than 2 seconds at a pressure no greater than 40cmH2O.	To allow effective MHI breaths and recruit closed alveoli.
15) Release bag sharply on expiration to stimulate forced expiratory technique	To mobilise secretions to central airways
16) If suction is required, the valve should be opened fully	To prevent the patient coughing against a resistance.
17) If the patient is coughing the expiratory pressure valve should also be released	Reduces the build up of pressure within the lungs and reduce risk of barotrauma.
18) Repeat the procedure several times as indicated maintaining a respiratory rate of 12 breaths/min or RR in line with ventilator settings. When the patient is breathing spontaneously, **MHI breaths should be timed to coincide with the patient's own breaths***	To maintain RR and synchronisation with treatment. To avoid patient distress.
19).On reconnection to the ventilator, all vital signs should be re-checked. Check that the ventilator is switched on and the patient is breathing.	Reestablishes ventilator support
20) If the patient is not triggering breaths – change to SIMV mode and consult with medical staff.	To maintain adequate ventilation
21) Document on the patient's chart that MHI has been performed and the effects of MHI on the patient.	Ensures the MDT's is aware of patient's response to MHI.

ASSESSMENT OF COMPETENCE
Manual Hyperinflation

This competency will be completed following 1 year of CC experience and will assess the following areas:

- Knowledge of definition of manual ventilation
- Knowledge of contraindications & risks of manual ventilation
- Demonstration of manual ventilation

Part A.	Assessment criteria	Competent		
1.	Explains the definition of manual hyperinflation (MH) & indications/ benefits for use.			
2.	Identifies contraindications for manual hyperinflation			
3.	Identifies complications associated with manual hyperinflation			
4.	Lists the equipment required.			
5.	Explains the considerations required e.g. observations/patient examination prior to MH.			
6.	Reasons for discontinuing treatment			
Part B	Assessment Criteria	1	2	3
7.	Demonstrates and describes technique, and measures taken to ensure safe practice:			
	Explanation to patient			
	Position patient			
	Wear goggles			
	Connect appropriate bagging circuit to oxygen			
	Test bagging circuit			
	Monitor observations			
	Connect catheter mount to bag			
	Deliver appropriately hyperinflated breaths			
	Monitor patient during treatment			
	Return patient to ventilator			
	Ensure patient is stable			
	Turn off oxygen to bagging circuit			
	Reassess patients respiratory status			

I confirm that has achieved the required competence for manual hyperinflation.
Signature of Assessor:
Name: *Position:*
Date:

I am satisfied that I am competent in manual hyperinflation and also undertake to maintain my competency in this area of practice in accordance with the NMC Code (2008)and will demonstrate my ongoing competence to a clinical work-based assessor as required by NHS Lothian.

Signature of Participant:
Name: *Position*
Date:

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