

Programming Tips

This document provides some scenario/patient shortcuts for controlling common vital signs. The descriptions and diagrams for the parameters provide detailed explanations of how changing parameters affects the patient.

Note: The patient 'Standard Man' or 'Untitled Adult Patient' is used as the starting point for each parameter adjustment. This is the recommended starting point. It is assumed that, unless otherwise noted, each change (e.g. hematocrit, blood pressure, heart rate, respiratory rate, SpO₂, etc.) begins with the default value for Standard Man.

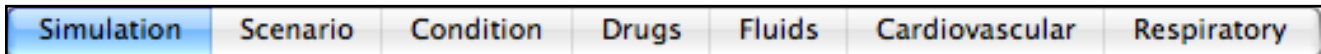
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Programming Tips

HPS Software Programming

The Seven Tabs

There are seven tabs that provide access to the physiological controls used during a simulator exercise. The tabs are located beneath the toolbar on the right side of the Patient Profile window.



The Seven Tabs

The tabs display seven different categories offering varying functionality:

- **Simulation** – Defaults to the Patient Profile (patient information and medical history)
- **Scenario** – Play or Edit scenarios
- **Condition** – Set parameters for assessment and trauma. iStan has the additional capability to set parameters for ICP and sounds.
- **Drugs** – Administer drugs
- **Fluids** – Affect plasma and blood volumes and urine output
- **Cardiovascular** – Set a wide array of parameters affecting cardiovascular physiology
- **Respiratory** – Control airway, lung and respiratory parameters

Numeric Versus Absolute Parameters

Numeric Parameters

- **Factor:** Multiplies the baseline value by the number specified.
- **Fixed:** Exact numerical values that override physiological changes. They stay the same until manually changed.
- **Model-driven:** Some parameters can be model-driven when set to (-1).
- **Absolute Parameters:** Can be set to either on or off, and drive specific functionality like lung sounds, bowel sounds and airway occluder.

Hematology Model

The physiological model calculates hematocrit values (e.g., percentage of total blood hemoglobin) dynamically and continuously, taking into account blood and fluid losses, as well as the intravenous infusion of fluids such as whole blood, packed red blood cells, colloids, and crystalloids.

The following important assumptions are made in the design of the Hematology Model:

Blood is comprised of two components: red blood cells and plasma.

Plasma is comprised of two components: colloids and crystalloids.

Colloids are substances that generate a clinically significant colloid osmotic pressure. Colloids include:

- Fresh frozen plasma
- Albumin
- Hetastarch

Crystalloids are salt solutions for infusion. Crystalloids include:

- Normal saline
- Dextrose in water
- Lactated Ringer's

Fluids Tab



The Fluids Tab

Within the **Fluids** tab you can control various types of fluids:

Fluid Loss Volume (Blood)

- Reflects a decrease in total blood volume
- Has no affect on hematocrit.

Fluid Loss Volume (Plasma)

- Reflects a decrease in plasma volume.
- Increases hematocrit.

Infusion (Colloids)

- Reflects an increase in the plasma volume.
- Decreases hematocrit.

Infusion (Crystalloids)

- Reflects an increase in the plasma volume.
- Decreases hematocrit.

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Infusion (Packed Red Blood Cells)

- Represents an infusion of 70% red blood cells and 30% liquid plasma.
- Increases hematocrit.

Infusion (Whole Blood)

- Represents an infusion of 40% red blood cells and 60% plasma.
- Has little effect on hematocrit.

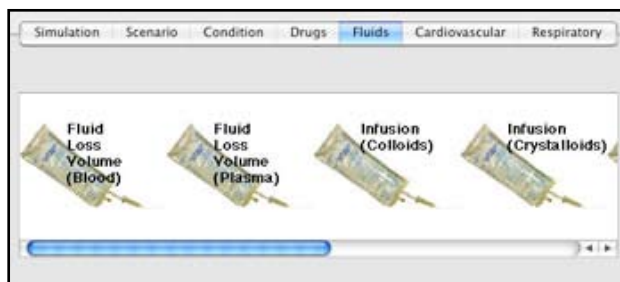
Hematocrit

Hct
42.30

Hematocrit is the ratio of red blood cell volume to the total blood volume. This is expressed as a percentage. The hematology model and hematocrit are affected by the choices made using the parameters provided by the **Fluids** tab. When developing a patient or scenario, the operator should consider if there is a change in the hematocrit (increase or decrease).

