

**UNC Clinical Skills and Patient Simulation Center
Training Program for “Programmer” Level For
The Adult and Child Human Patient Simulator, (HPS)**

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I Overview

A Training Overview:

This training is designed to be able to program patients, scenarios, and save changes as needed to improve function and design.

This training will need to be done in the Simulation Lab as we are not set up to do this anywhere else. However, review of this document prior to coming to the Simulation Lab will expedite the time spent in the Lab.

B Overview of the HPS:

The Human Patient Simulator is a sophisticated piece of equipment that demands structured training in order to operate effectively and also to avoid damage. The Simulator is designed to mimic human form and physiology. The simulator's base form is that of a very healthy if not 'buff' 33 year old male. This base mannequin can be modified to change genders and a variety of patient types and ages. In addition to the 33 year old adult simulator, the Simulation Lab also has pediatric (age 5) simulator that can be connected to the same components. The adult and pediatric simulators are known as 'Stan' and 'Lil Joe' respectively.

1) Components: The 'Rack', HPS mannequin, computers, gases, Anesthesia machine (monitors, ventilator, ETCO2 analyzer).

- a) The Rack: This is the central hub of what makes the mannequin physically work. All components plug into the rack. The various pieces of instrumentation that control things like pulses, lungs, etc are housed here along with several circuit boards. The computer controls how these various components in the rack will work and interface with one another.
- b) The computer: The HPS works off a Mac desktop computer. The computer contains all of the software to run the HPS. It is here that various 'patients' and scenarios are created, stored and operated. It is this programming that controls the components in the rack. As a **Programmer**, you will be chiefly using this portion of the simulator.

In addition, to the desktop, the HPS can be run via a remote IBook laptop. Wirelessly operated, the laptop is slaved to the desktop and can only run the HPS when the desktop is on. The HPS patient programming is on both computers.

- c) The simulator: The human form houses the components to physically move the lungs, provide pulses, etc. The mannequin provides output to a patient monitor as if so connected in an actual patient room. In addition, a multitude of procedures can be performed on the simulator, making it even more interactive.

- d) Gases: Four gases feed into the rack: Air, Oxygen, Nitrogen, and CO₂. These gases are blended to represent normal respiration. Oxygen is consumed and CO₂ is expired as in normal respiration.
- e) Anesthesiology Machine: Currently, the HPS is attached to a Datex-Ohmeda Aestiva/5 anesthesia machine. The current set up employs a sophisticated Phillips Intellivue MP70 monitor. This setup also includes a Datex-Ohmeda 7100 ventilator and an Agilent M1026A gas analyzer. In addition, there are two TEC7 anesthetic inhalation devices with 'Isoflurane' and 'Sevoflurane'.

The gas analyzer is to be left on at all times.

2) HPS Features

In order to program this equipment, it is essential to know just what the equipment can do. It is therefore, essential that a **Programmer** be familiar with the features and procedures of the HPS.

a) Airway:

- Esophageal intubation results in gastric distension and the absence of breath sounds, lung excursion, and carbon dioxide output.
- Right or left mainstem intubation results in: unilateral breath sounds and lung excursion.

b) Breathing

- Stan and Lil Joe physically consumes oxygen, and produces carbon dioxide
 - (also uptake or excretion of nitrous oxide, sevoflurane, isoflurane, enflurane, and halothane. We are currently not set up for this. If this is added you will be required to have an inservice prior to using the HPS.)
 - Appropriate and dose dependent response to inhaled anesthetics
- Respiratory responses to sympathetic and parasympathic activities are modeled.
- "Stan" and Lil Joe breathe with self regulated rate and tidal volume to maintain a target carbon dioxide partial pressure typically 40 mm Hg
- Pulse oximetry monitoring---responds in kind to nasal cannula, simple O₂ mask, NRB mask and other adjuncts
- End tidal CO₂ monitoring via capnography is possible.
- Airway resistance, lung compliance and chest wall compliance are modeled with independent control of the left and right lung. Changes in

airway resistance in these areas show appropriate wave form on a capnograph.

- Three modes of ventilation, (spontaneous, assisted, and mechanical) can be superimposed on one another---for example 'fighting the ventilator
- Ventilator compatible---and capable of triggering a ventilator in SIMV and Assist modes, (ventilator weaning can be realistically rehearsed)
- Built in continuous monitoring for: tidal volume and ABG—ph, PO₂, & PCO₂ (PO₂ & PCO₂ are measured at venous, arterial and alveolar locations.)

c) Circulation

- Invasive hemodynamic monitoring with the following capability:
 - Mannequin has right internal jugular PA catheter that can be:
 - ✓ Advanced with appropriate waveforms
 - ✓ Wedged (by inflation)
 - ✓ Used for thermodilution cardiac output.
 - Arterial blood pressure
 - Left ventricular pressure
 - Central venous pressure
 - Right arterial pressure
 - Right ventricular pressure
 - Pulmonary artery pressure

d) Neuro:

- Eyes constrict and dilate to light and can be independently controlled.
- Blink rate can be controlled.
- In addition, left and right pupil size can be independently varied as needed.
- Eyes will close automatically when cerebral perfusion fails
- Right arm will accommodate a peripheral nerve stimulator. Appropriate thumb response to type of test and level of medication present.

e) Other Features

- Logs, the software supports:
 - Event log
 - Physiological log
 - Drug logallowing for review of all aspects both during and post training.
- Temperature: both body and blood temperature are monitored.
- Weight: Patient can be weight adjusted to represent different body masses.

- The Microphone---‘The Voice of Stan’
This is one of the more interactive features if not one of the most fun things. It helps the simulator come alive as the students must interact and answer questions, address concerns of the patient. Not to use this is to leave a lot out.

