ASL 5000™ Lung Solution
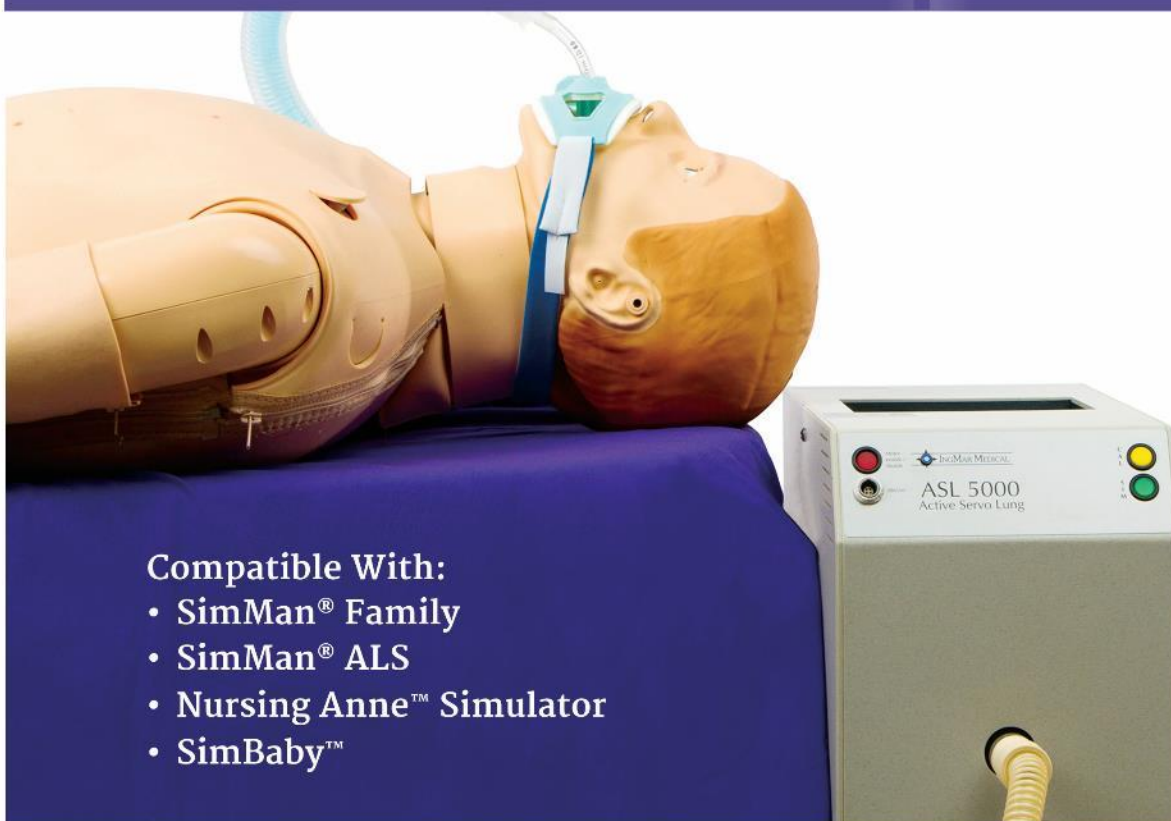## 420–11955

User's Manual

Compatible With:
- SimMan® Family
- SimMan® ALS
- Nursing Anne™ Simulator
- SimBaby™

IngMar Medical
Respiratory Simulation Specialists

Laerdal
helping save lives

Document History

Revision History	Date	Authors
Rev. 1	4/6/2017	Michael Bails
Rev. 2	4/14/2017	Michael Bails
Rev. 3	4/24/2017	Michael Bails
Rev. 4	7/14/2017	Michael Bails
Rev. 5	9/11/2017	Michael Bails
Rev. 6	12/13/2017	Michael Bails
Rev. 7	9/24/2018	Michael Bails, Brian Linn
Rev. 8	5/3/2019	Michael Bails
Rev. 9	5/28/2019	Michael Bails
Rev. 10	11/6/2019	Michael Bails
Rev. 11	3/13/2020	Michael Bails
Rev. 12	7/15//2020	Michael Bails
Rev. 13	2/7/2022	Michael Bails

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Table of Contents

1   SAFETY CONSIDERATIONS

1.1 Operator Safety

For correct and effective use of the product it is mandatory to read and to observe all INSTRUCTIONS, WARNINGS, and CAUTION statements in this manual. If the product is not used as instructed, the safety protection provided may be impaired.

⚠️ **WARNING!**

Indicates a potentially harmful condition that can lead to personal injury.

⚠️ **CAUTION!**

Indicates a condition that may lead to equipment damage or malfunction

📝 **NOTE**

Indicates points of interest or emphasis for more efficient or convenient operation.

1.2 Intended Use

The **ASL 5000™ Lung Solution** enhances the Laerdal SimMan®,SimMan® ALS, SimBaby™, and Nursing Anne™ products by merging the best-in-class ASL 5000™ Breathing Simulator into the Laerdal LLEAP simulation environment. This integration improves the true-to-life experience with realistic airway response to ventilators, anesthesia machines, CPAP, etc. A hardware component, which can be a permanent installation, allows the user to switch between the SimMan® and SimMan® ALS, configurations and the enhanced ASL 5000™ configuration. The Nursing Anne™ hardware component does not provide the same switching capability. The SimBaby™ hardware component is external to the manikin. A software component provides a series of windows which are added directly to the LLEAP environment. These windows give the user direct control of the ASL 5000™ as well as the ability to use LLEAP's existing *Airway & Breathing* window controls.

NOTE

In this manual the name SimMan® applies to SimMan® 3G, SimMan® Essential, SimMan®Essential Bleeding, SimMan® Trauma and SimMan® ALS unless otherwise stated.

The software provided for the Lung Solution is designed for LLEAP version 6.3 or greater for the SimMan® manikins and 6.7 or greater for SimMan® ALS, SimBaby™ and Nursing Anne™ manikins. Please contact IngMar Medical, LLC (sales@ingmarmed.com) for details on future integration into additional Laerdal manikin simulators. LLEAP software and firmware are directly accessible from the Laerdal website www.laerdal.com. Please verify the software and firmware are up to date before using the Lung Solution.

WARNING!

The use of supplemental oxygen is prohibited with the SimMan®, SimBaby™ and Nursing Anne™ products. The ASL 5000™ Breathing Simulator allows use of Oxygen-rich gas with these manikins disconnected but through the Local Connection option (ASL 5000™ as a stand-alone simulator connected directly to a ventilator, CPAP, or anesthesia machine).

2 AN INTRODUCTION TO THE ASL 5000™ LUNG SOLUTION

The **ASL 5000™ Lung Solution** creates a direct integration between the ASL 5000™ Breathing Simulator and Laerdal SimMan®, SimBaby™ and Nursing Anne™ manikin simulators. Once installed, the user can experience a high-fidelity respiratory system added to the many features already available with these manikin simulators.

This includes the ability to ventilate the patient with a wide range of lung resistance, compliance, and spontaneous breathing parameters. The ASL 5000™ can hold large amounts of PEEP (<20 cmH2O) and is able to exert and receive large volumes (up to 2.5L of tidal volume).

2.1 Lung Adapter for the SimMan®

Once installed, the Lung Adapter can be left in place as a permanent fixture. The system can be easily switched between the ASL 5000™ lung mode (bypassing the internal SimMan® lung bags) and the standard SimMan® mode.

Figure 2-1 – Installed Lung Adapter

2.2 Lung Adapter for the SimBaby™

As of LLEAP software version 6.7, the SimBaby™ includes internal components to detect if an ASL 5000™ Breathing Simulator is being used. The Lung Adapter for this manikin requires no internal reconfiguration as compared to the SimMan® manikin family. A 15mm side port next to the RJ45 Ethernet connector provides the link between the SimBaby™ and the ASL 5000™. When the ASL 5000™ is not required for simulations, a plug is included directing the flow of air into the baby lungs.

Figure 2-2 - SimBaby™ and Plug Location

2.3 Lung Adapter for Nursing Anne™

With the release of LLEAP software version 6.7, Nursing Anne™ can now be integrated with the ASL 5000™ Breathing Simulator. See the Nursing Anne™ Quick Setup Guide for more information on the conversion.

Figure 2-3 – Nursing Anne™ with ASL 5000™ conversion

2.4 Lung Solution Windows

The Lung Solution software enhances realism in the LLEAP environment by providing six (6) additional windows that work with the high-fidelity lung simulator. These windows are explained below.

ASL Session Control – This window controls the connection to the ASL 5000™ and the volume/gas conditions (e.g. ventilators working in BTPS mode). This window also displays connection status and controls the simulation with Play, Pause, and Stop functionality.
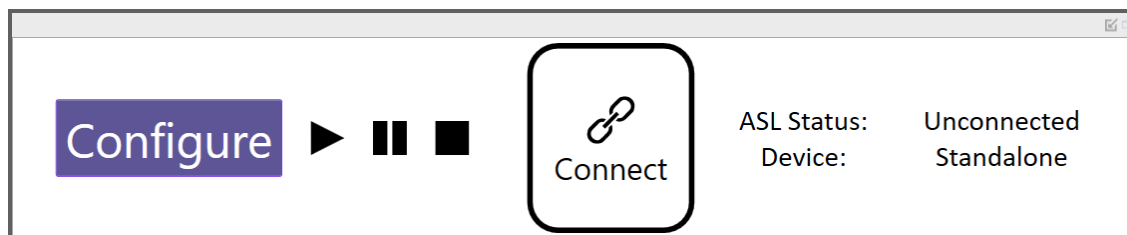
Figure 2-4 - ASL Session Control

ASL Quick Choice Menu – This window provides predefined patient types and disease states. The window gives the user easy access to various lung / airway diseases with the ability to adjust the severity of those diseases. Simply click on a disease, click apply and adjust the severity. Custom or user-defined disease states are also accessible from this window via the Custom Models toggle switch. The simulated patient can also mimic a passive (or paralyzed) patient via the Apnea toggle switch.
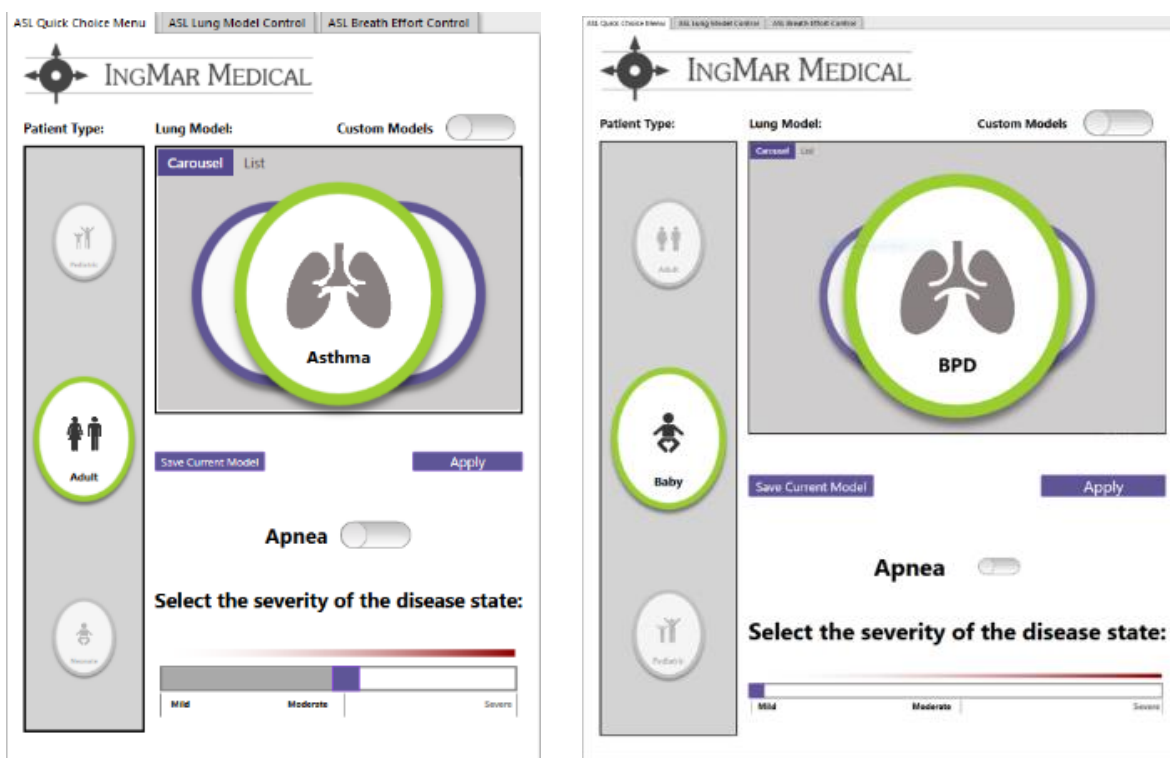
Figure 2-5 - ASL Quick Choice Menu

ASL Lung Model Control – This window controls the airway resistance and lung compliance of the ASL 5000™. The user can select a simplified lung model consisting of a single resistance and compliance. Switching to the Advanced view, the user can create a more complex dual lung model, which can include (but is not limited to) variations in inspiratory versus expiratory resistance.

Figure 2-6 - ASL Lung Model Control

ASL Breath Effort Control –This window has basic settings for Breath Rate and Muscle Pressure (patient effort required to take a breath), the driving force for volume in the lungs. Switch to the Advanced view and create a complex muscle pressure profile for an accurate representation of spontaneous breathing.

Figure 2-7 - ASL Breath Effort Control

NOTE
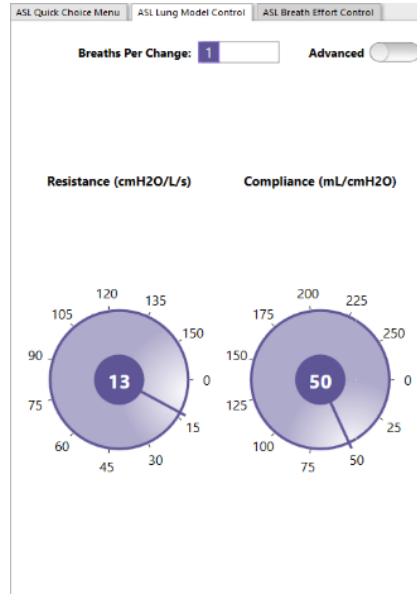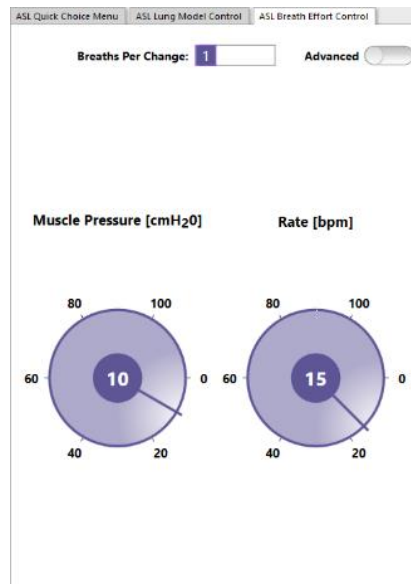
The Lung Model and the Breath Effort Control windows include a feature called **Breaths Per Change (BpC)**. This feature brings more realism to changes in the model by transitioning from one state to the next over the selected number of breaths. The user can control the progression of a change based on the selection. In the figure below, a change will transition over 4 breaths.

Breaths Per Change: 4

Figure 2-8 Breaths Per Change

ASL Monitor – This window provides feedback from the point of view of the lung. The window includes waveforms for lung pressure, flow, and volume. Also displayed are relevant breath parameters including PEEP, PIP and Tidal Volume.
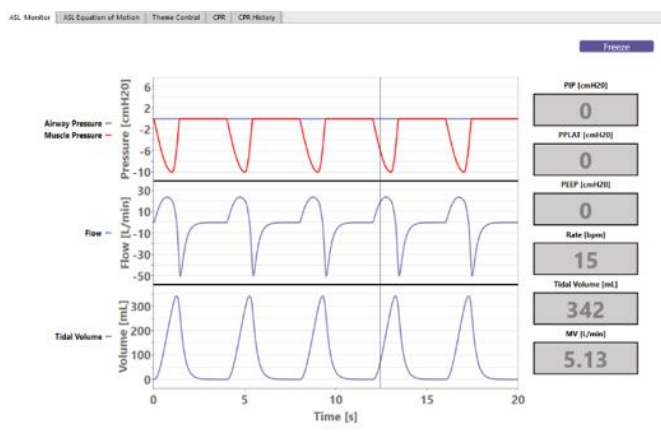

Figure 2-9 - ASL Monitor

ASL Equation of Motion – This window provides a graphical representation of the equation of motion of air in the system (as a teaching tool). At any time during the simulation, view the most recent breath in better detail by clicking the View Last Breath toggle switch.
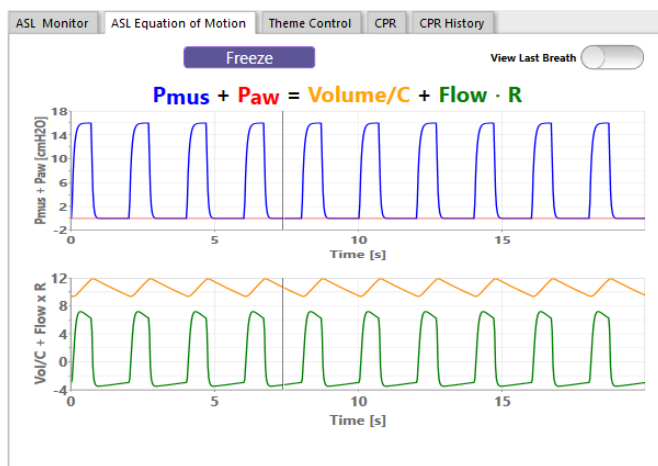

Figure 2-10 - **ASL Equation of Motion**

2.5 Components

The **ASL 5000™ Lung Solution** has three major components: Lung Adapter hardware (as applicable to the manikin), software installer, and ASL 5000™ Breathing Simulator. The Lung Adapter creates a bypass from the internal manikin lungs to the ASL 5000™. For the SimMan® family of compatible manikins, the Lung Adapter includes a selector-switch to easily toggle between the SimMan® lungs and the ASL 5000™. The Lung Adapter is designed to provide a user-friendly installation and does not require removal once it is installed. For the SimBaby™ manikin, the internal bypass is automatically controlled by the LLEAP and ASL Plugin software. Therefore, only the SimBaby™ Lung Adapter external tubing is required. For Nursing Anne™, the conversion kit does not include a selector switch.

Because the software is designed as an add-on to the LLEAP environment, the user can access any of the ASL 5000™ windows via the file menu, "View" dropdown.
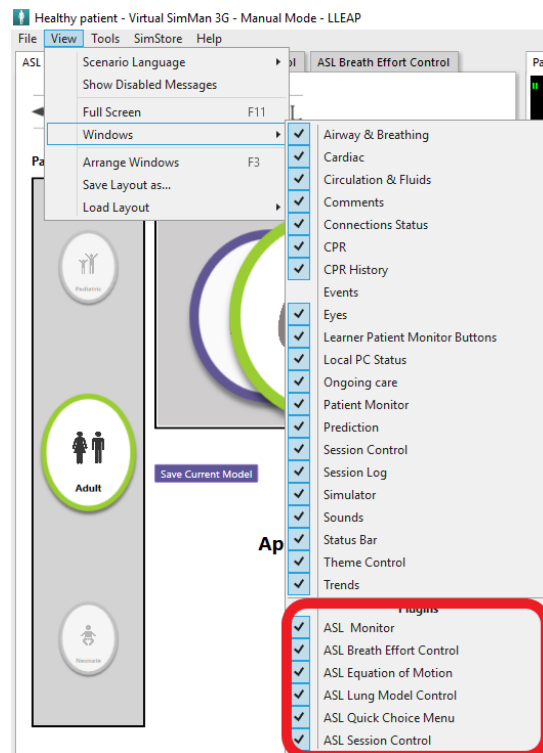
Figure 2-11 – ASL 5000™ Window Access

Each of the ASL windows allows for direct control of the ASL 5000™. This includes changing a predefined disease state / lung model or directly controlling lung mechanics (resistance, compliance, etc.). At any time during a simulation, the user can invoke real-time changes to the patient and observe a direct reaction from an external device (e.g. ventilator, CPAP, etc.).
By accessing the View -> Load Layout menu dropdown, users can load the "IngMarDefault" layout for the SimMan® family, the SimBaby™ and Nursing Anne™. This layout organizes the LLEAP and ASL 5000™ windows into a user-friendly view.

Figure 2-12 - ASL Default Layout

To improve the simulation experience, IngMar Medical has also created a custom view for the Respiratory themes provided by LLEAP, called "IngMarUnhealthy". These include:

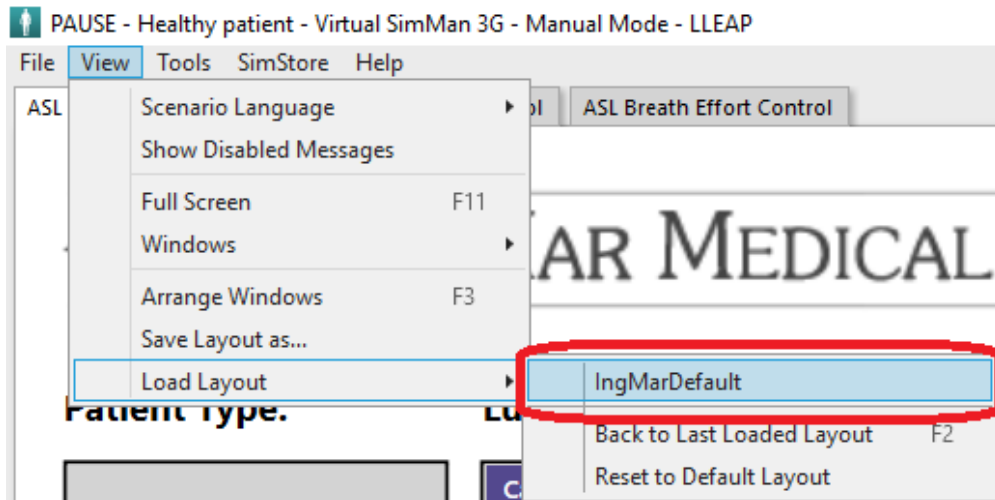- Adult -> Respiration -> Asthma
- Adult -> Respiration -> Morphine Overdose
- Adult -> Respiration -> Pneumothorax
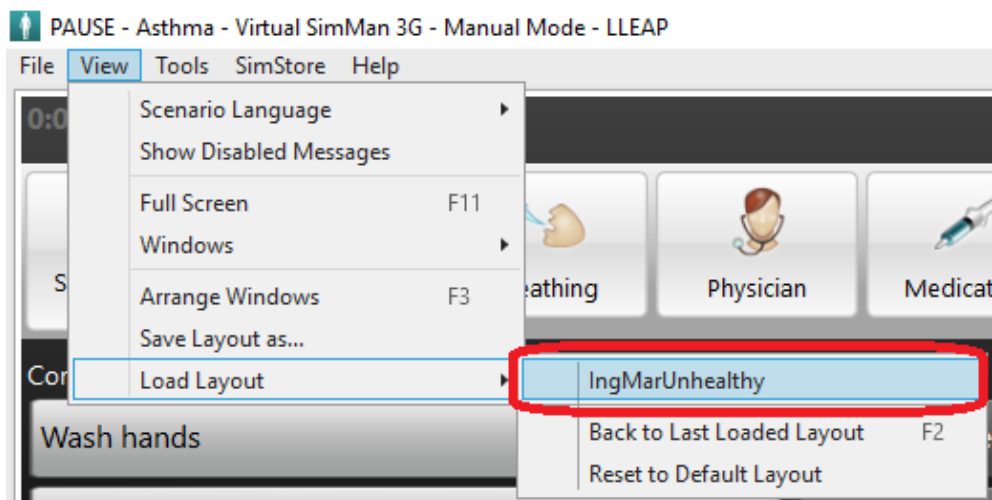
Figure 2-13 - ASL Unhealthy Layout

3 ASL 5000™ Lung Solution Operation for SimMan® Family

3.1 Switching Between SimMan® (SIM) and ASL 5000™ (ASL)

3.1.1 Selector Plate

Open the SimMan® and locate the selector plate.
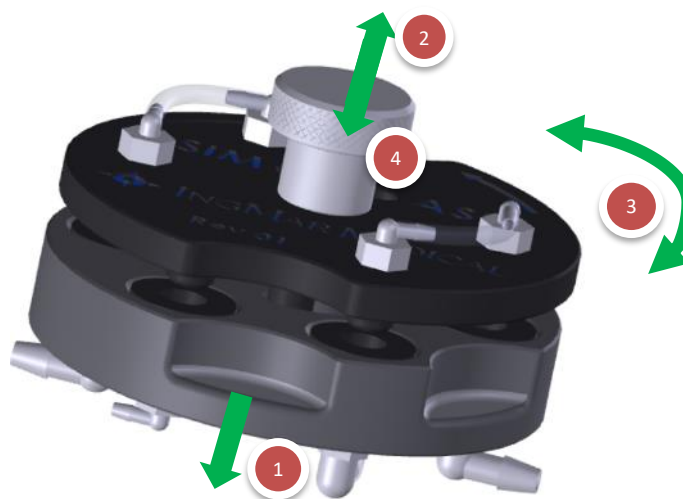
Figure 3-1 - Selector Plate

1. With the thumb and a finger, hold the bottom of the selector using the crescent-shape cutouts.
2. Pull up on the knob to separate the top and bottom of the Selector, allowing the top of the Selector to rotate.
3. Turn the selector to **ASL** or **SIM** mode.
4. Push the top and bottom of the Selector together to make a secure connection.