Setting the Hematocrit

Select **Fluids** tab



In the table below, the effects of fluid changes on hematocrit are shown as an increase (\uparrow), decrease (\downarrow), or no change (\Leftrightarrow).

	Fluid Loss Volume (Blood)	Fluid Loss Volume (Plasma)	Infusion (Colloids)	Infusion (Crystalloids)	Infusion (Packed Red Blood Cells)	Infusion (Whole Blood)
Hematocrit	\Leftrightarrow	\uparrow 0.06% per 10mL	\downarrow 0.06% per 10mL	\downarrow 0.06% per 10mL	\uparrow 0.06% per 10mL	\Leftrightarrow

All infusions increase blood pressure and cardiac output while decreasing heart rate.

Mean Arterial Pressure (MAP)



The Mean Arterial Pressure (MAP) is a term used to describe a notional average blood pressure in a patient. It is the average arterial pressure during a single cardiac cycle. For programming purposes only, the MAP can be approximated by the following equation:

$$MAP = \frac{(Systolic + Diastolic)}{2}$$

Baroreceptor Maximum Pressure defines the mean arterial pressure (MAP) at which the baroreceptor inhibitory activity on the heart is maximal. When a simulated patient's MAP increases above the baseline pressure, the baroreceptor response exerts greater inhibitory controls on the MAP (e.g., reduction in heart rate) in an attempt to return the MAP to baseline.

Baroreceptor Minimum Pressure defines the mean arterial pressure (MAP) at which the baroreceptor inhibitory activity on the heart is minimal. When a simulated patient's MAP decreases below the baseline pressure, the baroreceptor response exerts greater inhibitory controls on the MAP (e.g., increase in heart rate) in an attempt to return the MAP to baseline.

Using Baroreceptor Maximum and Minimum to Quickly Set Blood Pressure

The blood pressure can easily be quickly adjusted using the Baroreceptor Maximum and Minimum settings.

Setting the Baroreceptor Maximum Pressure

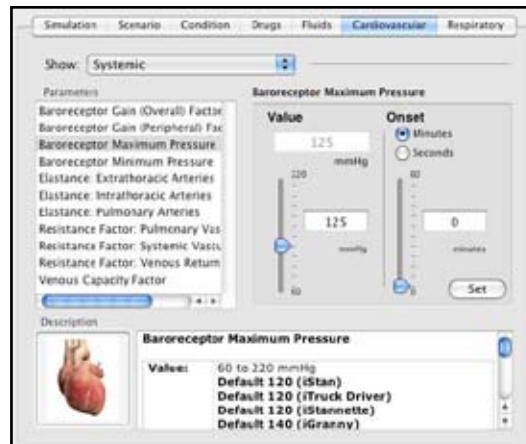
1. Select the **Cardiovascular** tab.
2. Select **Systemic** from the **Show** window.
3. Select **Baroreceptor Maximum Pressure**.
4. Use the MAP formula to figure the MAP, then add 20mmHg to establish the maximum pressure.
5. Enter the result as the **Baroreceptor Maximum Pressure** value.

Example
 For a blood pressure of 130/80:

$$MAP = \frac{130 + 80}{2} = 105$$

105 + 20 = Baroreceptor Maximum Pressure of 125

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Setting the Baroreceptor Minimum Pressure

1. Select the **Cardiovascular** tab.
2. Select **Systemic** from the **Show** window.
3. Select **Baroreceptor Minimum Pressure**.
4. Use the MAP formula to figure the MAP, then subtract 20mmHg to establish the minimum pressure.
5. Enter the result as the **Baroreceptor Minimum Pressure** value.

