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Approval Process

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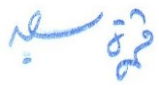
Validated by	Dr. Qamra Al Sariri	DG of QAC	Ministry of Health	Dec 2021	
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Acronyms:

A/C	Assist/Control
ABG	Arterial Blood Gas
ARDS	Adult Respiratory Distress Syndrome
BP	Blood Pressure
CO2	Carbon Dioxide
CPAP	Continuous Positive Airway Pressure
CPOE	Computerized Provider Order Entry
CXR	Chest X-Ray
DOPE	Displacement Pneumothorax Obstruction Equipment
ECG	Electrocardiogram
ET	Endo Tracheal
EtCO2	End Tidal Carbon Dioxide
ETT	Endo Tracheal Tube
FIO2	Fraction of Inspired Oxygen
GBS	Guillain-Barré Syndrome
GCS	Glasgow Coma Scale
Hb	Hemoglobin
HMD	Hyaline Membrane Disease
HME	Heat and Moisture Exchanger

HR	Heart Rate
I:E	Inspiratory to Expiratory Ratio
ICU	Intensive Care Unit
IMV	Intermittent Mandatory Ventilation
LPM	Liters Per Minute
MAP	Mean Airway Pressure
MV	Mechanical Ventilation/ Mechanical Ventilator
NICU	Neonatal Intensive Care Unit
O2	Oxygen
PEEP	Positive End Expiratory Pressure
PICU	Pediatric Intensive Care Unit
PIP	Peak Inspiratory Pressure
PPE	Personal Protective Equipment
PSI	Pounds Per Square Inch
RCS	Respiratory Care Services
RR	Respiratory Rate
SIMV	Synchronized Intermittent Mandatory Ventilation
SPO2	Peripheral Capillary Oxygen Saturation/ arterial Oxygen Saturation
STAT	Statum, meaning immediately
VT	Tidal Volume

Policy and Procedure of Mechanical Ventilation

1. Introduction

Mechanical ventilation (MV) refers to the use of life-support technology to perform the work of breathing for patients who are unable to do this on their own. Ventilators are designed for the critically ill patient who is intubated with respiratory failure from any cause including the following:

1.1 Inability to maintain a patent airway or clear secretions

1.2 Inability to adequately oxygenate tissues

1.3 Inability to adequately eliminate CO2 with patient's own respirations

1.4 Macroscopic or microscopic atelectasis

Mechanical Artificial Ventilation refers to any methods to deliver volumes of gas into a patient's lungs over an extended period of time to remove metabolically produced carbon dioxide. It is used to provide the pulmonary system with the mechanical power to maintain physiologic ventilation, to adjust the ventilatory pattern and airway pressures for purposes of improving the efficiency of ventilation and/or oxygenation, and to decrease myocardial work by decreasing the work of breathing.

2. Scope

This policy is applicable to all Respiratory therapists and health care practitioners in all healthcare institution in the Ministry of Health.

3. Purpose

The purpose of this policy is:

3.1. To be a reference for Respiratory therapist/ Respiratory Care Services staff, nurses and doctors, to follow if the patient is on mechanical ventilation.

3.2. To optimize the use of mechanical ventilation until patient is stable.

3.3. To provide an evidenced based measures for a safe and efficient management of the mechanically ventilated patients.

3.4. To provide mechanical support for patients with acute and chronic respiratory failure.

4. Definitions

4.1. Respiratory failure: apnea/respiratory arrest, inadequate ventilation, inadequate oxygenation, chronic respiratory insufficiency with ETT.

4.2. Cardiac insufficiency/shock: eliminates the work of breathing and reduces oxygen consumption.

4.3. Neurologic dysfunction: central hypoventilation/frequent apnea, GCS< 8, and inability to protect the airway.

5. Policy

5.1. Patients requiring mechanical ventilation shall be maintained primarily in an Intensive Care Unit (ICU) and secondary to Emergency Department, High dependency Areas or Step-down unit setting.

