WellSpan Health-YORK HOSPITAL **PULMONARY SERVICES POLICY AND PROCEDURE**

DATES: **Effective: 3/1/2012**
Reviewed:
Revised:

TITLE: **Inhaled Flolan/Epoprostenol via nebulization during mechanical ventilation**

PURPOSE: To safely administer continuous nebulized Flolan during mechanical ventilation.

POLICY STATEMENTS:

- Administration will be done only in the intensive care units and ordered only by a Pulmonary Intensivist and a member of the Pulmonary Services leadership team (Operations Manager, Education Coordinator or Team Leaders).
    - Appropriate hemodynamic monitoring is necessary
    - Monitoring of oxygenation parameters is also necessary
    - The physician must be aware that Flolan can potentiate the effect of other pulmonary vasodilators
    - No other inhaled bronchodilators can be administered.
- Solo Nebulizer Units are single patient use for single or multiple medication delivery.

INDICATIONS:

1. Refractory Hypoxemia and/or ARDS.
   ARDS should be documented based on the definition of
   - Acute onset of bilateral infiltrates
   - PaO2/FIO2 ratio <200 (<300 for ALI)
   - Pulmonary artery wedge pressure <18mmg or lack of evidence of left ventricular failure
2. Pulmonary Hypertension (PH)
3. Adult post operative patients with a MPAP >20 mmHG, PVR >200 dynes/sec/cm2, CI < 2.5l/min/m2 secondary to acute right heart failure.

GUIDELINES FOR INITIATING THERAPY:

- Inhaled Flolan can only be ordered via a Power Plan to include dose in ng/kg/min based on patient's ideal body weight**.**

- Flolan dose in **ng/kg/min** based on patient ideal body weight as follows:

    - Male = 50 + [2.3 x (height in inches – 60)]
    - Female = 45 + [2.3 x (height in inches – 60)]

	Flow rate in mL/hr for Epoprostenol 30,000 ng/mL						
Flolan dose (ng/kg/min)	40-49 kg	50-59 kg	60-69 kg	70-79 kg	80-89 kg	90-99 kg	>100 kg
5	0.45	0.55	0.65	0.75	0.85	0.95	1.05
10	0.9	1.1	1.3	1.5	1.7	1.9	2.1
15	1.35	1.65	1.95	2.25	2.55	2.85	3.15
20	1.8	2.2	2.6	3	3.4	3.8	4.2
25	2.25	2.75	3.25	3.75	4.25	4.75	5.25
30	2.7	3.3	3.9	4.5	5.1	5.7	6.3
35	3.15	3.85	4.55	5.25	5.95	6.65	7.35
40	3.6	4.4	5.2	6	6.8	7.6	8.4
45	4.05	4.95	5.85	6.75	7.65	8.55	9.45
50	4.5	5.5	6.5	7.5	8.5	9.5	10.5

PROCEDURE (Pharmacy/ Pulmonary):

1. RT will contact pharmacy when an order for inhaled Flolan/epoprostenol is received to coordinate pickup of the initial two (2) doses of reconstituted Flolan in 60ml syringes.
2. RT will pick up first syringe and backup syringe from pharmacy. One syringe will be immediately administered to the patient and the other syringe will be placed in the patient specific bin in the refrigerator by communication with the nursing staff.
3. The syringe is stable at room temperature for 8 hours and stable in the refrigerator for up to 48 hours. (40 hours refrigerated, followed by 8 hours at room temperature)
4. Clearly label the syringe with the date, time of administration, and Respiratory Therapist's initials.
5. The syringe must be changed every 8 hours or sooner to maintain stability. Any remaining Flolan/epoprostenol should be discarded per the medication disposal policy.
6. RT must call pharmacy 2 hours before the syringe infusion is complete or 6 hours after the syringe infusion is started, whichever is sooner, to allow adequate time for delivery of a replacement syringe if therapy will continue for greater than 8 hours.
7. Pharmacy will deliver replacement syringes and place in the designated refrigerator area. There must always be a back-up syringe in the refrigerator for emergencies.