Example

For a blood pressure of 130/80:

$$\text{MAP} = \frac{130 + 80}{2} = 105$$

$105 - 20 =$ **Baroreceptor Minimum Pressure of 85**



The Baroreceptor: Maximum and Minimum Pressures affect the MAP and put the blood pressure in the target range. In this example, the blood pressure changed to 134/70.

Blood Pressure



The following parameters are the main parameters used to control the blood pressure.

Setting the Contractility Factor: Left Ventricle

1. Select the **Cardiovascular** tab.
2. Select **Heart** from the **Show** window.
3. Select **Contractility Factor: Left Ventricle**.

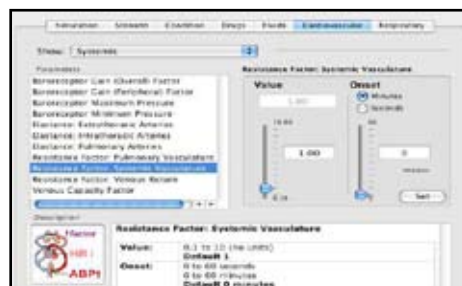


The **Contractility Factor: Left Ventricle** adjusts the contractility of the left ventricle of the heart. It has a direct effect on cardiac output and blood pressure. This parameter is a factor; thus, it is a multiplier. Example: Increasing the value to 2 doubles the contractility of the left ventricle, resulting in increased cardiac output and blood pressure. Decreasing the value to 0.5 results in a 50% decrease in the contractility of the left ventricle, decreasing the cardiac output and blood pressure.

- Increasing **Contractility Factor: Left Ventricle** increases the blood pressure.
- Decreasing **Contractility Factor: Left Ventricle** decreases the blood pressure.

Setting the Resistance Factor: Systemic Vascular

1. Select the **Cardiovascular** tab.
2. Select **Systemic** from the **Show** window.
3. Select **Resistance Factor: Systemic Vascular**.



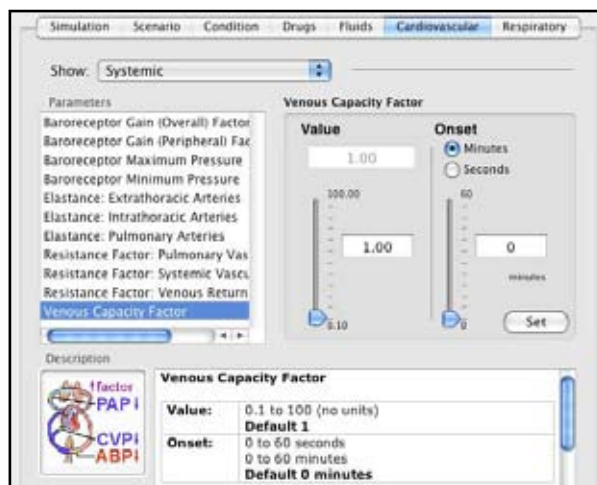
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The **Resistance Factor: Systemic Vasculature** adjusts the baseline systemic vascular resistance (SVR). Increasing this value increases the resistance of blood flow into the vascular system. This parameter is a factor; thus it is a multiplier. Example: Increasing the value to 2 doubles the vascular resistance, resulting in increased blood pressure and a decrease in heart rate. Decreasing the value to 0.5 results in a 50% decrease in the vascular resistance, thus decreasing the blood pressure and increasing heart rate.

- Increasing **Resistance Factor: Systemic Vasculature** increases the blood pressure.
- Decreasing **Resistance Factor: Systemic Vasculature** decreases the blood pressure.
- Adjusting **Resistance Factor: Systemic Vasculature** tends to affect the systolic pressure more than the diastolic pressure.

Setting the Venous Capacity Factor

1. Select the **Cardiovascular** tab.
2. Select **Systemic** from the **Show** window.
3. Select **Venous Capacity Factor**.



The **Venous Capacity Factor** adjusts the volume of blood contained in the unstretched venous system without an increase in venous pressure. Raising the value decreases the venous capacitance (vasodilatation and decreased vascular tone), while lowering the value increases the venous capacitance (vasoconstriction and increased vascular tone).

