Ventilator Hyperinflation by Physiotherapists Guideline – Bunbury Hospital

1. Guiding Principles

Ventilator Hyperinflation (VHI) is a physiotherapy intervention that enables the deliverance of larger than baseline tidal volumes (Vt) via adjustment of the ventilator in the intubated and ventilated patient.

Competency must be achieved prior to performing the technique.

2. Guideline

2.1 Purpose

To improve the respiratory status of intubated, ventilated patients by the deliverance of larger than normal tidal volume breaths, utilising safe peak inspiratory pressure (PIP), without interruption to the desired positive end expiratory pressure (PEEP) and the oxygen supply. This enables recruitment of collapsed alveoli and clearance of secretions from the bronchi, thereby improving gas exchange.

2.2 Indications:

VHI is indicated in the **stable** ventilated patient who:

- Secretion retention that does not respond to suction and positioning
- Patients who are PEEP dependent
- Prior / post endotracheal suctioning
- Segmental/lobar atelectasis
- Poor cough mechanism

2.3 Aims of VHI

- To aid in the resolution of atelectasis in the ventilated patient
- To mobilise and assist removal of excessive bronchial secretions
- To improve lung compliance
- To assist with prevention of nosocomial pneumonia

2.4 Contraindications

Any concerns about performing VHI on a patient should be discussed with the Senior Physiotherapist, Senior Medical Officer and or Senior Nursing Staff prior to commencing VHI

2.5 Absolute Contraindications

Condition	Rationale
Patients requiring nitric oxygen or prostaglandin infusion	Patient too unstable

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Severe bronchospasm	Increased airway pressure will increase airway irritation and inflammatory response
Unexplained frank haemoptysis	May be indicative of acute trauma to the lung parenchyma
Broncho pleural fistula	May exacerbate air leak
Undrained pneumothorax or intercostal catheter with an air leak / subcutaneous emphysema of unknown cause	May increase size of pneumothorax
Documented cystic lung changes (bullae/blebs)such as in severe chronic obstructive pulmonary disease with large emphysematous bullae or cavitating lung pathology	Increases risk of pneumothorax
Peak airway pressure(Paw)>30cm H_2O	High risk of barotrauma
Mean arterial blood pressure(MAP)<60mm Hg or Systolic <80mm Hg	Increased positive pressure in thoracic cavity compromises venous return – reduces cardiac output
Inotropic requirement equivalent to 15-20mls/hr total of adrenaline and noradrenalin (dilution 4mg/50ml} or a sudden increase in inotropes	Increased positive pressure in thoracic cavity compromises venous return – reduces cardiac output.
Head injury with intracranial pressure (ICP) > 20mmHG	Increasing intra-thoracic pressure can compromise mean arterial pressure and compromise cerebral perfusion pressure

2.6 Relative Contraindications

Obstructing airway tumour or lung tumour at risk of cavitation	Risk of gas trapping or causing trauma
Recent oesophageal or lung surgery e.g. oesophagectomy, lobectomy/pneumonectomy, long volume reduction surgery, diaphragmatic repair	High airway pressure may compromise the anastomosis. Check with surgeons regarding stump pressure.
Acute pulmonary oedema	Technique not indicated, will not be beneficial
Large undrained pleural effusion	High risk of barotrauma
Acute respiratory distress syndrome (ARDS) / large contusions	Increased risk of barotrauma / pneumothorax
Fractional oxygen(FiO_2)>0.7	Pt may be too unstable to do VHI
High positive end expiratory pressure(PEEP)>10cm H_2O	Generally if the pt. requires a PEEP > 10 to maintain PaO_2, they may be too unstable to do VHI. Also with high PEEP there is a lower expiratory flow therefore less effective for airway clearance.

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Unexplained increase in respiratory rate	High respiratory rate makes it hard to co-ordinate breaths
CVS instability/arrhythmias	Compromised venous return - further increases effort required to maintain adequate tissue perfusion

Delivery of VHI in patients with any identified relative contraindications requires approval of ICU Consultant prior to initiating treatment

Other:
Take care and monitor Paw (airway pressures) closely with patients who are coughing vigorously on the ventilator as this generates high intrapulmonary pressures.

2.7 Competencies

Refer to Competency assessment documents accessed via the Bunbury Hospital Physiotherapy Department. Contact via Sally Barrett, ICU Physiotherapist, Bunbury Hospital.