8. Call pharmacy immediately if the back-up syringe is used or it is realized that there is no back-up syringe in the refrigerator.
9. The syringe concentration will be 1.5mg/50ml (30,000ng/ml).
10. Flolan/epoprostenol is photosensitive and the syringe will be dispensed in a light protective cover with an inhalation only label attached by pharmacy.
11. The light protective cover must remain on the syringe during placement into the syringe pump and throughout the entire infusion.
12. Patient response should be apparent within ten minutes of initiating treatment, and the patient should reach steady-state concentrations after 30 minutes at the same dosage. Patients that show a > 20% increase in PaO_2, or a > 20% reduction in pulmonary artery pressure, or clinical or diagnostic signs of a reduction in pulmonary artery pressure will be considered responsive to treatment.
13. If the patient responds to treatment pharmacy will reconstitute additional syringes of the drug as requested and will keep a syringe in the medication fridge at all times.
14. The need to continue treatment should be reassessed every 2 hours.
15. If the patient does not respond as evidenced by a > 20% increase in PaO_2, or a > 20% reduction in pulmonary artery pressure, or clinical or diagnostic signs of a reduction in pulmonary artery pressure, therapy will be discontinued 2 hours after initiation.

EQUIPMENT NEEDED:

1. Two (2) Infusion pump's with IV delivery module * only one (1) is necessary for Flolan administration, the second will remain on standby as a backup.
2. Two (2) Aeroneb Pro-X controller with AC/DC power cable and Aeroneb power cable * only one (1) is necessary for Flolan administration, the second will remain on standby as a backup.
3. Disposable Aeroneb Pro-x nebulizer cup with T-adapter
4. Additional Aeroneb Pro-x nebulizer cups
5. Aerogen continuous tubing set.

PROCEDURE TO INITIATE THERAPY:

1. Functional Test to be done prior to use of each new nebulizer unit

    1. Inspect the unit.
    2. Place 1-4 mL of sterile water or 0.9% Normal Saline Solution in nebulizer unit.
    3. Connect Nebulizer to controller.
    4. Press and Release on/off button so intermittent delivery light indicator is on and watch for visible output.
    5. Press and release on/off button to turn off.
    6. Press and hold on/off button for continuous delivery.

7. Press and release on/off button to turn off.

2. Placement of nebulizer:
    a. Place the Aeroneb nebulizer in-line with circuit on the Inspiratory limb at the wye.
    b. Connect the Aerogen infusion tubing from the syringe to the nebulizer
    c. Prepare the infusion pump as follows:

Turning on the Pump

1. Press and hold the **Power** button until the dark screen appears. Verify the screen shows all pixels on, then all pixels off.
2. The pump should "beep" twice and then the indicators flash for Alarm, Infusing, and Lock as the self-test cycles. The pump ID, if it has one, appears in the upper left corner.
3. You should now verify the display indicates successful completion of system startup self-tests.

Selecting Delivery Mode

1. After successfully completing its system startup self-tests, the pump displays the SELECT THE MODE screen.
2. If the SELECT THE LIBRARY ENTRY screen appears, press the **Main Menu** button to call the SELECT THE MODE screen.
3. Press Number button adjacent to "ML/HR" to select the desired delivery mode. If you make a mistake use the **Back** button to undo it.

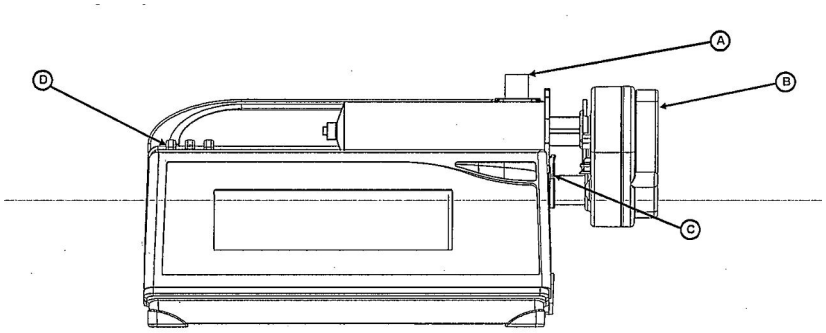
Syringe Manufacturer/Type Setup

1. Use your standard protocol for preparing your syringe & tubing and filling the syringe.
2. When delivery mode is chosen, set the syringe information. If more than one manufacturer is configured for the pump then the SELECT SYRINGE MANUFACTURER / TYPE screen appears.
3. Press **button** to select "B-D" syringe manufacturer. If you make a mistake use the **Back** button.



