Providence HEALTH CARE	**RESPIRATORY SERVICES**	DATE CREATED: September 1986 DATE REVIEWED/REVISED: **February 2017**
PROTOCOL	TITLE: CRITICAL CARE – Ventilator Monitoring Critical Care (Respiratory Therapy) NUMBER: B-00-12-12011	RELATED DOCUMENTS:

SITE APPLICABILITY:

ST. PAUL'S HOSPITAL
MOUNT SAINT JOSEPH HOSPITAL

GENERAL INFORMATION:

All patients in Critical Care areas that have an artificial airway in situ, are receiving specialty gas or high-flow oxygen therapy, or are mechanically ventilated (invasive or non-invasive) will be routinely monitored and assessed for adequate ventilation parameters and measured patient values.

The Respiratory Services Critical Care Flowsheet is considered a legal part of the patient record. Each page of the flowsheet must be labelled with the patient-specific label and the date. The flowsheet is a 24-hour record. A new flowsheet is started daily at 0700 and will be changed the next day at 0659.

All entries are to be completed in black ink only. Entries must be legible and concise, and offer rationale for any changes made. All documentation on the flowsheet must include the therapist's initials. The therapist must also sign and initial the Interdisciplinary Signature Sheet in the front of the patient record. Preceptors of students must review and co-sign each student entry. Completed flowsheets are filed in the Respiratory Flowsheet section of the patient record. The last 3 days of flowsheets should be retained on the ventilator clipboard to maintain a readily available and recent overview of the patient condition and progress.

The perforated strip on the bottom of the flowsheet is for statistical purposes and must be filled out accurately. It includes:

- Date
- Patient full name
- Location
- Respiratory related studies
- Specialty gases or other advanced modalities (iNO, iFlolan, Heliox, NAVA, EPM, ILV)

PROTOCOLS:

Monitoring of mechanical ventilation is guided by the following protocols:

1. Admission and Initiation
2. Routine Monitoring
3. Plateau Pressure Monitoring

4. AutoPEEP Assessment
5. Ventilator Waveform Analysis

1. ADMISSION AND INITIATION PROTOCOL:

Upon the initiation of mechanical ventilation the following must be completed:

- Full ventilator monitor as per Respiratory Flowsheet guidelines
- Initial Shift Assessment and full respiratory assessment
- Plateau pressure measurement
- AutoPEEP determination
- Ventilator waveform analysis
- Non-invasive physiologic monitoring (i.e. pulse oximetry and/or capnography)

NOTE: Capnography should be used for confirmation of intubation, cardiac arrest management, ventilated patients who do not have an indwelling arterial catheter, ventilated patients in Emergency, and on an as needed basis as determined by the physician and/or respiratory therapist.

2. ROUTINE MONITORING PROTOCOL:

The following monitoring procedures must be completed and documented on a regular and routine basis:

- A complete respiratory **AND** physical assessment at the start of each shift
- A full ventilator monitor as per Respiratory Flowsheet guidelines a **MINIMUM** of every 4 hours **AND** with significant ventilator parameter adjustments
- A respiratory assessment a **MINIMUM** of every 4 hours **AND** with any change in patient status
- A visual observation of the patient and patient-ventilator interaction a **MINIMUM** of every 1-2 hours

NOTE: All applicable ventilator alarms must be updated with every parameter change.

3. PLATEAU PRESSURE MONITORING PROTOCOL:

Plateau pressure measurement will be recorded a minimum of once per shift for all patients on control modes of ventilation. In addition, plateau pressure will be measured if any of the following are present:

- The initial plateau pressure measurement is greater than 20 cmH_2O
- The peak airway pressure is greater than 50 cmH_2O
- Changes in tidal volume are noted
- Ventilator waveform analysis is indicative of changes in compliance and/or resistance
- Findings on patient assessment (i.e. auscultation, work of breathing) which may indicate changes in compliance and/or resistance
- To assess the effectiveness of bronchodilator therapy (should be performed pre and post therapy to assess degree of change between peak and plateau pressure)
- Changes in flow rate (to assess degree of change between peak and plateau pressure)