3) Procedures:

A large number of procedures may be performed on the simulator. Several of these procedures require advanced preparation in order to function. For example urine out put requires priming with ‘urine’ (and to be flushed clean once done.) Setting up for these procedures is not a Programmer function. However, as a matter of FYI, how to set up all of the features has been included in the Appendix.

a) Airway:

- Oral pharyngeal airway
- Nasal pharyngeal airway
- LMA
- Combitube
- Oral intubation*
- Nasal intubation*
- Use of lighted stylets
- Fiberoptic intubation*
- Retrograde intubation*
- Digital intubation*
- Needle cricothyrotomy---jet ventilation as well
- Surgical cricothyrotomy

b) Breathing

- Three modes of ventilation, (spontaneous, assisted, and mechanical) can be superimposed on one another---for example ‘fighting the ventilator’
- Needle thoracostomy
- Chest tube insertion

c) Circulation

- Actual non invasive blood pressure cuff readings---manual, or by monitor
- CPR
- IV insertion---simulator measures actual input and responds accordingly
- 5-lead EKG synchronized to pulse. (Many rhythms can be generated.)
- Electrical Therapy: traditional defibrillators, pacers can be applied and utilized
- Foley placement: Male or Female
- Pericardial fluid simulation and pericardiocentesis are possible
- Diagnostic peritoneal lavage

d) Neuro:

- Thumb twitch

4) Medications

- Medication administration: Appropriate and dose depended response to administered medications. [Actual intravenous administration of some 61+ commonly used medications is possible.] Among the supported. Medications mentioned are all drugs required for ACLS.
- Additional medications can be added to the existing formulary through a separate software package.
- Medications may be administered by the participant using the drug recognition module.
- Medications may also be given by the operator using the software to administer the medication in the amount, manner the participant requested.
- It is not necessary to memorize the entire medication formulary as this can be looked up during programming.
- List of medications:

Adenosine	Fentanyl	Phentolamine
Alfentanil	Flumazenil	Phenylephrine
Amiodarone	Glycopyrrolate	Procainamide
Atracurium	Isoproterenol	Propranolol
Atropine	Ketamine	Propofol
Bicarbonate	Labetalol	Quindine
Bretylium	Lidocaine	Remifentanil
Calcium	Lorazepam	Rocuronium
Cisatracurium	Methohexital	Succinylcholine
Curare	Metocurine	Sufentanil
Diazepam	Metoprolol	Thiopental
Digoxin	Meperidine	Vasopressin
Diltiazem	Midazolam	Vecuronium
Dobutamine	Mivacurium	Verapamil

Dopamine	Morphine
Doxacurium	Naloxone
Droperidol	Neostigmine
Edrophonium	Nifedipine
Ephedrine	Nitroglycerin
Epinephrine	Nitroprusside
Esmolol	Norepinephrine
Etomidate	Pancuronium

5) Adjustable Software Parameters

In order to program the simulator, a Programmer must be able to locate and use the various software parameters. It is these parameters that make the simulator mimic various disease states and injuries. The Programmer needs to develop a thorough working knowledge of these parameters. **[Green denotes parameters that can be clinically assessed by the student.]**

a) Cardiovascular

1) Catheters:

Cardiac output measurement

Aterial: peripheral and left ventricle locations

Central Venous, (CVP): intrathoracic vein and extrathoracic vein locations

Pulmonary Artery: pulmonary artery, intrathoracic vein, right atrium, and right ventricle locations

2) External cardiac stimulation:

Defibrillation and cardioversion

Pacing: capture threshold, current, and rate

3) Heart:

Baroreceptor Gain, (cardiac) Factor

Cardiac rhythm override

Contractility factor:

Left ventricle

Right ventricle

Fixed Heart Rate

Heart Rate Factor

Heart sounds; (normal, S3, S4, S3 & S4, early systolic murmur, mid systolic murmur, late systolic murmur, pan systolic murmur, late diastolic murmur.)

Ischemic Index averaging
Ischemic Index sensitivity
Pericardial Fluid

Pericardiocentesis

Resistance Factor
Aortic Valve
Mitral Valve
Pulmonic Valve

Pulses

Chest compression Efficacy

4) Systemic

Baroreceptor gain, (overall) Factor
Baroreceptor gain, (peripheral) factor
Baroreceptor maximum pressure
Baroreceptor minimum pressure
Elastance: extrathoracic arteries
 Intrathoracic arteries
Resistance Factor: Venous Return
Venous Capacity Factor

b) Respiratory

1) Airway

Airway occluder / resistance
Laryngospasm
Swollen tongue
Bronchial Occulsion
PEEP

2) Lung

Chest Wall compliance Factor
Functional Residual Capacity
Breath sounds; (Normal, rales, wheezes, muffled)
Chest Wall Capacity
Chest Wall Compliance
Distended Chest Wall Compliance Factor
Fixed Alveolar Enflurane
Fixed Alveolar Halothane
Fixed Alveolar Isoflurane
Fixed Alveolar Sevo Flurane
Fraction of inspired Oxygen Override
Intrapleural Volume: left and right
Lung Compliance Factor: Left and right
Ph shift
Venous Carbon Dioxide Shift
Chest tube air leak
Chest Tube flow rate
Needle decompression

- 3) Respiratory Control
 - Carbon Dioxide Production Factor
 - Carbon Dioxide Setpoint
 - Fixed neuromuscular blockade.
 - I to E ratio**
 - Oxygen Consumption
 - PetCO₂ – PaCO₂ Factor
 - Respiratory Gain Factor
 - Respiratory Quotient
 - Respiratory Rate** Factor
 - Respiratory Rate Override
 - Shunt Fraction
 - Tidal Volume** Factor
 - Tidal Volume Override
 - Volume/Rate** Control Factor

c) Other Patient Conditions:

1) **Assessment**

- Bowel sounds:** (All four quadrants, Normal, Absent, Hyperactive, Hypoactive.)
- Eye blink control** (Closed, Right or left only blink.)
- Eye blink speed** (Normal, Slow, Fast)
- Pupil diameter** (2 mm to blown)
- Fixed neuromuscular blockade** (No respiration, Normal pulses present.)