Loading the Syringe onto the Pump

Load the syringe using to the following steps:
1. Lift and swivel the syringe Barrel Clamp "A" out of the way.
2. Squeeze Plunger Release Lever "B" on the syringe plunger driver and pull gently to extend it all the way.
3. Load the syringe onto the pump as illustrated, making sure the flange of syringe barrel is pressed or rolled into Flange Clip "C".
4. Squeeze Plunger Release Lever "B" on the end of the syringe plunger driver and slip the end of the syringe plunger into place, then release the lever to close it around the syringe. Be sure both holders close around the syringe plunger.

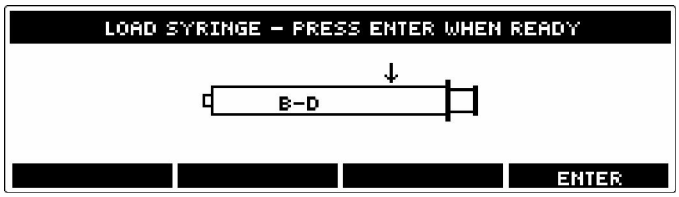


5. Turn and lower Barrel Clamp "A" onto the barrel of the syringe. The size should appear in the display. If the syringe is incorrectly loaded, guide arrows appear onscreen to identify the problem.

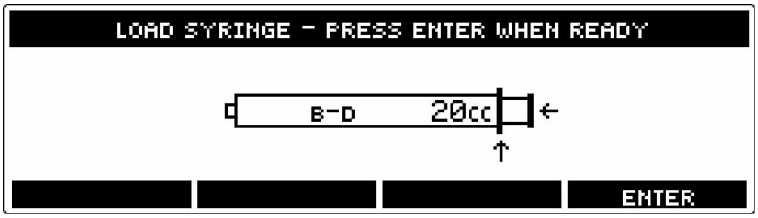
Down arrow "↓"onscreen means check syringe barrel clamp "A"

Right arrow "←"onscreen means check syringe plunger holders "B".

Up arrow "↑**"** onscreen means check syringe flange clip "C".

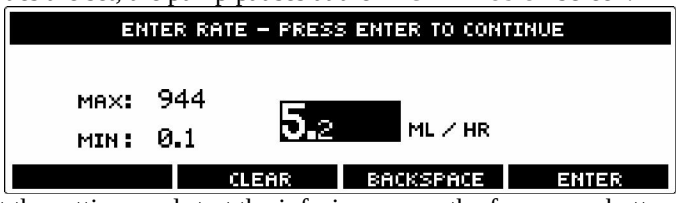


6. There are no arrows onscreen when the syringe is correctly loaded.
7. Make sure the pump correctly recognizes the syringe size, and the syringe manufacturer is correct. If not, verify that the manufacturer and size are listed in the technical specifications of this manual.
8. Thread the tubing through the 3 Tubing Holders "D" on the top left side of the pump.
9. Then press the **Enter** button to confirm this information.



Enter Flowrate (ml/hr)

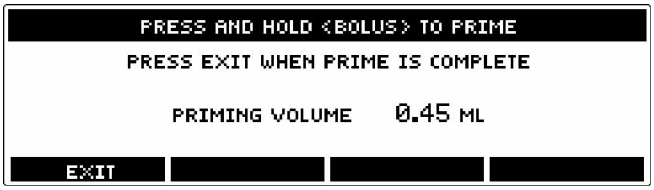
1. Use the **number** buttons to set flow rate and decimal point. Press **Clear** to clear an entry. Press **Backspace** to erase a character. Press the **Enter** button to accept the setting.
2. After all infusion values are set, the pump pauses at the BEGIN INFUSION screen.



3. You may now accept the settings and start the infusion, or use the four menu buttons to modify the settings.
4. Prior to beginning the infusion, press <BOLUS> to initiate the priming sequence (see next session).
5. When ready, press the **Start** button to begin infusion

Priming the System

1. Press the **Bolus** button to call the priming screen illustrated below.
2. To prime a loaded syringe, press and hold the **Bolus** button while observing for fluid movement at the patient end of the system.
3. For safety reasons there is a built-in priming.



