



Use of Philips Respironics DreamStation and System One BiPAP ST (bilevel) as invasive ventilators: guidelines for clinicians

Philips Respironics DreamStation Operational Checklist and Instructions for Use

Philips Respironics System One Operational Checklist and Instructions for Use

Version 3.0 [Apr 27 2020]

Mount Sinai Health System

Current Working Guidelines – Subject to Revision

These current working guidelines are subject to revision. It is expected this document will be updated and re- released as additional experience is accumulated.

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For additional information and associated documents, please see below links:

- [Primer - Theory and Background for Bilevel Repurposing](#)
- [Protocol - Repurposing of Bilevel Devices for Invasive Ventilation](#)
- [Clinical Guidelines / Operating Checklist - Philips Respironics Devices](#)
- [Clinical Guidelines / Operating Checklist - ResMed Devices](#)
- [Monitoring and Alarm Guidelines / Construction](#)
- [Construction of an Anesthesia Circuit Component Diagram](#)
- [Construction of a Bilevel Circuit Component Diagram](#)
- [Frequently Asked Questions](#)

This document should be used as a clinical adjunct to the protocol “Repurposing bilevel ventilators for use with intubated patients while minimizing risk to health care workers during insufficient supply of conventional ventilation for patients with COVID-19” and is shared with our health care colleagues to increase knowledge about potential solutions to increase the capacity and access to mechanical ventilation during the COVID-19 crisis. Icahn School of Medicine does not warrant the contents or effectiveness of the protocol, and the use and implementation of this protocol should be first reviewed and evaluated with each hospital’s medical staff.

QUICK GLANCE: POTENTIAL CANDIDATES FOR USE OF BILEVEL FOR INVASIVE VENTILATION

To be followed for support of intubated ICU patients if there is a crisis shortage of ventilators

Ideal initial candidates for bilevel ventilation if there is a crisis induced shortage of ventilators are patients with either:

- Stable or improving P/F ratio
- or
- Decreasing or stable ventilator requirements

We do not recommend use in newly intubated patients unless no other ventilators are available. Newly intubated patients should be reassessed and considered for transition to Philips Respironics BiPAP ST (bilevel) once they are stable, as detailed in Table 1.

Table 1: Criteria

Parameter on Conventional Ventilator	Acceptable Limit
FiO ₂	≤ 85%
PEEP*	≤ 20 cm H ₂ O
Driving pressure: (P _{plateau} – PEEP) or inspiratory pressure (Pi)*	≤ 20 cm H ₂ O
*Driving Pressure + PEEP	<28

The DreamStation and System One BiPAP ST devices can deliver a maximum pressure (Driving Pressure + PEEP) of 30 cmH₂O. Given a potential increase of resistance in the bilevel circuits, it is recommended that the device is most appropriate for patients with settings on conventional ventilation as follows:

- *If patient on Pressure Control mode: check that Inspiratory Pressure (Pi) + PEEP is below 28 cmH₂O*
- *If patient on Volume Control mode: check that plateau pressure is below 28 cmH₂O*

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TRANSITIONING FROM CONVENTIONAL VENTILATOR TO BILEVEL VENTILATOR

Bilevel devices provide positive pressure ventilation in a manner analogous to pressure control ventilation on traditional ventilators.

Calculate the patient’s ideal body weight (IBW) from height and goal tidal volume (TV) of 6 - 8 cc/kg with plateau pressure ≤ 30.

Device Settings:

MODE: ST (bilevel)

EPAP = PEEP

IPAP:

- If patient is on Pressure Control (AC/PC) mode:

$$IPAP = PI + PEEP$$

- If patient is on Volume Control (VC/PC) mode:

$$IPAP = \text{plateau pressure (perform inspiratory pause maneuver)}$$

Resp Rate: Match the patient’s rate

Ti: 0.5-3 sec (see limits based on respiratory frequency; see chart (Table 2))

Rise Time: 1

Oxygen: 15 l/m via first port, add additional O₂ via second port if needed to achieve goal FiO₂ 90-92%. Check PaO₂/SpO₂

Table 2: Ti settings based on Respiratory Rate (RR):

Respiratory Rate (bpm)	Max Ti = 30/RR
30	1
25	1.2
20	1.5
15	2.0
12	2.5

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Whenever a patient is started on the Philips Respironics BiPAP ST or if a change in IPAP or EPAP is made, VERIFY TV reading on the DreamStation display or on gas sampling/flow monitor:

- TV > 6 - 8 cc/kg IBW → lower IPAP in 3-5 cmH₂O increments until at/near goal
- TV < 6 - 8 cc/kg IBW with unacceptable hypercapnia/respiratory acidosis:
 - If not already at device maximum IPAP (30 cmH₂O), increase IPAP in 3-5 cm H₂O increments until TV at goal
 - If IPAP at maximum of 30 cmH₂O, check ABG → if unacceptable degree of hypercapnia/respiratory acidosis, increase RR to maximum of 35 bpm
 - If IPAP at maximum of 30 cmH₂O, RR at maximum of 35 bpm, with severe respiratory acidosis, decrease EPAP by 3-5 cmH₂O (if oxygenation tolerated as measured)
 - NOTE: More advanced device support may be needed if adequate ventilation and oxygenation are not achieved despite these adjustments.
- End-tidal CO₂ readings can be used as a surrogate indicator of changes in ventilation if tidal volume readings are not available
- Check FiO₂

OXYGEN and FIO2

The circuit will start with oxygen flow at 15 l/m. A second oxygen port can be used to add additional oxygen if needed.