⚠️ **CAUTION!**

Do not try to unscrew the knob from the Selector. The top plate will rotate once it is pulled away from the bottom plate.

3.1.2 ASL 5000™ Operation (Switching from SIM to ASL)

- Set the selector to **ASL**. The indicator hole next to the ASL label should be green
- Remove the external orange / red plug
- Insert the 90° elbow, from the external tubing, into the ASL port
- Insert other end of the external tubing into the ASL 5000™ simulator
- Close the SimMan®

Figure 3-2 - ASL Option

3.1.3 ASL 5000™ Operation (Switching from ASL to SIM)

- Set the selector to **SIM**. The indicator next to the SIM label should be green
- If applicable, remove the 90° elbow and external tubing from the SimMan®
- Insert the external orange / red plug
- Close the SimMan®

Figure 3-3 - SIM Operation

3.2 Preparing the SimMan® for use

Once the software is installed and the manikin has been prepared with the Lung Adapter, the ASL 5000™ Breathing Simulator can be connected to run the enhanced respiratory simulations within the LLEAP software environment.

3.2.1 Preparing the Simulation Environment

Prior to zipping the side skin of the manikin, plug the 22mm 90° elbow adapter into the external ASL port and close the SimMan®. If the orange / red plug is not tethered to the Lung Adapter, make sure to store the plug when the ASL 5000™ is not in use.

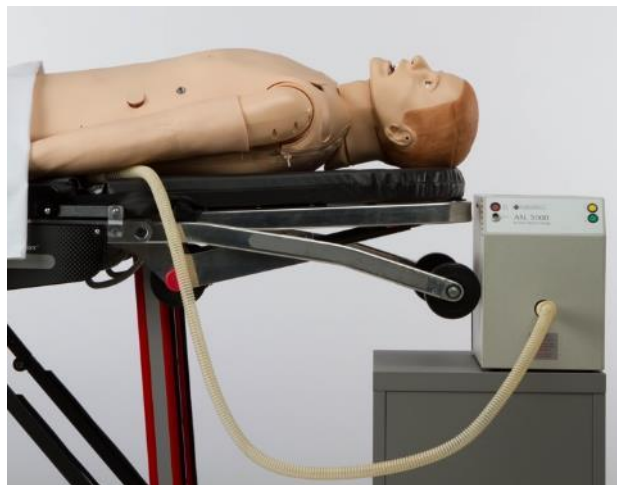**Figure 3-4 - External Airway Port**

Figure 3-5 - System Setup

3.2.2 Preparing the Network Configuration

	***N*OTE**

It is assumed that for SimMan, LLEAP version 6.3 or later is installed, or for SimMan ALS, LLEAP version 6.7 or later is installed. It is also assumed that the latest ASL 5000™ LLEAP plugin is installed prior to configuring the connection

Once the SimMan® network is configured, connect the ASL 5000™ and the SimMan® in one of the configurations as recommended below.

	CAUTION!

> Please assure that the order of operations is followed. If the ASL 5000™ is turned on before a functioning network is connected, the ASL **will not** obtain an IP address and thus not connect to LLEAP.

	***N*OTE**

The SimMan® ALS does not have an internal network router. This manikin has a similar network configuration to the Nursing Anne and SimBaby simulators. Instructions on preparing the network configuration for these manikins can be found in Section 4.3 of this guide.

3.2.2.1 Connection Using SimMan® in "AP" Mode (not SimMan®ALS)

1. Connect an Ethernet cable from the LAN port of the SimMan® to the Ethernet port of ASL 5000™

Figure 3-6 - Ethernet Cabling

2. Turn the SimMan® power ON and wait until the system has completed its booting process
3. **AFTER** the SimMan® is breathing and its eyes are blinking, turn on the ASL 5000™

Figure 3-7 - ASL Power and Ready States

4. After the red light on the front of the ASL 5000™ is OFF (~30 seconds), start the LLEAP software
5. From the View menu, open the IngMarDefault layout to view the six (6) ASL windows
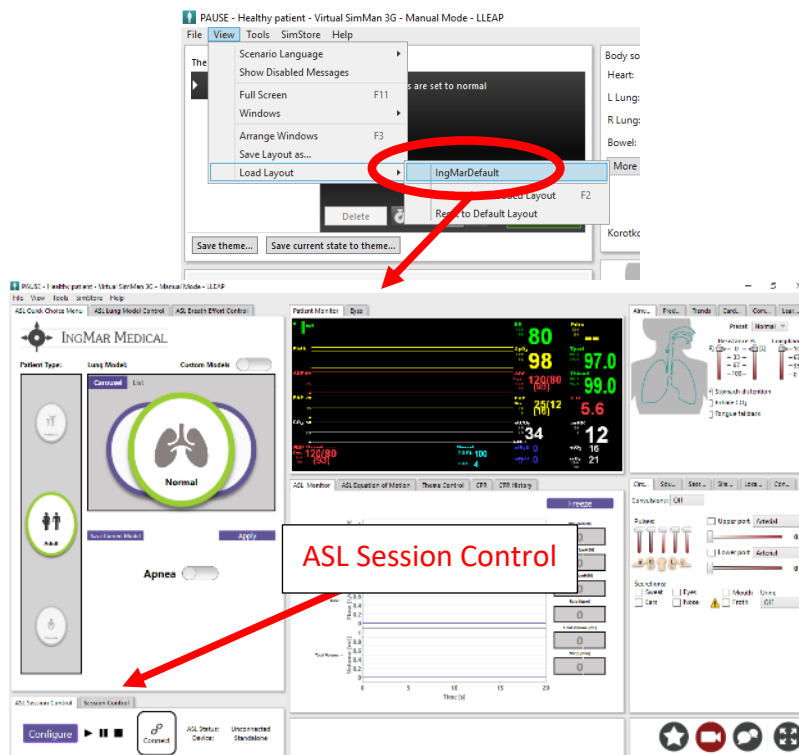6. Locate the *ASL Session Control* tab which will share the window with LLEAP's *Session Control*

Figure 3-8 - IngMarDefault Layout

7. Configure the ASL 5000™ connection settings in *ASL Session Control* window

Click Configure

Configure ▶ ‖ ■   Connect   ASL Status: Unconnected
                                Device: Standalone

IngMar Medical   ASL Configurator
ASL 5000 Configuration

Click Connection Settings

Connection Settings   Volume Conversion Settings

Manikin Attached
Show Total Volume
Done

IngMar Medical   ASL Configurator
Please select the connection type:

Ethernet   Stand Alone

Click Ethernet
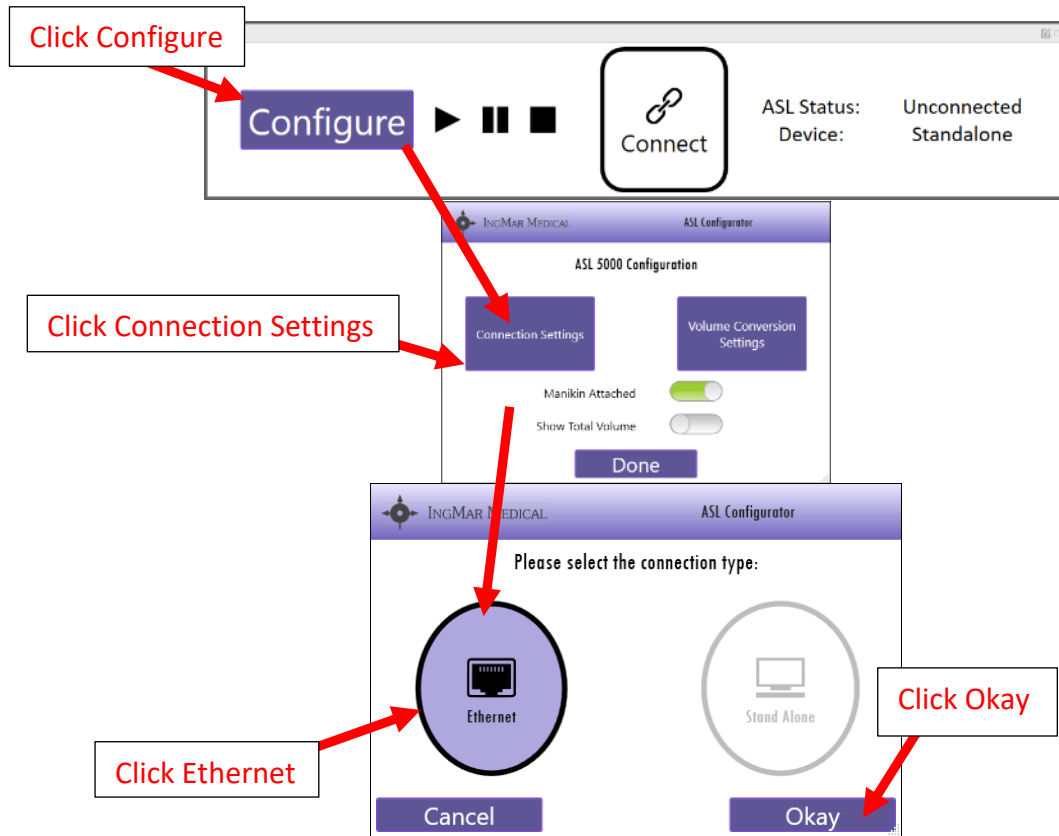
Click Okay

Cancel   Okay

Figure 3-9 - Configuring Ethernet Connection

8. Click on **Device ID:**
9. Type the ASL serial number into the **Device ID:** field
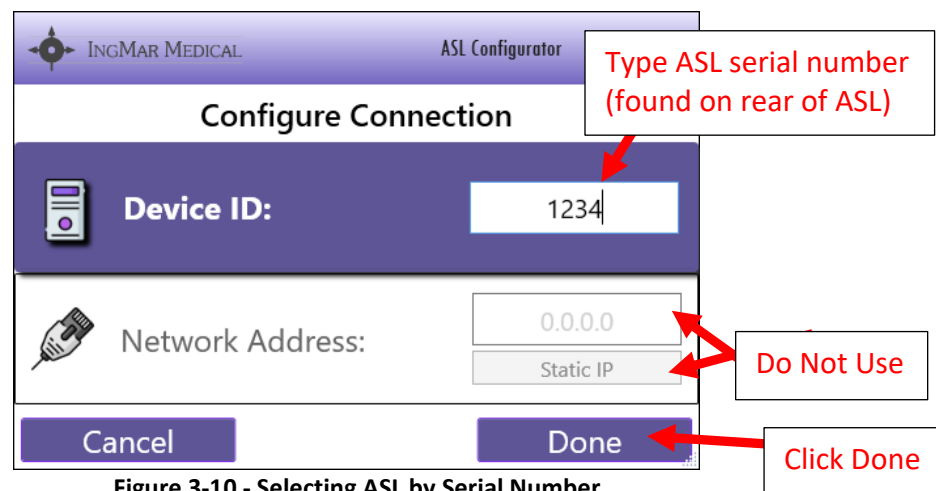10. Ignore the **IP:** field and the *Static IP* button
11. Click Done

IngMar Medical   ASL Configurator
Configure Connection

Device ID: 1234

Type ASL serial number (found on rear of ASL)

Network Address: 0.0.0.0
                    Static IP

Do Not Use

Cancel   Done

Click Done

Figure 3-10 - Selecting ASL by Serial Number
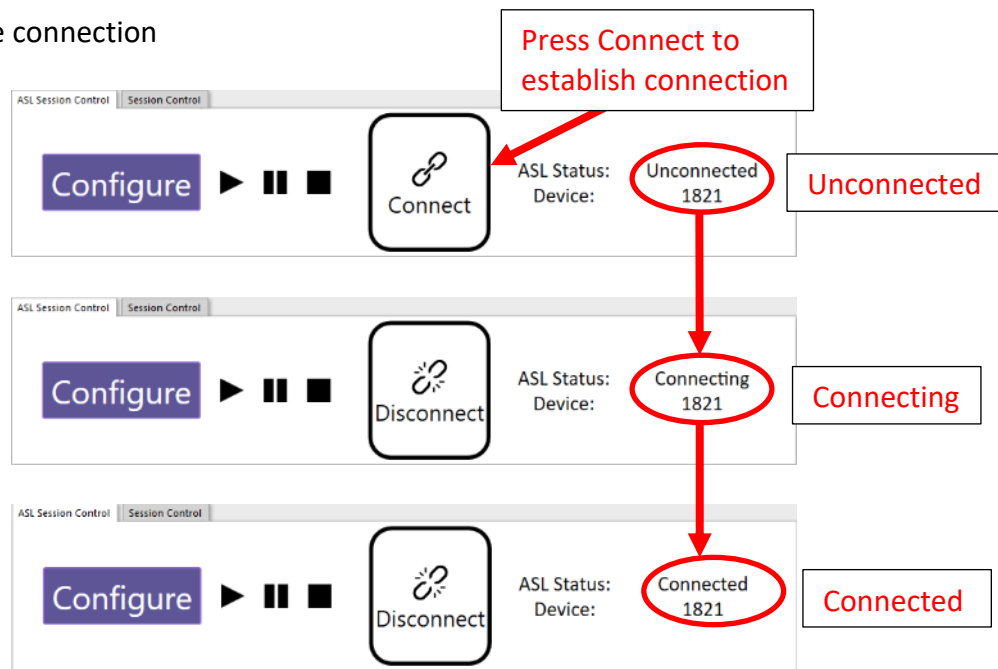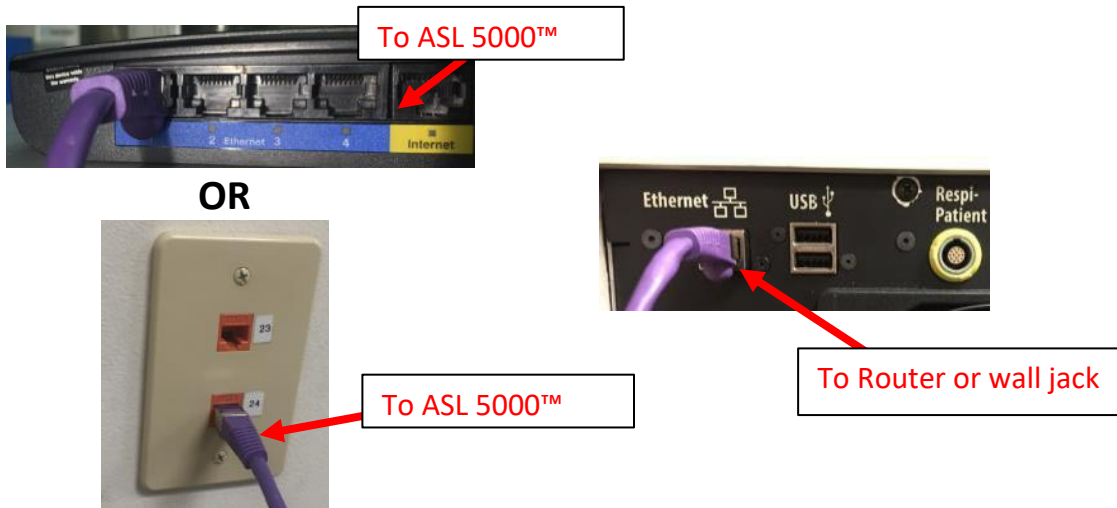
12. Complete the connection

Figure 3-11 - Connecting to ASL by Serial Number

13. The ASL 5000™, when connected, makes an audible "wiggle" as part of its initialization

14. On the "ASL Session Control" or LLEAP "Session Control" windows, click the ▶ button to start a simulation

3.2.2.2 Connection Using SimMan® in "Client" Mode (not SimMan®ALS)

1. Connect an Ethernet cable from ASL 5000™ to a <u>numbered</u> port on an external router

OR

2. Connect an Ethernet cable from ASL 5000™ to a network (via wall jack, for example)

To ASL 5000™

OR

To ASL 5000™

To Router or wall jack

Figure 3-12 - Ethernet Cabling

3. Turn the SimMan® power ON and wait until the system has completed its booting process
4. <u>**AFTER**</u> the SimMan® is breathing and its eyes are blinking, turn on the ASL 5000™

ASL power switch (rear of system)

Wait for red light to turn **OFF** for system ready

Figure 3-13 - ASL Power and Ready State

5. After the red light on the front of the ASL 5000™ is OFF (~30 seconds), open the LLEAP software
6. From the View menu, open the IngMarDefault layout to view the six (6) ASL windows
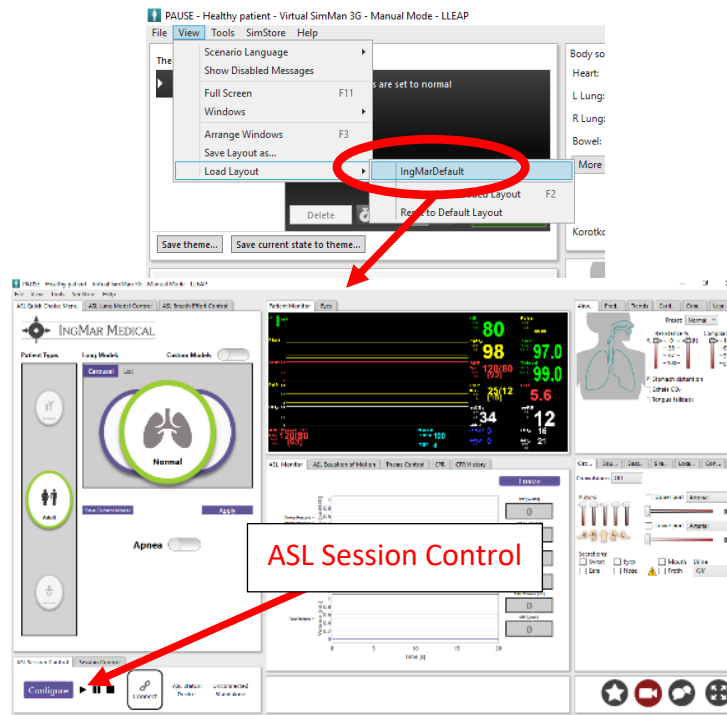7. Locate the *ASL Session Control* tab which will share the window with LLEAP's *Session Control*

25

Figure 3-14 - IngMarDefault Layout

8. Configure the ASL 5000™ connection Settings in the *ASL Session Control* window

Click Configure

Click Connection Settings

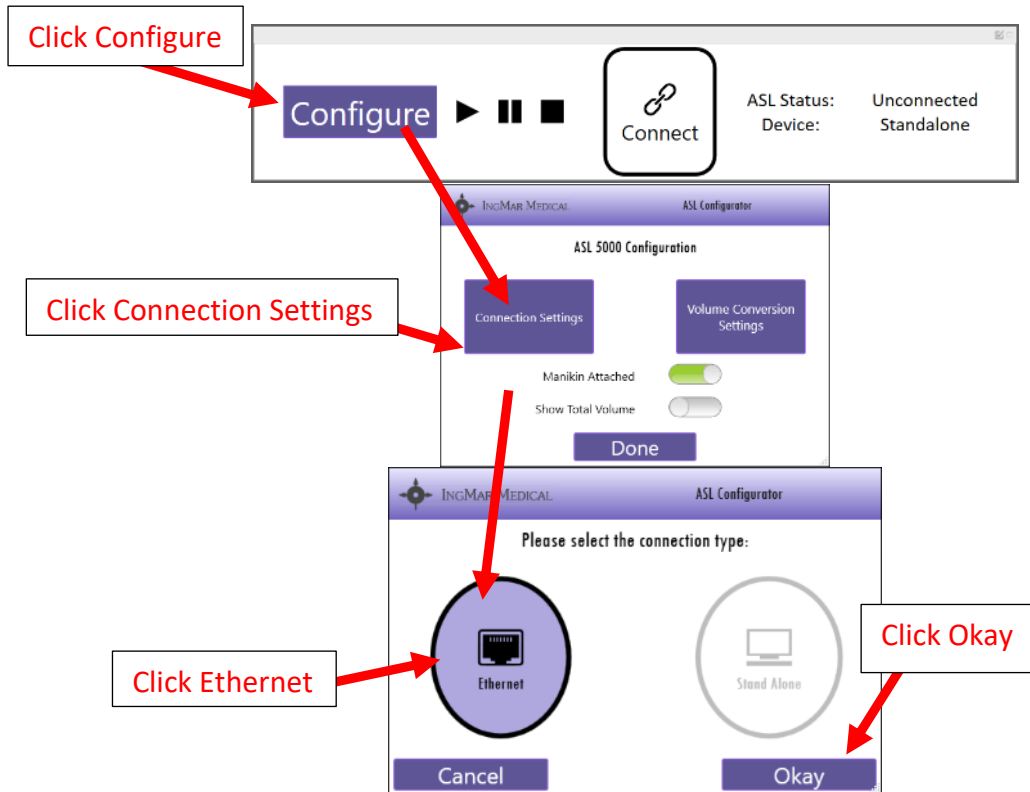Click Ethernet

Click Okay

Figure 3-15 - Configuring Ethernet Connection

9. Click ***Device ID:***
10. Type the ASL serial number into the ***Device ID:*** field
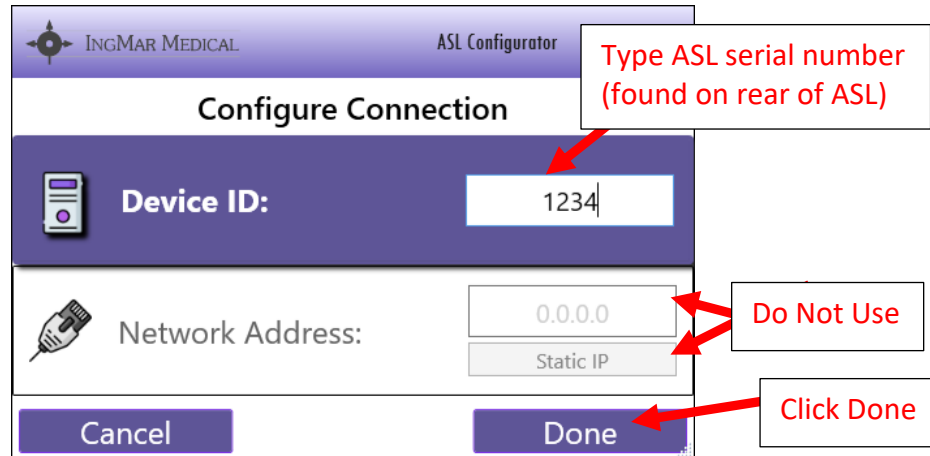11. Ignore the *IP:* field and the *Static IP* button
12. Click Done

Figure 3-16 - Selecting ASL by Serial Number
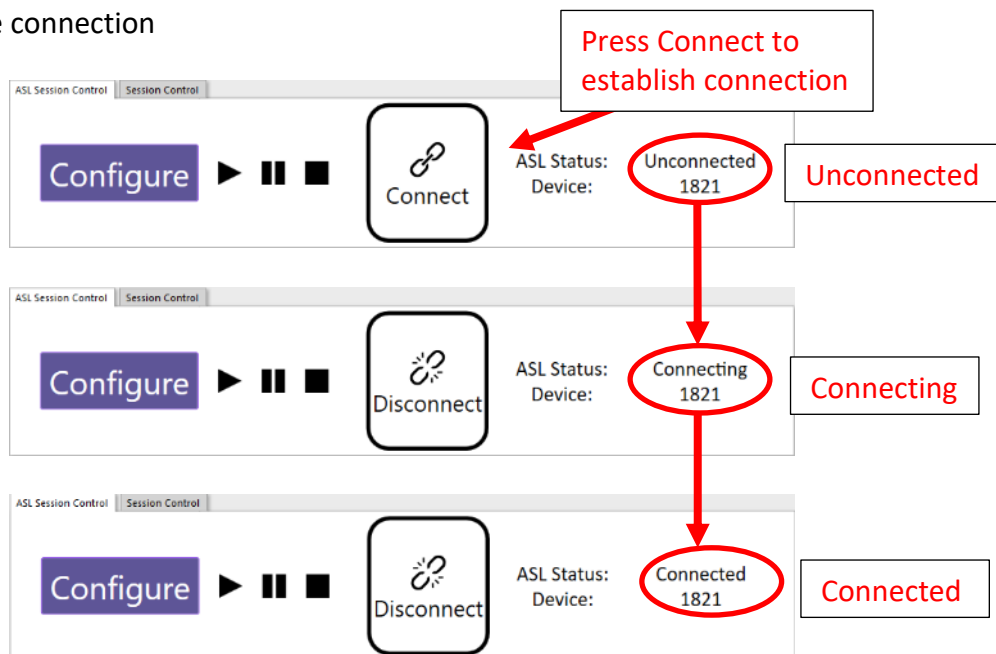
13. Complete the connection

Figure 3-17 - Connecting to ASL by Serial Number

14. The ASL 5000™, when connected, makes an audible "wiggle" as part of its initialization
15. On the "ASL Session Control" or LLEAP "Session Control" windows, click the ▶ button to start a simulation

3.2.2.3 Connection Using SimMan® in "Client" Mode, when the ASL 5000™ requires a unique IP address (not SimMan®ALS)

NOTE

In some configurations, the customer may require all devices on their network be given specific IP addresses. Once the IP address is known, follow the steps below for a successful connection.