5.2. If a patient's spontaneous ventilation is clinically adequate, mechanical ventilation may not be indicated.

5.3. Staff involved in the close monitoring of patients in critical care requiring mechanical ventilation shall exhibit knowledge of basic principles of mechanical ventilation, arterial blood gas interpretation, pulmonary hygiene techniques, modes of mechanical ventilation, and emergency airway management in cases of mechanical failure or inadvertent extubation.

5.4. All parameter changes require a physician's order in the Computerized Provider Order Entry (CPOE) system and documentation on the bedside ventilator flow sheet.

6. Procedure

6.1. Verify physicians order.

6.2. Set up ventilator with an appropriate circuit based on patient requirements (neonatal, pediatric, or adult).

6.2.1. Patients who weigh < 3 kg, or whose tidal volume is < 90m1, should be ventilated with an infant circuit.

6.2.2. Patients who weigh > 3 kg and < 30 kg, or whose tidal volume > 90ml and < 450m1, should be ventilated with a pediatric circuit.

6.2.3. Patients who weigh > 30 kg, or whose tidal volume is > 450m1, should be ventilated with an adult circuit.

6.2.4. If needed to Perform Circuit Change:

6.2.4.1. The night shift staff will perform NICU and ICU circuit changes once in a month.

6.2.4.2. A circuit should always be changed whenever it is visibly soiled.

6.2.4.3. Generally neither the ventilator circuit nor the condensation from the circuit is considered infectious waste or identified as one of the "Red-Bag" hazardous waste items requiring "Red Bag" hazardous waste handling.

6.2.4.4. The patient's ventilator circuit may be removed and disposed of into the regular trash waste unless there is visible contamination with blood or the circuit is from a patient isolated to protect others from a highly communicable disease.

6.2.4.5. Face shields, gloves and gowns should be worn when doing any circuit changes.

6.3. Provide the General Equipment Needed

6.3.1. Ventilator

6.3.1.1. Set the Ventilator parameters according to patient's weight and medical condition. Pressure modes will include inspiratory time, pressure control level and pressure support in NICU/ PICU, inspiratory time are per physician or nurse practitioner's written order.

6.3.1.2. The procedure for STAT ventilator order is as follows:

6.3.1.2.1. Verbal order by a physician or relayed by a nurse is acceptable

6.3.1.2.2. The exception to requiring a written ventilator order is a STAT situation

6.3.1.2.3. Deliver the required therapy or setting change.

6.3.1.2.4. The nurse or physician who gives the verbal order must document that order in the chart as soon as possible after the STAT situation has been resolved (but always within 24 hours.)

6.3.1.2.5. In the event the order cannot be written before the therapist leaves the floor, the therapist should document in the progress notes what the order was, who gave the order, what actions they took to get the order signed, and the date and time of the order.

6.3.1.2.6. Ventilator should be attached to a 50 pounds per square inch (PSI) oxygen and compressed air gas source

6.3.1.3. Choose the Mode-Setting-Control every breath if plan for heavy sedation and muscle relaxation

6.3.1.3.1. Use SIMV when patient likely to breathe spontaneously. Whenever a breath is supported by the ventilator, regardless of the mode, the limit of the support is determined by:

6.3.1.3.1.1. Volume limited: -preset tidal volume (VT)

6.3.1.3.1.2. Pressure limited: - preset Peak Inspiratory Pressure (PIP).

6.3.1.3.2. Fi02-start at 100% and quickly wean down to a level < or 60 %(to avoid O2 toxicity) depending on O2 requirement. 60% may be a starting point.

6.3.1.3.3. I: E ratio – normally set at 1:2-1:3. Higher inspiratory times may be needed to improve oxygenation in difficult situations (inverse ratio ventilation), increasing the risk of air leak. Lower rate and higher expiratory time-1:3-1:4 may be needed in asthma to allow proper expiration due to expiratory obstruction.

6.3.1.3.4. Trigger Sensitivity- set at 0 to -3. Setting above zero is too sensitive; triggered breath from ventilator will be too frequent while too negative a setting will increase work for patient to trigger a ventilator breath.