4. AUTOPEEP ASSESSMENT PROTOCOL:

AutoPEEP determination will be performed a minimum of once per shift for all patients receiving mechanical ventilation. Measurement of AutoPEEP will occur with each ventilator monitor if any of the following are present:

- Minute volume greater than 15 L/min
- Increase in airway resistance
- Known or suspected obstructive lung disease
- Expiratory flow limitation is noted on the ventilator waveform

5. VENTILATOR WAVEFORM ANALYSIS PROTOCOL:

Ventilator waveform analysis is to be performed upon the initiation of mechanical ventilation, and a minimum of once per shift. Waveform analysis will be used to determine the following:

- Presence of air trapping (AutoPEEP)
- Efficacy of bronchodilator therapy
- Changes in respiratory mechanics (compliance and/or resistance)
- Adequacy of trigger sensitivity
- Assessment of work of breathing
- Adequacy of flow rate
- Adequacy of inspiratory time
- Determination of suitability of tidal volume
- Assessment of leaks

RESPIRATORY SERVICES CRITICAL CARE FLOWSHEET:

GENERAL GUIDELINES:

1. A complete respiratory and physical assessment will be performed with each new admission and at the beginning of each shift. Initial shift assessments will be documented on the first page of the Respiratory Services Critical Care Flowsheet.

2. Patient observations, changes to therapy and clinically significant events will be documented in chronological order on the Respiratory Services Critical Care Flowsheet. All documentation will be signed and/or initialed by the therapist.

3. At the beginning of each shift all artificial airway information will be recorded in the space provided on the first page of the Respiratory Services Critical Care Flowsheet, including:

    - Type and size of airway
    - EVAC (indicate Yes/No)
    - Position of artificial airway laterally and vertically
    - Repositioning of ETT – record markings at the teeth (ATT)
    - Cuff pressure measurement (to be recorded in cmH_2O)
        - Minimal occluding volume (MOV) technique is **not** an acceptable form of cuff pressure measurement; MOV may be used ONLY as an interim measure until a cuff pressure measuring device is available
    - Time of ETT tape or tie change
    - Date due for Stabiltube or AnchorFast change
    - Esophageal catheter position (if using EPM or NAVA)

4. Bronchodilator orders will be indicated and include:

    - Method of delivery (nebulizer or MDI)
    - Dosage
    - Frequency of administration

5. A visual bedside and patient safety check will be done every 1-2 hours on all ventilated patients, and will include the following assessments:

    - Adequate chest expansion
    - Adequate tidal volume
    - Appropriate alarm function
    - Satisfactory non-invasive monitored parameters (SpO_2, $ETCO_2$)

6. All **ventilated** patients in critical care areas receiving invasive or non-invasive mechanical ventilation will have a complete monitor performed a minimum of every 4 hours and PRN, which will include:

    - Monitor and documentation of ventilator parameters and alarms
    - Documentation of respiratory system assessment, including observation of patient-ventilator synchrony, work of breathing, adequacy of ventilation, and chest auscultation

7. All **non-ventilated** artificial airway patients in critical care areas will initially be monitored and documented every 2 hours (unless otherwise ordered) on the Respiratory Services Critical Care Flowsheet. This will include the following:

    - Mode of therapy
    - Spontaneous tidal volume measurements (if cuff inflated)
    - Spontaneous respiratory rate
    - Satisfactory non-invasive monitored parameters

NOTE: If the patient has been OFF the ventilator for 24 hours and has been stable, monitor and documentation can occur at a minimum frequency of every 4 hours.

8. All specialty gas or high-flow oxygen therapy patients (i.e. Optiflow) will be monitored and assessed every 4 hours while in a critical care area.

NOTE: Patients on Optiflow on the wards may be assessed every 6 hours.

FLOWSHEET VENTILATOR PARAMETERS:

Record the ordered parameters for pH, SpO_2 and "Other" as applicable. Calculate the Ideal Body Weight (IBW) and determine the target tidal volume.