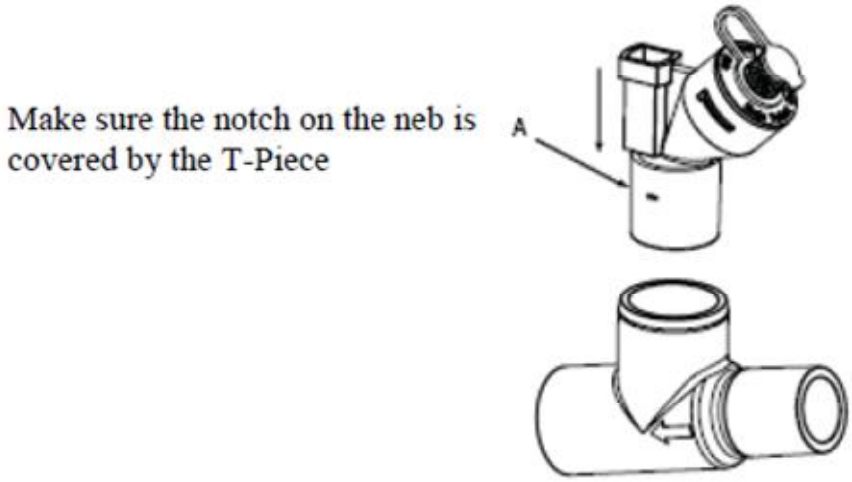
The priming sequence is extremely important to assure the accuracy of the delivery and reduce the start-up time. The priming sequence is performed after the infusion is programmed, and before the delivery is started. The message at the top of the "BEGIN INFUSION" screen will alternate between "Press <START> To Begin Infusion", and "Press <BOLUS> To Prime" to remind the operator of the prime sequence.

Turning Off the Pump

You can turn off the pump at **any time**, in any delivery mode, while the pump is running.
1. Press and hold the **Power** button. This calls the SHUTDOWN OR CONTINUE screen. Infusion has not stopped at this point.
2. Press and hold the **Power** button to turn OFF the pump. To cancel, press the **Continue** or **Back** buttons.
3. Infusion stops when you turn OFF the pump.

PROCEDURE CONTINUED:

3. Depress and hold the Aerogen power button for 3 seconds. Confirm the green light is visible adjacent to the continuous mode and is illuminated.
4. Visually verify aerosol production
5. Ensure Flolan syringe is covered with the photosensitive protective bag provided by pharmacy.



6. The Respiratory Therapist will obtain the premixed Flolan from pharmacy. The Respiratory Therapist will discuss the treatment regimen with the nursing team and together they will identify a location where the second syringe can be safely refrigerated.
7. Verify the medication syringe with another Respiratory Therapist or RN by obtaining a co signature in the EMAR. Verify proper administration setup and ordered infusion rate.

8. Prior to starting the infusion, document the following in the patient's EMR:
    a. Complete ventilator check including plateau pressure, airway resistance and compliance.
    b. Hemodynamic parameters including HR, BP and Oxygen Saturation and if possible; CVP, PAP, SvO2.

9. For delivery of medication, a med-infusion syringe pump with an alarm will be utilized to prevent an overfill situation of the nebulizer. In the case of overfill, the occlusion alarm on the syringe pump will sound indicative of an overfill situation. If this occurs, briefly disconnect medication line to depressurize then reattach medication line at a lower infusion rate.

10. Place a sign on the infusion pump that states: RESPIRATORY THERAPY USE ONLY. FLOLAN BEING ADMINSTRATED.

11. Place a sign on the ventilator stating "Inhaled Flolan in use, DO NOT ADMINISTER ANY OTHER AEROSOLIZED MEDICATIONS"

12. Place two extra Aeroneb Pro-X nebulizer cups and four extra filters on the ventilator for emergencies.

13. Change the exhalation ventilator filters every syringe change to prevent clogging. Change the IV tubing every 24 hours. The nebulizer cups can be changed when necessary.