2.8 Procedural Guidelines

- Assess the patient's suitability and need for hyperinflation.
- Check for any contraindications.
- Discuss current status of patient with nurse caring for patient in all instances (for handover and to review current status of patient). In instances where patients have relative contraindications or where concerns exist discuss suitability for VHI with relevant duty Consultant prior to delivering VHI.
- Apply personal protective equipment as per WACHS Infection Prevention and Control Policy.
- Explain the procedure to the patient if appropriate.
- Position the patient optimally for sputum drainage.
- Measure the height of the patient, and take note of body weight on admission.
- Calculate Body Mass Index (BMI)=Mass/Height^2 ; In the event that BMI is greater than 25, Vt is to be calculated using the ideal weight at a BMI of 25 for their height. When BMI is less than 25 then the calculation is adjusted to the patient's weight. Determine target tidal volume of 15ml/kg Take note of pre intervention ventilator mode, settings, alarm parameters, Vt, PIP and lung compliance over 3 ventilator cycles using the form located in: A ventilator competent Senior RN competent to adjust parameters on the ventilator under the guidance of the Senior Physiotherapist.

2.9 Simultaneous Intermittent Mandatory Ventilation (SIMV) auto flow

1. Maintain the FiO_2 at pre-set levels.
2. Adjust Vt alarm to target Vt plus 300 mls(15ml/kg).
3. Change Paw alarm to 35cm/H_2O.
4. Note pre-treatment minute ventilation(Vm) and $EtCO_2$, aim to keep similar.

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5. Reduce RR(respiratory Rate) to 8/min. and then increase Ti 3sec, if I:E ratio alarms decrease RR and increase Ti,increase incrementally until RR 8 and Ti 3 achieved.
6. Increase Vt by 150-300mls increments until target volume achieved.
7. If Paw increase too high then increase Ti (3-5sec) and if necessary decrease RR minimum 6/min.
8. Aim for 8 breaths at target volume, include vibes if indicated.
9. A manual inspiratory hold (3-5 seconds) may be added if indicated and patient does not have any evidence of Chronic Obstructive Pulmonary Disease (COPD) related hyperinflation.
10. Aim for 3 sets of 8 VHI breathes.
11. Senior Nurse to return ventilator to pre-treatment parameters (ventilation mode, Vt, RR and Ti) and Senior Physiotherapist to suction as required following pre-oxygenation. This may occur following interruption of the VHI breaths or at the end of the cycle of breaths.
12. Ensure the return of all parameters to pre intervention (Ventilation mode, Vt, RR Ti FiO_2 Paw & high Vt alarms) by the Senior Nurse.
13. Document settings utilised and outcome measures.

2.10 Pressure Control + (PCV+)/ Mandatory minute ventilation (MMV)

1. Change ventilation mode to SIMV auto flow
2. Set Vt to that being achieved on the PCV+ mode
3. Follow steps 1-13 above returning the ventilator parameters to PCV+ between each cycle. Check after each cycle that the PC setting is correct
4. Ensure the return of all parameters to pre intervention settings (PCV+/PC level/FiO_2/RR/Tinsp/Paw alarm/Vt alarm) by the Senior Nurse
5. Document settings utilised and outcome measures

2.11 Pressure Support (PS)

1. Maintain the FiO_2 at pre-set levels.
2. Adjust Vt alarm to target Vt plus 300 mls(15ml/kg).
3. Change Paw alarm to 35cm/H2O, Change MV alarm to 20L/min.
4. Note pre-treatment minute ventilation(Vm) and EtCO2, aim to keep similar
5. Change Slope time from 0.2 to 0.7, then gradually increase PS in 2cm/H_2O increments until either Target Vt or maximum Paw (35 cm/H2O) reached.
6. Aim for 8 breaths at target volume, include vibes if indicated.
7. Senior Nurse to return ventilator settings to pre-treatment parameters (PS, and Slope) between cycles and Senior Physiotherapist to suction as required following pre-oxygenation if required. This may occur following interruption of the VHI breaths or at the end of the cycle of breaths.
8. Aim for 3 sets of 8 VHI breathes.
9. Ensure the return of all parameters to pre intervention (PS, Slope, FiO_2 Paw & high Vt alarms) by the Senior Nurse.
10. Document settings utilised and outcome measures.
11. Ensure patient is breathing at an adequate minute ventilation when returned to pre VHI PSV setting and if necessary get Senior RN to return to SIMV settings.