1. **VENT:**
    - Record the type of ventilator being used

2. **MODE:**
    - Record mode of ventilation or therapy

3. **TIDAL VOLUME Set/Exhaled:**
    - Record the set tidal volume and the effective exhaled tidal volume

4. **RESPIRATORY RATE Set/Total:**
    - Record the set and total measured respiratory rate

5. **MINUTE VOLUME:**
    - Record effective minute volume

6. **FiO_2 or LITRE FLOW:**
    - Record set FiO_2 ***or*** the set litre flow of oxygen being delivered
    - FiO_2 should be measured at ALL times by a calibrated oxygen analyzer (internal or external); to calibrate an oxygen analyzer refer to B-00-12-12032

7. **P_{PEAK}/P_{PLAT}:**
    - Record peak inspiratory pressure and plateau pressure measurements

8. **P_{MEAN}:**
    - Record mean airway pressure

9. **PEEP set/total or CPAP:**
    - Record set PEEP and Total PEEP ***or*** CPAP level

10. **$P_{SUPP}/P_{CONTROL}$:**
    - Record the set pressure support level ***or*** the set inspiratory pressure level as appropriate

11. **RISE$_{INSP}$/CYCLE$_{OFF}$%:**
    - Record the set inspiratory rise time ***and/or*** the set expiratory cycle off level

12. **PEAK FLOW/WAVEFORM:**
    - Record the set flow rate ***and/or*** the set flow waveform
    - Square flow waveform → sq
    - Decelerating flow waveform → dec
    - Accelerating flow waveform → acc
    - Sine waveform (i.e. Legendair ventilator) → sin

13. **SENSITIVITY pressure or flow:**
    - Record the set pressure ***and/or*** the set flow sensitivity
    - When recording flow sensitivity record the litre flow
    - *Pressure and flow sensitivity are active at the same time on the AVEA ventilator*

14. **I:E Ratio/T$_{INSP}$:**
    - Record the actual inspiratory to expiratory ratio
    - Where applicable record the set inspiratory time

15. **P$_{TP\ PLAT}$/P$_{TP\ PEEP}$ ESOPHAGEAL PRESSURE:**
    - Record the transpulmonary plateau pressure
    - Record the transpulmonary PEEP

16. **NAVA LEVEL/E$_{DI}$ PEAK:**
    - Record the set NAVA level
    - Record the measured peak level of diaphragm electrical activity

17. **Temperature:**
    - Record the temperature on the humidifier display
    - For patients with a heat-moisture exchanger in place record HME

NOTE: For MR850 humidifiers, the chamber and heater wire temperatures are automatically set based on the selection of invasive or non-invasive mode. The displayed temperature is the chamber temperature, which in invasive mode will usually read 37°C but may fluctuate between 35.5°C and 39°C to compensate for environmental conditions. In non-invasive mode the display will normally read 31°C.

Select invasive for patients with artificial airways or Optiflow, and non-invasive for patients on BiPAP or if ventilated non-invasively. The MR850 humidifier will always default to invasive mode when first turned on.

18. **H_2O LEVEL/VADI ON $_{CHECK}$:**
    - Assess the water level in the humidifier and place a check mark when verified
    - Ensure the VADI filter is turned on and warm; place a check mark when confirmed

19. **C$_{ST}$/C$_{DYN}$/R$_{AW}$:**
    - Static compliance will be calculated for all patients in volume control mode
    - Dynamic compliance will be used when plateau pressure is unavailable
    - Airway resistance will be calculated for all patients in volume control mode, using the square flow waveform if tolerated

FLOWSHEET ALARM PARAMETERS:

All alarms must be activated, operational and set appropriately to ensure patient safety. Verification of all alarms must be confirmed with each monitor and parameter change.

1. **PRESSURE $_{HIGH/LOW}$:**
    - High → Set 10-15 cmH_20 above peak inspiratory pressure
    - Low → Set 10-15 cmH_20 above baseline (PEEP or CPAP)

2. **LOW VOLUME $_{TIDAL/MINUTE}$:**
   - Low tidal volume → Set 100-200 mL below the set V_t
     - The low V_t alarm may be disabled if the low V_E alarm is set
     - In mandatory modes record the low V_t
     - In spontaneous modes record low $V_{t\text{-spont}}$
     - If combined mandatory/spontaneous mode record both low V_t alarms as applicable
   - Low minute volume → Set 2-3 L below exhaled minute volume

