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Clinical Bulletin

To: Domestic Sales Representatives and International Distributors

Cc: Sales Management Team, Clinical Team and Customer Care Team

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Introduction:

Recently, the term "Spontaneous Breathing Trial" (SBT) has become a common part of the respiratory therapist's lexicon. The LTV® 1200 includes an SBT mode. The SBT mode was designed to help respiratory therapists comply with the American College of Chest Physician's *Evidence-Based Guidelines for Weaning and Discontinuation of Ventilatory Support*[1].

As soon as the mechanically ventilated patient is stabilized, the clinician should begin strategizing the optimal method and the optimal time to discontinue mechanical ventilation. In this bulletin we will discuss SBTs and how the SBT mode is used with the LTV® 1200.

It is estimated that 75% to 80% of mechanically ventilated patients can be removed from ventilation when the medical indication for ventilation is reversed. For example, a patient on the vent due to pneumonia can usually be removed from the vent as soon as the pneumonia is resolved. Weaning protocols are used for 10% to 15% of ventilated patients over an 8 to 72 hour period. The remaining 5% to 10% of patients require a gradual weaning program, which could stretch over several months. Approximately 1% of the mechanically ventilated patient population is ventilator-dependent.

When Should the SBT Be Started?

An assessment of the ventilated patient should be performed with each ventilator check. An evaluation of the patient's physiologic condition will help determine when the SBT should be started.

The following table of clinical conditions can be used to evaluate the patient's readiness to start an SBT.

Criteria To Determine If Patient Can Be Considered for SBT[1]	
Evidence of Reversal	❑ The initial reason the patient was put on the vent must be resolving
Adequate Oxygenation	❑ $PaO_2 \geq 60$ mm Hg on $F_IO_2 \leq 0.4$ ❑ PEEP $\leq$ 5-10 cm ❑ $PaO_2/ F_IO_2 \geq$ 150-300
Stable Cardio-vascular	❑ HR $\leq$ 140 ❑ Stable BP ❑ Pressors < 5 μg/kg/min
Core Temp.	❑ 36 - 38º C
pH	❑ No significant respiratory acidosis * ❑ pH $\geq$ 7.25
Hemoglobin	❑ Hgb $\geq$ 8-10 g/dL
Effort	❑ Patient capable of making inspiratory effort
Mentation	❑ Arousable, Glasgow Coma Score $\geq$ 13 ❑ No continuous sedative infusions
Metabolic	❑ Acceptable electrolytes
Subjective clinical assessments	❑ Physician believes dc possible ❑ Adequate cough
Rapid Shallow Breathing Index (f/Vt) at 1 minute of SBT	❑ <105

*Respiratory acidosis pH < 7.35 caused by elevation of arterial blood CO_2

Monitoring During the SBT:

During the SBT, the clinician should monitor and assess the patient's tolerance. The clinician can use one or more of the criteria listed in the following chart, to evaluate for a successful SBT. The Rapid Shallow Breathing Index (RSBI) is calculated as: respiratory rate (frequency) divided by tidal volume. According to Yang and Tobin's landmark article[2], the RSBI is the most accurate predictor of weaning success. If the RSBI is less than 105, the probability of a successful wean is high. The RSBI is a monitored value while the patient is in the SBT mode on the LTV 1200 and is displayed as f/Vt.

The clinician should perform assessments to evaluate if the patient is tolerating the SBT. In addition to the listed criteria below, the RSBI can be used during the SBT as it is monitored by the LTV 1200. If an SBT is preformed while using high levels of Pressure Support Ventilation (PSV), an f/Vt of 50 might be expected.

Criteria To Define Tolerance of an SBT[1]	
Criteria	**Description**
Gas exchange acceptable	❑ SpO2 ≥ 85–90% ❑ PO2 ≥ 50–60 mm Hg ❑ pH ≥ 7.32 ❑ Increase in PaCO2 ≤ 10 mm Hg
Hemodynamic stability	❑ HR < 120–140 beats/min ❑ HR not changed > 20% ❑ systolic BP < 180–200 and > 90 mm Hg ❑ BP not changed > 20% ❑ No pressors required
Stable ventilatory pattern	❑ RR ≤ 30-35 bpm ❑ RR not changed > 50%
Mental status	❑ No evidence of somnolence, coma, agitation, anxiety**, no worsening of discomfort
Appearance	❑ No diaphoresis ❑ No signs of increased Work of Breathing
Rapid Shallow Breathing Index (RSBI) or f/Vt	❑ <105*

*Some clinicians feel that if the RSBI is < 105 but increases significantly during a 20-30 min SBT, a longer SBT should be performed.
**In some pts, anxiety can be managed with verbal reassurance

What are the Different Methods for Performing the SBT?

SBT with T-Piece

When using the T-Piece method, a long piece of corrugated tubing is attached to a heated or cool aerosol of water via a large volume nebulizer or passover humidifier. On the other end of the corrugated tubing is a T connector. A shorter length of corrugated tubing is attached to the opposite side of the T connector. The patient is removed from the ventilator, and the T connector is attached to the patient. Oxygen is either attached at the large volume nebulizer or bled in near the patient. The F_IO_2 is set but cannot be well controlled. None of the usual ventilator monitored data is available (e.g., PIP, MAP, or rate). There are also no alarms and no apnea back up ventilation mode; therefore it is imperative that the therapist be continually at the bedside. A T-Piece trial is more costly due to the increased therapist's time, as well as the circuit costs.