1. Connect an Ethernet cable from ASL 5000™ to a <u>numbered</u> port on an external router

OR

2. Connect an Ethernet cable from ASL 5000™ to a network (via wall jack, for example)
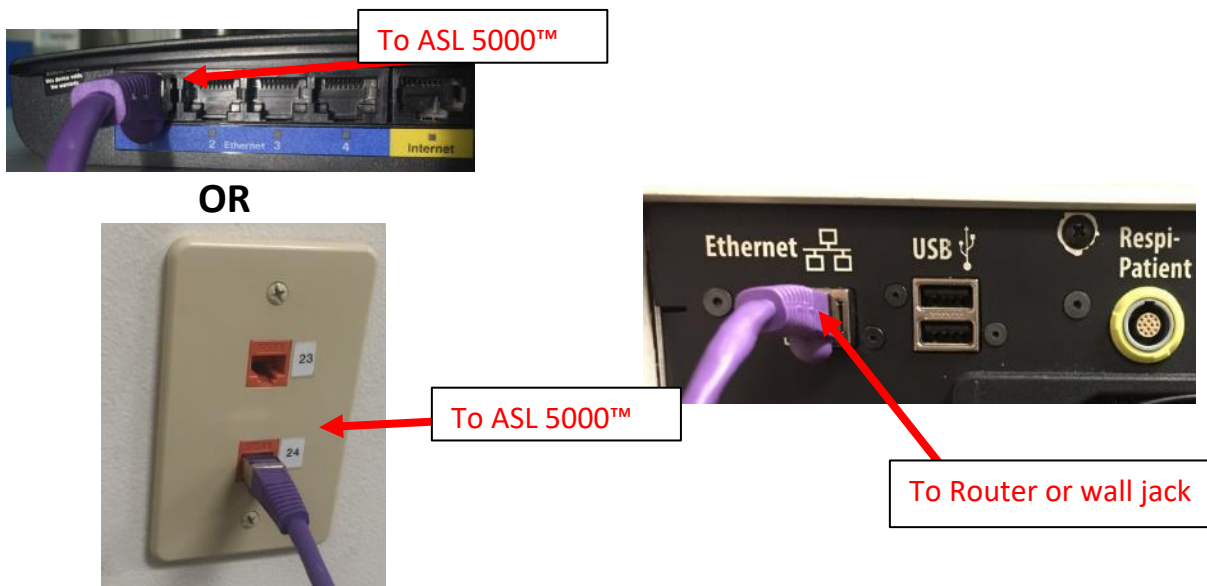
To ASL 5000™

OR

To ASL 5000™

Ethernet USB Respi-Patient

To Router or wall jack

Figure 3-18 - Ethernet Cabling

3. Turn the SimMan® power ON and wait until the system has completed its booting process
4. **_AFTER_** the SimMan® is breathing and its eyes are blinking, turn on the ASL 5000™

ASL power switch (rear of system)

Wait for red light to turn **_OFF_** for system to be ready

Figure 3-19 - ASL Power and Ready State

5. After the red light on the front of the ASL 5000™ is OFF (~30 seconds), open the LLEAP software
6. From the View menu, open the IngMarDefault layout to view the six (6) ASL windows
7. Locate the *ASL Session Control* tab which will share the window with LLEAP's *Session Control*
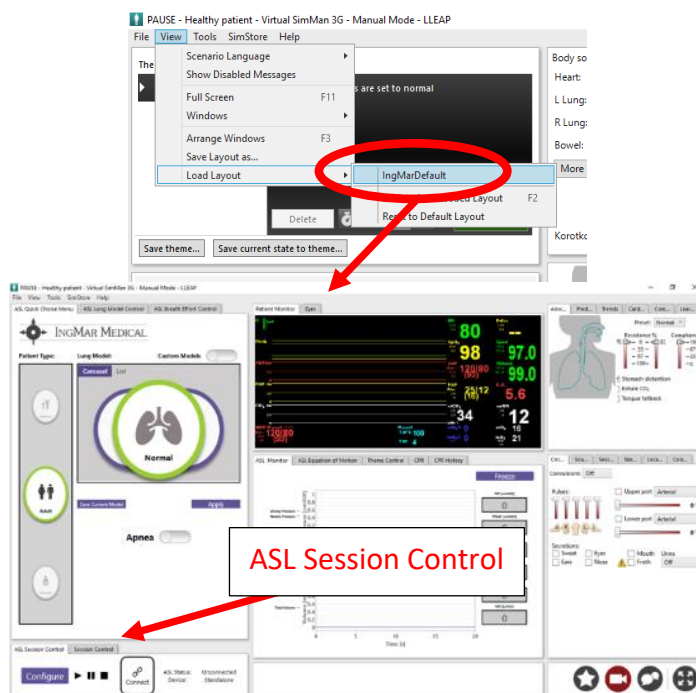
Figure 3-20 - IngMarDefault Layout

8. Configure the ASL 5000™ connection settings in the *ASL Session Control* window

Click Configure

Click Connection Settings
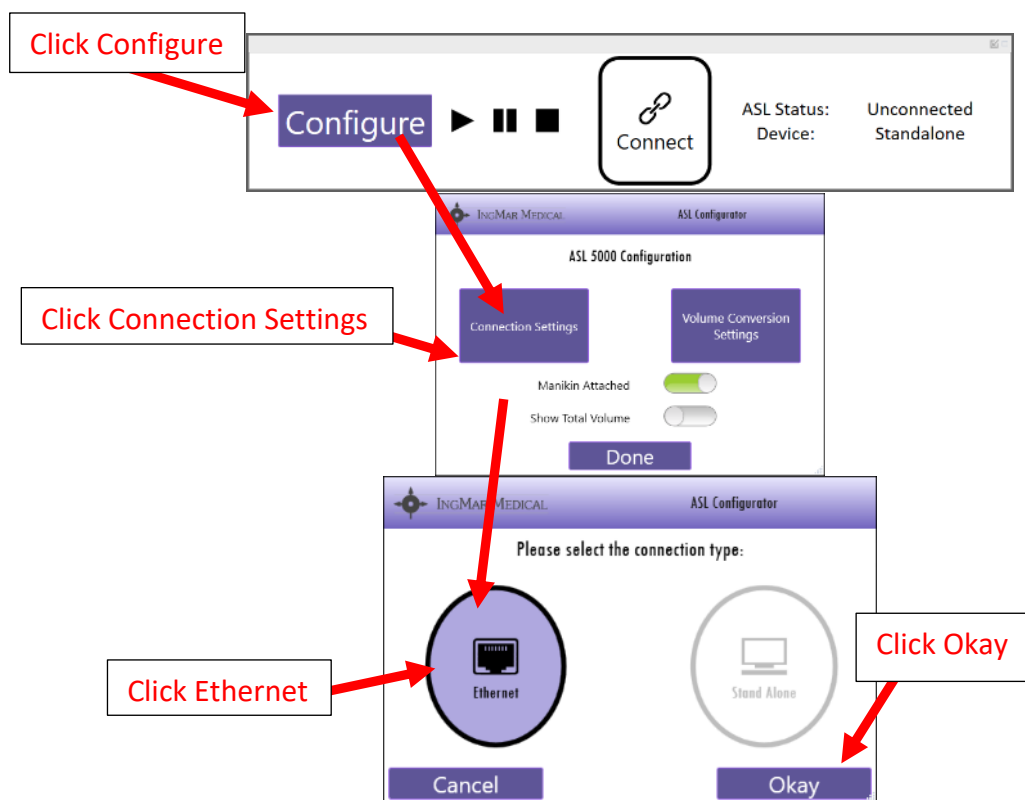
Click Ethernet

Click Okay

Figure 3-21 - Configuring Ethernet Connection

9. Click **Network Address:**
10. Type the IP address provided by the customer into the **Network Address:** field
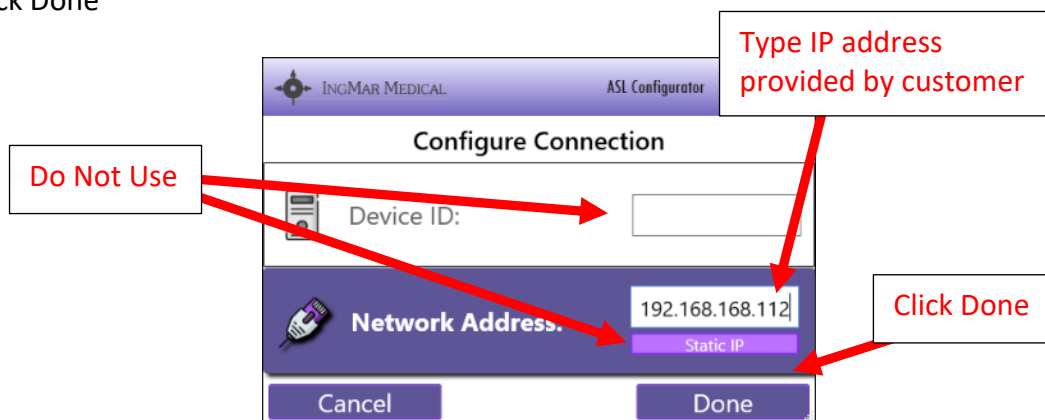11. Ignore the **Device ID:** field and the *Static IP* button
12. Click Done

Figure 3-22 – Selecting ASL by IP Address
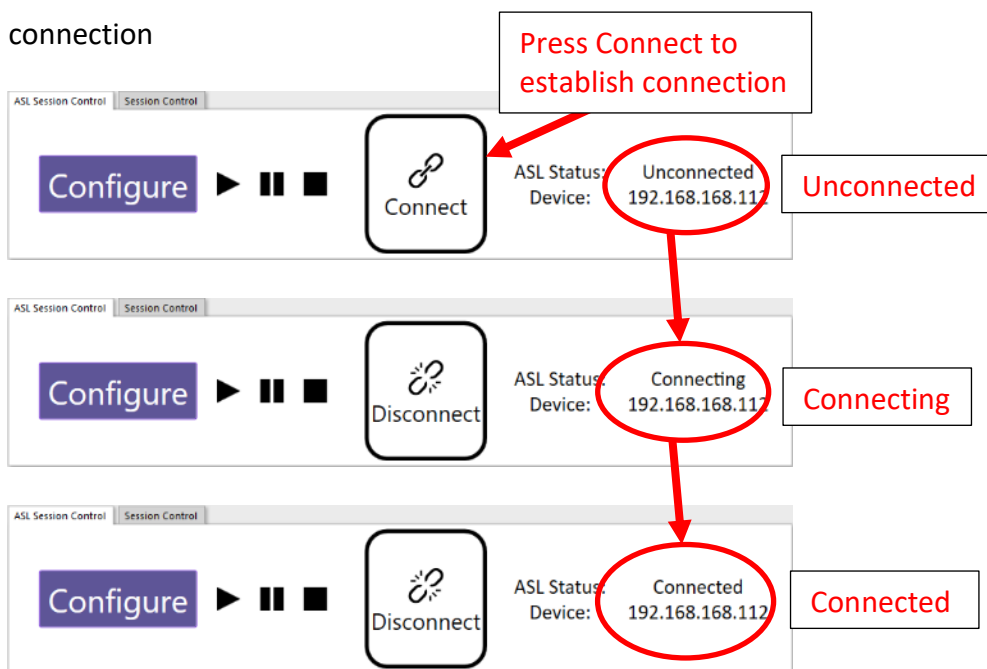
13. Complete the connection

Figure 3-23 – Connecting to ASL by IP Address

14. The ASL 5000™, when connected, makes an audible "wiggle" as part of its initialization
15. On the "ASL Session Control" or LLEAP "Session Control" windows, click the ▶ button to start a simulation

3.2.2.4 Connection Using SimMan® as Virtual Simulator (Local Computer) with a Physical ASL 5000™ Breathing Simulator (not SimMan®ALS)

NOTE

LLEAP can control the ASL 5000™ while running as a Virtual Simulator. The same requirements hold for the ASL 5000™ where it must have an IP address provided by any of the methods defined above. The computer running the LLEAP software MUST be connected to the same network as the ASL 5000™ (same IP subnet)

1. Connect an Ethernet cable from the LAN port of the SimMan® to the Ethernet port of ASL 5000™

OR

2. Connect an Ethernet cable from ASL 5000™ to a <u>numbered</u> port on an external router

OR

3. Connect an Ethernet cable from ASL 5000™ to a network (via wall jack, for example)
4. If using the SimMan® as the network in AP mode (using the Virtual Simulator via LLEAP), turn the SimMan® power ON and wait until the system has completed its booting process.
5. ***AFTER*** the SimMan® is breathing and its eyes are blinking, turn on the ASL 5000™
6. After the red light on the front of the ASL 5000™ is OFF (~30 seconds), open the LLEAP software
7. When the LLEAP *Select Simulator* window opens, in the Virtual Simulator window, select Local computer
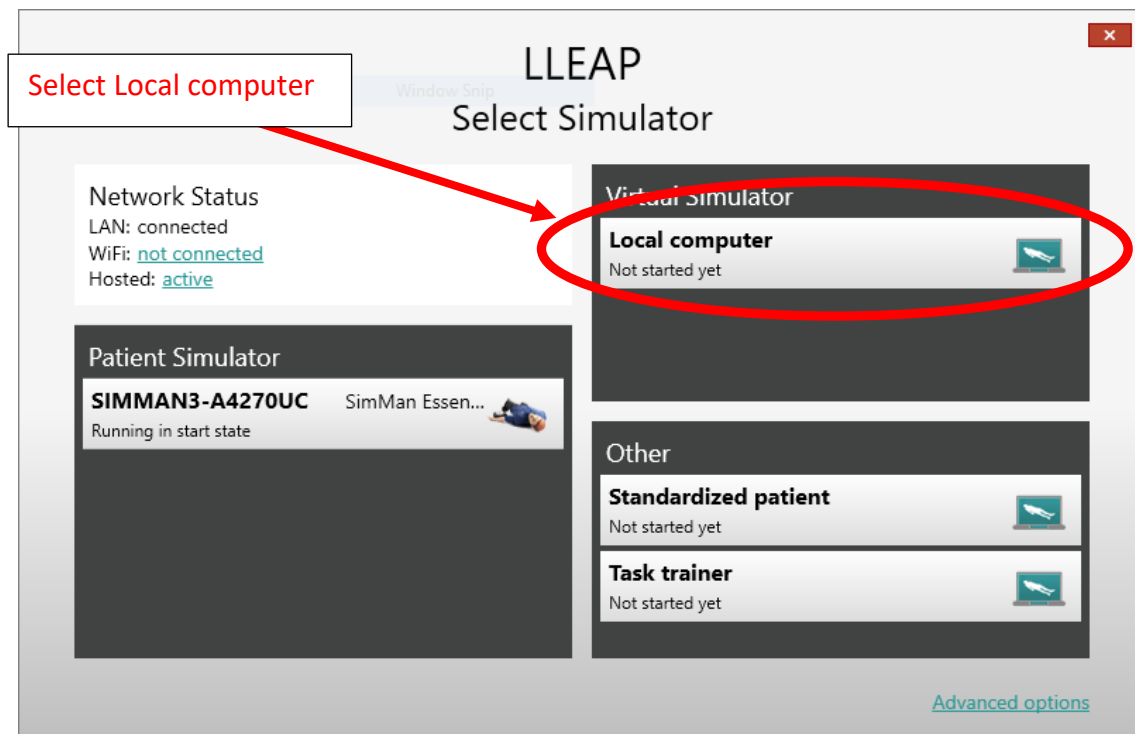

Figure 3-24 - LLEAP Select Simulator Window

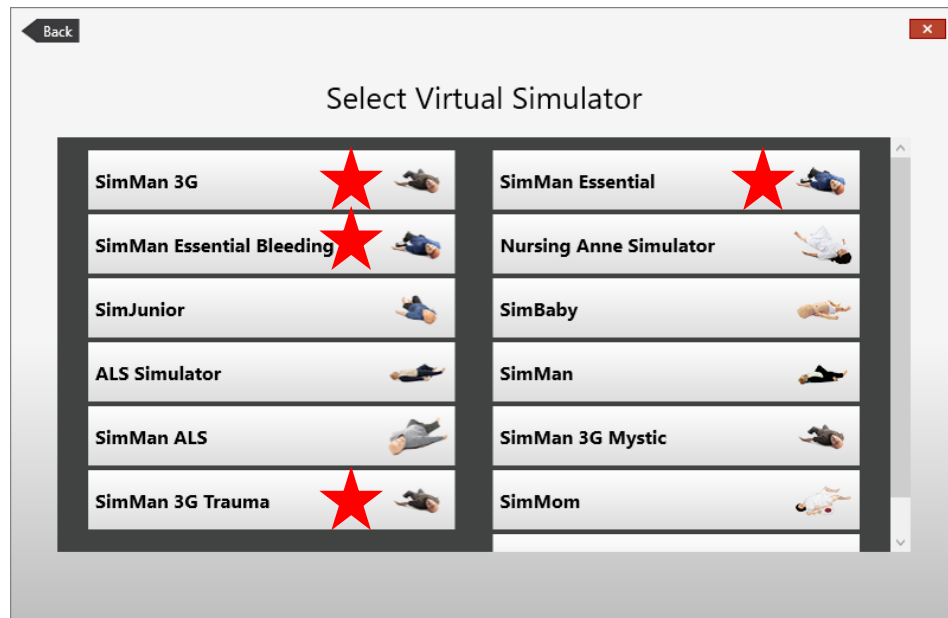8. Select one of the compatible manikin simulators

Figure 3-25 - LLEAP Available Manikins

9. From the View menu, open the IngMarDefault layout to view the six (6) ASL windows
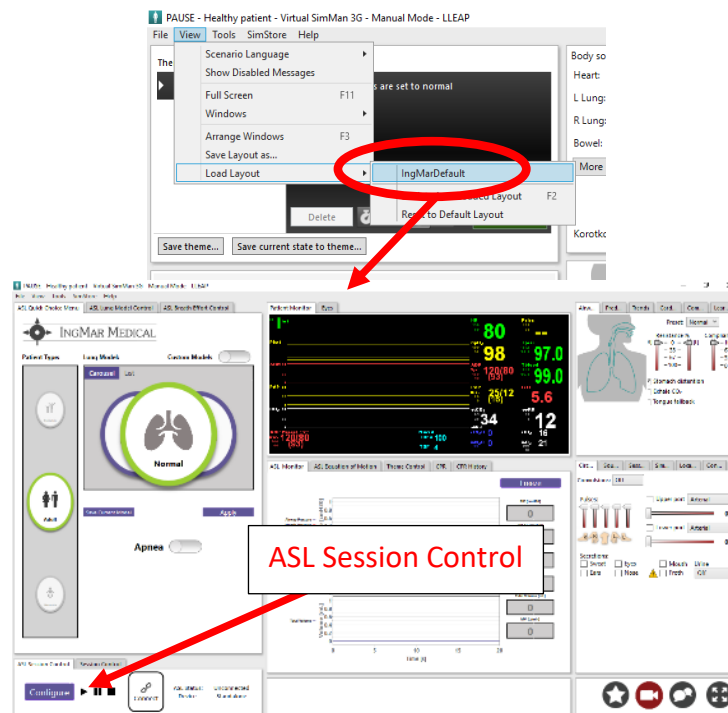10. Locate the *ASL Session Control* tab which will share the window with LLEAP's *Session Control*

Figure 3-26 - IngMarDefault Layout

11. Configure the ASL 5000™ connection Settings in the *ASL Session Control* window in any of the configurations from the options above.