3. **$FiO_{2\ HIGH/LOW}$:**
   - High → 5-10% above set FiO_2 (for external analyzers with alarm silence lasting less than 2 minutes, high FiO_2 alarm may be turned "off" to prevent nuisance alarms during pre-oxygenation for suction)
   - Low → 5-10% below set FiO_2
   - For internal analyzers →Record **INT**
   - *If an internal oxygen analyzer fails, an external analyzer with alarms must be placed in-line*

4. **APNEA INTERVAL $_{SECONDS}$:**
   - Set at 15-20 seconds

FLOWSHEET ARTERIAL BLOOD GAS RESULTS:

Arterial blood gases are to be drawn as per the clinical practice guideline B-00-12-12012. Record all blood gas values and the time the sample was drawn into the space provided.

Make changes as appropriate to the ventilator parameters based upon arterial blood gas values, and note the changes on the Respiratory Critical Care Flowsheet Ventilator Parameters section. Rationale must be provided for all parameter changes based upon arterial blood gas values and must be documented in the narrative section of the Respiratory Flowsheet. Patient response to therapy changes must also be noted in the narrative.

Any patient receiving inhaled nitric oxide therapy must have methemoglobin measured every 12 hours.

FLOWSHEET PATIENT PARAMETERS:

1. **SUCTIONING:**
   - Record the amount, consistency and colour of tracheal secretions

2. **EVAC PATENT/SUCTION $_{mmHg}$:**
   - Assess and confirm the patency of the evacuation port of the subglottic suction endotracheal tube (if applicable)
   - Record the set pressure level of the subglottic suction

3. **SpO_2:**
   - Record measured value from the pulse oximeter with each monitor
   - Change probe site with each monitor (minimum Q 4 hours)

4. **SvO_2 or $ETCO_2$:**
   - Record mixed venous saturation from the non-invasive monitor if applicable, or the value as reported from the lab
   - Record the end-tidal CO_2 value from the capnography monitor if applicable
   - *Patients without an arterial line should have $EtCO_2$ monitoring in place*

FLOWSHEET SPONTANEOUS PARAMETERS:

1. **TIDAL VOLUME:**
   - Exhaled tidal volume will be recorded for all spontaneously breathing patients
   - Exhaled tidal volume will be measured externally using a respirometer for all spontaneously breathing non-ventilated artificial airway patients

2. **RESPIRATORY RATE:**
   - Patient spontaneous respiratory rate will be counted and recorded

3. **MINUTE VOLUME:**
   - Exhaled minute volume will be recorded for all spontaneously breathing patients
   - Exhaled minute volume will be measured externally using a respirometer for all spontaneously breathing non-ventilated artificial airway patients

4. **f/V_t RATIO or VC or NIF:**
   - Using the critical care weaning protocol determine the f/V_t ratio as per B-00-13-12012 ***or*** record the measured vital capacity ***or*** record the measured best effort negative inspiratory force

OTHER THERAPIES AND FLOWSHEETS:

HELIOX THERAPY:

Refer to Heliox Gas Therapy and Mechanical Ventilation orHeliox Gas Therapy for NON-Ventilated Patients for additional charting and documentation guidelines when delivering Heliox gas non-invasively or via a ventilator.

INHALED PULMONARY VASODILATOR FLOWSHEET:

Obtain the IPV Flowsheet from Chartscan and use as an addendum to the Respiratory Services Critical Care Flowsheet by noting **"Refer to IPV Flowsheet"** on the Respiratory Critical Care Flowsheet when IPV is in use.

Narrative comments and initial shift assessments will continue to be charted on the Respiratory Critical Care Flowsheet and should correspond to the appropriate entries on the IPV Flowsheet.

Refer to Policy & Procedure, Flolan Administration Protocol via AERONEB and Clinical Guideline, Nitric Oxide Administration Protocol for additional charting and documentation guidelines when delivering inhaled pulmonary vasodilators via a ventilator.

DOCUMENTATION & COMMUNICATION:

1. PHC-RE053 Respiratory Services Critical Care Flowsheet
2. PHC-RE060 Respiratory Services Inhaled Pulmonary Vasodilator Flowsheet
3. PHC-RE003 Respiratory Services Critical Care Kardex
4. PHC-RE004 Respiratory Services Long Term Ventilated Patient Kardex

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