2) Other parameters

- Intracranial pressure
- Patient weight
- Arterial Temperature**
- Body Temperature**

3) Fluids

- Blood loss
- Fluid loss—plasma
- Fluid infusion**
 - Colloids
 - Crystalloids
 - Packed RBC
 - Whole Blood
- Urine output**

II Programming the HPS

A Power On & Off Procedures: (Note, this is for the computer only!)

1) Power On:

1) Turn the computers on.

Desk top Mac-This is a round silver push button located to the bottom left. It is above the USB ports and headset jack. It looks pretty innocuous and more like a symbol than a button.

Mac Laptop is located on the second shelf of the beige rolling cart. Power button is a push button located above the keyboard and to the right.

2) Open the **HPS Program**

Click on "HPS User". You will then have to enter the case sensitive password:

3) Start up your programmed patient

There are two 'Meti Men' on the tool bar the bottom of the screen. Click on the one at on the right. This will open the "Patients@localhost" screen. Click "Open". Patients are listed alphabetically. Scroll down and click on "Standard Man" or the patient you desire.

You are running in 'virtual mode' at this point, meaning the simulator is not active which is ideal for programming.

2) Shut Down Procedure

(Basically the reverse of Power up)

1) Close the **patient**

First click 'Disconnect' located on the top left of the patient screen. Then click 'Stop'. You will see a command asking you if you want to save----click '**Don't Save**'.

2) Quit **HPS**

Click on "**HPS**" on the topmost toolbar. Click 'Quit HPS' at the bottom of the screen that comes up.

3) Shut Down the **computer**

Click the 'Apple symbol' on the topmost toolbar. Click on "Shut Down" from the

screen that pops up. The computer will shut down. As this is a Mac, you will not have to wait long for the computer to shut down---nice!

Note: The start up and shut down directions are posted at the computer.

B: Getting the Feel: Running a Patient:

The first step in writing a successful simulation is to understand how the simulator functions. Opening a patient and running a scenario is the best way to get a feel for this technology.

A 'Patient' is usually developed for each case. This patient has the appropriate vital signs and compromises to normal that would be expected for that patient. A 'Scenario' is the event(s) that is going to happen to this patient.

1) Opening a METI configured patient:

From this point on, this is going to be an active exercise done on the computer. You will need to turn on the computer as above.

We are going to begin by opening the patient "**Standard Man**". This is a METI programmed patient crafted to represent a perfectly healthy 33 yr old.

To do this click on "**Patient**" on the topmost tool bar followed by selecting "**Open**". You may also click on "**Open**" on the "**Patient @ local host**" menu. Both pathways will take you to the Patient Menu. When first opening the software, this generally defaults to the METI preprogrammed patients menu*. At this point scroll down to find the patient you want and open it by highlighting it and clicking. For the purpose of illustration scroll down and open "**Standard Man**".

*[Note: If the "METI HPS Patients" menu is not displayed, then you are in the "**Shared**" patient menu. This is where all custom programmed patients have been saved. If this is the case then, at the top of the menu you will see "**Shared**".]

To get to the **METI HPS Patient** menu where "**Standard Man**" is, look to the right of the "**Shared**": menu and you will see the orange METI man that has: "**METI HPS Patients**" written with it. Click on this icon and the METI preprogrammed patients will open. Scroll down and select "**Standard Man**".]

When any patient opens, you default to the "**Simulation**" tab. There are no adjustable parameters under this tab. What is displayed is all of the patient history that allows the instructor to frame the patient for the students—nice!

There are six other tabs on the same line as "**Simulation**" and they are: "**Scenario**", "**Condition**", "**Drug**". "**Fluids**", "**Cardiovascular**", and "**Respiratory**". These are pretty much self explanatory.

However, let's explore some of these tabs. Click on "Respiratory" and you will see that the default submenu is for "Airway". If you click the arrows beside "Airway", you will open another menu with the choices: Airway, Lung and Respiratory Control. Click on "Respiratory Control". Scroll down under Respiratory Control and click on "Shunt Fraction". The default setting is 0.02, To change this to 0.24, either type that in the same box or use the slide bar and move it to 0.24. Click on 'set'. This will give the patient a respiratory shunt.

You can see how interconnected the physiology is via software as the patient compensates for this shunt. Heart rate will increase from 73 to 82, BP will remain about the same, respiratory rate will increase from 13 to 22, SPO2 will fall from 98% to 95%. Spontaneous tidal volume will increase from ~848 to ~1306. PaCO2 will fall from 38.8 to 36.6 and PaO2 will fall from 92.2 to 69.6.

If the simulator was connected to the computer at this time, you would be able to clinically assess an increased respiratory rate and an increase in chest rise. If oxygen was to be administered to the simulator, you would see a response to therapy with vital signs returning to virtually normal.

Return the 'Shunt Fraction' back to 0.02. You will see the values return to normal.

Open the 'Drug' tab and scroll down to epinephrine and click on it. This medication is given in mcg (vs mg as we tend to think of epinephrine). Type in 100 and click 'administer'. You will see that epinephrine works very fast with large increase in heart rate and BP. BP will then begin to fall as heart is too high to allow for adequate filling time. EKG will show ST depression and go into V-tach. The patient has not yet coded and will still have a pulse and BP. (A higher dose will cause the simulator to go into cardiac arrest.) At 2 and a half minutes the epinephrine has been metabolized and the EKG will revert back to normal sinus rhythm.

The simulator will react to the medication given in the correct onset, duration, and with the effects that dose of that medication would be expected to achieve.

In addition to pharmacology, the instructor can demonstrate proper medication administration, physiology, EKG interpretation, and in this case with epinephrine also the problem with tachycardia---very nice!.

All of this has only taken several minutes and has made the material come alive for the student. This is one way simulation can help to accelerate learning. While cases can be presented in real time, they can also be sped up to reach teaching points sooner.

The ability to tie together multiple teaching points as well as across course lines is one of the true strengths of the simulator. This helps with both vertical and horizontal integration of the medical school curriculum.

To open a custom programmed patient you must go to the **'Shared'** patient menu. Once there, scroll down and select the patient you want.