12. Make sure the "Manikin Attached" toggle is in the OFF position (not green) as shown in the image below
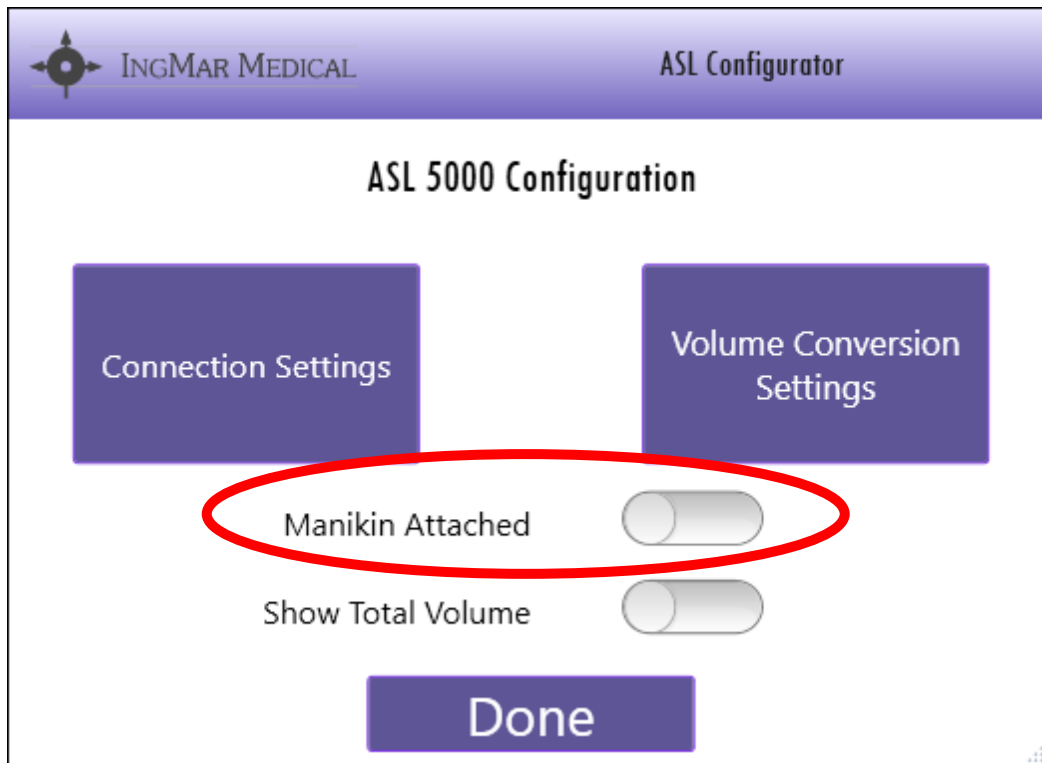

Figure 3-27 – Manikin Compensation Toggle

13. The ASL 5000™, when connected, makes an audible "wiggle" as part of its initialization

14. On the "ASL Session Control" or LLEAP "Session Control" windows, click the ▶ button to start a simulation

3.2.3 Returning to the Standard SimMan® Configuration

The standard SimMan® configuration for simulations not requiring the enhanced respiratory option requires the following steps.

- Unzip the side skin of the manikin and remove the 22mm elbow adapter
- Switch the Selector to **SIM** mode
- Insert the red / orange external plug and zip the side skin
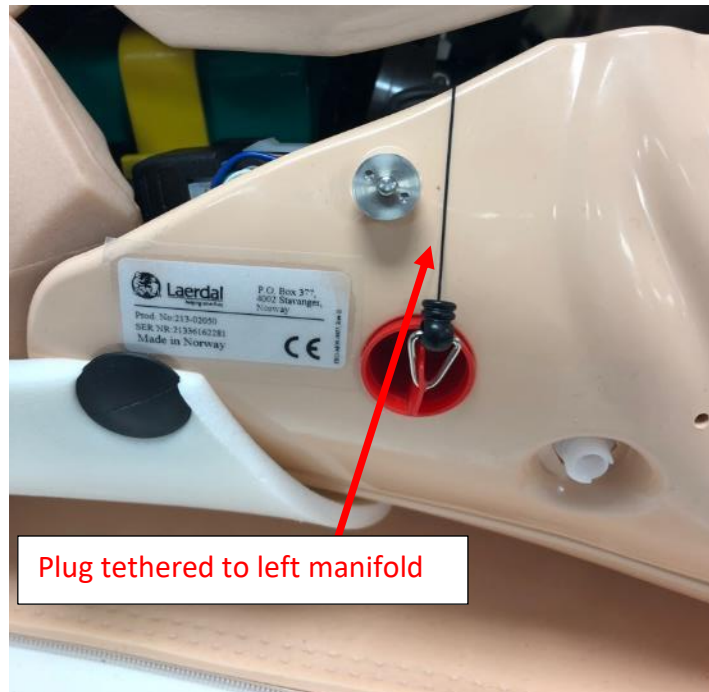
Figure 3-28 - External Plug for SIM Mode

4 ASL 5000™ LUNG SOLUTION OPERATION FOR SIMBABY™, SIMMAN® ALS AND NURSING ANNE™

![note icon] **NOTE**

The SimBaby™, SimMan® ALS and Nursing Anne™ have the same general functionality when connecting to the ASL 5000™ Breathing Simulator. Preparation for the SimMan® ALS was explained in Section 3 of this manual. The details below will identify the differences between each manikin setup.

4.1 Preparing SimBaby™ for use with the ASL 5000™

4.1.1 SimBaby™ with ASL 5000™ Operation

- On the SimBaby™ right side (from the perspective of the baby), separate the skin where the Ethernet adapter is located
- Remove the rubber plug – DO NOT DISCARD

Figure 4-1 - Plug for Operation without ASL 5000™

- Insert the 15mm elbow connector from the Lung Adapter kit into the side port of the SimBaby™

Figure 4-2 - Lung Adapter with SimBaby™

- Insert the 22mm connector into the ASL 5000™ port

Figure 4-3 – SimBaby™ Connected to ASL 5000™

4.1.2 SimBaby™ without ASL 5000™ Operation

- Remove the 15mm elbow connector from the side port of the SimBaby™

Figure 4-4 - Remove 15mm Adapter

- Insert rubber plug into side port of SimBaby™

Figure 4-5 - Insert Rubber Plug

4.2 Preparing Nursing Anne™ for use with the ASL 5000™

- Nursing Anne™ has a 15mm connector protruding from the hip of the manikin. Connect this to a 22mm tube to the ASL 5000.

Figure 4-6 – Connecting Nursing Anne™ to the ASL 5000™

4.3 Network Configuration for SimBaby™ / SimMan® ALS / Nursing Anne™

NOTE

For use with SimBaby™ / SimMan® ALS / Nursing Anne™, LLEAP version 6.7 and associated firmware or later must be installed as well as the latest ASL 5000™ LLEAP plugin prior to configuring the connection.

SimBaby™ / SimMan® ALS / Nursing Anne™ do not have an internal router that can be placed in AP or Client mode. The manikins can operate wirelessly or can be connected directly to a network via an Ethernet cable.

If using an external router, IngMar Medical, LLC recommends the following minimum specifications:
- Support 802.11n minimum, 802.11ac preferred
- At least 2 ethernet ports (not including uplink port)
- Region-specific power adapter

4.3.1 Connecting SimBaby™ / SimMan® ALS / Nursing Anne™ Using the ASL 5000™ Serial Number

1. Connect wirelessly or use an Ethernet cable from the Ethernet port on the right side of the SimBaby™ / SimMan® ALS / Nursing Anne™ to one of the following options
    a. Numbered port on an external router
    b. Network (via wall jack or switch)
2. Connect an Ethernet cable from the ASL 5000™ to the same option as listed above

NOTE

Configure the SimBaby™ / SimMan® ALS / Nursing Anne™ to the same network as the ASL 5000™ using the LLEAP "Simulator Firmware & Network Wizard"

Wireless connection OR to router or wall jack

To router or wall jack

To ASL 5000™ / To manikin
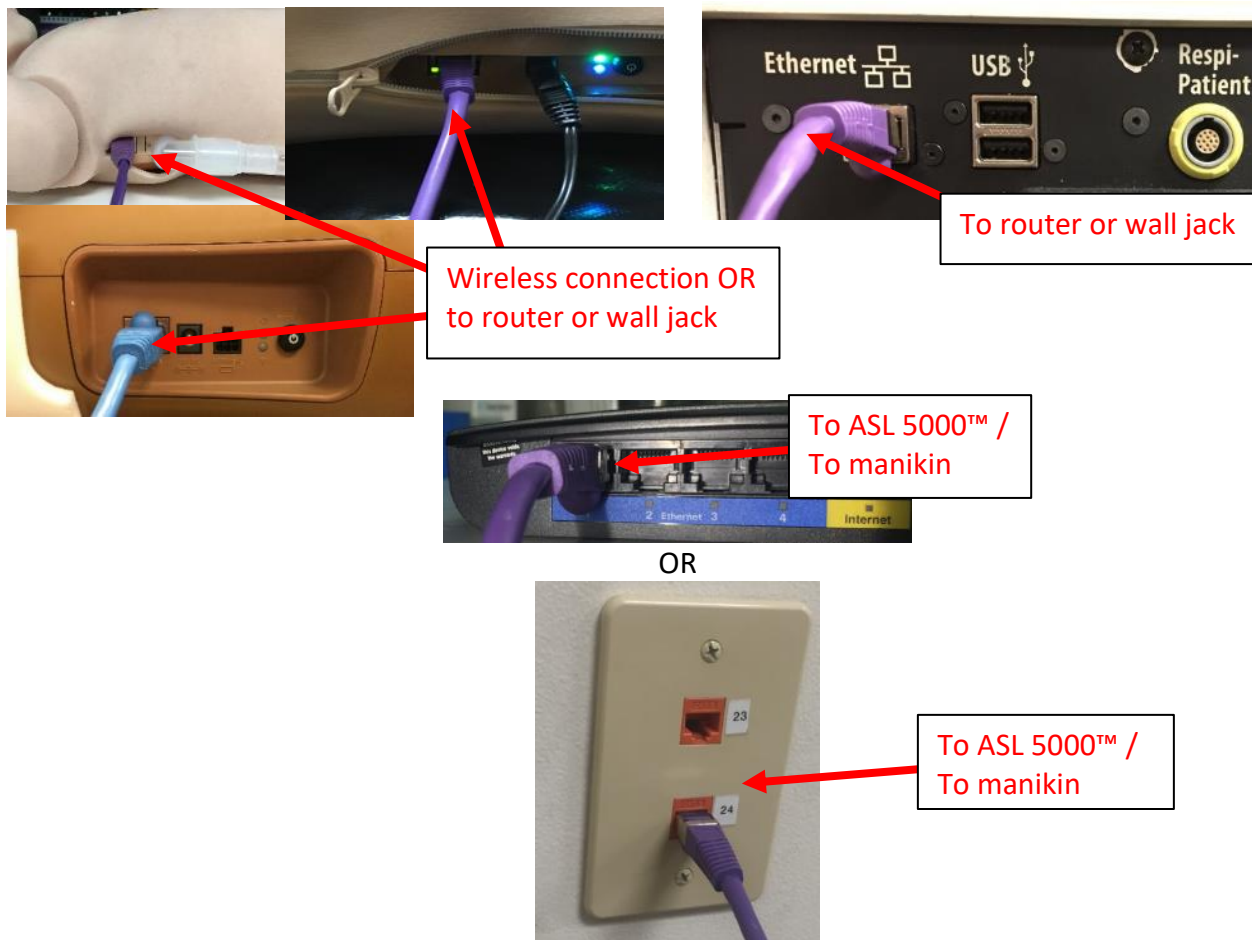
OR

To ASL 5000™ / To manikin

Figure 4-7 - Ethernet Cabling

3. Turn on the SimBaby™ / SimMan® ALS / Nursing Anne™ and the ASL 5000™
4. **AFTER** the red light on the front of the ASL 5000™ is OFF (~30 seconds), start the LLEAP software

ASL power switch (rear of system)

Wait for red light to turn **OFF** for system ready

Figure 4-8 - ASL Power and Ready State

5. From the View menu, open the IngMarDefault layout to view the six (6) ASL windows
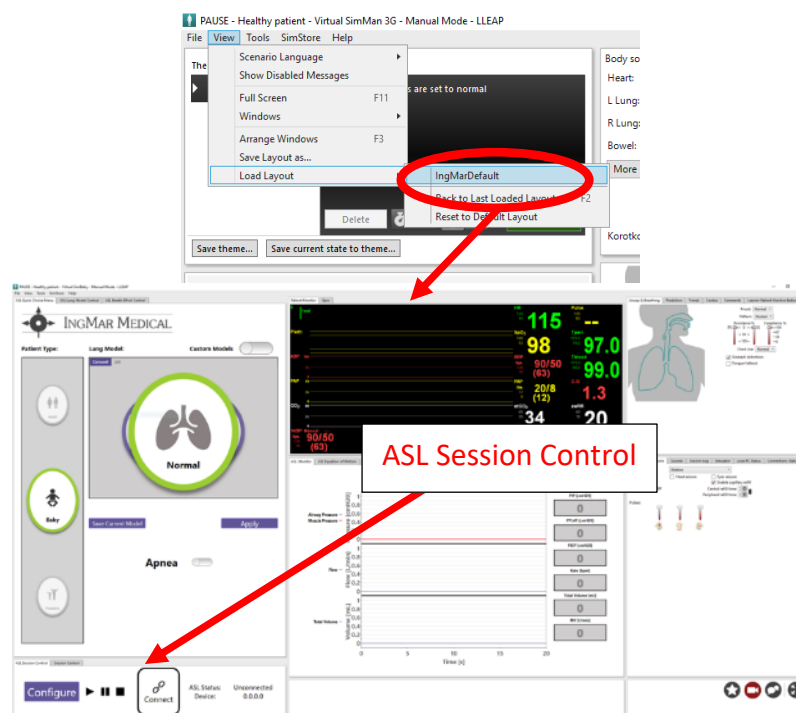6. Locate the *ASL Session Control* tab which will share the window with LLEAP's *Session Control*

ASL Session Control

Figure 4-9 - IngMarDefault Layout

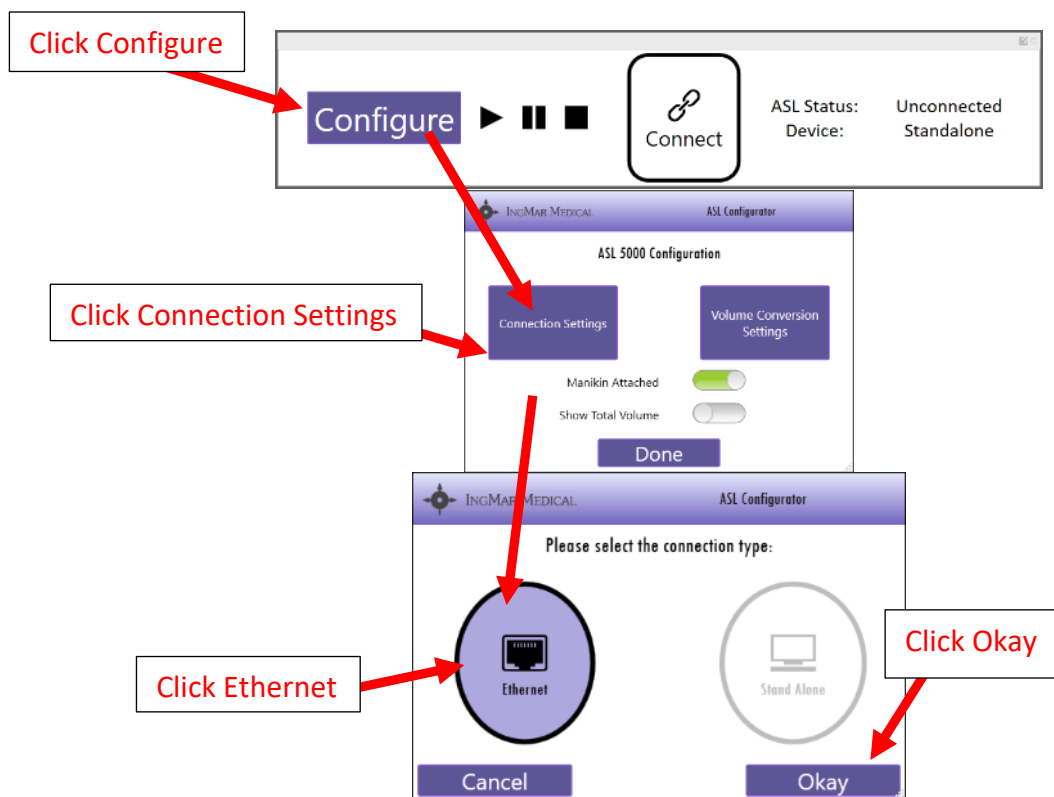7. Configure the ASL 5000™ connection Settings in the *ASL Session Control* window

Figure 4-10 - Configuring Ethernet Connection

8. Click **Device ID:**
9. Type the ASL 5000™ serial number into the **Device ID:** field
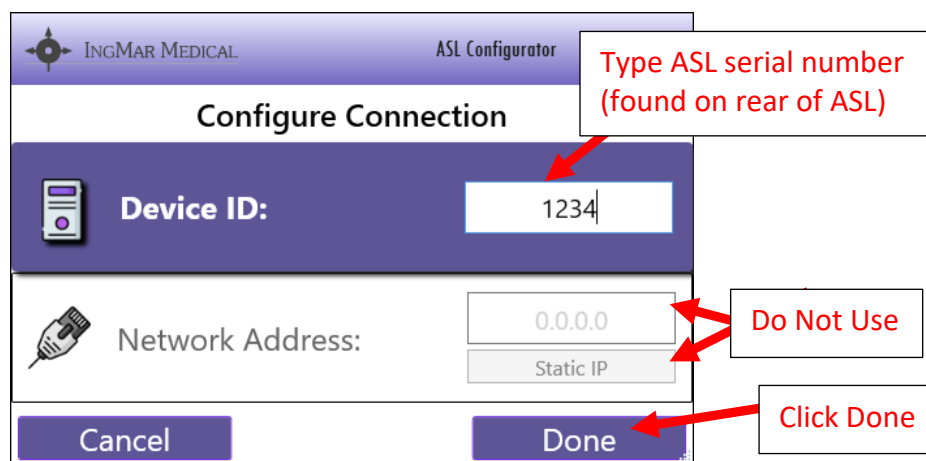10. Ignore the *IP:* field and the *Static IP* button
11. Click Done

Figure 4-11 - Selecting ASL by Serial Number

12. Complete the connection

Press Connect to establish connection
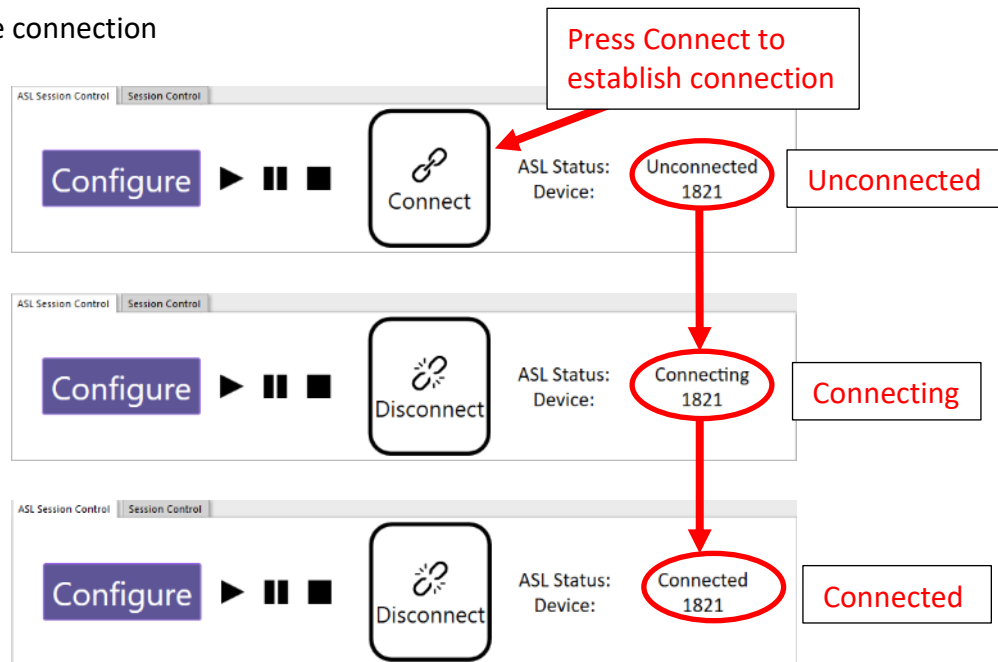
Unconnected

Connecting

Connected

Figure 4-12 - Connecting to ASL by Serial Number

13. The ASL 5000™, when connected, makes an audible "wiggle" as part of its initialization
14. On the "ASL Session Control" or LLEAP "Session Control" windows, click the ▶ button to start a simulation

4.3.2 Connecting SimBaby™ / SimMan® ALS / Nursing Anne™ where the ASL 5000™ requires a unique IP address

1. Connect wirelessly or use an Ethernet cable from the Ethernet port on the right side of the SimBaby™ / SimMan® ALS / Nursing Anne™ to one of the following options
    a. Numbered port on an external router
    b. Network (via wall jack, for example)
2. Connect an Ethernet cable from the ASL 5000™ to the same option as listed above

NOTE

Configure the SimBaby™ / Nursing Anne™ to the same network as the ASL 5000™ using the LLEAP "Simulator Firmware & Network Wizard"

Wireless connection or To router or wall jack

To router or wall jack

To ASL 5000™ / To SimBaby™
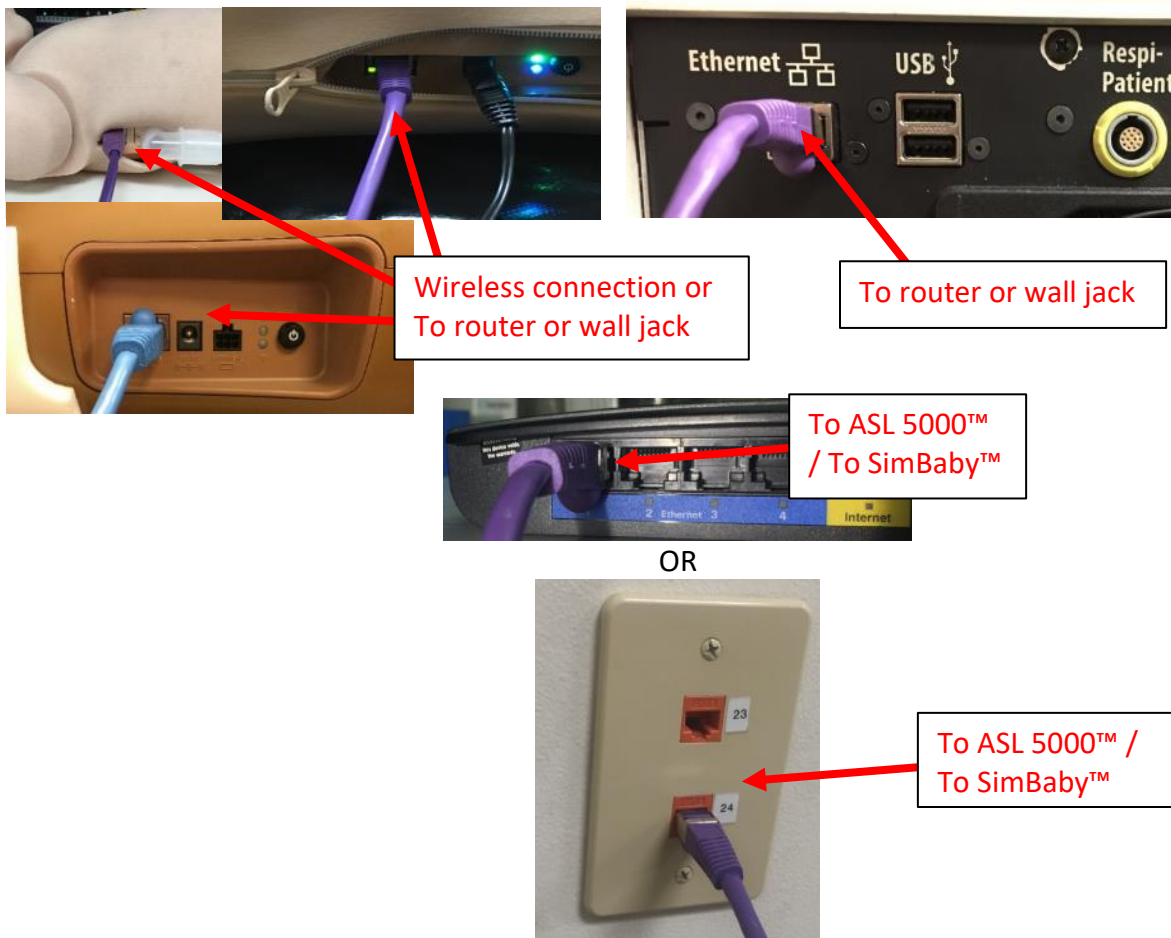
OR

To ASL 5000™ / To SimBaby™

Figure 4-13 - Ethernet Cabling

3. Turn on the SimBaby™ / SimMan® ALS / Nursing Anne™ and the ASL 5000™
4. **AFTER** the red light on the front of the ASL 5000™ is OFF (~30 seconds), open the LLEAP software