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2.12 Monitoring During VHI

It is very important to closely observe throughout the intervention the following:

- Blood Pressure (BP)
- Heart Rate (HR)
- Saturations
- $ETCO_2$/Vm
- Signs of patient distress
- Peak airway pressure
- Intracranial Pressure (ICP)if indicated

2.13 Potential Negative Responses to VHI

- If I:E ratio alarms when establishing larger Vt in SIMV then decrease RR and increase T insp , incrementally until RR 8 and Ti 3 achieved.
- If Peak airway increases too high> 33 when establishing larger Vt in SIMV, increase Ti(3-5sec) and if necessary decrease RR minimum 6/min.
- Patient may become stressed during the intervention (tachycardia, hypertension); if observed check if bolus sedation can be delivered and provide reassurance. Reduce Vt or PS if necessary to see if VHI is better tolerated, proceed with slower incremental rises in Vt or PS, modify T insp/RR to achieve better synchrony in SIMV. Accept Vt at a lower level than target Vt and reassess tolerance in subsequent sets of VHI.
- Haemodynamic Instability: Hyperinflation may potentially increase intra-thoracic pressure and reduce venous return and cardiac output. It is important to recognise CVS instability prior to commencing treatment and to be vigilant during intervention ceasing if instability noted.
- If there is marked deterioration in SpO_2/HR/BP discontinue VHI and assess for reasons it has occurred.
- If the intracranial pressure increases >20 mmHg during application of VHI in the Head Injury Patient monitor Vm and $ETCO_2$ and ensure they are closely matching pre treatment levels (fluctuating levels and inadequate ventilation can influence ICP).

2.14 Documentation

Documentation should include:

- Ventilator mode
- Patients position
- Number of breaths delivered
- Maximum volumes reached and Target volume
- Inspiratory time/plateau time
- Patients response to treatment (static lung compliance, gas exchange, SpO2, sputum clearance, CXR/auscultation findings, wave forms, ICP/$ETCO_2$ where indicated, CVS)
- Any changes to medication management throughout
- Adverse responses and action taken
- Plan for frequency and dosage of treatment

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3. Definitions

H_2O	Water
Hg	Mercury
FiO_2	Fraction of Inspired Oxygen
PaO_2	Partial pressure of Oxygen
ICU	Intensive Care Unit
CVS	Cardiovascular system
$EtCO_2$	End tidal Carbon Dioxide
Ti	Inspiratory Time
SIMV	Synchronized Intermittent mandatory ventilation

4. Roles and Responsibilities

The ICU Physiotherapist will review the relevant guidelines every year or earlier as appropriate. Prior to releasing the guidelines they will be endorsed by the Director of ICU

All Physiotherapists must complete a supervised training program and competency based assessment with a senior Intensive Care Physiotherapist. Competency will be observed and assessed over a number of sessions before unsupervised practice is allowed.

The Physiotherapist, Medical team, and ICU Nurse must be in partnership for the delivery of the intervention, which will be congruous with the agreed team care of the patient

5. Compliance

Failure to comply with this policy document may constitute a breach of the WA Health Code of Conduct (Code). The Code is part of the Integrity Policy Framework issued pursuant to section 26 of the *Health Services Act 2016* (WA) and is binding on all WACHS staff which for this purpose includes trainees, students, volunteers, researchers, contractors for service (including all visiting health professionals and agency staff) and persons delivering training or education within WACHS.

WACHS staff are reminded that compliance with all policies is mandatory.

6. Records Management

All WACHS clinical records must be managed in accordance with Health Record Management Policy.

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7. Evaluation

Monitoring of compliance with this document is to be carried out by the Senior ICU Physiotherapist, every 2 years using Evidence Based research in conjunction with other ICU Senior Physiotherapists in W.A.

8. Standards

National Safety and Quality Health Service Standards 1.27

9. Legislation

Health Services Act 2016 (WA)

10. References

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16. St George University, NHS V.H.I Guidelines 2016
17. Government of Western Australia East Metropolitan Health Service. Ventilation Hyperinflation Procedure (2017) Armadale Health Service, Perth, Western Australia
18. Government of Western Australia South Metropolitan Health Service. Physiotherapy Management of Organ Donors (Acute) Guideline (2018) Rockingham Peel Group, Rockingham, Western Australia

11. Related Forms

Nil

12. Related Policy Documents

WACHS Ventilation (Non-Invasive and Invasive Mechanical) – Clinical Practice Standard

13. Related WA Health System Policies

Nil

14. Policy Framework

Clinical Services Planning and Programs

This document can be made available in alternative formats on request for a person with a disability

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