2) **Getting the Feel: Opening a "Scenario" :**

The **"Scenario"** tab is used to manage scenarios. The default tab under **"Scenario"** will display **'Player'**. If you click the arrows beside **'Player'** you will be able to access the **'Editor'** feature. The **'Editor'** function is used to create, change and store scenarios. The **"Player"** function is used to open and close scenarios without any changes being made to the scenario.

Under the "Player" menu is another tab that says **"Scenario"** It is this submenu tab from which all scenarios are opened and closed. Click on submenu **"Scenario"** and then click on **"Open"** in the next menu that pops up.

Access to both METI created scenarios and custom made scenarios under this tab. Opening a scenario is similar to opening a patient.

[The custom scenarios are under the "Shared" folder just as custom patients are under a separate "Shared" patient folder.]

The METI scenarios are accessed by clicking on the METI Man just as you did to open the patient itself. The menu that appears, will show seven categories to choose from: **ACLS 2006, ACLS, Anesthesia, Allied Health, Obstetrical, Pediatric, and Factory Test scenarios**. Each of these headings has a number of scenarios that pertain to that heading.

Select the **'Shared'** scenario folder and scroll down to find **Jim MI.hps**. Click **"Open"**.

The Scenario will open in **"Baseline"**.

'Baseline' means the scenario is open and ready to advance, but no changes have actually been made yet to the patient. This allows the Operator to open the scenario and be ready to start the case. [When you write a scenario, the first state should always be **'Baseline'** with no changes being made to the patient.]

To get a scenario to advance from Baseline, click on **"Next"** in the bottom right hand corner of the scenario you are in. Clicking "Next" will only advance the scenario one step (or state as they are called) at a time.

Any changes that have been designated at that state will then start to affect the patient. In this instance, the patient begins to show signs of myocardial ischemia.

Some scenarios will have transitions built in and will advance without clicking **'Next'**. In this scenario, the first state, ('Myocardial Ischemia') has a time transition of 90 seconds. At 90 seconds the scenario will automatically jump to the next state, (Myocardial Ischemia 2).

Anytime 'Next' is clicked the scenario will advance. This is still true regardless of whether or not a transition is in place.

For this particular scenario, the case will stay in 'Myocardial Ischemia 2' until 'Next' is clicked as there is no transition for this state.

At times, it is desirable to advance the scenario, by skipping a state(s). You can highlight the step you wish to advance to and click on "Go To" above the "Next" button. The scenario will skip all of the states in between. Try this and go directly to 'Resolution' and bypass 'VTach Arrest'.

3) **Getting The Feel: Making Changes On-The-Fly:**

The tabs, (**Conditions, Drugs, Fluids, Cardiovascular, and Respiratory**) all deal with making changes to the simulator. The author whom originally crafted the patient (or scenarios) used these tabs to write the case.

Although the patient has been programmed to represent a certain condition, we can still change that condition at any time. Same is true for the programming within the scenario. Often, you will find that you will want to do this.

While a patient or scenario is running in "Player" mode you can go into each tab and change any parameter under that tab. This will immediately change the physiology and physical presentation of the 'patient'. This is referred to making changes on the fly.

There can be any number of reasons to make changes while the case is running. It could be the Operator needs to tweak and fine tune the case while the case is in progress. It is also an avenue to take the case in a whole new direction which can be advantageous at times. It may become necessary to do this when the students have administered the incorrect therapy and the case is going in a direction you do not want. Conversely, the students have pretty much nailed the case and you wish to make them work a bit more.

When we gave 'Standard Man' a shunt we made a change on the fly.

At the present, you have 'Standard Man' running and have reached the end of the MI scenario by skipping the Vtach arrest state and going to 'Resolution'. You can close the scenario by clicking on the submenu 'Scenario' and then clicking on 'Close'.

This is a good time to self select parameters to open and change on your own to better understand how all of this works together.

C Program a Patient

1) General:

- It is going to be beneficial for a Programmer to peruse the content of existing Patient folders/menus. A desired patient may already exist or an existing patient can be modified to suit one's needs. This will save a lot of time.
- In addition, by studying at how these Patients are written, one can learn how various patents have been achieved thus providing insight on how to create other patients.
- The Simulation Lab has a template available for patient and scenario development.

2) Programming a patient

Once you have a patient in mind it is time to make it happen. The following is meant to be a practical exercise and we are going to develop an actual patient.

a) Create your history: [The Patient]

For this case we have created the following history. He is a 53 yr old welder with a history of multiple admissions for asthma exacerbations who comes in with severe wheezing, Onset was while he was working outside, (it is 37 degrees today as the high) welding some 'H' beams. [Note these are thick pieces of metal that require more time that usual to heat up and weld together. He has been working under a deadline and it is a large project. As a result, he has been working straight through on this for several days despite the fact he 'has been getting a cold'. He has nebulizer treatments he uses at home: Albuterol and Atrovent. He has tried these multiple times today without success.

HR 135 RR 40 BP 95/60 Temp: 103.1 (if they ask) Pulse oximeter is 91

He's in severe distress, see-saw breathing with panic

Breath sounds=near silent

b) Create the Flow: [The Scenario]

The students should order nebs, portable CXR, steroids, magnesium but he will not get any better unless they give IM epi (0.1-0.3 mg) since he won't pull any of the nebulized drug into his lungs because the air volume is so low.

If the students do not recognize and give IM epinephrine early on, the patient should subsequently go on conscious. [If the student misses this, then have the simulator gurgle while unconscious---from emesis].

c) Program this patient

Turn on the computer as outlined
Open "Standard Man"

Now for the really important part---saving your patient, (and scenarios later). After spending time creating, you do not want to lose your work. We will want to start out of the chute by creating a file. All of the METI files are read only. We will want to take 'Standard Man' and modified him. We can save this 'patient' but just not as 'Standard Man' nor in the same folder that the METI patients are in.