42

Figure 4-14 - ASL Power and Ready State

5. From the View menu, open the IngMarDefault layout to view the six (6) ASL windows
6. Locate the *ASL Session Control* tab which will share the window with LLEAP's *Session Control*
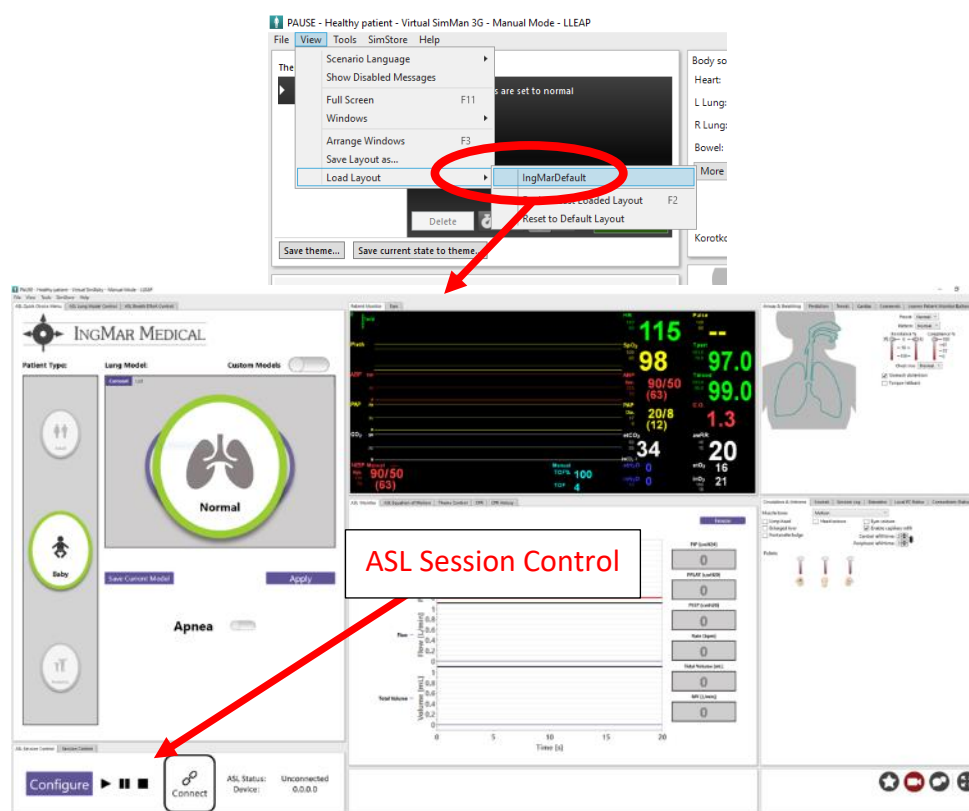

Figure 4-15 - IngMarDefault Layout

7. Configure the ASL 5000™ connection Settings in the *ASL Session Control* window
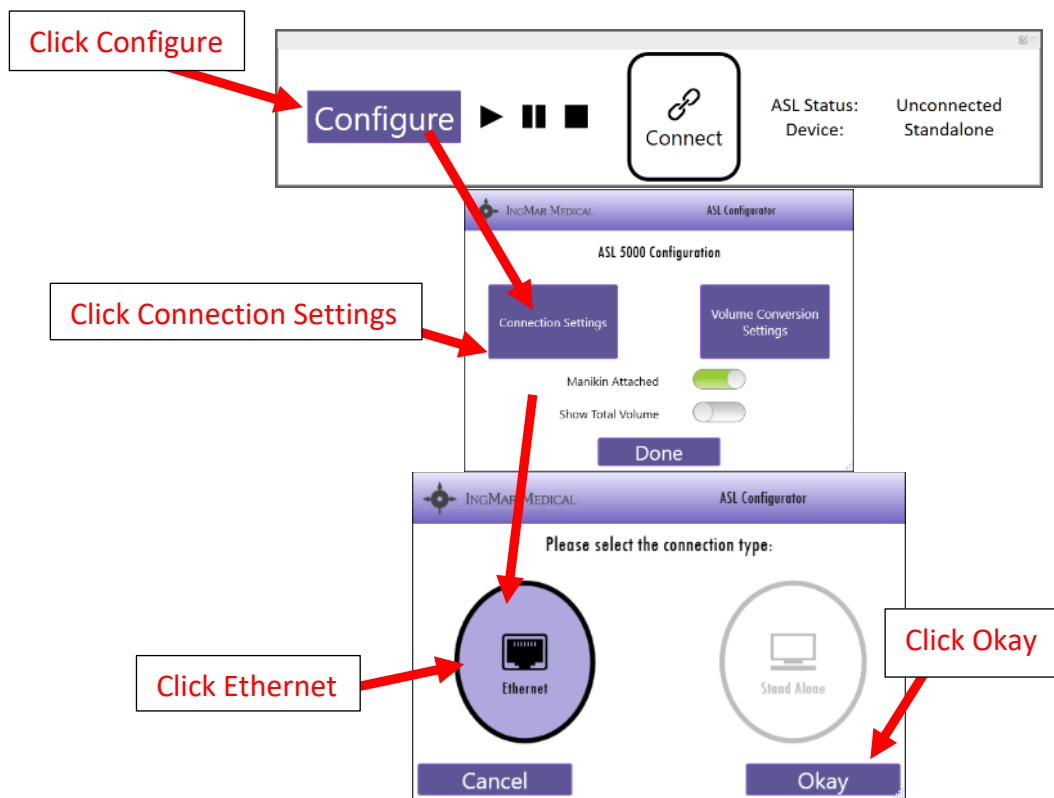
Click Configure

Click Connection Settings

Click Ethernet

Click Okay

Figure 4-16 - Configuring Ethernet Connection

8. Click **Network Address**
9. Type the IP address provided by the customer into the **Network Address:** field
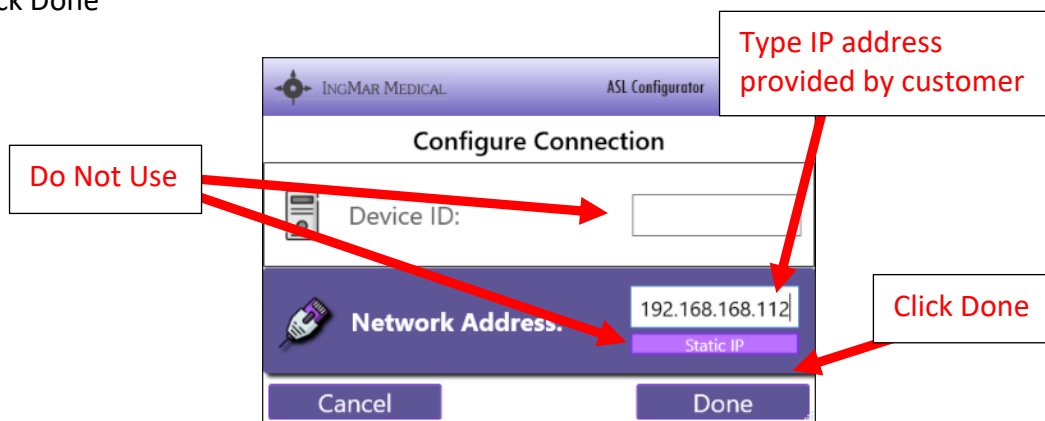10. Ignore the **Device ID:** field and the *Static IP* button
11. Click Done

Type IP address provided by customer

Do Not Use

Click Done

192.168.168.112

Figure 4-17 - Selecting ASL by IP Address
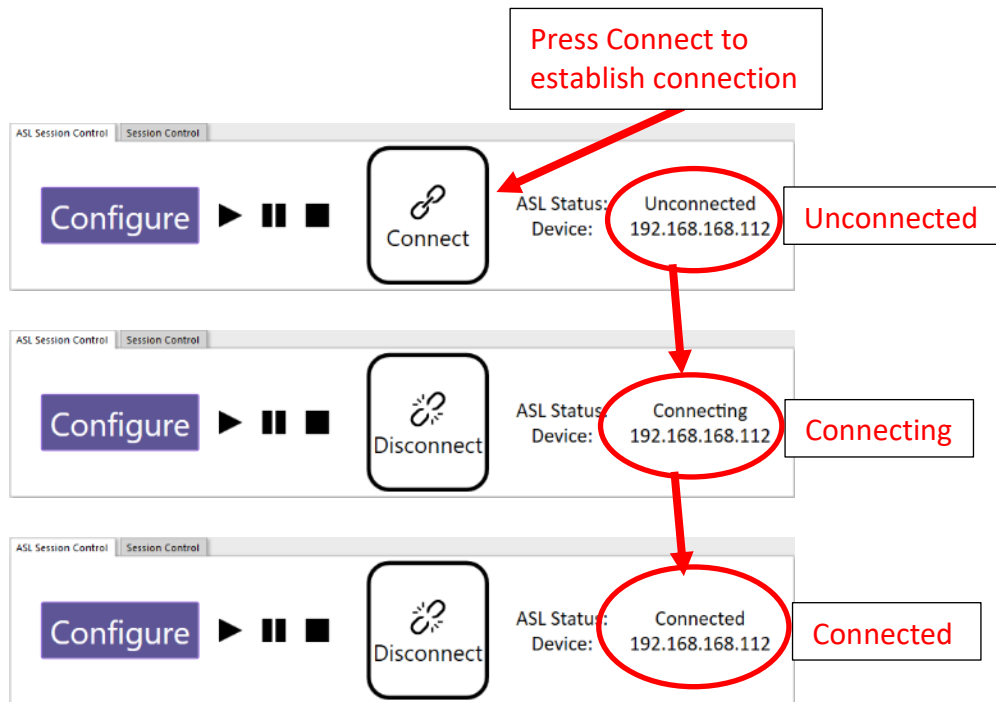
12. Complete the connection

Figure 4-18 - Connecting to ASL by IP Address

13. The ASL 5000™, when connected, makes an audible "wiggle" as part of its initialization
14. On the "ASL Session Control" or LLEAP "Session Control" windows, click the ▶ button to start a simulation

4.3.3 Connection using SimBaby™ / SimMan® ALS / Nursing Anne™ as Virtual Simulator (Local Computer) with a Physical ASL 5000™ Breathing Simulator

NOTE

LLEAP can control the ASL 5000™ while running as a Virtual Simulator. The ASL 5000™ must have an IP address provided by any of the methods defined above. The computer running the LLEAP software MUST be connected to the same network as the ASL 5000™ (same IP subnet)

1. Connect an Ethernet cable from ASL 5000™ to a <u>numbered</u> port on an external router

OR

2. Connect an Ethernet cable from ASL 5000™ to a network (via wall jack, for example)
3. Turn on the ASL 5000™
4. **AFTER** the red light on the front of the ASL 5000™ is OFF (~30 seconds), open the LLEAP software
5. When the LLEAP Select Simulator window opens, in the Virtual Simulator window, select Local computer
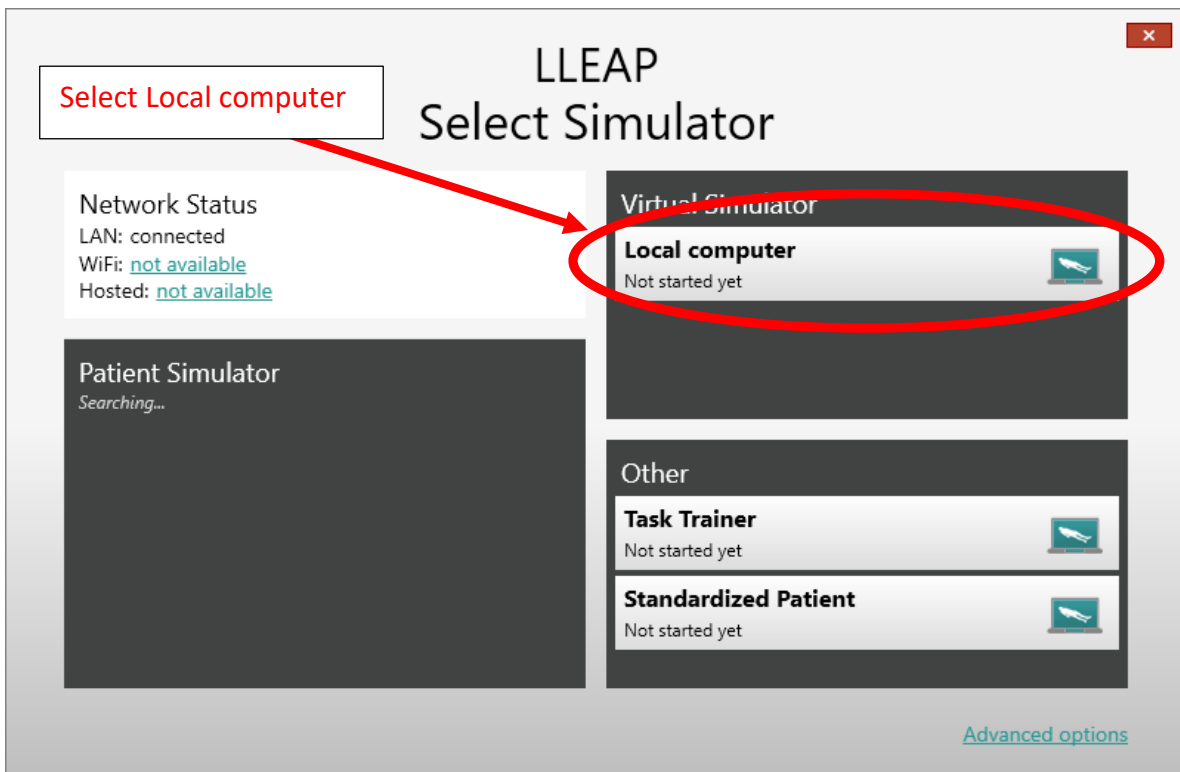

Figure 4-19 - LLEAP Select Simulator Window

6. Select the SimBaby™, SimMan® ALS or Nursing Anne™ option as it is the only compatible manikin
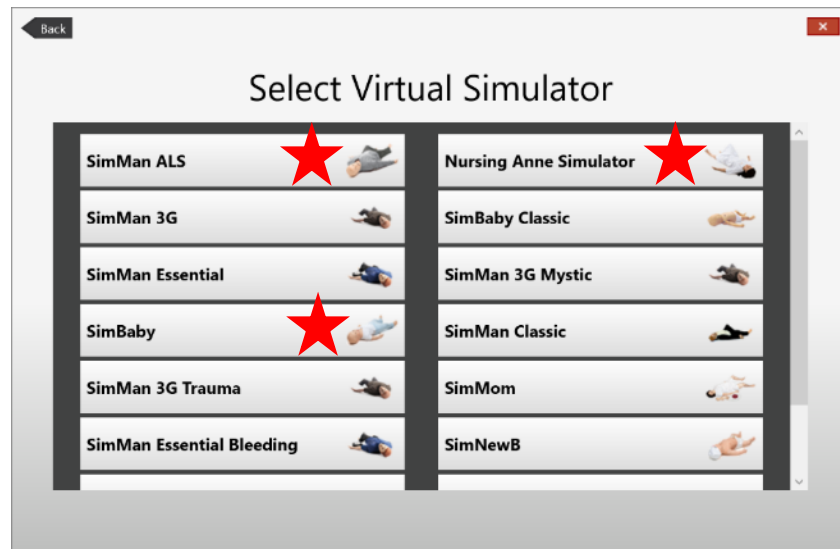

Figure 4-20 - Select Option

7. From the View menu, open the IngMarDefault layout to view the six (6) ASL windows
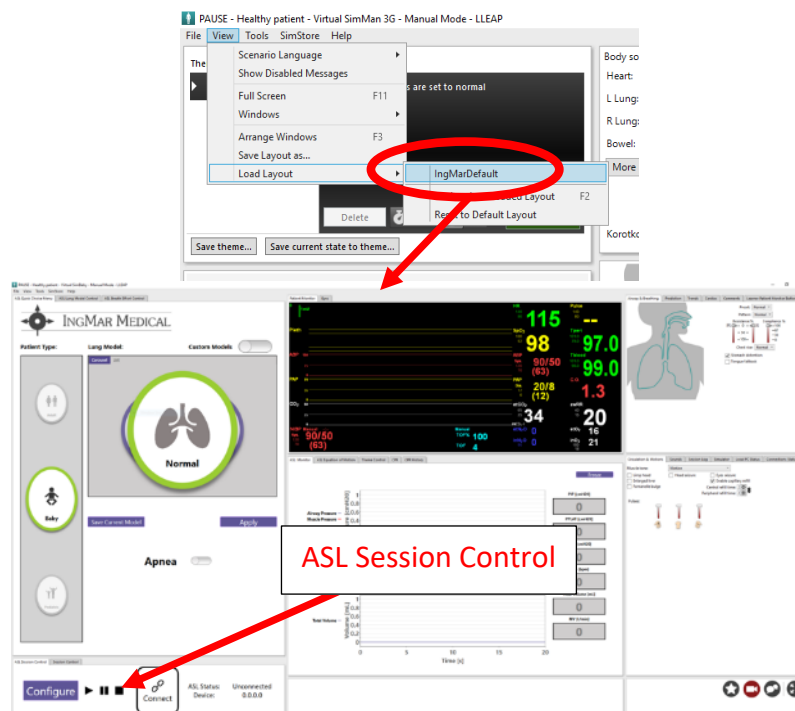8. Locate the *ASL Session Control* tab which will share the window with LLEAP's *Session Control*

Figure 4-21 - IngMarDefault Layout

9. Configure the ASL 5000™ connection Settings in the *ASL Session Control* window in any of the configurations from the options above
10. Make sure the "Manikin Attached" toggle is in the OFF position (not green) as shown in the image below
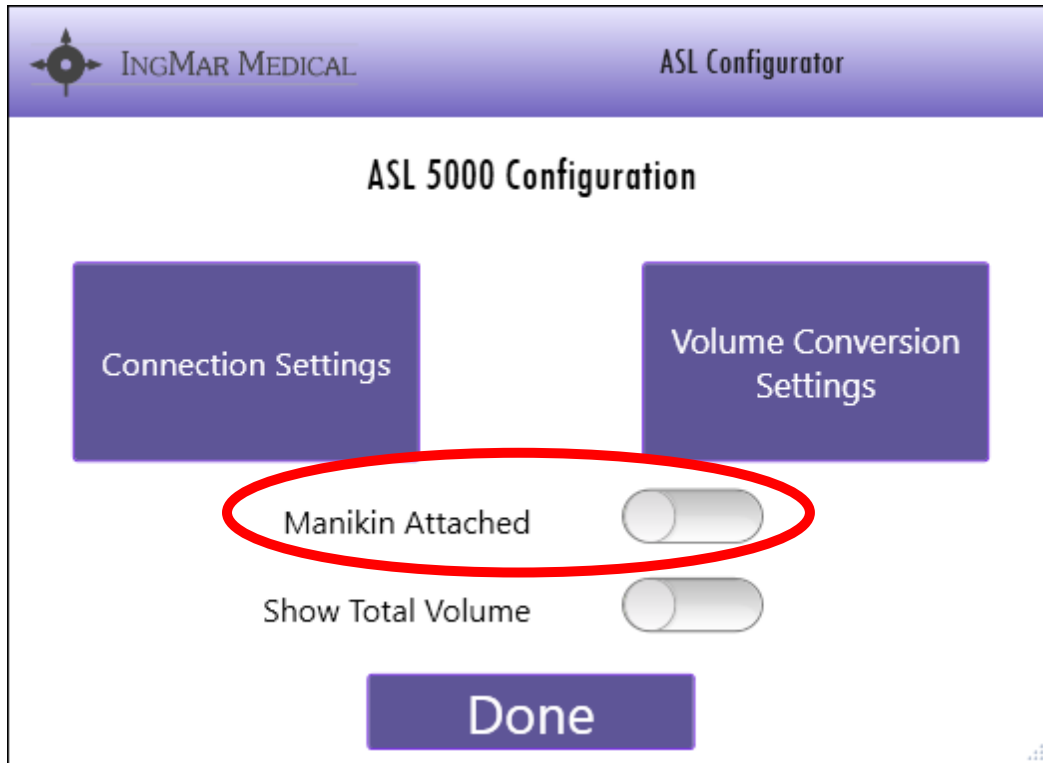

Figure 4-22 – Manikin Compensation Toggle

11. The ASL 5000™, when connected, makes an audible "wiggle" as part of its initialization
12. On the "ASL Session Control" or LLEAP "Session Control" windows, click the ▶ button to start a simulation