The volume of blood in the venous system has an inverse relationship to the blood pressure. Lowering the value is analogous to a “shift” in blood from the venous system to the arterial system, and this shift, when coordinated with increased systemic vascular resistance (SVR), results in an increase in blood pressure (ABP, PAP and CVP).

- Increasing **Venous Capacity Factor** decreases the blood pressure.
- Decreasing **Venous Capacity Factor** increases the blood pressure.

Elastance: Extrathoracic Arteries and Elastance: Intrathoracic Arteries

The Elastance: Extrathoracic Arteries and Elastance: Intrathoracic Arteries parameters should be adjusted at the same time and in the same direction as one another.

Setting the Elastance: Extrathoracic Arteries

1. Select the **Cardiovascular** tab.
2. Select **Systemic** from the **Show** window.
3. Select **Elastance: Extrathoracic Arteries**.



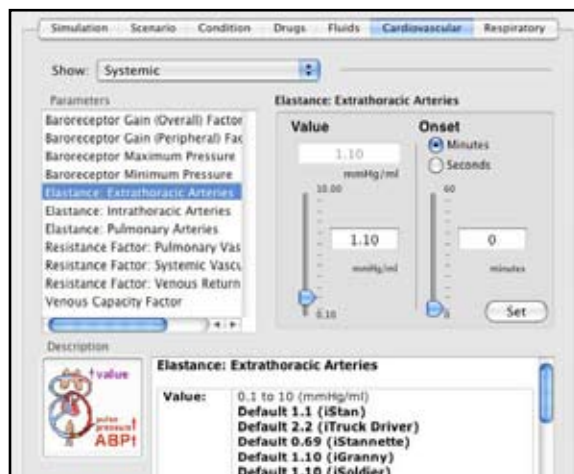
The **Elastance: Extrathoracic Arteries** parameter adjusts the pulse pressure (difference between systolic and diastolic pressures) of the simulated patient's systemic blood pressure. Increases in the elastance value increase (widen) the pulse pressure, while decreases in the elastance value decrease the pulse pressure.

Widening and Narrowing the Pulse Pressure (Systolic to Diastolic Ratio)		
Systolic	Diastolic	Increasing Elastance: Extrathoracic Arteries widens the ratio between systolic and diastolic pressure (pulse pressure). It raises the systolic pressure while slightly dropping the diastolic pressure.
←	→	
Systolic	Diastolic	Decreasing Elastance: Extrathoracic Arteries narrows the ratio between systolic and diastolic pressures (pulse pressure). It slightly rises systolic pressure while increasing diastolic pressure.
→	←	

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Setting the Elastance: Intrathoracic Arteries

1. Select the **Cardiovascular** tab.
2. Select **Systemic** from the **Show** window.
3. Select **Elastance: Intrathoracic Arteries**.



The **Elastance: Intrathoracic Arteries** parameter adjusts the pulse pressure (difference between systolic and diastolic pressures) of the simulated patient's systemic blood pressure. Increases in the elastance value increase (widen) the pulse pressure, while decreases in the elastance value decrease the pulse pressure.

Widening and Narrowing the Pulse Pressure (Systolic to Diastolic Ratio)		
Systolic	Diastolic	Increasing Elastance: Intrathoracic Arteries widens the ratio between systolic and diastolic pressure (pulse pressure). It raises the systolic pressure while slightly dropping the diastolic pressure.
←	→	
Systolic	Diastolic	Decreasing Elastance: Intrathoracic Arteries narrows the ratio between systolic and diastolic pressures (pulse pressure). It slightly rises systolic pressure while increasing diastolic pressure.
→	←	