We can save any patient we create in the "Shared" folder. To save our patient, click on "Patient" on the very topmost tool bar. Scroll down and select "Save As". You should see a menu open up that has "Patients" (with up and down arrows beside it). Click on the arrows and you will see a submenu that will have "Shared" (along with 'Users', and "/").** Click on 'Shared' and this will open the Shared folder. The patient can now be saved.

In the "Selection" field at the bottom of the 'Shared' folder, type in the name you would like to give the patient. **As a rule, we want to name our patients for what they are---this is going to help you and others to see what sort of patient inventory already exists.** Type in: Asthma Case, Faculty Development and click on save. Note, at the top of the patient you are working in should no longer say 'Standard Man', but Asthma Case, Faculty Development

**[If you see "Users" or "/" with arrows, then click on the arrows which will display a menu with "Shared" .]

[Note, you can only save and METI created patients using the 'Save As' function and the 'Shared' folder. The programming will not allow you to save a METI patient any other way. This prevents inadvertent alterations of their canned patients. It also allows you to take one of their well crafted patients and alter it to suit your purposes which is nice.]

[When saving a non-METI patient and using the 'Shared' folder, you can save the patient by clicking on the square green 'Save' icon beside the red 'Stop' sign. This is quicker.]

We are now going to change (Standard Man) "Asthma Case, Faculty Development" to fit our patient profile. Target vital signs are: HR 135 RR 40 BP 95/60 Temp: 103.1 Pulse oximeter is 91.

[We are going to focus on programming for this exercise. However, normally you will want to start by typing in all of the history you have created under the 'Simulation' tab.]

The physiology is interconnected meaning any changes in HR will also mean changes in blood pressure, respiratory rate, etc. Some factors affect the physiology more than others.

Therefore it does matter somewhat which parameters to alter first. **[See Appendix, Section 'C'---- Tips On Programming.] We look under Tips for Programming and find a section that fits what is going to happen to our patient:** (increased HR, decreased SPO2, and increased RR). The suggestions under here are going to be our best approach to programming.

Using these suggestions, we are going to start by first adjusting the 'shunt fraction' downward. Click the 'Respiratory' tab, then click on 'Respiratory Control'. Scroll down the menu to near the bottom to find 'Shunt Fraction' (SF). Using slide bar increase the shunt fraction to 0.3. You will see the SPO2 drop to 93%. Our target was 91 so increase the SF to 0.33. **[Note for small changes, it is sometimes easier to type in the desired number in the field versus using the slide bar.]** 0.33 got us to 92% so again increase the SF. At 0.38 we have the desired SPO2.

Note: RR and HR have increased as a result of the shunt created which would be a normal response. We are going to increase the respiratory rate by increasing the 'Respiratory Rate Factor' (RRF). To do this we will stay in the same menu and click on RRF. **['Factors' are multipliers over the existing value.]** We are at 25 and wish to go to 40. So once again we will estimate the number change needed to achieve the desired vital sign. As 40 is .75 times greater than 25, it is logical to start there. Using the slide bar move the RRF from 1.0 to 1.75. You are now at 40 which was the target range.

We know that HR will increase as a result of BP drop, so we will want to drop BP first, then see how close HR is to our target value. BP is primarily raised or lowered using five parameters: 'Resistance Factor: Systemic Vascular' (Commonly known as SVR), 'Venous Capacity Factor, Blood volume, Elastance: Extrathoracic Arteries, and Elastance Intrathoracic Arteries.

To adjust these parameters we will need to use the 'Cardiovascular' tab. Click on this tab, the default menu is for 'Catheters' which is not what is needed. Click on the arrows beside 'Catheters' and from the menu that pops up select 'Systemic'.

The most appropriate way to adjust BP for this patient is going to be to use the Venous Capacity Factor. Select 'Venous Capacity Factor' (VCF). This is a 'Factor' therefore it is a multiplier. We need about a 20 point drop so estimate a value and enter. Here we will enter 1.5 which does not give us much bang for the buck. Try a larger increase of say 2.0. Now we see that we have over shot the mark and BP is falling dramatically and split the difference and change the VCF to 1.75. The ABP is pretty close to the 95 systolic we desired. As this is a dynamic read out, it is close enough.

Our diastolic is below the target value. The question as the author you have to ask at this point, is this acceptable. If so, no further adjustments need to be made. However, if it is important to a particular case then we can use the [Elastance: Intra and Extrathoracic Arteries](#) parameters to adjust the systolic / diastolic split. To get the 35 point split desired these values are adjusted downward from their default settings. You should try adjusting these parameters to see if you can reach our target values.

After some adjustment, the values end up being [0.56](#) for [Extrathoracic](#) and [0.93](#) for [Intrathoracic](#).

The BP has gone down as a result of these adjustments. Moving the [VCF](#) down to [1.65](#) has resulted in regaining our target BP.

Heart Rate is now about 104 and needs to go up to reach 135. To adjust HR use the [Heart Rate Factor \(HRF\)](#). This parameter is under the [Heart](#) menu. Click on the arrows beside the [Systemic](#) menu we are in and select [Heart](#). Scroll down to the [HRF](#). Based on the existing rate you estimate there needs to be about a [0.4](#) increase and increase the [HRF](#) to [1.4](#). A HR of 135 results.

These adjustments have resulted in dropping the BP below target value. So we reduce the [VCF](#) some more to achieve the desired BP. This will drop the HR below desired rate so HRF must increase. The drop in BP has resulted in SPO2 being 90 and below target of 91. You are now pretty close to the patient desired. To achieve the exact values will require going back and tweaking the parameters we have been using to fine tune this patient Now do this.