5 USING THE ASL 5000™ WINDOWS IN LLEAP

5.1 The LLEAP Environment with ASL 5000™ Windows

With the Lung Adapter installed, the LLEAP interface now has the enhanced respiratory features of the ASL 5000™ Breathing Simulator. Get started by loading the LLEAP software with the additional ASL 5000™ windows. As stated above in the Overview (Section 2.1), each ASL 5000™ window is accessible via the **View Menu** option. The instructor can place the ASL 5000™ windows into convenient positions within the LLEAP view. IngMar Medical has created respiratory-centered views for some of the themes defined in the LLEAP **Select Theme** window. The following figures display the LLEAP default themes and an example of a respiratory-centered theme:
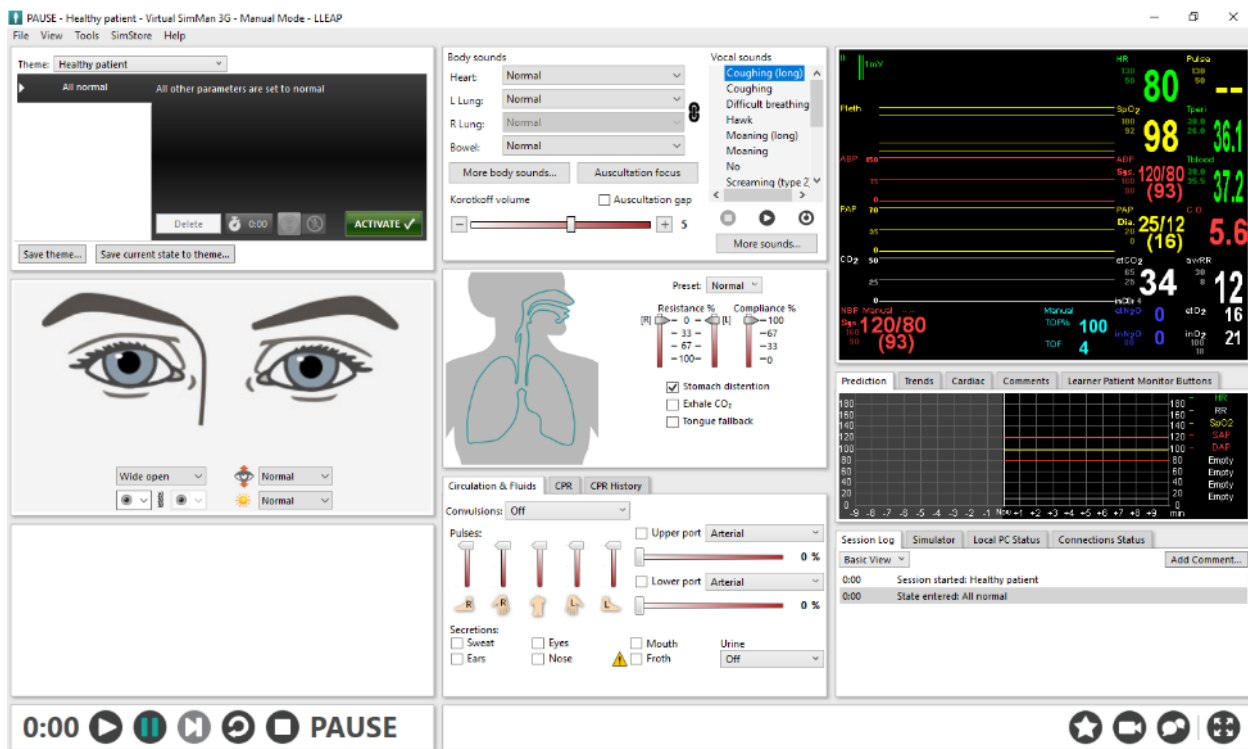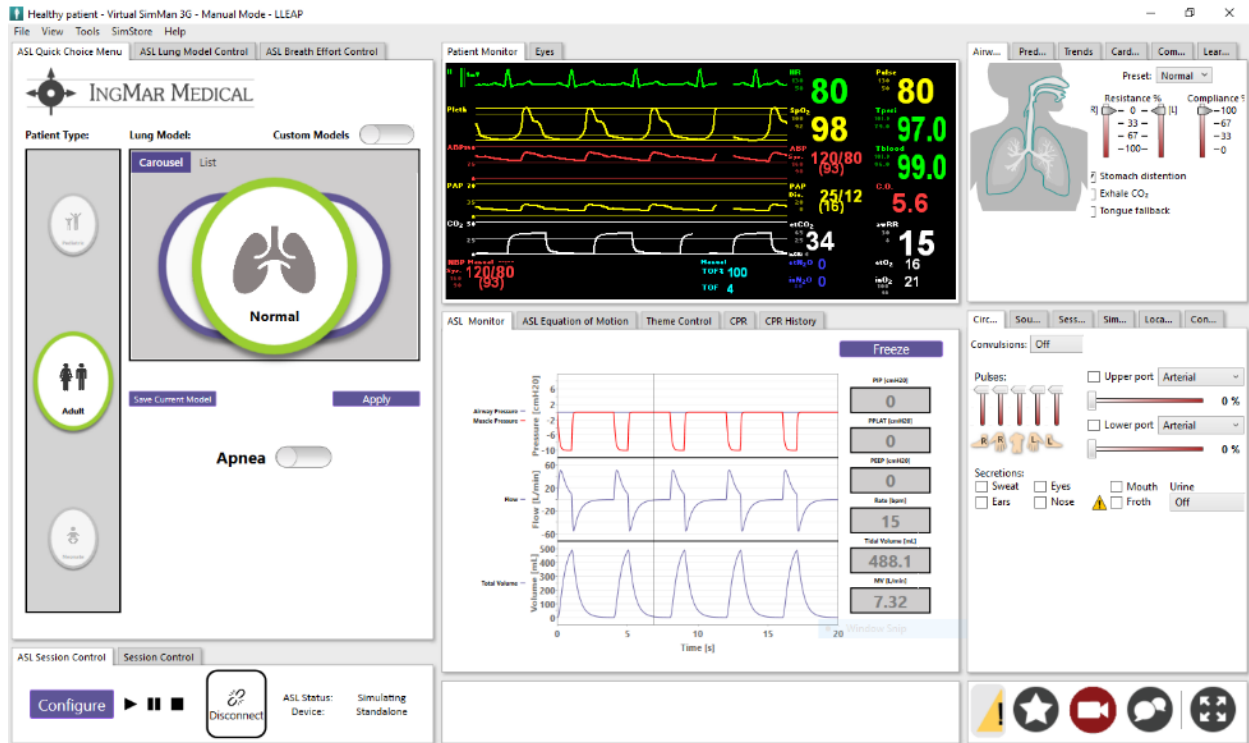

Figure 5-1 - LLEAP Healthy Patient Theme

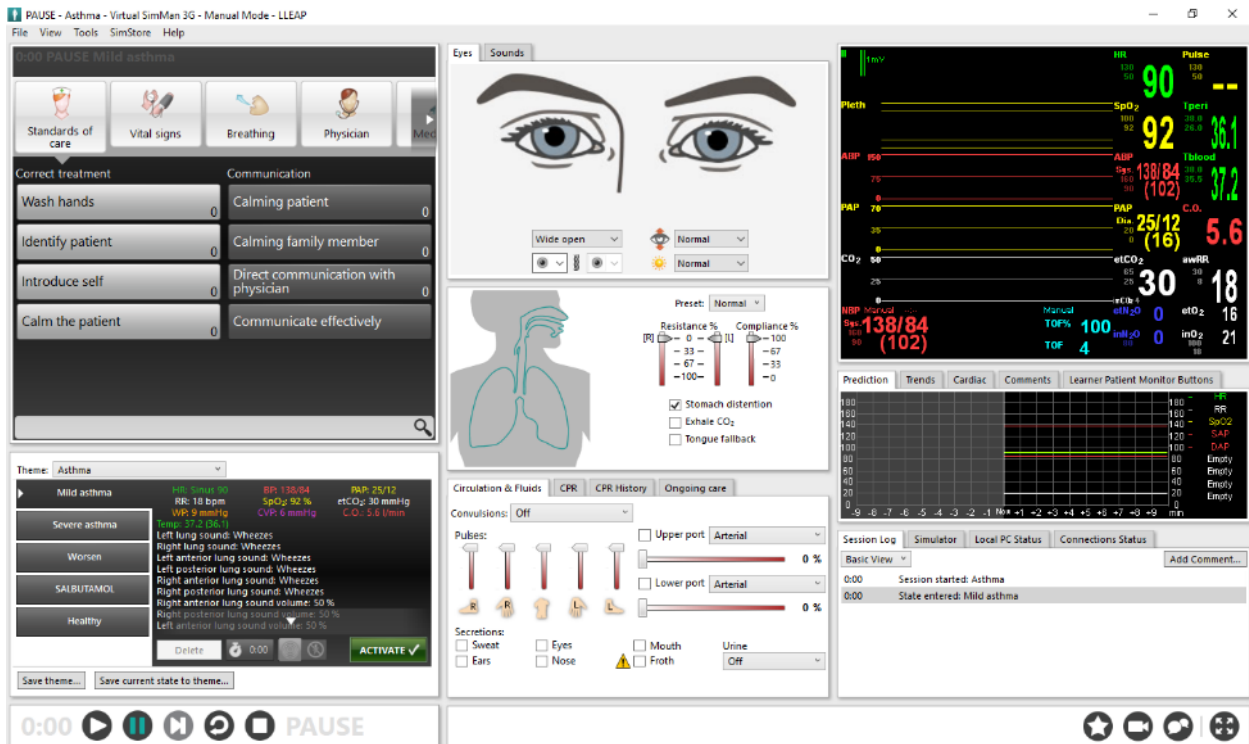**Figure 5-2 - Respiratory-centered Healthy Patient Theme**

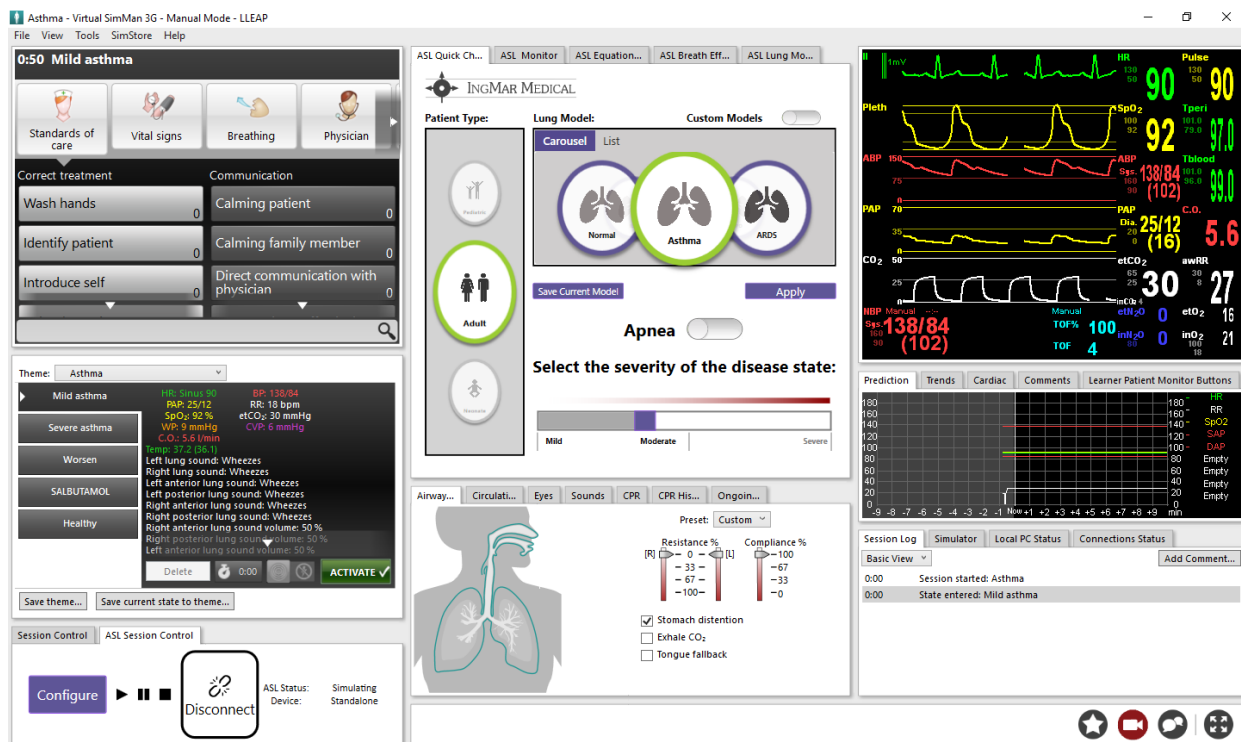**Figure 5-3 – LLEAP Asthma Patient Theme**

Figure 5-4 – Asthma Theme with IngMarUnhealthy Layout

NOTE

Please refer to the LLEAP tutorials for information about working with windows and themes. Details can be found at www.laerdal.com

5.2 ASL Session Control
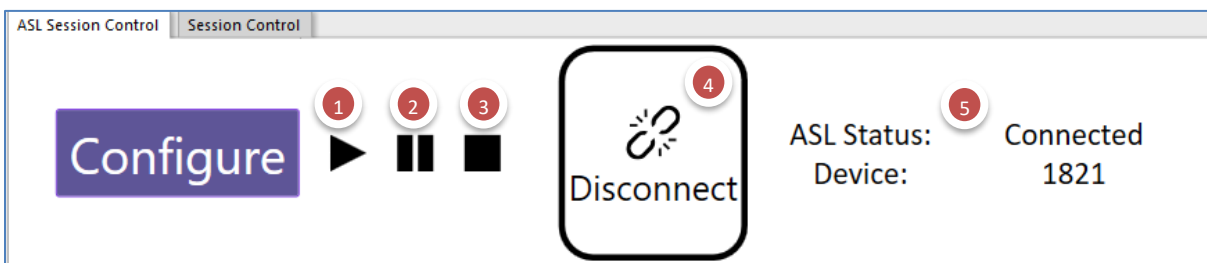
5.2.1 Connect / Control buttons

Figure 5-5 - ASL Session Control

The **ASL Session Control** window includes control of the ASL 5000™ and simulation session.

1. The ▶ (Play) button mimics the function of the same button in the LLEAP Session Control
2. The ⏸ (Pause) button mimics the function of the same button in the LLEAP Session Control. It also sets the ASL 5000™ breath effort to zero (a passive lung) to avoid any ventilator alarms.

3. The ■ (Stop) button ONLY stops the ASL 5000™ lung. The other components of the LLEAP simulation is unaffected.

4. The ⟳ (Connect / Disconnect) button connects to an instance of the ASL 5000™ (Standalone, ASL with s/n, or ASL with IP address)

5. The Status and Device monitors provide connection feedback to the user

5.2.2 Configure Button

Clicking the Configure button opens the ASL Configurator window. This window is used to set the connection type and the volume conversions to be used.


Figure 5-6 - Configuration Tool

The simulation environment can be informed if a SimMan®, SimBaby™, or Nursing Anne™ is connected using the "Manikin Attached" toggle switch. When ON (green), the software will compensate for the additional tubing between the ASL 5000™ and the mouth of the manikin. If the simulation does not require a manikin as in sections 3.2.2.4 and 4.2.3 above, the "Manikin Attached" toggle should be se to OFF (not green) and a ventilator (for example) can be connected directly to the ASL 5000™.

The "Show Total Volume" toggle represents different way to view the waveforms provided by the ASL 5000 lung. The default is for the toggle to be set to the OFF position. When the toggle is OFF, the waveforms represent feedback similar to how a ventilator displays information. The volume waveform displays a single waveform representing the Tidal Volume (Vt). The pressure waveform is represented by two graphs (if applicable). One is the airway pressure and the other is the muscle pressure. The flow waveform is a representation of the total flow into and out of the lung.
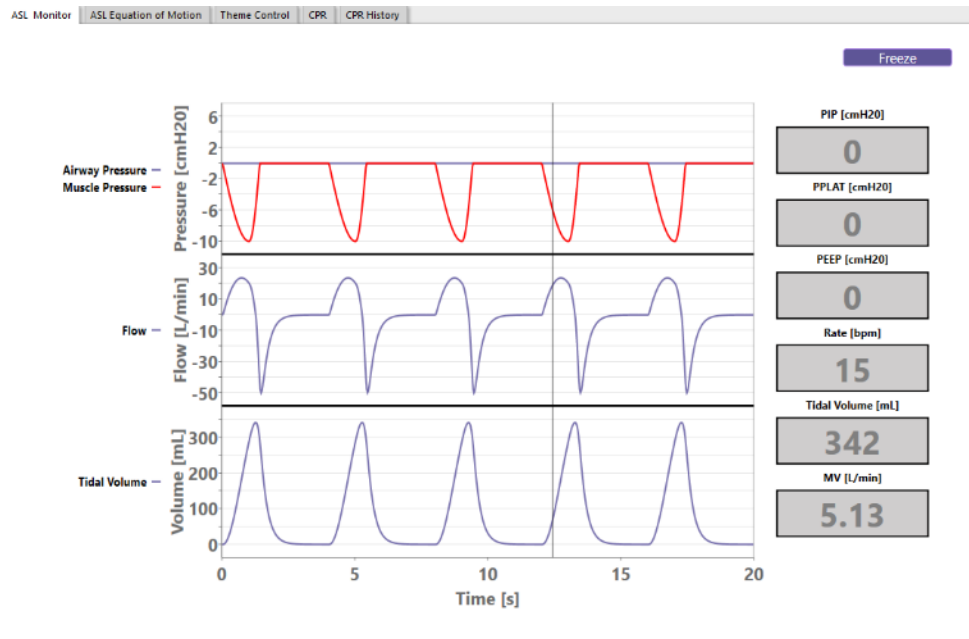
5-7 - Total Volume Toggle OFF - Showing Tidal Volume

When the toggle is ON, the waveforms change to be representative of the various compartments of the lung. This includes Total Volume (including volumes related to air-trapping) as well as left and right lung volumes (if a 2-lung model is being used). The pressure waveforms, in addition to the airway and muscle pressure graphs, include the left and right lung pressures. The flow waveform is the same regardless of toggle position.
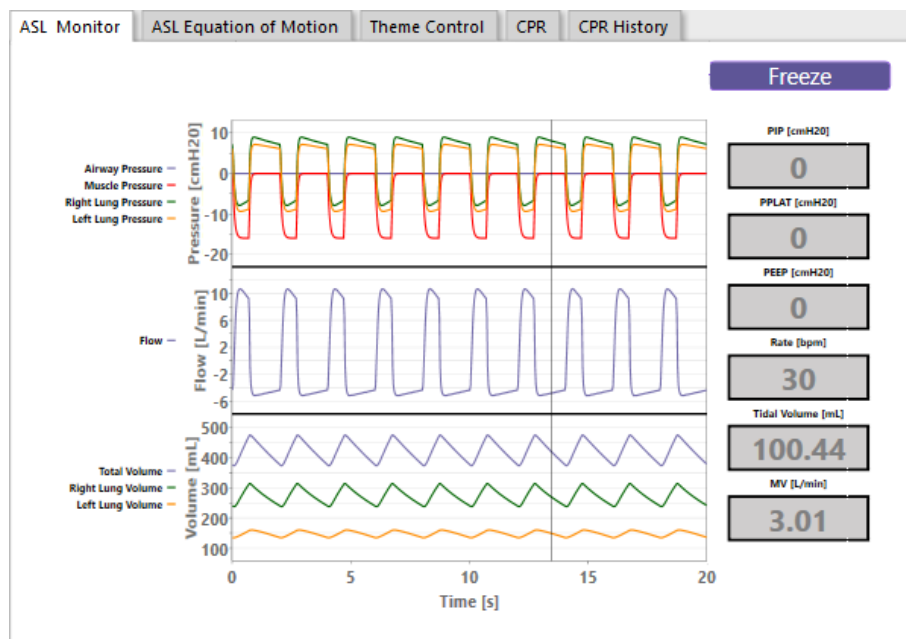
5-8 - Total Volume Toggle ON

📝 ***NOTE***

Tidal volume is represented by the change in volume that is not affected by PEEP or air-trapping within the lung. Thus, Tidal Volume always returns to zero on the y-axis. Total volume is a more detailed representation of what is actually happening in the lung. Total volume includes the offset due to PEEP or air-trapping.

Click **Volume Conversion Settings** to adjust volumes based on the volume/gas correction factors planned for the upcoming simulation.
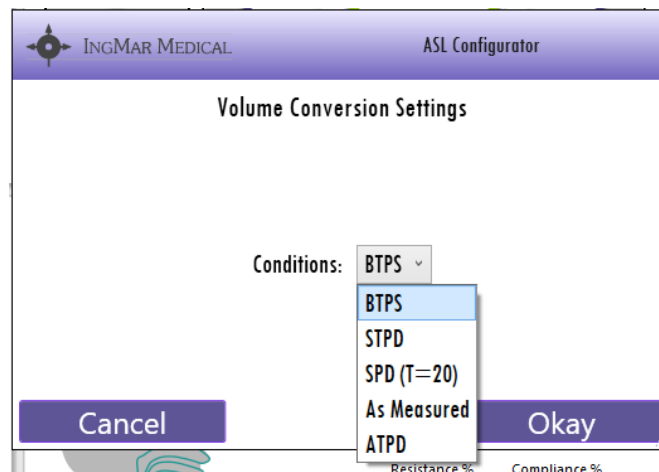

Figure 5-9 - Volume Conversion Options

The volume conversions are based on the gas correction factors as defined below:
- As Measured – Geometrical volume including compressible gas in the lung
- ATPD: Ambient temperature (variable) and pressure (variable), dry (no humidity)
- BTPS (Default Setting): Body Temperature (37 °C or 310 K) and pressure (generally same as ambient), saturated (47 mmHg or 6.2 kPa)
- STPD: Standard temperature (0 °C or 273 K) and pressure (760 mmHg (101.33 kPa) or 100 kPa (750.06 mmHg)), dry (no humidity)
- SPD (T=20): Standard pressure (760 mmHg (101.33 kPa) or 100 kPa (750.06 mmHg)), dry (no humidity) at a temperature of 20°C

Click **Connection Settings** to configure the connection type as Stand-alone or Ethernet. When the software is first installed, the system will be configured with the connection setting set as *Stand Alone*. This option is a software-only based simulation with the ASL 5000™ windows. This is similar to using the Virtual Simulator in the LLEAP environment.
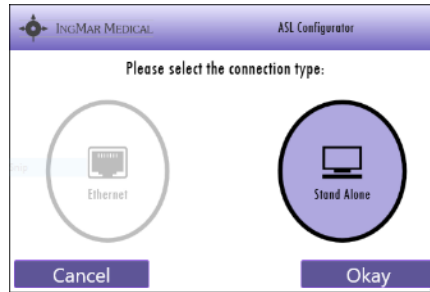
54

Figure 5-10 - ASL Configurator in Stand Alone Mode

When connecting to the physical ASL 5000™, click the Ethernet egg, then click Okay to open the Ethernet configuration. Ethernet mode has three (3) options for setup:

- Using the ASL 5000™ 4-digit serial number by clicking **Device ID:** (recommended)
- Using a defined IP address by clicking **Network Address:** (IP address set by network)
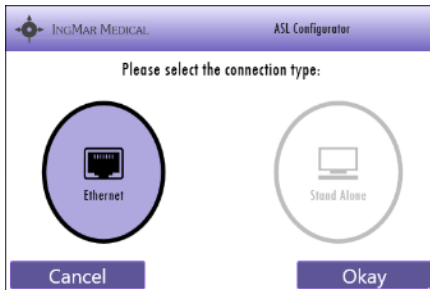- Using a static IP address by clicking [Static IP] (manually assigning IP address for ASL 5000™)

Figure 5-11 - ASL Configurator in Ethernet Mode

Figure 5-12 - ASL Configurator Ethernet Options

The **Static IP Config** option directly assigns an IP address to the ASL 5000™. If this option is used, the software will search for the first connected ASL 5000™ and set the IP address to the address defined by the user.

Figure 5-13 - Static IP Configuration

⚠️ **CAUTION!**

The Static IP option configures the ASL 5000™ with an internal, hardcoded IP address. Only trained technicians should use this option. Assigning an address that is not compatible with the network would make the ASL 5000™ unreachable.

5.2.3 ASL 5000™ Firmware Updates

The ASL 5000™ Breathing Simulator runs on a version of firmware that is verified each time a connection is made to the LLEAP software. In most cases, the ASL 5000™ has the correct firmware and the connection to the lung is established. The user may, however, be prompted to update to a newer version of firmware (internal to the lung simulator) if a new software is released. When clicking the (Connect/Disconnect) button, the following prompt will open.

Figure 5-14 - Firmware Update Prompt

Click **Yes** to allow the upload to take place. This brings up details about the firmware update.
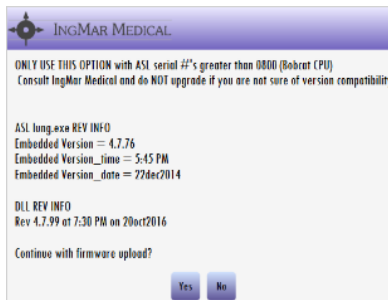

Figure 5-15 - Firmware Update Details

Click **Yes** and the upload process will begin. Once complete, the user will be prompted to restart the ASL simulator as well as close and restart the LLEAP software.
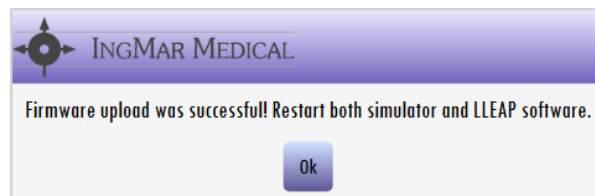

Figure 5-16 - Firmware Update Complete

 CAUTION!

Do not turn off the ASL 5000™ Breathing Simulator during a firmware update.

5.3 ASL QuickChoice Menu

The **ASL QuickChoice Menu** window provides an array of preconfigured patient types and lung disease states. The Quick Choice Menu is a great starting point for working with the SimMan® family, SimBaby™ and Nursing Anne™ with the ASL 5000™ through the LLEAP software interface.