- Check FiO₂ on gas sampling/flow monitor if possible at the start of therapy
- FiO₂ may drop slightly if IPAP or EPAP is increased without increasing oxygen flow rates (especially if using single source of O₂ at 15 l/m)
- Check for changes in SpO₂ and/or PaO₂ after increasing IPAP or EPAP

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Comments on LEAK

- The current set up of the circuitry provides the necessary degree of leak needed to prevent CO₂ re-breathing; this leak is filtered.
- The total leak is displayed on the Philips Respironics BiPAP ST screen when therapy is ongoing (e.g. at settings of IPAP 30 cmH₂O/EPAP 15 cmH₂O, leak readings will be ~25-30)
- Leak will change relative to pressure changes: leak will rise if IPAP/EPAP is increased and will drop if IPAP/EPAP is lowered
 - If leak readings on screen are >60-80, there may be an unexpected leak in the system (cuff leak, disconnected tubing etc), which can result in:
 - Loss of delivered pressure, unexplained drop in patient SpO₂, sudden change (up or down) in end-tidal CO₂, and drop in TV readings,
 - Exposure of healthcare providers to *unfiltered* leak
- If you see this, check circuit, including all connections, ETT cuff inflation

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PHILIPS RESPIRONICS DREAMSTATION OPERATIONAL CHECKLIST AND INSTRUCTIONS FOR USE

Ensure that emergency ventilator equipment (i.e. the patient's original ventilator connected to an oxygen source, Ambu-Bag®) is readily available in the event of device malfunction.

BEFORE ROOM ENTRY:

- Have the following ready:
 - DreamStation machine with power brick and cable.
 - Pre-assembled "Bi-level Vent Circuit Kit" with tubing and components.
 - Rolling cart or Mayo stand.
 - GE CARESCAPE™ B450 freestanding monitor. **This stays outside of the negative-pressure isolation room.**
- Connect the gas sampling line and spirometry connector to the GE monitor.
- Don appropriate PPE per institutional protocol.
- Enter the room with the DreamStation, circuit kit, and rolling cart.
 - **Be sure not to disconnect the gas sampling line from the GE monitor.**

AFTER ROOM ENTRY:

- Move the patient so the endotracheal tube is less than 5 feet away from the door.
- Plug in DreamStation to an outlet capable of backup generator power (usually a **red outlet** in most hospitals) in the event of power outage.
- Connect the **pre-assembled** circuit to the DreamStation. **Do not disconnect the patient from the ventilator.**
- Connect O₂ line to wall regulator.
- Adjust O₂ flow to 15 l/m per clinical protocol.
- To enter "Clinical Mode" on the DreamStation press and hold both the Ramp button ◀ and control dial for at least 5 seconds. "Therapy" will then display on the screen.

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- ❑ Press the control button while in “Therapy” to allow you to adjust settings.



- ❑ Rotate the control dial and press to select setting, rotate again to change the setting.
- ❑ Press the control dial to save the change. ***CONFIRM THE AAM OPTION IS OFF***



- ❑ To exit “Clinical Mode”, rotate dial to the “arrow up” icon and press control dial.

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- ❑ Once “Therapy” is displayed, rotate to “Patient mode” and press control dial once more.



- ❑ Press on/off button on top of device to begin therapy.



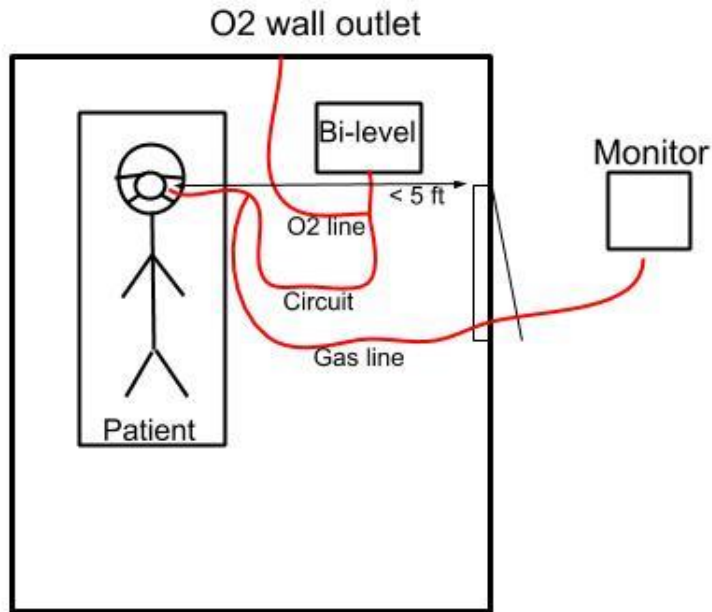
Before attaching the circuit to the patient’s endotracheal tube, perform final safety checks:

- ❑ Check circuit for uncapped openings
- ❑ Confirm DreamStation settings
- ❑ Confirm O₂ flow rate

- ❑ Disconnect the patient from the ventilator. **CAUTION: THIS IS AN AEROSOLIZING PROCEDURE.**

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- ❑ Connect the DreamStation circuit to the endotracheal tube. Confirm that the DreamStation is delivering set tidal volumes.
- ❑ Leave ventilator accessible at patient’s bedside, if possible. **CAUTION: DO NOT TURN OFF THE BILEVEL DEVICE ONCE THE PATIENT IS CONNECTED.**



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PHILIPS RESPIRONICS SYSTEM ONE OPERATIONAL CHECKLIST AND INSTRUCTIONS FOR USE

Ensure that emergency ventilator equipment (i.e. the patient's original ventilator connected to an oxygen source, Ambu-Bag®) is readily available in the event of device malfunction.

BEFORE ROOM ENTRY:

- Have the following ready:
 - System One machine with power brick and cable.
 - Pre-assembled "Bi-level Vent Circuit Kit" with tubing and components.
 - Rolling cart or Mayo stand.
 - GE CARESCAPE™ B450 freestanding monitor. **This stays outside of the negative-pressure isolation room.**
- Connect the gas sampling line and spirometry connector to the GE monitor.
- Don appropriate PPE per institutional protocol.
- Enter the room with the System One, circuit kit, and rolling cart.
 - **Be sure not to disconnect the gas sampling line from the GE monitor.**

AFTER ROOM ENTRY:

- Move the patient so the endotracheal tube is less than 5 feet away from the door.
- Plug in System One to an outlet capable of backup generator power (usually a **red outlet** in most hospitals) in the event of power outage.
- Connect the **pre-assembled circuit** to the System One. **Do not disconnect the patient from the ventilator.**
- Connect O₂ line to wall regulator.
- Adjust O₂ flow to 15 l/m per clinical protocol.
- To enter "Clinical Mode" on the System One, select the "set-up" quadrant on the LCD screen by turning the knob. (The LCD screen appears when the device is plugged into the wall outlet).

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- Press down the knob and arrow key simultaneously until you hear the device beep twice.
- Scroll down by turning the knob. Make a selection by pressing the knob down, which will activate the option. Press knob to lock that choice in.



- Scroll up to “back” and select by pressing knob. This will take you out of the clinical mode.

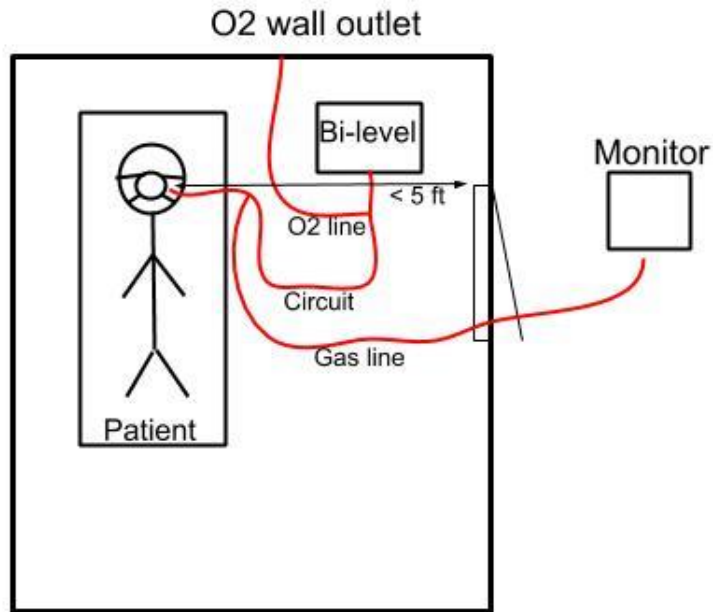
Before attaching the circuit to the patient’s endotracheal tube, perform final safety checks:

- Check circuit for uncapped openings
- Confirm System One settings
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- Disconnect the patient from the ventilator. **CAUTION: THIS IS AN AEROSOLIZING PROCEDURE.**
- Connect the System One circuit to the endotracheal tube. Confirm that the System One is delivering set tidal volumes.
- Leave ventilator accessible at patient’s bedside, if possible. **CAUTION: DO NOT TURN OFF THE BILEVEL DEVICE ONCE THE PATIENT IS CONNECTED.**



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