6.3.1.3.5. Volume Limited-Tidal Volume - 8-10ml/kg with a goal to get to 6-8ml/kg. If leak present around ET tube, set initial tidal volume to 10-12ml/kg.

6.3.1.3.6. Flow rates and waveforms are left to the therapist's discretion with the following understanding:

6.3.1.3.7. I: E ratios shall not fall less than 1:1 unless specified in the patient's orders or unless inverse ratio pressure support ventilation has been ordered.

6.3.1.3.8. If the ventilator being used in a Time Cycled mode to deliver volume ventilation, the flow rate will be set in accordance with the

accepted formula (I Time x LPM x 1000) /60 (also found on ventilator flow sheet).

6.3.1.3.9. Apnea Parameters will be set with the patient's most current settings and a time of 20 seconds.

6.3.2. Provide Heated Humidifier or HME

6.3.3.1. Humidification - to ensure adequate humidification, temperature verification will be done every four hours during routine vent checks. Verification will be done by utilizing the temperature probe located at the Wye port of the patient circuit. The reading should be between 31 - 35 degrees centigrade and can be measured by using a temperature probe. The temperature is to be recorded on the ventilator flow sheet.

6.3.3.2. HME setups are required to be changed out to a heated and humidified ventilator circuit after 48 hours of use.

6.3.4. Make Resuscitation Bags for the mechanically Ventilated Patient readily available at the bedside for all patients with artificial airways.

6.3.4.1. Make sure proper size of resuscitator bag and mask are at bedside attached to an O2 source (with flow meter and nipple adapter)

6.3.4.2. Any patient receiving PEEP of 5 or greater shall have his/her bedside "resuscitation bag" fitted with a PEEP valve which has been properly set to the same PEEP as that the patient is receiving while on the ventilator

6.3.5. Place Ventilator Flow sheet for each ventilated patient.

6.3.5.1. Ventilator checks must be done every four hours (+ or - 15 minutes) and documented on the ventilator flow sheet.

6.3.5.2. Oxygen should be analyzed when the ventilator is initiated and each day thereafter and documented on the ventilator flow sheet.

6.3.6. Set-up in- line suction using sterile catheter/kit for ventilated patients.

6.3.6.1. Determine suctioning frequency according to patient need: amount of secretions, respiratory pattern, SpO2, and breath sounds.

6.3.6.2. The care provider(s) should wear personal protective equipment (mask, eye shield, gloves) during the suctioning procedure.

6.3.6.3. Hyper oxygenate with 100% oxygen before and after each suctioning "pass". Allow the SpO2 to return to the patient's baseline prior to the next pass of the catheter.

6.3.6.4. Using sterile technique, apply suction during withdrawal of suction catheter. The entire suctioning "pass" should not exceed 10-15 seconds.

6.3.7. Wear Appropriate Personal Protective Equipment (PPE) for the procedure.

6.3.8. Connect patient to a cardiac monitor (with SPO2, HR, RR, and BP reading) for monitoring.

6.3.9. Make Syringe available to inflate and deflate the ETT cuff.

6.3.10. Make Laryngoscope and blade ready.

6.3.11. Make ET tie available post intubation for proper placement of the tube and patient comfort.

6.3.12. Make a test lung available for each ventilator to be used for calibration prior to use of machine

6.4. Maintain and Adjust Ventilation Setting according to each patient medical condition.

6.4.1. Fine tuning after initiation is based on blood gases and oxygen saturations. Do not make more than 2 alterations at any one time.

6.4.2. For oxygenation –adjust FiO2, PEEP, inspiratory time, PIP (tidal volume) increase MAP.

6.4.3. For ventilation -RR, tidal volume (in volume limited) and PIP (in pressure limited mode) can be adjusted.

6.4.4. PEEP is used to prevent alveolar collapse at end of inspiration, to recruit collapsed lung spaces or to stent open floppy airways.