The SimBaby™ QuickChoice Menu operates exactly in the same manner as the SimMan® and Nursing Anne™ QuickChoice Menu.
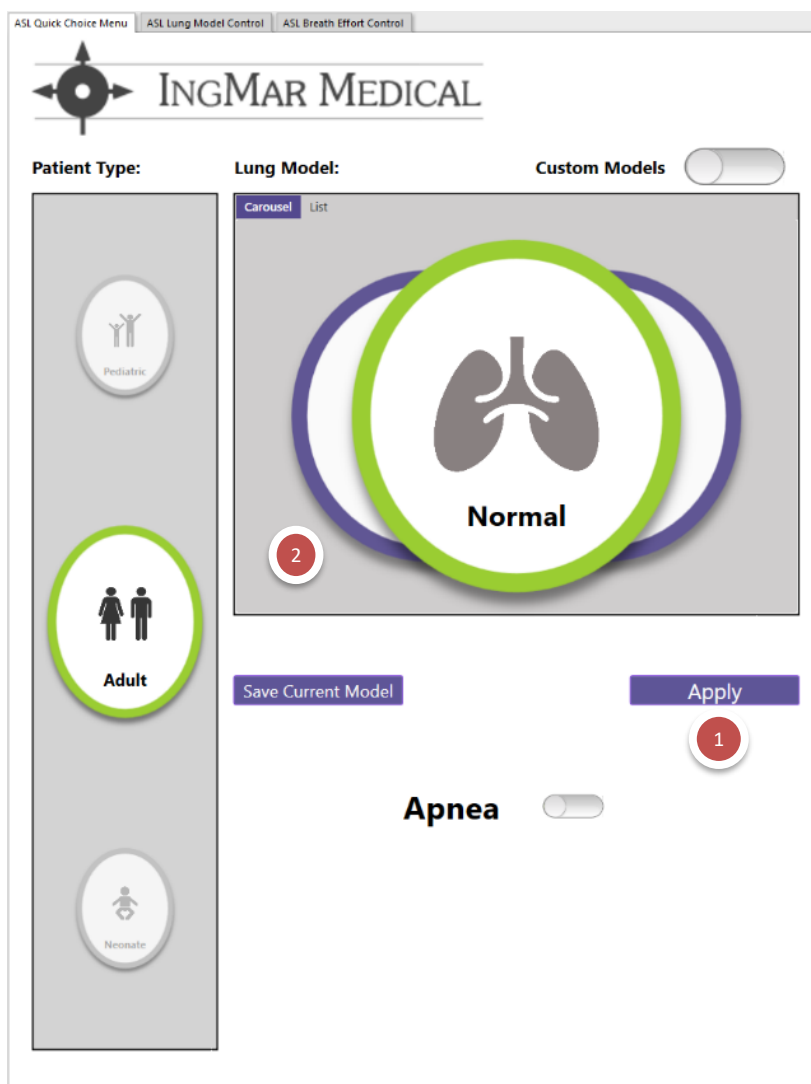
Figure 5-17 - ASL QuickChoice Menu

1. Select a **Patient Type** and **Lung Model** by clicking the appropriate "eggs," then clicking
   Apply
2. The selected Lung Model will be highlighted in green

Figure 5-18 - ASL QuickChoice Menu

3. When selecting a disease other than **Normal**, the user can adjust the severity of the disease
4. At any time during the simulation, the patient can be set to become completely passive by clicking the **Apnea** switch

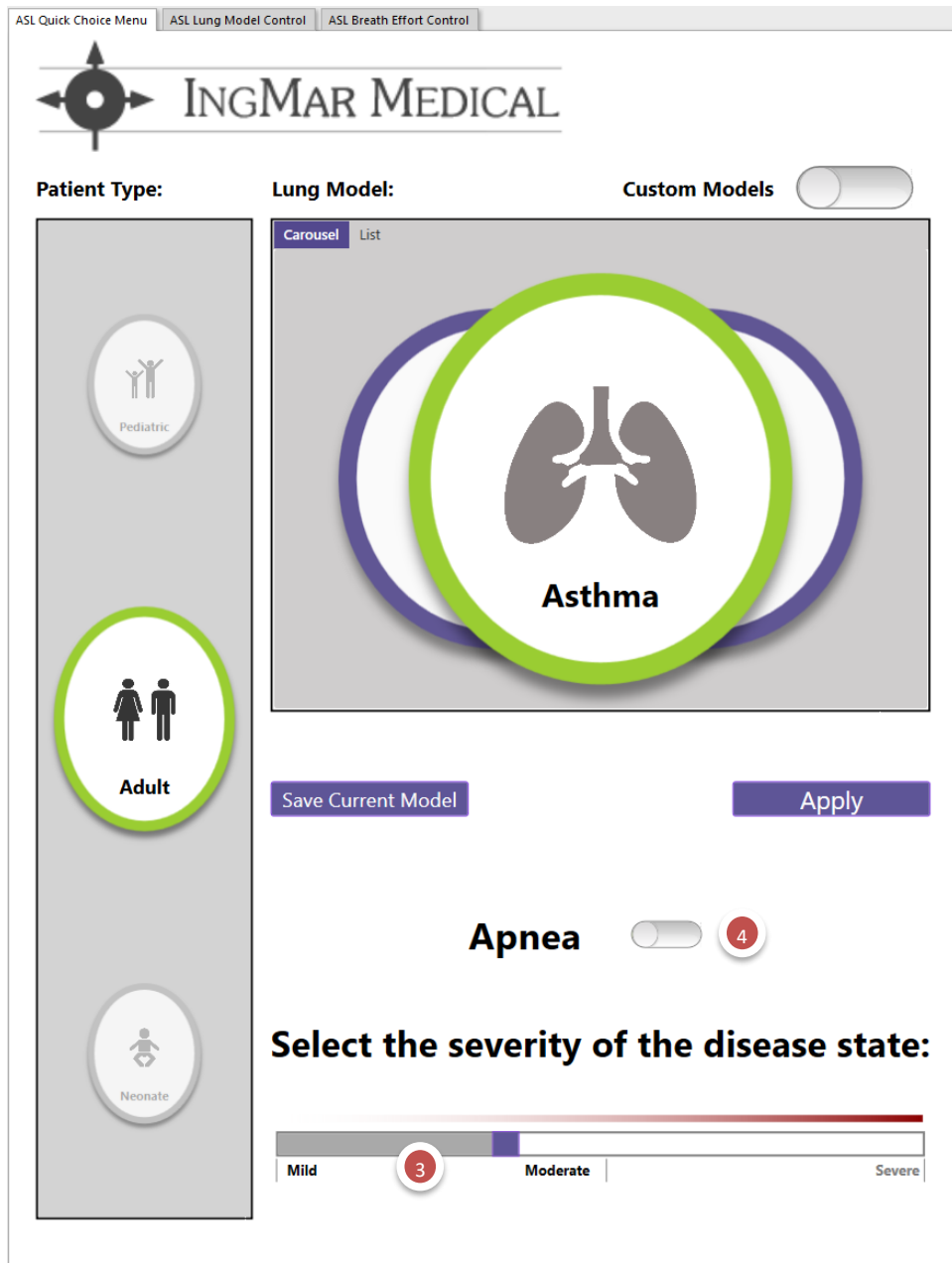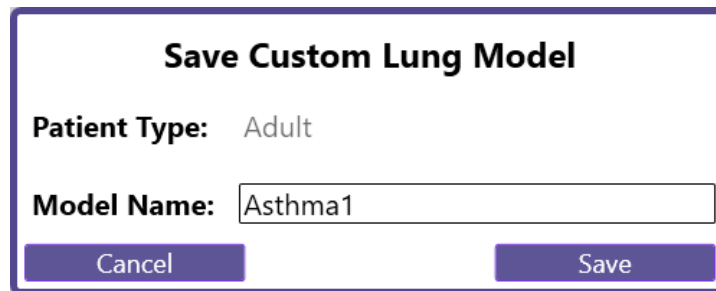The table below displays the lung settings for all the patient models in the Quick Choice library:

Table 1 - Patient Model Definitions

Adult Normal						
	Compliance	Resistance	Patient Rate	Effort	Rise %	Release %
Healthy	50	13	15	10	25%	10%
Adult Asthma						
	Compliance	Insp/Exp Resistance	Patient Rate	Effort	Rise %	Release %
Mild	80	35/55	20	15	20%	15%
Moderate	40	45/95	30	15	35%	20%
Severe	35	55/125	35	30	20%	20%
Adult ARDS						
	Compliance	Resistance	Patient Rate	Effort	Rise %	Release %
Mild	40	21	25	7	35%	10%
Moderate	25	35	30	10	40	20%
Severe	10	40	40	20	30	10
Adult COPD						
	Compliance	Insp/Exp Resistance	Patient Rate	Effort	Rise %	Release %
Mild	50	17/20	12	4	20%	15%
Moderate	53	26/28	22	8	35%	30%
Severe	53	26/28	30	5	35%	42%
Adult ILD						
	Compliance	Insp/Exp Resistance	Patient Rate	Effort	Rise %	Release %
Severe	18	40	27	10	18	10
Baby Normal						
	Compliance	Resistance	Patient Rate	Effort	Rise %	Release %
Healthy	6	86	28	10	20%	10%
Baby RSV						
	Compliance	Insp/Exp Resistance	Patient Rate	Effort	Rise %	Release %
Mild	5	40/60	45	6	30%	10%
Moderate	4	65/85	50	7	35%	10%
Severe	3	80/100	60	14	40%	10%

Baby BPD						
	Compliance	Resistance	Patient Rate	Effort	Rise %	Release %
Mild	4	60/120	55	15	32%	10%
Moderate	3	80/150	60	15	32%	10%
Severe	2	120/180	65	15	32%	10%

In any given simulation, the instructor may believe that the lung diseases provided by the software do not fully represent the teaching goals. For example, an asthmatic patient model should have a much higher inspiratory resistance than what the QuickChoice model provides (see Severe Adult Asthma in the table above). The user can make changes directly to the Lung Model and Breath Effort windows and see the resulting waveforms in the ASL Monitor window. Once a satisfactory response is created,

the user can click the **Save Current Model** button. This will prompt the user for a custom model name.

Figure 5-19 - Save Custom Model Prompt

Once saved, view all custom patient models by clicking the Custom Models toggle switch. This gives the instructor a listing of all custom patient models that have been created. Use the search function to quickly find your custom patient models.
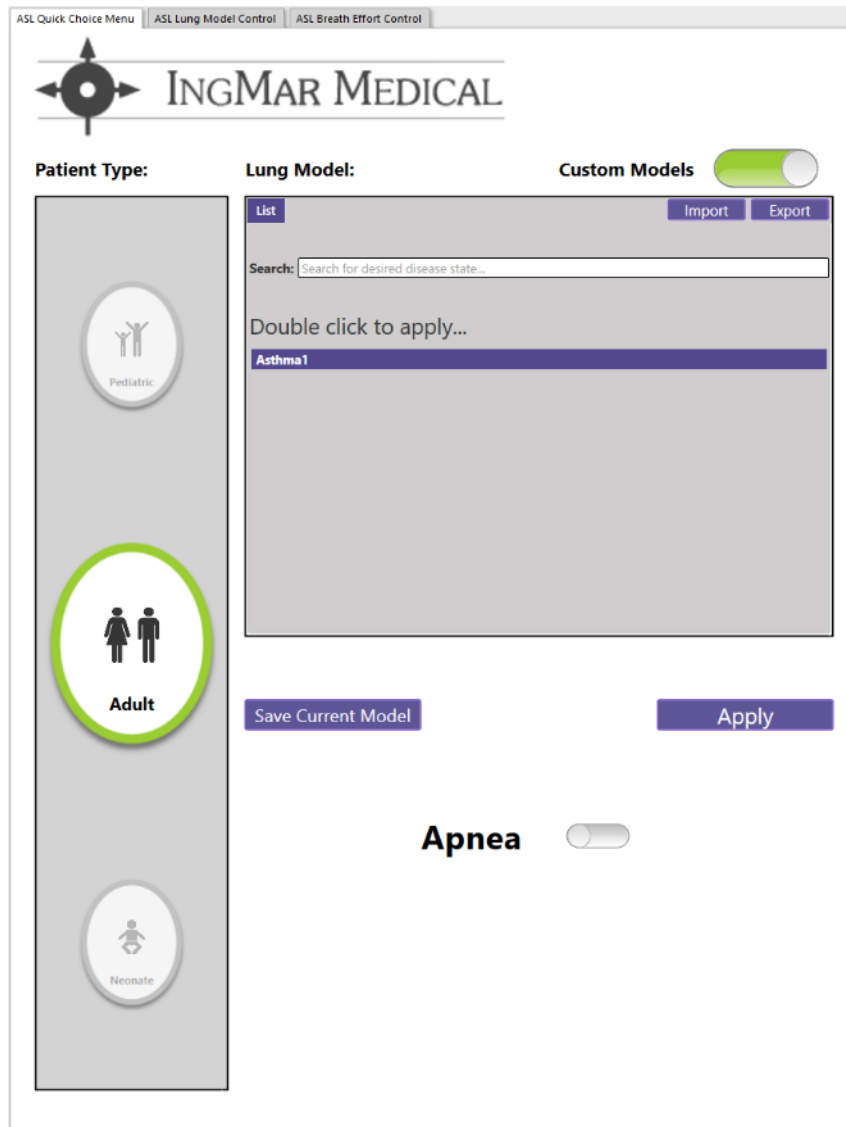
Figure 5-20 - Custom Disease States

Delete any unwanted custom disease states by clicking the file name and pressing the delete key on a keyboard. This will open prompt confirming the deletion.
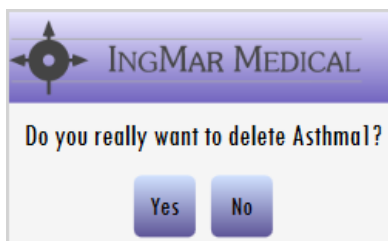

Figure 5-21 - Deleting Custom Disease State

The QuickChoice window gives the user the ability to import and export custom lung models.

Exporting a model:

After a model is created and saved as a custom model, click the **Export** button from the Custom Model window. This opens the *Export Custom Lung Models* window.
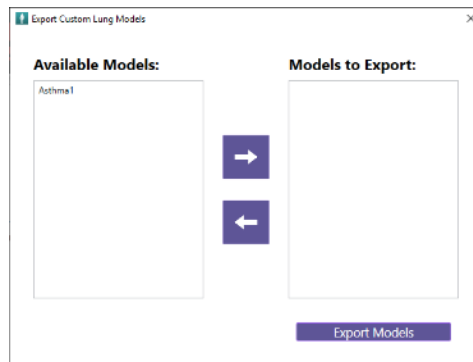

Figure 5-22 - Export Custom Models

Click the model to export from the Available Models. Clicking the right-facing arrow will shift the selected models to the Models to Export field. More than one model can be exported at a time. When the models are ready to export, click the **Export Models** button which will open a navigation window with the default MyPatientModels.pat filename and format.
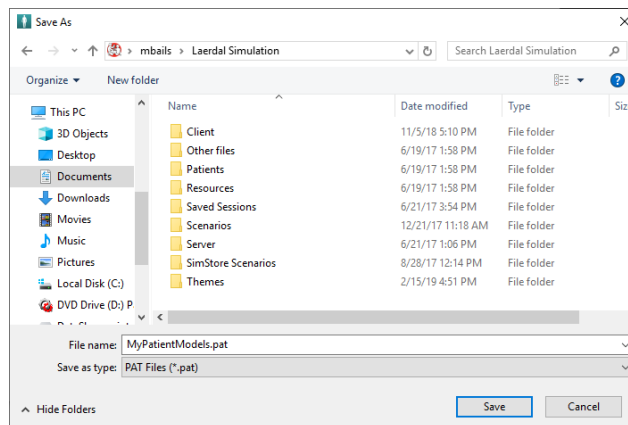

Figure 5-23 - Exporting Lung Models

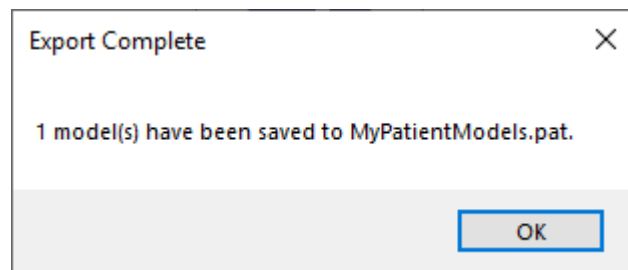Clicking the Save button will confirm the export is complete with the following message:

Figure 5-24 - Export Confirmed

Importing a Model:

The process for importing a lung model is similar to exporting. Click the [Import] button which opens a navigation window. Browse and select the [filename].pat and click Open.
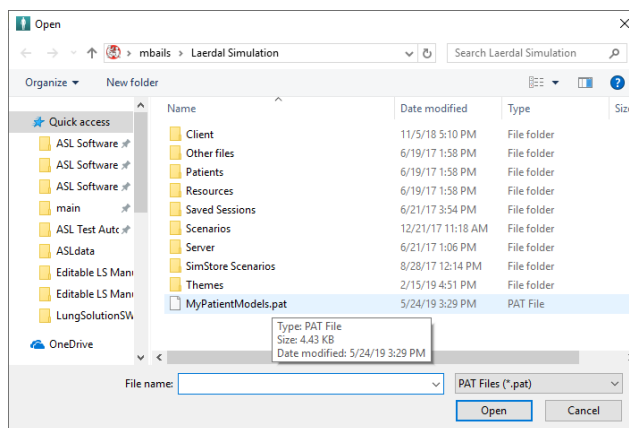

Figure 5-25 – Importing Lung Models

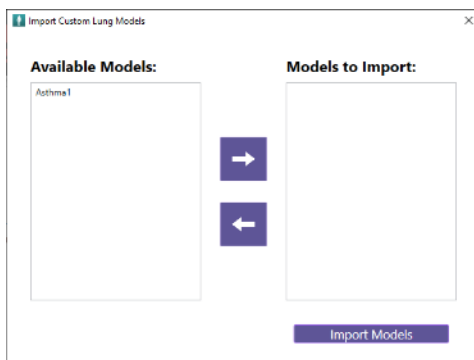The *Import Custom Lung Models* window opens.

Figure 5-26 - Import Custom Models

Click the model to import from the Available Models. Clicking the right-facing arrow will shift the selected models to the Models to Import. More than one model can be imported at a time. Clicking the [Import Models] button will confirm the import is complete with the following message:
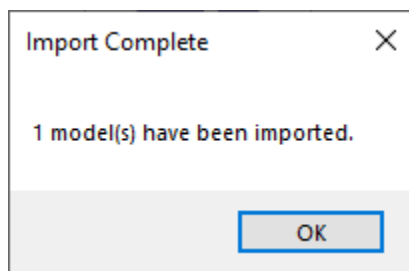

Figure 5-27 - Import Confirmed

5.4 ASL Monitor

The **ASL Monitor** window includes two views for the instructor, the **Monitor** view and the **Equation of Motion** view.

The **Monitor** view is a useful tool for analyzing the waveforms and readings directly from the lung. These include pressure (cmH2O), flow (L/min) and volume (mL) waveforms. Relevant lung parameters are also monitored and are updated upon the completion of a patient breath. Set the view (Tidal or Total volume) from the Configure button in the "ASL Session Control" window.
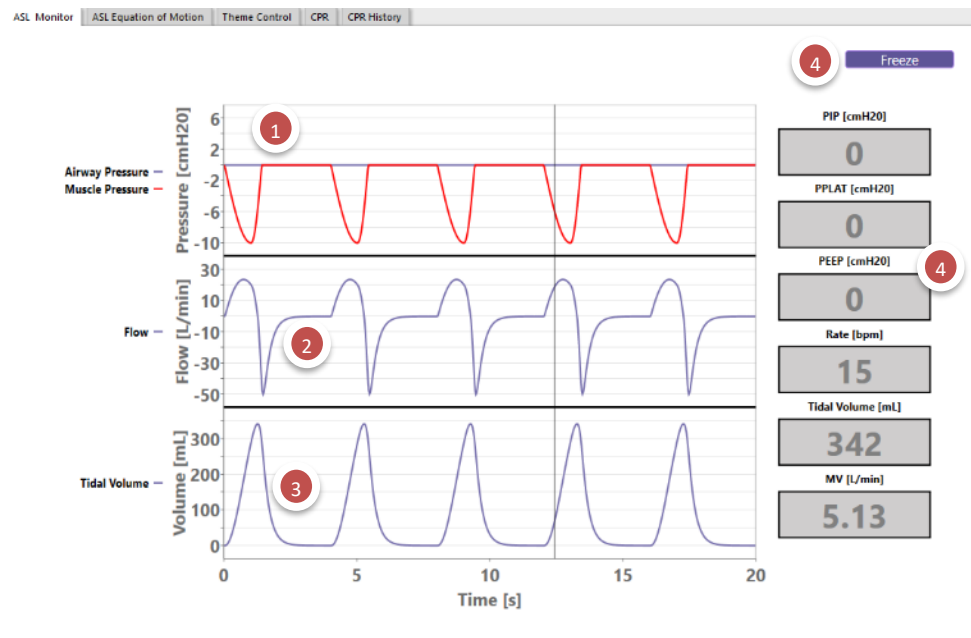
5-28 - Toggle OFF showing Tidal Volume

1. Pressure waveforms include airway (external) and muscle (spontaneous breathing)
2. Flow is the total flow in the system
3. Volume waveforms are based on Tidal Volume and always return to a zero baseline
4. At any time during the simulation, click Freeze to freeze the waveform view for debriefing purposes
5. Seven (7) breath parameters provide lung details that may be essential to a simulation.