Heart Rate



Fixed Heart Rate Versus Heart Rate Factor

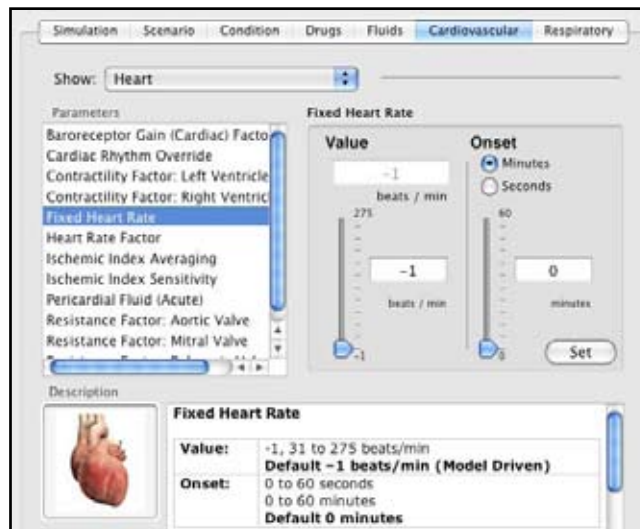
The **Fixed Heart Rate** parameter is used to set the heart rate to a fixed number of beats per minute. Once a fixed heart rate is set, administered drugs, hypoxia or intravascular volume changes have no effect on the heart rate, but continue to influence other components of the physiological models. Use this parameter to set the heart rate to a specific, unchanging number. The heart rate does not change until another heart rate is entered or the **Fixed Heart Rate** parameter is reset to the default -1 (model-driven).

The **Heart Rate Factor** parameter is used to change the baseline heart rate before physiological controls are taken into account. For example, a value of 2.0 doubles the baseline heart rate, while a value of 0.5 decreases the heart rate by 50%. Use this parameter to raise or lower the heart rate.

It is recommended that you use the **Heart Rate Factor** to maintain the physiological modeling of the simulated patient when setting the heart rate. If you choose to use **Fixed Heart Rate**, remember that you must manually change the **Fixed Heart Rate** to simulate changes as they would occur physiologically or default the **Fixed Heart Rate** back to -1 (model-driven) to allow physiological changes to affect the heart rate.

Setting a Fixed Heart Rate

1. Select the **Cardiovascular** tab.
2. Select **Heart** from the **Show** window.
3. Select **Fixed Heart Rate**.

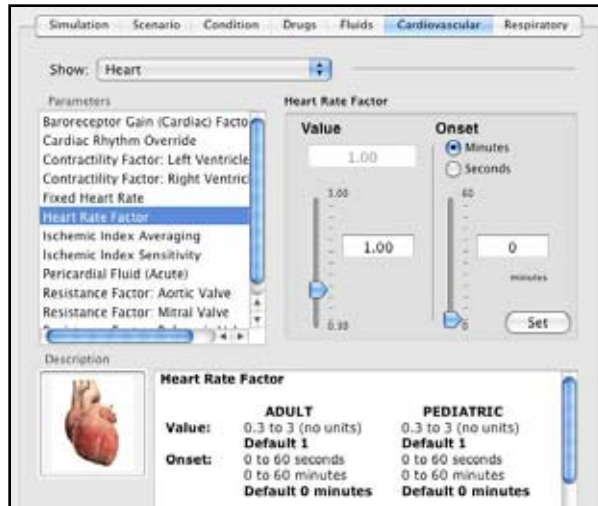


Fixed Heart Rate can be set between 31 and 275 beats per minute, with a setting of -1 returning control of the underlying heart rate to the physiological models. Settings between 0 and 30 should not be used. **Settings above 220 bpm are recommended only for the simulation of pediatric patients.**

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Setting the Heart Rate Factor