After some adjusting of these factors, we end up with the following parameter values: [VCF 1.60](#); [HRF 1.50](#); [Extrathoracic Elastance of 1.1](#); [Intrathoracic Elastance of 1.8](#); [RRF 1.75](#) and [SF of 0.38](#),

The last thing to do is to change the temperature and breath sounds. These parameters are independent of the above parameters and may be changed any time without affecting the physiology. To do this Click on the [Conditions](#) tab. Scroll down to [Temperature: esophageal \(body\)](#) and click on it. Use the slide bar to adjust the temperature to 103.1 F. Note the temperature is always expressed in degrees Celsius so 103.1 will have to be converted. [\(39.46\)](#) [C= F-32 x 5/9]

Breath sounds can be changed under the [Conditions](#) tab or under the [Respiratory](#) tab. Since you are under the [Conditions](#) tab select [Breath Sounds](#) and click [muffled](#), (as opposed to wheezing. Note the volume can be adjusted up or down to simulate just how tight you want the patient to be. This patient should be pretty tight so adjust the volume all the way downward when the patient is in play mode (versus virtual mode which we are in for programming purposes.)

Congratulations! You have just created your first patient. The very next thing is to save your work. Since we are in the 'Shared' folder you can use the square green 'Save' icon beside the red 'Stop' sign. Click on this and you should see the "Saving Patient" flash on the screen.

At this point, click on the red 'Stop' sign. You will have a warning screen pop up. It will ask you if you want to save. This is a very helpful reminder. Since we have just saved will do not need to save again. Click on 'Don't Save' and the patient will close.

If you now go to the 'Patient' tab on the topmost tool bar and click on it, you will see a menu that will allow you to reopen your patient. The 'Open Recent' is a short cut. By highlighting it with the cursor you will see a list of the last 10 patients opened. Our patient should be at the top of the list with 'Standard Man' just under it. By sliding the cursor over and highlighting you can open any patient in that list without having to go to the folder they are stored in. This is a real time saver. [When we get down to 'Scenarios' there is also an 'Open Recent' function.]

The check off for this training will require you as a 'Programmer' to create your own patient complete with history and to create one scenario to use with the patient.

It is important to craft the patient to reflect the disease process or condition being presented. For example, a patient in cardiogenic failure/shock will have a low blood pressure, but this low BP should be achieved primarily using contractility factor for left and right ventricles and not by volume loss or increasing venous capacity factor. Because the physiology is interconnected, using the contractility factors will result in values for cardiac output, pulmonary artery pressure, and central venous pressure that will be appropriate for someone in cardiogenic shock.

Similarly, for someone in neurogenic shock from a spinal cord injury, the VCF would be the primary means for dropping BP. Cardiac output in these two examples will be greatly different.

The teaching point here for faculty is that the simulator is wonderfully sophisticated and can be used to realistically present a wide variety of patients when correctly set up. As a faculty member it provides a great deal of satisfaction to create a patient, and then see your work come alive as the students work through the case. The students will remember their experience.

Teaching objectives should also accompany the case / scenario.

D Program a Scenario

1) General

- It is important to understand that a scenario is expected to go from State to State and top to bottom. Each State builds on and depends on the one in front of it. Clicking 'Next' always moves the scenario to the State below the present State.
- It is also important to realize that when a State(s) is skipped, the changes that would have occurred in that State, do not occur.
- It is going to be beneficial for a Programmer to peruse the content of existing scenario submenus. A desired scenario may already exist or an existing scenario can be modified to suit one's needs. This will save a lot of time.
- In addition, by looking at how these scenarios are written, one can see how various events and states have been achieved providing insight on how to create other conditions.

2) Program a scenario:

Once you have a flow of events you want to occur, it is time to make it happen. The following is meant to be a practical exercise and we are going to develop an actual scenario.

By going through and creating the above patient, you have learned what you need to know to make the changes occur to your patient in a scenario. You only need to know how to set up a scenario.

We are first going to create a typical scenario and then add to it to create a scenario that is more involved. This will be good practice to first develop a scenario and then to how to modify it for other purposes.

A good scenario, will leave room for the learner to go beyond the stated objectives, (should those objectives be achieved faster than anticipated.)

Also, a scenario with multiple layers of difficulty will allow the instructor to keep a mixed group challenged. For example, a group that might have Medical Students, Interns, and Residents together. Since this is the sort of 'team' that exists on the floor, this is a good learning situation.

A technique that works well for this sort of mixed group is to let the Medical Student start with something fairly straight forward in which the patient is not going to crash on them. [You want them, and they need to be, successful in the beginning.] You can progress the case to where the Medical Student needs to (and should recognize that they need to) call for assistance. In this manner, you work through the chain of command as well as Teamwork.

a. Open The Patient For Whom the Scenario is For

In order to write a scenario, you must have a patient of some sort open.

Start by opening the patient you have just created. Remember to go to the 'Shared' folder to open the patient. This patient will open with the 'Simulation' tab as the default.

b. Player versus Editor Mode

Click on "Scenario" tab. You will see two default menus: "Player" with arrows beside it and a submenu below "Players" that also says 'Scenario'.

The submenu 'Scenario' is used to: open, close, save, create, modify, etc. all scenarios. In 'Player' mode scenarios are open and run. 'Editor' mode is used to create and modify scenarios.

You need to be in 'Editor' mode. Click on the arrows beside 'Player' and subsequently click on 'Editor' when it pops up. You are now in Editor mode.

c. Using the Submenu 'Scenario'

Now Click on the submenu 'Scenario'. You can now create a new scenario by clicking on 'New' (or edit an existing scenario by clicking on 'Open'.)

d. Create 'States' for your Scenario

If you have not clicked on 'New' go ahead and do that. .

You will see "Untitled 1" appear as we have now started the process. We will want to go a head and start saving our work. Click on 'Save' under 'Scenario'. This will take you to the 'Shared' scenario folder. "Untitled 1" will appear in the 'Selection' field. We want to name our scenarios for what they are. Type in: Asthma Case, Faculty Development and click on save. [Note, 'Untitled 1' should have changed to our new name.]

Click on submenu 'Scenario'. You will now see that much of the menu that had been light gray and inactive is now black and active, (including 'New State').