6.4.5. Gas Exchange Related Problems (Hypoxemia, Hypercarbia)What to do if:

6.4.5.1 Hypoxemia

6.4.5.1.1. Increase FiO2 and MAP. Need to find a balance as per clinical situation

6.4.5.1.2. Increase tidal volume if volume limited mode, PEEP, or inspiratory time.

6.4.5.1.3. Increase PIP/PEEP/ I Time if pressure limited mode.

6.4.5.1.4. If O2 worse, get CXR to look for air leak, if increasing PEEP decreases saturations, suspect low cardiac output due to tamponade effect of PEEP(treat by fluids and inotropes) or pneumothorax.

6.4.5.2 Hypercarbia

6.4.5.2.1. If volume limited: increase tidal volume or rate. If asthma-increase expiratory time to >1:3.

6.4.5.2.2. If pressure limited: increase PIP, decrease Positive End Expiratory Pressure (PEEP), increase rate.

6.4.5.2.3. Decrease dead space (increase Cardiac Output, decrease PEEP, vasodilator, shorten ET tube).

6.4.5.2.4. Decrease CO2 production: cool, increase sedation, decrease carbohydrate load.

6.4.5.2.5. Change endotracheal tube if blocked (may be remedied by suction), kinked, misplaced or out, check proper placement.

6.4.5.2.6. Fix leaks in the circuit, endotracheal tube cuff, humidifier. Note: Increasing ventilator parameters may not be acceptable in conditions like:

6.4.5.2.7. Patient ventilator dysynchrony –common causes include hypoventilation, hypoxemia, tube block/kink/malposition, bronchospasm, pneumothorax, silent aspiration, increased oxygen demand/increased CO2 production (in sepsis), inadequate sedation.

6.4.5.2.8. Permissive Hypercapnia-higher paCO2 are acceptable in exchange for limited peak airway pressures, as long as ph>7.25. Otherwise to be discussed with Consultant.

6.4.5.2.9. Permissive Hypoxemia- PaO2 of 55-65; SaO2 88-90% is acceptable in exchange for limiting FiO2 <60%, as long as there is no metabolic acidosis. Adequate oxygen content can be maintained by keeping Hct >30%. To be discussed with Consultant.

6.5. Monitor the Duration of Ventilation

6.5.1. Duration varies by nature of disease process:

6.5.1.1. HMD may take 3days to a week

6.5.1.2. Pneumonia 5-7days,

6.5.1.3. ARDS 10days to 3weeks and neurological illness (e.g. GBS) from 1week to few months.

6.5.1.4. Post cardiac surgery ventilation may vary from 24hrs to 7days or more and postoperative chest or abdominal cases would vary from 24 - 48hrs.

6.5.2. Risk of nosocomial infection increases with ventilation > 5-7days

6.6. Prepare Assessment for each patient

6.6.1. Verify position of ETT in reference to lip or gums with securing device

6.6.2. Assess skin condition around ETT/oral mucosa every shift.

6.6.3. Verify ventilator settings every shift and with each order change.

6.6.4. Monitor the following for tolerance of ventilator support (minimum every 2 hours):

6.6.4.1 Breath sounds;

6.6.4.2 Respiratory rate/pattern;

6.6.4.3 SpO2;

6.6.4.4 Peak inspiratory pressure;

6.6.4.5 Exhaled tidal volume/Minute Volume;

6.6.4.6 Amount/consistency of secretions;

6.6.4.7 Response to suctioning/ventilator changes/activity;

6.6.4.8 Patient self-report of dyspnea, as appropriate;

6.6.4.9 Anxiety

6.7. Make documentation available

6.7.1. Document each patient on ventilator.

6.7.1.1. Type, size and location of airway.

6.7.1.2. Level of an Endotracheal Tube (ETT) at the teeth/gum once a shift, after any adjustments and prn.

6.7.1.3. Document ventilator settings at the onset of the shift and with any change in orders or patient's condition.

6.7.1.4. Sp02 and ETC02 during ventilator checking rounds or with any change in orders or patient's condition.

6.7.1.5. Amount, consistency and color of tracheal secretions after each suction session on the flow sheet.

6.7.1.6. Outline assessment plan for the patient

6.7.1.7. Explain and document the procedure to patient or family (if possible).

6.7.1.8. Other documentation as per unit guidelines

6.8. Attend to patient for any troubleshooting.

If patient is fighting the ventilator and existing desaturations, immediate measures include: DOPE

6.8.1. D-Displacement-check tube placement. When in doubt take ET Tube out and start manual ventilation with 100% O2 and with bag and mask.