1. Select the **Cardiovascular** tab.
2. Select **Heart** from the **Show** window.
3. Select **Heart Rate Factor**.



Respiratory Rate



Respiratory Rate Override Versus Respiratory Rate Factor

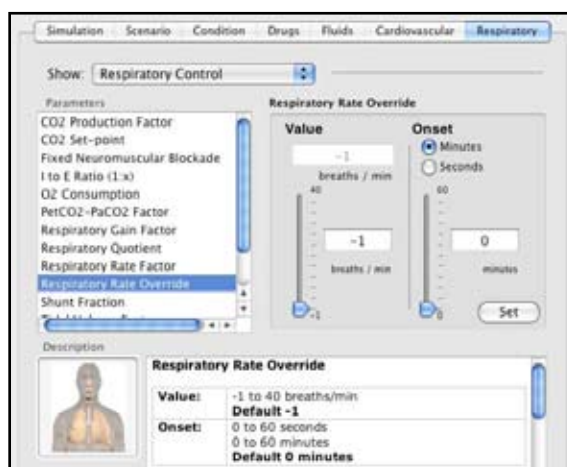
The **Respiratory Rate Override** parameter is used to set the respiratory rate to a fixed number of breaths per minute. Once set, arterial oxygen and carbon dioxide values have no effect on the resulting respiratory rate, but continue to influence other components of the physiological models. The patient continues to breathe at the set number of breaths per minute, regardless of the arterial oxygen or carbon dioxide levels. The respiratory rate does not change until another **Respiratory Rate Override** value is entered or the value is reset to the default -1 (model-driven).

The **Respiratory Rate Factor** (along with the **Tidal Volume Factor**) parameter is used to change the baseline respiratory rate before control-of-breathing and drug influences are taken into account. For example, a value of 2.0 doubles the baseline respiratory rate. A value of 0.5 decreases the baseline respiratory rate by 50%.

It is recommended that you use the **Respiratory Rate Factor** to maintain the physiological modeling of the simulated patient when setting the respiratory rate. If you choose to use **Respiratory Rate Override**, you must manually change the **Respiratory Rate Override** value to simulate physiological changes as they would occur or default the **Respiratory Rate Override** back to -1 (model driven) to allow physiological changes to affect the respiratory rate.

Setting the Respiratory Rate Override

1. Select the **Respiratory** tab.
2. Select **Respiratory Control** from the **Show** window.
3. Select **Respiratory Rate Override**.



The **Respiratory Rate Override** is set to a fixed respiratory rate, regardless of arterial oxygen or carbon dioxide levels. When a patient has a fixed respiratory rate, the respiratory control mechanism must be used to adjust the patient's tidal volume in response to arterial oxygen or carbon dioxide levels.

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To simulate apnea, set the **Fixed Respiratory Rate** to a low value. For example, if the **Fixed Respiratory Rate** is set to 4, the mannequin breathes at four respirations per minute and gives the appearance of apnea. Increase the value to change the length of apnea. Once set, the **Fixed Respiratory Rate** must be manually controlled or returned back to the default value of -1 (model-driven) to exhibit physiologic modeling.

Setting the Respiratory Rate Factor

1. Select the **Respiratory** tab.
2. Select **Respiratory Control** from the **Show** window.
3. Select **Respiratory Rate Factor**.



Setting the **Respiratory Rate Factor** to increase or decrease respiratory rate allows the simulator's respiratory rate to continue operating within the physiologic models in response to changes such as hypoxia or oxygen administration

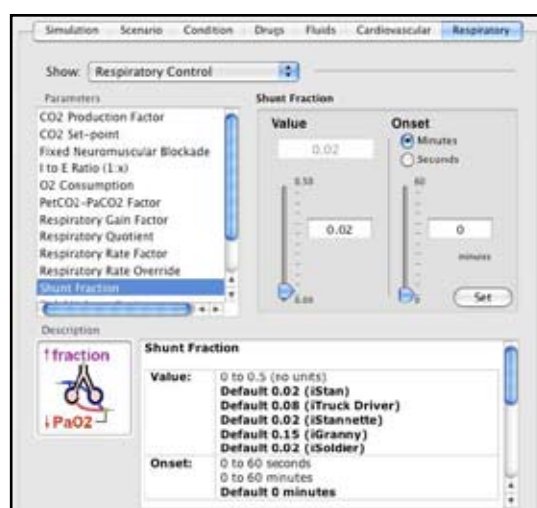
To increase the arterial CO_2 , such as in the patient with COPD, increase the **CO_2 Setpoint**. This causes the simulator to not breathe until the value you entered is achieved as the CO_2 increases. Increasing the **CO_2 Production Factor** also leads to an increase in arterial CO_2 . Keep in mind that arterial CO_2 above 50mmHg displays PVCs in the model-driven cardiac rhythm.