SBT with CPAP

While using the CPAP (Continuous Positive Airway Pressure) method, the patient remains on the ventilator on a continuous positive pressure level (e.g., 8 cm). While performing an SBT using the CPAP method, the F_IO_2 can be tightly controlled. Another advantage is that ventilator monitored data, such as MAP and PIP, is available. In addition, alarms, such low pressure and

low minute volume, are available. Most importantly, the apnea back up mode of ventilation is available. It is recommended that a ventilator with bias flow and flow triggering be used in order to minimize imposed work of breathing.

SBT with PSV

Pressure Support Ventilation (PSV) may be the most comfortable method of SBT for the patient. The level of PSV is set to maintain a target respiratory rate and tidal volume. A minimal Pressure Support level of 5 to 8 cmH_2O is recommended to decrease the imposed work of breathing from the ET tube. While performing an SBT using the PSV method, the F_IO_2 can be tightly controlled. Another advantage is that ventilator monitored data, such as MAP and PIP, is available. In addition, alarms, such as low pressure and low minute volume, are available. Most importantly, the apnea back up mode of ventilation is available. It is recommended that a ventilator with bias flow and flow triggering be used in order to minimize imposed work of breathing.

Opponents of PSV for SBT argue that PSV does not allow for a rest period. Secondly, many ventilators do not have the ability to modify the flow termination percentage. An improperly set flow termination may force the patient to use the expiratory muscles to actively exhale—resulting in an increased work of breathing and a potential for auto-PEEP.

The LTV 1200 has the answers to the opponents: 1) SBT is set for a prescribed period of time; therefore PSV can be lower during SBT and increased for a rest period during normal ventilation. 2) The LTV 1200 has variable flow termination. Additionally, the LTV 1200 allows the therapist to set a time termination, which can be used as a "back up" method to cycle the breath in the event that it does not flow terminate in a timely manner.

What is the duration of an SBT?

The duration of an SBT is established according to the protocol of the facility and the tolerance of the patient. Duration can be as little as 15 minutes or as long as 2 hours. The duration of an SBT protocol is determined by patient diagnosis. Protocols should always give the clinician the finial determination of duration according to the patient's tolerance of the SBT.

What happens after a successful SBT?

The healthcare team may determine the patient should be extubated. Some points that should be considered before extubation:

1. If the RSBI was <105, was there minimal PSV and FIO2 $\leq$ .50?
2. Can the patient protect their own airway?
3. Is the patient able to mobilize secretions?
4. What is the probability of upper airway obstruction?

Is RSBI used as a predictor of weaning success for pediatric patients?

Many children's facilities are not using RSBI as a weaning predictor for their pediatric patients. The primary reason for not using RSBI is the lack of studies published on the topic. However, one article specifically evaluated the usefulness of RSBI and CROP index as a predictor in pediatric patients. Note: The CROP index is an integrated index incorporating respiratory mechanics, a measure of oxygenation, respiratory rate, and muscle strength. Calculated as [Cdyn x Pimax x (PaO2/PAO2)]/RR).

"Predictors of Successful Extubation in Children" authors Thiagarajan, Bratton, Martin, Brogan and Taylor [3], included 227 mechanically ventilated pediatric patients. Their study showed children with a RSBI of ≤ 8 had successful extubation. Data collection also included the patient's endotracheal tube size, presence of air leak around the endotracheal tube, mode of ventilation prior to extubation, pre-extubation arterial blood gases, peak inspiratory airway pressure (PIP; cm H_2O), positive end-expiratory pressure (PEEP; cm H_2O), mean airway pressure (MAP; cm H_2O), corrected exhaled VT from mechanical ventilator breaths (vVT; ml/kg), total $\dot{V}E$ on the ventilator ($v\dot{V}E$; ml/kg · min), and fraction of inspired oxygen concentration (F_IO_2).

The patients that were successfully extubated had lower respiratory rates, larger tidal volumes and shorter duration of mechanical ventilatory support. Thiagarajan and co-authors note the "duration of mechanical ventilation should be considered when defining a threshold value for RSBI when used to predict extubation outcome."

For this study extubation failure is defined as reintubation within 24 hours of after extubation. A total of 227 patients underwent 254 episodes of extubation. "Two hundred twenty-six were successful and 28 were failures." Rapid Shallow Breathing Index (RSBI) had a positive predictive value of 97%.

The final remarks noted by Thiagarajan and co-authors; adult integrated RSBI can be reliably used to predict extubation outcome. Other factors including endotracheal tube size, psychological issues, measurement technique and duration of mechanical ventilation may alter the predictive value of the index. RSBI predicts extubation success more accurately than failure. Final result RSBI is useful in predicting pediatric extubation success.