6.8.2. O-Obstruction-is the chest rising. Are breath sounds present and equal? Changes in examination? Atelectasis, treat bronchospasm/tube block/malposition/pneumothorax (consider needle thoracocentesis). Examine circulation? Shock, Sepsis.

6.8.3. P-Pneumothorax-check ABG, saturation and CXR for pneumothorax and worsening lung condition.

6.8.4. E-Equipment failure-examine ventilator, ventilator circuit/humidifier/gas source.

6.8.5. If no other reason for hypoxemia: - increase sedation/muscle relaxation, put back on the ventilator

6.8.6. If unable to determine the reason for an alarm sounding, remove patient from the ventilator and manually ventilate the patient with 100%.

7. Responsibilities

7.1. Respiratory therapist is responsible for:

7.1.1. The mechanical ventilator and all aspects of the application of mechanical ventilation

7.1.2. Implementing guidelines and protocols for the application of mechanical ventilation

7.1.3. Providing adjunctive ventilator equipment, initiation of mechanical ventilation, setting the alarms and troubleshooting

7.1.4. Managing artificial airways and performing bedside monitoring techniques required of mechanically ventilated patients.

7.1.5. Maintenance of ventilation, monitoring, adjusting and documenting ventilator settings according to physicians order.

7.1.6. Making a plan of action according to patient's assessment and need that is communicated with the doctor before application.

7.2. Physician (Anesthesiologists, Critical Care Attending, and Critical Care Fellows) is responsible for:

7.2.1. Entering written orders

7.2.2. Directing the plan of care or treatment for patients requiring respiratory therapy service specifically mechanical ventilation.

7.2.3. Making parameter changes to mechanical ventilators.

7.2.4. Deciding the duration of ventilation according to the nature of the disease of the patient according to their assessment and management.

7.2.5. Covering the Respiratory Therapist responsibilities if the Respiratory Care Services Department cannot provide the necessary staff.

7.3. Nursing Staff is responsible for:

7.3.1 Verifying the doctors' orders relating to mechanical ventilation

7.3.2 Monitoring patients receiving mechanical ventilation that includes vital signs: Temperature, HR, RR, BP, Sp02, EtC02, sedation score.

7.3.3 The prompt communication with the RT relating to Physician orders and ventilator setting change requests.

7.3.4 Assisting the doctor in evaluating patient on mechanical ventilation.

7.3.5 Covering the Respiratory Therapist responsibilities if the Respiratory Care Services Department cannot provide the necessary staff.

8. Document History and Version Control

Document History and Version Control			
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02			
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9. Related Documents:

There are no related documents for this policy

10. References:

Title of book/ journal/ articles/ Website	Author	Year of publication	Page
AARC Clinical Practice Guidelines; Patient-Ventilator System Checks,		1992	37: 882-886
AARC Clinical Practice Guidelines; Humidification During Mechanical		1992	37: 887-890
Egan's Fundamentals of Respiratory Care, Eighth Edition, Mosby; June 2,	Donald F. Egan, Craig L. Scanlan, Robert L. Wilkins, James K. Stoller	June 2, 2003	
Essentials of Mechanical Ventilation,	Dean Hess, Robert Kacmarek		
Ventilator Operating Manuals	McGraw-Hill Professional	1st edition (March 1, 1996)	
http://www.aarc.org/wp-content/uploads/2017/03/statement-of-delivery-of-respiratory-services.pdf		04/2016	
https://www.saskatoonhealthregion.ca/about/NursingManual/1138.pdf			