Oxygen Saturation (SpO₂)

SpO₂
98

Setting the Shunt Fraction

1. Select the **Respiratory** tab.
2. Select **Respiratory Control** from the **Show** window.
3. Select **Shunt Fraction**.



The **Shunt Fraction** parameter is frequently used to assist in desaturating a patient. This parameter creates a physiologic bypass of the normal pulmonary circulation, resulting in changes in O₂, CO₂ and anesthetic gases at the alveolar level. Typically, values of 0.10 to 0.40 are needed to create large alveolar-arterial oxygen gradients sufficient to cause arterial hypoxemia. If the parameter is set high (0.50), the patient desaturates rapidly and responds to administered supplemental O₂.

Increasing the Shunt Fraction to 0.5 decreases the SpO₂ to approximately 85% in Standard man, with a corresponding increasing respiratory rate. Always adjust this parameter first when levels of hypoxia are desired. To further decrease the SpO₂, increase **O₂ Consumption**. This also causes an increase in arterial CO₂ concentration.

Programming Tips

Ischemic Index Sensitivity

Isch. Idx.
1.74

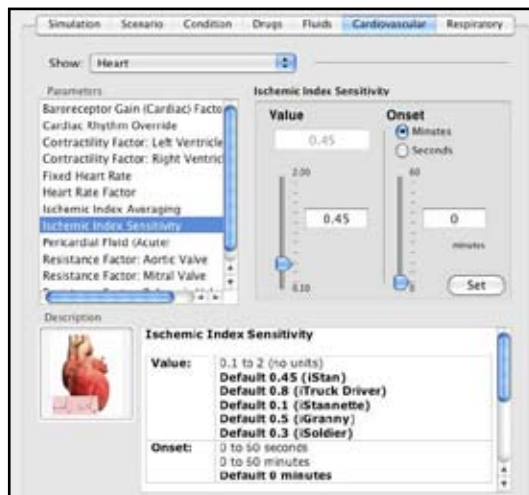
The Ischemic Index is derived through underlying HPS physiologic modeling and cannot be clinically measured. However, the numeric value is important in relation to the expected cardiac rhythm. Favorable supply and demand ratios such as slower heart rates and higher blood oxygen levels generally result in a higher Ischemic Index value. Unfavorable supply and demand ratios such as faster heart rate and lower blood oxygenation levels generally result in a lower Ischemic Index value.

When the Ischemic Index declines in a model-driven simulation, ST segment depression, premature ventricular contractions (PVCs) and ventricular tachycardia are displayed on the cardiac rhythm. The table below displays this progression as it relates to the Ischemic Index.

Model-Driven ECG Rhythm	Ischemic Index
Normal Sinus Rhythm (NSR)	> 0.90
Mild ST Segment Depression	0.90-0.70
Moderate ST Segment Depression	0.70-0.60
PVCs, Bigeminy, Trigeminy, Couplets	0.60-0.40
Ventricular Tachycardia (V-tach)	<0.40
Ventricular Fibrillation (V-fib)	1 minute after V-tach
Asystole	1 minute after V-fib

Setting the Ischemic Index Sensitivity

1. Select the **Cardiovascular** tab.
2. Select **Heart** from the **Show** window.
3. Select **Ischemic Index Sensitivity**.



The **Ischemic Index Sensitivity** determines the relative sensitivity of the simulated patient to myocardial ischemia. A lower ischemic index sensitivity value corresponds with less sensitivity to an unfavorable oxygen supply/demand ratio (i.e. poor oxygenation with high heart rate). A patient with a low **Ischemic Index Sensitivity** value is less

sensitive to poor oxygenation, takes longer to go into the death spiral and survives longer.

To make the simulated heart less sensitive to ischemic changes and to prevent unexpected ST segment depression, PVCs or cardiac arrest during the course of the scenario exercise, set the **Ischemic Index Sensitivity** to 0.1 in the baseline state of the scenario.