Using the LTV 1200 In The SBT mode:

SBT is a new submenu in the Extended Features, designated by **SBT OP**.

1. Once **SBT OP** has been selected, scroll to **PRES SUPPORT** and set the level desired (typically 8-15 cm).
2. Scroll to **PEEP** and set the **PEEP** level (typically 5 cm).
3. Scroll to **FIO2** and set the desired FIO2 (typically < 40%).
    a. The **FIO2** is set specifically for the SBT, and may be higher or lower than the FIO2 for ventilation.
4. Scroll to **MINUTES** and set the desired length of time for the SBT (typically 30 minutes).
5. Scroll to the **HIGH f/Vt** and set the desired value (typically 105).
6. Scroll to the **LOW f/Vt** and set the desired value (typically ≤ 50).
7. Scroll to **SBT HIGH f** and set the desired value (typically 35).
    a. Note: This high frequency alarm is in effect during the SBT only. It overrides the Alarm Op High Frequency alarm during the SBT.
8. Scroll to the **SBT LOW f** and set the desired value (typically 8 bpm).
9. Scroll to **DISPLAY f/Vt** and set to **DISPLAY ON**.
    a. When the display is ON, the patient's RSBI during the SBT will appear in the display window.
10. The SBT parameters are now all set.
    a. If you wish to exit the SBT menu, press the Control Lock button 3 times until monitored values appear in the display window.

b. If you wish to begin an SBT, scroll to **SBT START.** Push the Select button (**SBT OFF** will display). Scroll to **SBT ON** and push the Select button. **SBT** is now on. Press Control Lock 2 times to exit the SBT OP menu. The monitored values will then appear in the display window.

The SBT mode will be terminated when:

- The user turns the **SBT OFF** by accessing the **SBT OP** menu.
- The minutes preset in the **SBT OP** menu are elapsed.
- Any control is pressed *other than* the Manual Breath button, the Select button, the Control Lock button or the Silence/Reset button.
- An **SBT** alarm (**SBT <f, SBT >f, SBT <f/Vt, or SBT > f/VT**) has been active for 5 minutes.
    - Note: If any SBT alarm remains active for 5 minutes, the ventilator will resume ventilation with the previous vent settings.
- An Apnea alarm (**APNEA**) occurs.
    - Note: If an Apnea alarm occurs the ventilator automatically enters the Apnea Backup mode of ventilation

Advantages of the LTV 1200 SBT Mode: Patient Safety:

1. If the patient's respiratory rate goes too high or too low, an alarm will sound.

2. If the patient's rapid shallow breathing index goes too high or too low, an alarm will sound.

3. If the patient becomes apneic, the apnea back ventilation mode will be activated.

4. If the patient's respiratory rate goes too high or low, and the therapist doesn't respond within 5 minutes, the LTV will resume normal ventilation with the previous ventilator settings.

5. If the patient's rapid shallow breathing index goes too high or low, and the therapist doesn't respond within 5 minutes, the LTV will resume normal ventilation with the previous ventilator settings.

6. When the spontaneous breathing trial minutes have elapsed, the LTV will resume normal ventilation with the previous ventilator settings. The LTV keeps the RSBI score and frequency for the therapist to review.

7. The patient parameters (including PIP, MAP, f, f/Vt, Vte, VE) are monitored and displayed.

8. The F_IO_2 can be precisely controlled.

9. There is less chance of infection, changing back and forth between the T-piece circuit and vent circuit.

10. The Therapist can set the LTV 1200 to a standard weaning protocol (PS, PEEP, FIO2, alarm parameters and time).

11. And most importantly, the therapist can leave the bedside knowing the patient is safe-- alarms will sound if preset parameters are not met, and the LTV will return to the previous vent settings if it becomes necessary.

Advantages of the LTV 1200 SBT Mode: Reduced Costs:

1. Each time a T-Piece trial is run; a new circuit is used and then discarded.

2. Each time a T-Piece trial is run, at least 10 minutes of therapist time is required to switch the patient from the vent circuit to the T-Piece circuit.

3. Since the T-Piece has minimal patient monitoring, no alarm system and no apnea back up mode of ventilation, the therapist must remain continuously at the bedside during the entire T-Piece trial. When using the LTV 1200 SBT Mode, the therapist can leave the bedside knowing the patient is safe-- alarms will sound if preset parameters are not met, and the LTV will return to the previous vent settings if it becomes necessary.

References:

[1] Guest Editors: Neil R MacIntyre, ME, FCCP; Deborah J. Cook, MD, FCCP; Gordon H. Guytt MD, FCCP Evidence-Based guidelines for Weaning and Discontinuing Ventilator Support; Chest, Vole 120, No. 6, Dec 2001

[2] Yang KL, Tobin MJ. A prospective study of indexes predicting the outcome of trials of weaning from mechanical ventilation. N Engl J Med 1991; 324:1445–1430

[3]Ravir Thiagarajan, Susan L. Bratton, Lynn D. Martin, Thomas V. Brogan and Debra Taylor. Predictors of Successful Extubation in Children. Am J Respir Crit Care Med, Volume 160, Number 5, Nov. 1999, 1562-1566.

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