SPECIAL CONSIDERATIONS:

1. The continuous nebulization should never be interrupted unless the patient develops serious side effects (i.e. significant hypotension) at which point the on call pulmonologist should be notified immediately. Abrupt discontinuation could result in rebound pulmonary hypertension, right ventricular failure, hypoxemia, etc.
2. If any adverse effects occur (nausea/vomiting, hypotension, chest pain, dyspnea, bradycardia, tachycardia, headache, anxiety, or dizziness) decrease the Flolan dose by 50% and notify the Pulmonary Intensivist on call immediately.
3. Concurrent inhaled medications (i.e. bronchodilators) may not be given with inhaled Flolan/epoprostenol due to incompatibility.
4. Absolute contraindications to inhaled Flolan/epoprostenol include:
    a. Allergy or sensitivity to Flolan/epoprostenol or glycine diluent
    b. Active pulmonary hemorrhage
5. Relative contraindications to inhaled Flolan/epoprostenol include:
    a. Pregnancy
    b. Pediatrics
    c. Thrombocytopenia (platelets <50,000)
    d. Patients with significant active bleeding

6. Although systemic side effects are rare at dosages $\leq$50ng/kg/min the following are possible:
    a. Hypotension
    b. Flushing

c. Headache
d. Nausea/vomiting
e. Anxiety
f. Chest pain
g. Dizziness
h. Bleeding

Delivery Complications

Hypotension secondary to auto peep caused by expiratory filter clogging from glycine diluent therefore filters are to be changed with each syringe change.

Dosing and Weaning

ARDS & Refractory Hypoxemia:

1. Maximum dose: 50ng/kg/min based on ideal body weight (doses above this have not demonstrated any additional efficacy and may increase the risk of systemic side effects)
2. Dose range: 10-50ng/kg/min based on ideal body weight
3. Initial dose is typically 50ng/kg/min. Dose should then be weaned down as tolerated to lowest effective dose based on monitoring parameters as described above.
4. All dose changes/weaning must be made by physician order only.
5. Weaning: Decrease dose by 50% every 2 hours until less than 10ng/kg/min. Once at 10 ng/kg/min, turn off. Ex. 50 ng/kg/min, then 25 ng/kg/min, then 10 ng/kg/min, then off.
6. If patient does not tolerate, a slower weaning process may also be used. For example: decrease dose by 10ng/kg/min q 2 hours until less than 10ng/kg/min. Once at 10 ng/kg/min, turn off. Ex. 50 ng/kg/min, then 40 ng/kg/min, then 30 ng/kg/min, then 20 ng/kg/min, then 10 ng/kg/min, then off.

Pulmonary Hypertension and Right Heart Failure:

1. Maximum dose: 50ng/kg/min based on ideal body weight (doses above this have not demonstrated any additional efficacy and may increase the risk of systemic side effects)
2. Dose range: 5-50ng/kg/min based on ideal body weight
3. Starting dose varies depending on patient setting and characteristics, but is typically initiated between 20-50 ng/kg/min.
4. Wean dose based on monitoring parameters.
5. All dose changes/weaning must be made by physician order only.

Dosage titration

1. Titration process will be as recommended in the power plan.
2. During any dosage change the Respiratory Therapist must remain at the patient's bedside for the first 15 minutes after the dosage change.
3. Therapist will document all pertinent information in the patient's EMR after dosage change.

Discontinuing Therapy-* Flolan/epoprostenol must be titrated*

1. The Respiratory Therapist will verify the physician's order.
2. Depress the BLUE button on the Aeroneb controller to power off the unit.
3. Remove the Aeroneb from the ventilator circuit.
4. Power off the infusion pump and unload the syringe.
5. Discard the Aeroneb tubing
6. Document all pertinent information in the patients EMR.

Documentation:

1. Respiratory therapist to document delivery of medication in patients EMAR as well as in Iview all pertinent patient information including: HR, RR, O2 Sat, breath sounds, and when if available hemodynamic parameters every 2 hours.
2. Initiation of first syringe, all syringe changes, and all dose changes must be co-signed on EMAR by 2 respiratory therapists or RT and RN.
3. Monitor for adverse effects (systemic hypotension, facial flushing, nausea, headache, bronchodilation/bronchoconstriction)

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