Click on 'New State'. You should see that "New State 1" has appeared. Click on 'New State' again and 'New State 2' should appear below New State 1. You will want to create as many 'States' as there are stages in your scenario. Here we are going to create three States for this scenario. You will need to click on "New State" three times.*

***[Tip From the Trenches:** you can not insert a State between two existing States. The only way to insert a State is to add a State at the end of the scenario and then reprogram each State with the programming from the State above until you get to where you would like to add in a State. This is not at all convenient.

It is therefore a good idea to leave an empty State between each State until you finish writing and working the bugs out of the scenario. You can always go back and delete any State once you finish. This is particularly helpful when creating something from scratch that is complicated, (in which case you may find that you need to add in something you either did not consider or need to add in order to get the scenario to flow like you envisioned.) Also, you may think of another twist you would like to add in---and now you can with much less effort.

So for our own experience today, let's create 5 states by continuing to click on 'New State'.

Now click on 'New State 1' and you will see that you can now name it in the field at the bottom that says "Change state name to:". You will want to name the first State "Baseline" so type this in that field and click on 'Apply'. You should no longer see 'New State 1' but 'Baseline'.

Label all of the odd numbered States in the following order:

New State 3 as 'No IM Epinephrine Given

New State 5 as 'IM Epinephrine Given'

Leave the even numbered States unlabeled as our back up.

There is no autosave. It is a good idea to get in the habit of saving your work every so often. Save your work so far by clicking 'Save' under the submenu 'Scenario'.

e. Program the 'States' you have created.---Beginning with 'Baseline'

Click on 'Baseline' [it should be highlighted in blue] and you will have two headings under it: "Events" and "Transitions".

These are pretty much what they sound like. 'Events' are changes we are going to make to the patient's condition.

'Transitions' are things that will move the patient from the present State (or condition) to another State.

Every 'State' has these two headings. Whether or not you need to use each of these for a given state will depend on what you are trying to do.

The patient is sick enough that IM epinephrine (after oxygen) is the initial treatment. Our objective for this scenario is for the students to recognize just how sick the patient already is on presentation and begin to treat his condition. Therefore, we do not need to make any changes yet to his condition, so we have nothing under the 'Events' heading to change or add in.

Should the students recognize and treat the patient correctly we want the patient to improve. We will need to create a State where this will occur. For this scenario this is going to be the one we have labeled: 'IM epinephrine Given'.

We can use the administration of epinephrine as a trigger to make the transition to the 'IM epinephrine Given' State. [We will bypass the states where IM epinephrine is not given early and the patient has deteriorated further.]

To do this click on the submenu 'Scenario' (while "Baseline" is highlighted.) Near the bottom of the submenu you will see that you can now click on "New Transition". Do that.

[Still in the 'Baseline' State] Under 'Transitions' you will now see that: "if ? = ?, then go to ?" has appeared.

Click on "if ? = ?, then go to ?". You will see the active field below the list of "States" has changed. You can now fill in the "?"s with what you would like to specify.

Beside the "if" there is a '?' with a [down arrows](#) beside it. Click on the [arrow](#). You now have a menu that will include all of the things that can be changed with the simulator. They are listed alphabetically.

Scroll down until you find '[epinephrine](#)' and click on it. "[Epinephrine](#)" should appear in the field beside 'if'.

Next click on the [up and down arrows](#) beside "=". From the menu that appears select '[≥](#)'. [A word to the wise here. If you use equal, (for example a medication dose), then the simulator will be looking for that exact value. If you use 'equal or greater than', then the simulator will use any value at or above---important if you do not need an exact value. Most of the time you are going to want to specify \leq or \geq to drive the scenario.]

Next specify how much epinephrine you want the simulator to sense before making a change. To do this [type](#) in that amount, (use "[0.01](#)" for today) in the field that has a question mark (right under where '[epinephrine](#)' appears).

Now that we have specified what action is going to move the scenario, we need to specify what State we want to go to. There is "go to" with up and down arrows** to the right of where you typed in "[0.01](#)". Below the active field you typed in "[0.01](#)" is another 'go to' (in bold) with a blank active field that has up and down arrows beside it as well.

Click on the up and down arrows beside that blank field. You will see a list of all of the States you created.

Select the desired State, ('IM epinephrine' Given) by clicking on it. That State should now appear in the active field.

To complete the transition click on 'Apply'. You should now see that the transition for 'Baseline' state says:

"If epinephrine \geq 0.01, then go to "IM epinephrine given"

We could have used a different sort of Transition than the "go to" function we used. If you click on the **arrows beside the "go to" that is to the right of "0.01" you will see that you have five choices. ["call", "give bolus of", "go to", "set", and "infuse".] adding greatly to the sort of Transitions we can make.

You have just made your first 'Transition'! The rest occur in the same manner.

Time to Save!

If you are going to use the same Transition in another State you can save time by using the 'Edit' function (copy and paste) on the topmost tool bar in the usual fashion. Highlight: "If epinephrine \geq 0.01, then go to "IM epinephrine given", then click 'Edit' on the topmost tool bar, followed by 'copy'. Scroll down to the second State, ("No Epinephrine Given"), click on it to highlight it. Then click 'paste' under 'Edit' on the topmost tool bar. You should see: "If epinephrine \geq 0.01, then go to "IM epinephrine given" appear under Transition in the "No IM epinephrine Given" State---nice!

[Note when you have completed the scenario and are ready to delete and 'extra' States you will use edit and cut to remove these States.]

From experience, the transitions that have the most use are:

- 'things done' for example medication given or a defibrillation,
- 'time' (either in a particular state or in the scenario as a whole.)

Most scenarios do not have a lot of transitions and advance from state to state by manually clicking on the 'Next' button. The advantage to not having a transition is that it allows the instructor complete hands on control to best tailor the movement from State to State to fit the group.

You can set up a scenario using Transitions at every State, hence on automatic. This is not utilized often. However, this could be the preferred programming when doing an assessment versus a training exercise.

This brings us to another important feature of simulation: assessment. While simulation is currently useful as a powerful teaching modality, it can be, (and will become) an equally valuable tool for assessment.