Figure 5-29 - ASL Monitor View

1. Pressure waveforms include airway (external), muscle (spontaneous breathing), as well as left and right internal lung pressures
2. Flow is the total flow in the system
3. Volume waveforms include total, right, and left lung volumes as well as a representation of air trapping (or breath-stacking) due to PEEP or lung mechanics (resistance or compliance)
4. At any time during the simulation, click Freeze to freeze the waveform view for debriefing purposes
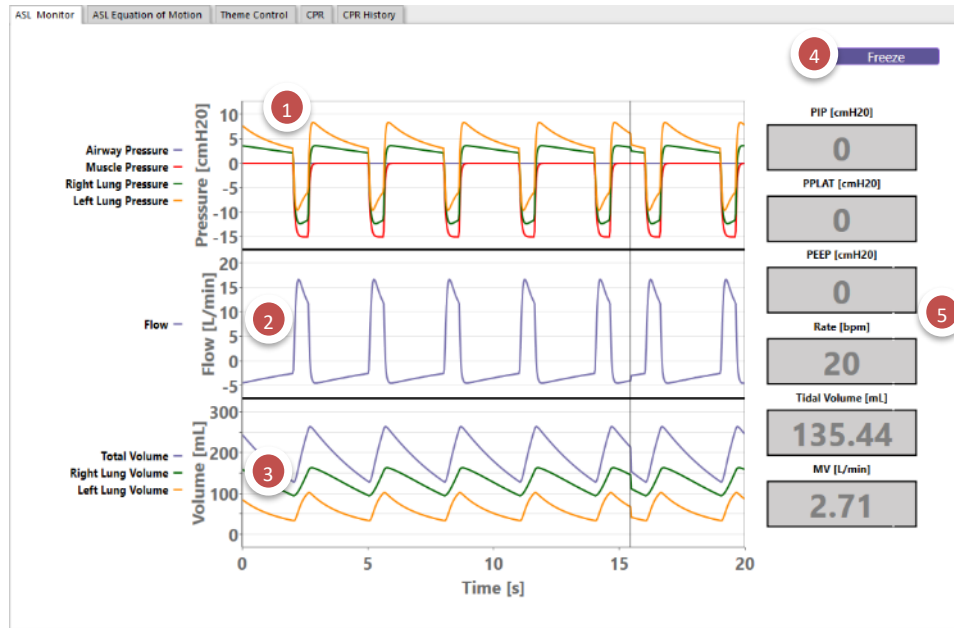5. Seven (7) breath parameters provide lung details that may be essential to a simulation. The Tidal Volume calculation is based on the maximum volume over baseline (e.g. volume due to the presence of PEEP)

5.5 ASL Equation of Motion

The **Equation of Motion** (EOM) window gives the user a different way to look at the patient breathing. This is a real-time analysis of the mechanics of breathing represented by the components of the EOM.
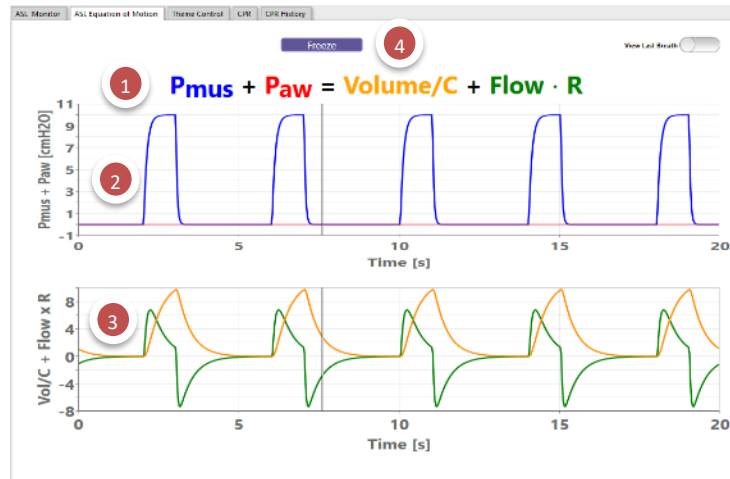

Figure 5-30 - Equation of Motion Window

1. Definition of the Equation of Motion where Pmus is the patient's spontaneous muscle pressure in cmH2O, Paw is external pressure sensed by the ASL 5000™ in cmH2O. Volume is in mL, C is lung compliance in mL/cmH2O, Flow is in L/min and R is airway resistance in cmH2O/L/s
2. The left side of the equation is shown in the top graph
3. The right side of the equation is shown in the bottom graph
4. Click the Freeze button to freeze the waveform view for debriefing purposes
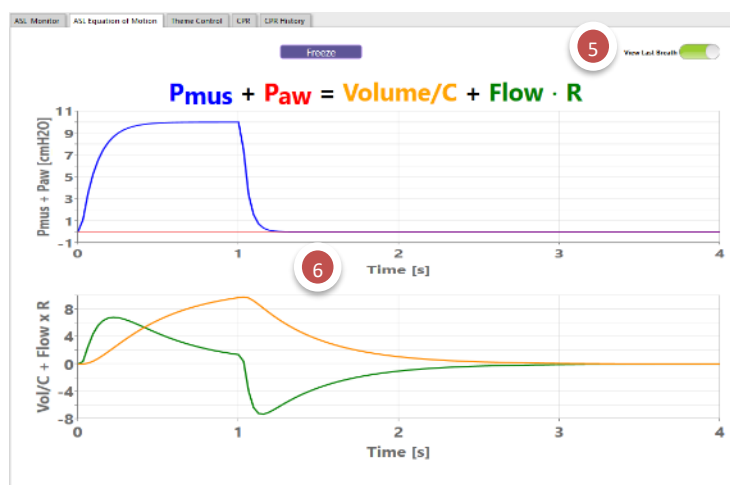

Figure 5-31 - Equation of Motion Last Breath

5. Switch between the real-time view and a snapshot of the last recorded breath
6. Follow the changes in a single breath for better understanding of how pressures, flows and volumes relate to the patient's lung conditions (Resistance and Compliance)

5.6 ASL Lung Model Control

The **ASL Lung Model Control** window provides direct control of the patient's lung and airway mechanics related to resistance and compliance. This includes single or dual lung models and inspiratory versus expiratory resistance.
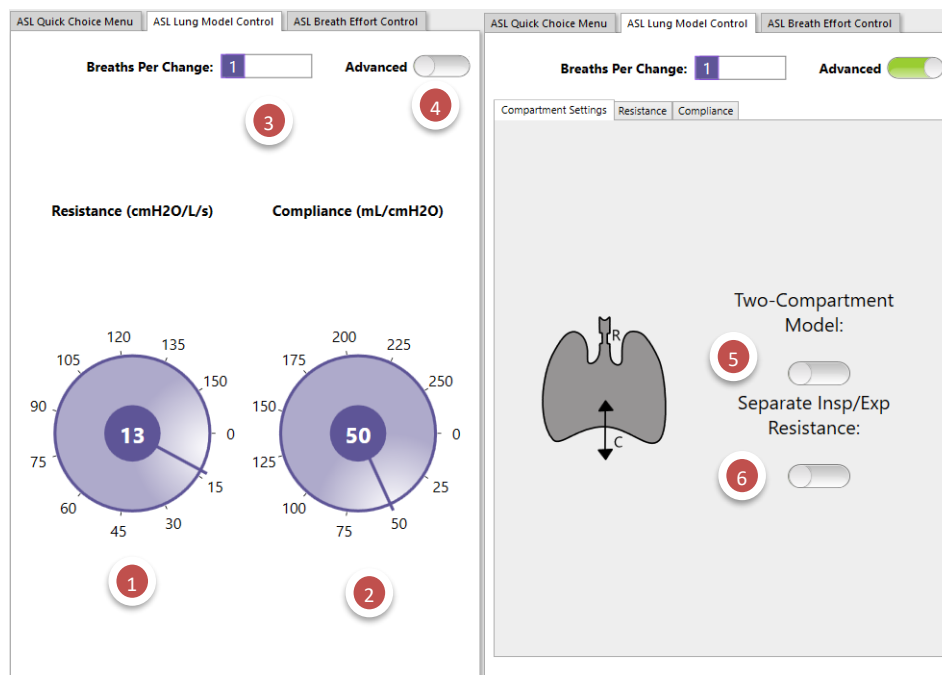

Figure 5-32 - Lung Model Control

1. **Resistance** knob: the user can also double click the number inside and directly type a value.
   a. SimMan® / Nursing Anne™ total resistance range is from 8 – 157 cmH2O/L/s
   b. SimBaby™ total resistance range is from 23 – 250 cmH2O/L/s
2. **Compliance** knob: the user can also double click the number inside and directly type a value.
   a. SimMan® / Nursing Anne™ total compliance range is from 0.5 – 250 mL/cmH2O
   b. SimBaby™ total compliance range is from 0.5 – 15 mL/cmH2O
3. **Breaths per Change** slider is used to adjust the number of breaths used to transition from an existing value to the new set value (e.g. Set compliance from 50 to 10 with 5 Breaths per Change, it will gradually reduce its value)
4. Switch to the **Advanced** view for greater control of the lung characteristics. The figures below provide the different control options for the lung models
5. Switch defining **One** or **Two** compartment lung models
6. Switch defining Resistance where inspiratory and expiratory resistances are equal or unequal (e.g. Asthmatic patients typically have unequal inspiratory and expiratory resistances Rin ≠ Rout)

5.6.1 Advanced – Single Compartment Lung Model

Figure 5-33 - Lung Model – Simplified Lung Model 1 Compartment with Equal Resistances

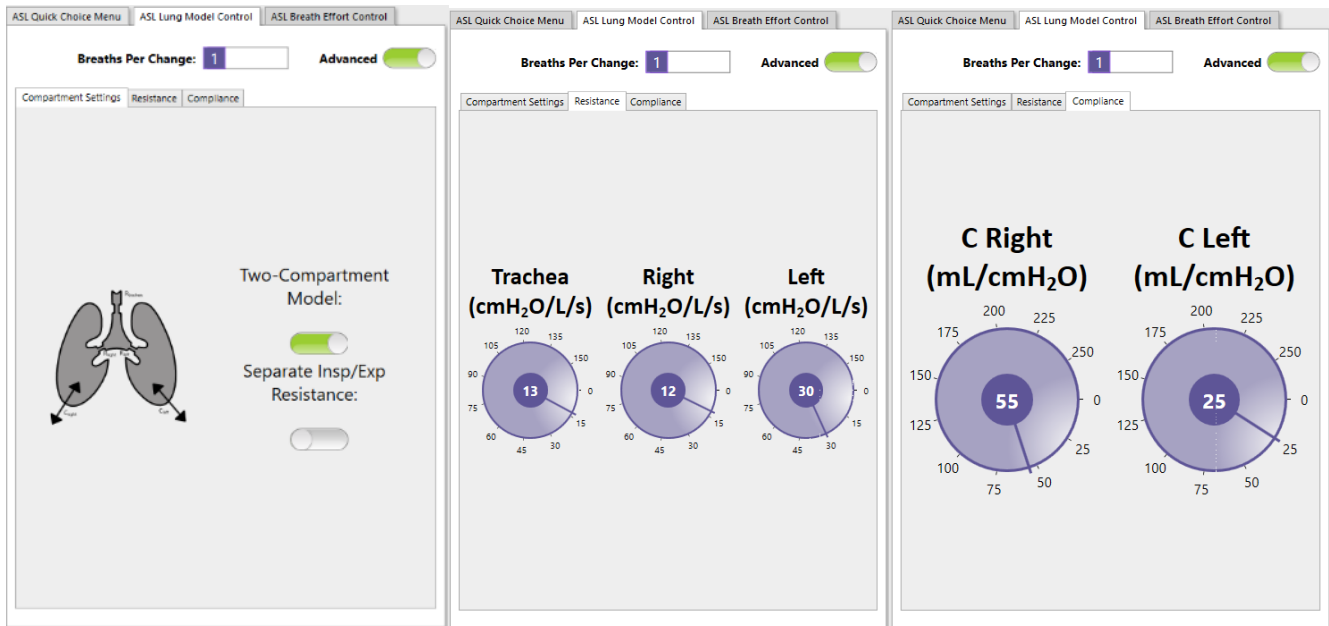## 5.6.2 Advanced – Two Compartment Lung Model, Equal Resistance (Rin = Rout)

Figure 5-34 - Lung Model - 2 Compartment with Equal Resistances

5.6.3 Advanced – Single Compartment Lung Model, Unequal Resistance (Rin ≠ Rout)
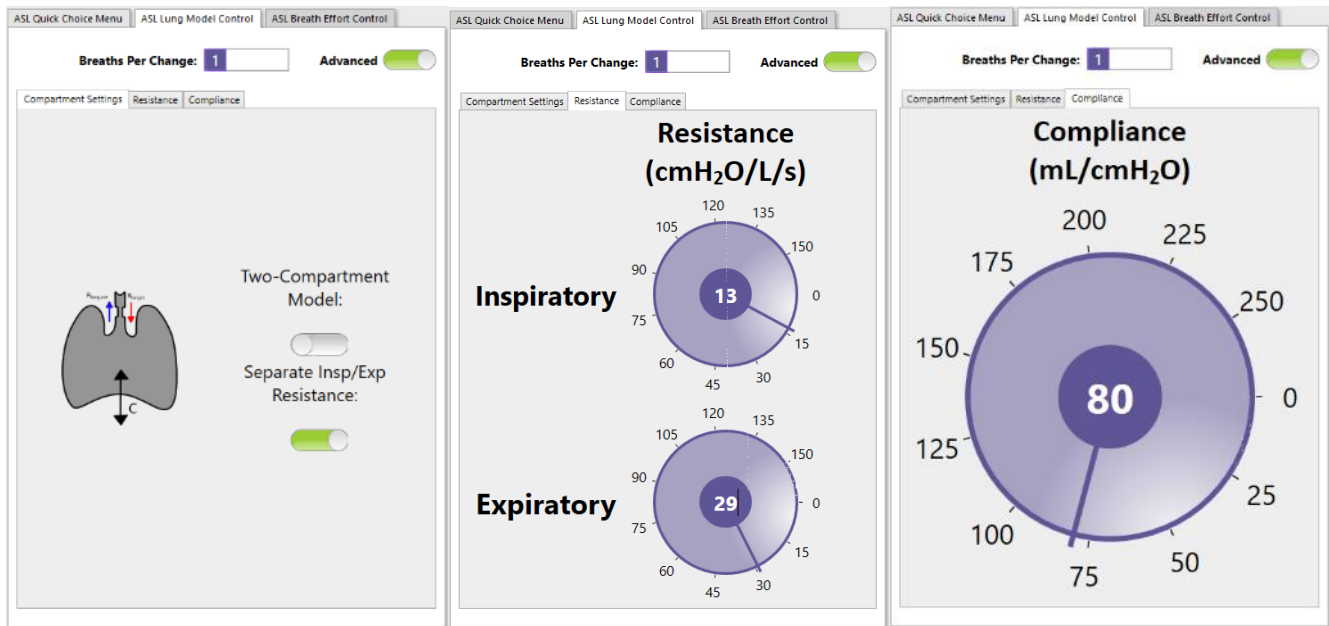

Figure 5-35 - Lung Model - 1 Compartment with Resistance_in not equal to Resistance_out

5.6.4 Advanced – Two Compartment Lung Model, Unequal Resistance (Rin ≠ Rout)
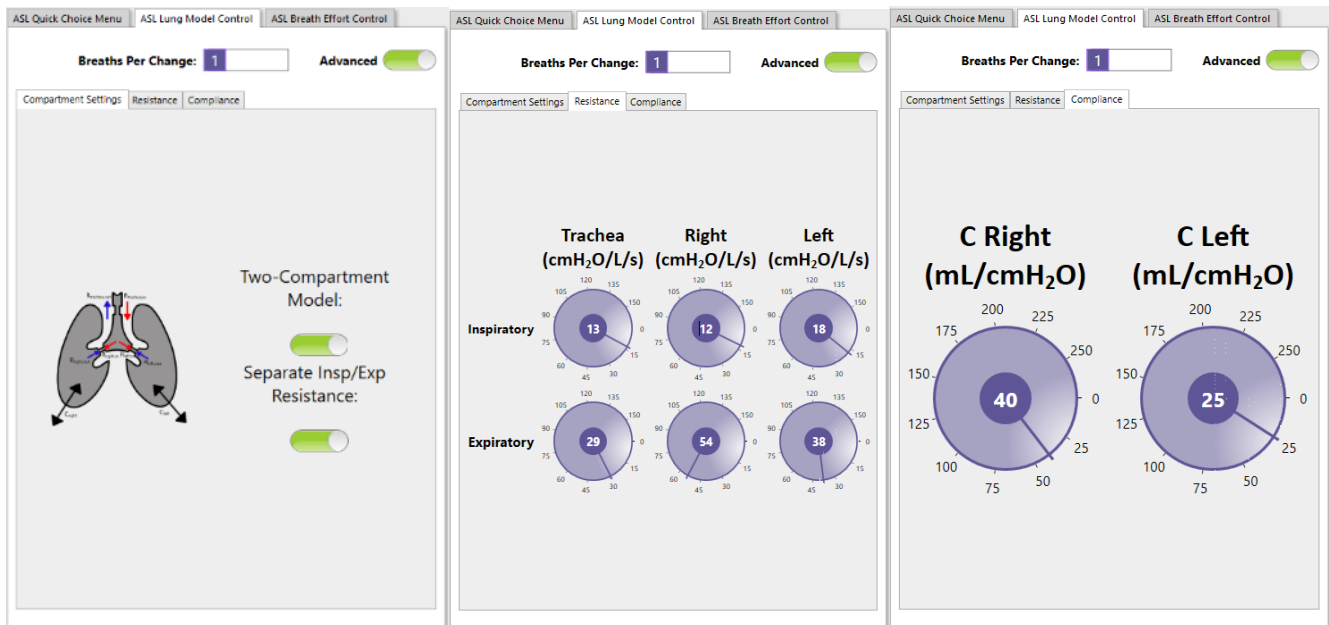

Figure 5-36 - Lung Model - 2 Compartment with Resistance_in not equal to Resistance_out

5.7 ASL Breath Effort Control

The **Breath Effort Control** window controls spontaneous breathing and breath rate.
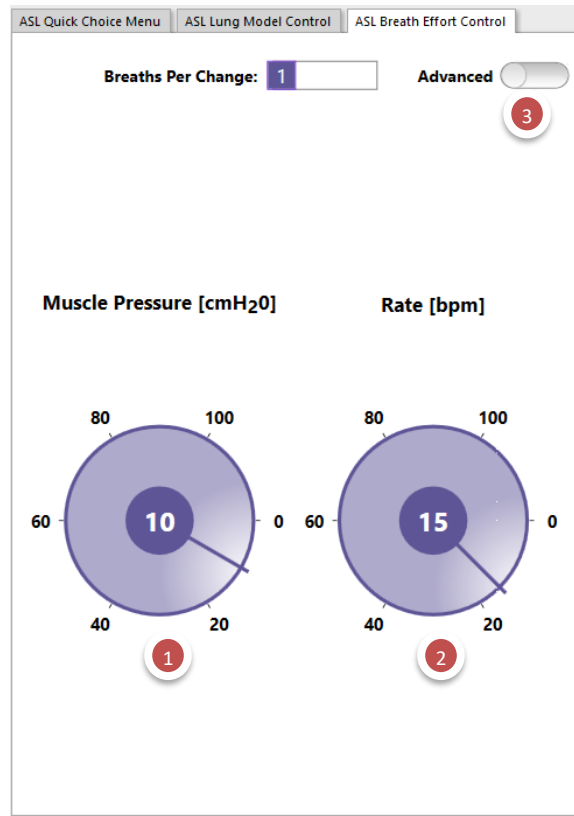

Figure 5-37 - Simple Effort Control

1. **Muscle Pressure** knob: Patient muscle pressure (negative pressure inside the lungs creating flow into the mouth). The user can also double-click the number inside and directly type a value.
    a. SimMan® / Nursing Anne™ muscle pressure range is from 0 - 100 cmH2O
    b. SimBaby™ muscle pressure range is from 0 – 30 cmH2O

> **NOTE**
>
> A value of zero (0) Muscle Pressure represents a passive, paralyzed or apneic patient. It is also important to note that this cannot be accomplished by setting the Rate to zero. The ASL 5000™ does not allow a Rate of zero but does allow a muscle pressure of zero.

2. **Rate** knob: the user can also double-click the number inside and directly type a value. Breath rates range from 3 to 100 breaths per minute.
3. Switch to the **Advanced** view for greater control of the breath effort
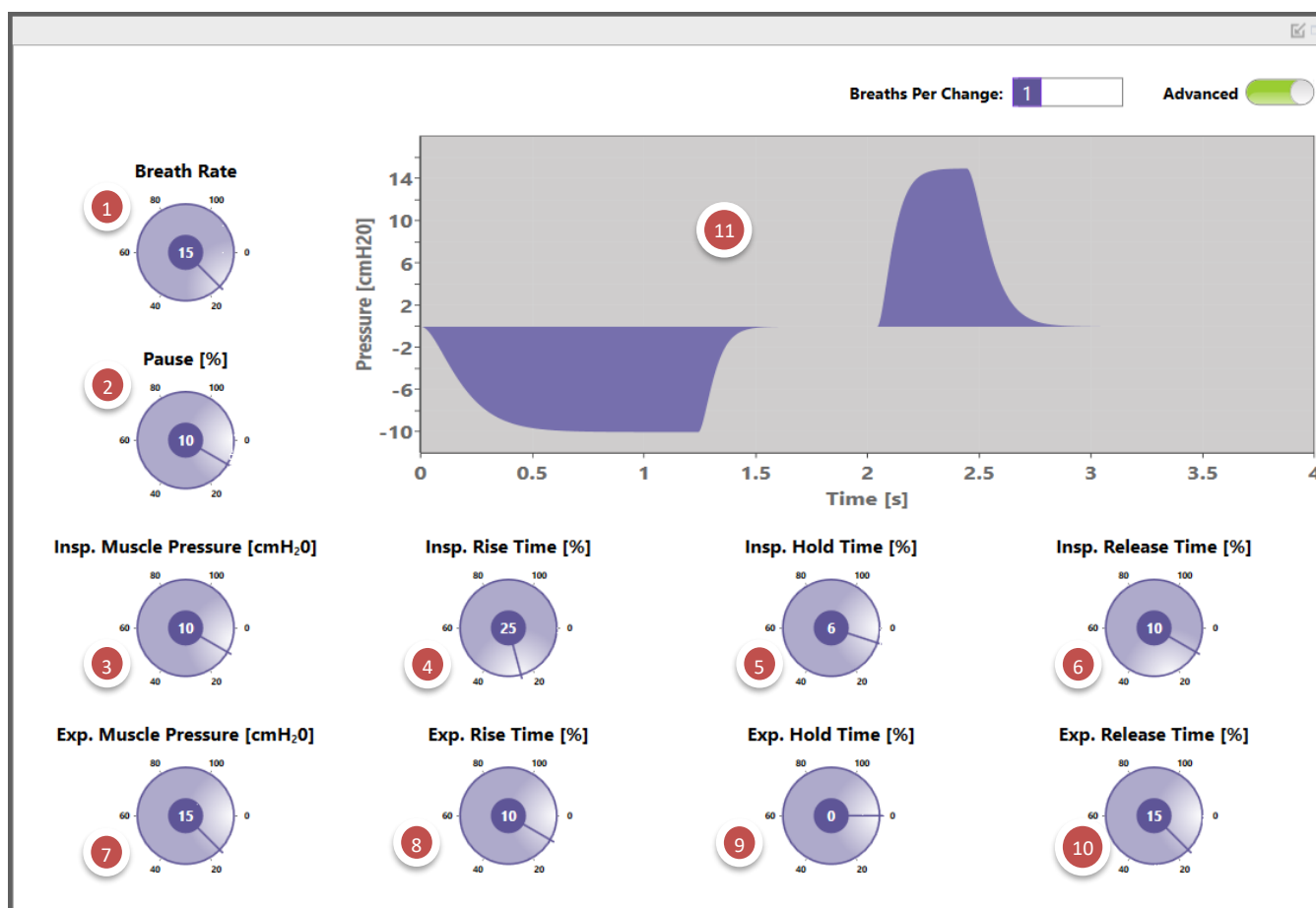
Figure 5-38 - Advanced Breath Effort Control

1. **Breath Rate** (breaths per minute)
2. **Pause %** (percent of total breath time between insp. vs exp. muscle pressure)
3. **Insp. Muscle Pressure** (maximum negative muscle pressure in the lung)
4. **Insp. Rise Time** (percent of total breath time for rise to peak negative muscle pressure, similar to i-time)
5. **Insp. Hold Time** (percent of total breath time for holding peak negative muscle pressure)
6. **Insp. Release Time** (percent of total breath time for release of the negative muscle pressure, similar to the passive component of e-time)
7. **Exp. Muscle Pressure** (maximum positive pressure in the lung – forced exhalation. It is recommended that when setting an Exp. Muscle Pressure, the Insp. Release Time should be set to zero %)
8. **Exp. Rise Time** (percent of total breath for rise to peak positive muscle pressure)
9. **Exp. Hold Time** (percent of total breath time for holding peak positive muscle pressure)
10. **Exp. Release Time** (percent of total breath time for release of the positive muscle pressure)
11. Graphical representation of spontaneous pressure profile over the defined breath cycle

6 TROUBLESHOOTING

The following conditions are problems that can be easily identified and remedied by the user.
For any help/support related to the ASL 5000™ please send an e-mail to: *support@ingmarmed.com*.

6.1 Lung Solution software installer fails

Problem
When installing the Lung Solution software, the installer fails.

Resolution
Make sure LLEAP is installed prior to running the Lung Solution installer. Once this is verified, try to run the installer again.

6.2 Connecting to ASL 5000™ Simulator

Problem
ASL 5000™ is configured to a serial number or IP address and the Status remains as "Unconnected"

Resolution
Check all connections. Make sure the SimMan® is properly configured in AP or Client mode. Check to see that the computer running LLEAP is receiving an IP address from SimMan® or the external router network (for the SimBaby™/ SimMan® ALS / Nursing Anne™ connection). This can be done by opening the command prompt and typing "ipconfig." Contact your Laerdal representative if the problem persists.

6.3 Red LED on the front of the ASL 5000™ remains illuminated

Problem
The red LED on the front of the ASL 5000™ remains on after starting the simulator

Resolution
ASL 5000 Serial Numbers below 2500:
The red LED is a push button switch. If the LED does not turn off after 30 seconds, make sure the LED is slightly depressed. If the LED is flush with the black housing, the motor inside the unit is disabled. Once the switch is slightly depressed, cycle the power to the ASL 5000™. If problems persist, please contact your Laerdal representative.
ASL 5000 Serial Numbers after 2500:
Contact your Laerdal representative.