The easiest way to “rescue” a patient from the model-driven death spiral (i.e. ECG rhythm cascade as the ischemic index falls) is to use **Cardiac Rhythm Override**. Selecting any of the rhythm overrides (e.g., Sinus, Sinus Tachycardia) sets the ECG rhythm to the selected rhythm and prevents the patient from arresting secondary to myocardial ischemia.

Setting the pH Shift

pH
7.44

1. Select the **Respiratory** tab.
2. Select **Lung** from the **Show** window.
3. Select **pH Shift**.



The **pH Shift** parameter is used to create a metabolic acidosis or metabolic alkalosis under script control.

The default pH value displayed on the HUD is dependent on respiratory arterial CO₂ values. Under default conditions (P_aCO₂ = 40 mmHg) the pH is approximately 7.40. Rising arterial CO₂ produces a subsequent drop in pH while falling arterial CO₂ levels result in rising pH values.

To simulate pH changes with metabolic changes (acidosis or alkalosis), the pH Shift value is a mathematical addition to or subtraction from to the displayed pH HUD value.

To adjust the pH, subtract the desired pH from the current value. For example, if the current value is 7.47 and the desired value is 7.14, subtract 7.14 from 7.47.

- 7.47 – 7.14 = -0.33
- Enter a **pH Shift** value of -0.33.

Programming Quick Reference

Use this guide to make quick adjustments or for reference when programming specific scenarios.

	Fluid Loss Volume (Blood)	Fluid Loss Volume (Plasma)	Infusion (Colloids)	Infusion (Crystalloids)	Infusion (Packed Red Blood Cells)	Infusion (Whole Blood)
Hematocrit	↔	↑ 0.06% per 10mL	↓ 0.06% per 10mL	↓ 0.06% per 10mL	↑ 0.06% per 10mL	↔

Factors	Mean Arterial Pressure		Blood Pressure			Heart Rate	Ischemic Index	Respiratory Rate	Shunt Fraction (SpO ₂)
	Baroreceptor Maximum Pressure	Baroreceptor Minimum Pressure	Contractility Factor: Left Ventricle	Resistance Factor: Systemic Vasculature	Venous Capacity Factor				
↑ HR ↑ BP	✓	✓	↑	↑	↓				
↑ HR ↓ BP	✓	✓	↓	↓	↑	↑			
↓ HR ↑ BP	✓	✓	↑	↑	↓	↓			
↓ HR ↓ BP	✓	✓	↓	↓	↑	↓			
↑ HR ↑ C.O.			↑	↑	↑	↑	↓		
↓ HR ↓ C.O.			↓	↓	↓	↓	↓		
↑ HR ↑ BP ↑ C.O.	✓	✓	↑	↑	↓	↑			
↑ HR ↓ BP ↓ C.O.	✓	✓	↓	↓	↑	↑			
↓ HR ↓ BP ↓ C.O.	✓	✓	↓	↓	↑	↓			
↓ HR ↑ BP ↑ C.O.	✓	✓	↑	↑	↓	↓			
↑ HR ↓ SpO ₂ ↑ RR						↑		↑	↓
↑ HR ↓ SpO ₂ ↓ RR						↑		↓	↓
↑ HR ↑ BP ↓ SpO ₂ ↑ RR	✓	✓	↑	↑	↓	↑		↑	↓
↑ HR ↓ BP ↓ SpO ₂ ↑ RR	✓	✓	↓	↓	↑	↑		↓	↓
↑ HR ↓ BP ↓ SpO ₂ ↓ RR	✓	✓	↓	↓	↓	↑		↓	↓
↓ HR ↓ BP ↓ SpO ₂ ↓ RR	✓	✓	↓	↓	↓	↓		↓	↓
↓ HR ↑ BP ↓ SpO ₂ ↓ RR	✓	✓	↑	↑	↓	↓		↓	↓
↓ HR ↑ BP ↓ SpO ₂ ↑ RR	✓	✓	↑	↑	↓	↓		↓	↓