Today we are using a Transition for two purposes: one it will work quite well for our objective and two it provides a nice practical exercise.

f. Program the next 'State' ---"IM epinephrine given"

It is certainly more than reasonable to program from State to State going top to bottom. For simple and uncomplicated scenarios this works quite well making it the preferred method. It would work nicely for this scenario.

However, you may also find it beneficial to go a head and establish the final condition you want the patient to have. Using the presenting and ending States as reference points can be beneficial in crafting the changes in between. Today we are going to do just that.

For the flow we have created, we want the patient to end up being much better than he presented. However, he will not be completely over his event. To that end, we are going to undo many of the changes we made in order to make him sick to start with. However, we are not going to return all parameters back to normal.

We will want the patient breathing easier, slower, with heart rate lower and BP improved. He will still have some wheezing, but that is an improvement (and audible) as opposed to very very tight (no breath sounds). His SPO2 will be improved.

To achieve the patient we desire we have the following target vital signs: HR 97, BP 114/60, RR 25, SPO2 97%,

To figure out what to change and how much, you can modify our patient, (Asthma Case, Faculty Development) and lessen the changes to those same parameters. Try to reach these Target Values by modifying: Venous Capacity Factor, Shunt Fraction, Respiratory Rate Factor, Heart Rate Factor, Elastance Extthoracic and Intrathoracic Arteries in the same order we did to create the patient.

Tip From the Trenches: You can open more than one patient at a time. You may find it beneficial to open a second copy of the starting patient (or Standard Man) to tinker with. [This help to keep you from inadvertently modifying your patient you have worked to create.] After figuring out what you need, try it on the 'real' patient to see how it flows.

[Remember these are things we want to put into the scenario and not the patient. So do not save your patient when you close or you will be saving any changes made as part of the patient.]

After some trial and error you should have values close to:

VCF of 1.0

SF of 0.02

RRF of 1.6

Breath sounds to wheezing, with sound up.

HRF to 1.21

Elastance Extrathoracic Arteries to 1.1

Elastance Intrasthoracic Arteries to 2.8

Having made note of what parameters needed to be adjusted we are now going to make these changes happen in the final state, ('IM epinephrine given').

To do this first click on the State: 'IM epinephrine given'. [It should be highlighted in blue.] Click on the submenu 'Scenario'. [You should see the same menu that 'Transition' was in.] Scroll down the submenu and highlight "New Event". When you do, you will have a popup menu to the right. Highlight 'New "Set Event"' and click.

Under 'Events' (for 'IM epinephrine given') you will now see "set ? to ?". You will need to add one 'New "Set" Event' for each parameter change to be made. Go ahead and enter these, you need seven.

Making changes to parameters under 'Events' is similar to making a 'Transition'. Click on the first 'set ? to ?' You will see 'set' with ? beside it appear below the list of 'States'. [just as you saw 'if' with a ? appear when you did the Transition.]

Click on the [down arrow](#) beside the question mark and you will have a menu of parameters that can be changed just as you had when creating a 'Transition'. [Again, listed alphabetically.]

Scroll down to '[Heart Rate Factor](#)' and click on it. You should see [Heart Rate Factor](#) appear where the question mark had been.

Now in the active field below 'Heart Rate Factor' replace the ? there with the value (1.21) you want for HRF by [typing](#) it in.

Lastly, [type in](#) the time period (in minutes) you over which you would like the HRF to change.. Click on '[Apply](#)'

Repeat for the remaining parameters.

Good time to [save](#) what you have.

After creating a State, it is a good idea to see how the scenario transitions from State to State. To do this close the scenario and exit from Editor mode to Player mode. Close the patient ('Asthma Case, Faculty Development') by clicking on the red 'Stop' sign. Do not save when it asks you to.

Now reopen the patient 'Asthma Case, Faculty Development' by using the "Patient" tab and "Open Recent" function..

After our patient is open, click on the 'Scenario' tab and then click on the submenu 'Scenario' You can click on 'Open' or click on 'Open Recent'. 'Open Recent' will be faster and our scenario should be at the top of the list that opens to the right. Highlight and click. The scenario will open and the patient will sit in Baseline.

Use the 'Go to' button to move to the State "IM epinephrine Given". Watch to see how the changes in vital signs occur. Note: when you have made large changes in parameters you will mostly likely see large fluctuations in vital signs until the programming 'smoothes out'. You can mediate these fluctuations by having them occur over time, which is what normally happens to a real patient. Here our changes were not too bad, but could be improved upon.

You will want to experiment with how fast these changes will occur in order to get a representative improvement over time. [Also, keep in mind that for the new learner you want things to be pretty clear.]

After some trial and effort, you should come up with something close to the following:

- VCF of 1.0 over 1 minute
- SF of 0.02 over 30 seconds
- RRF of 1.6 over 1 minute
- Breath sounds to wheezing, with sound up.
- HRF to 1.21 over 1 minute
- Elastance Extrathoracic Arteries to 1.1
- Elastance Intrasthoracic Arteries to 2.8

g. Program the next 'State' .---"No IM Epinephrine given"

The flow for this scenario calls for the patient to become unconscious from hypoxia when not treated properly. Properly means quickly and with the right medication given by the right route. So we could use a time Transition to get to this State if we desired or use the 'Next' function.

We will want the simulator to close his eyes and our patient to be hypoxic. We would like to have the following vital signs: RR 40, SPO2 78%, HR 148, and BP 90/60, and EKG sinus with PVCs.

To do this we want to open our patient, (Asthma Case, Faculty Development) in “Baseline”. We will use the same parameters we used to create the patient, to get the target vital signs we have in mind. We will want the oxygen saturation to drop a lot and quickly and is our initial starting point as before.

Try adjusting the Shunt Fraction. Open the ‘[Respiratory](#)’ tab by clicking on it. Next click on the [up and down arrows](#) beside the default menu “Airway”. Click on “[Respiratory Control](#)” to get to the ‘[Shunt Fraction](#)’ parameter.

While under the same “Respiratory Control” tab, try adjusting (increasing) the O2 Consumption also. To get a large rapid, smooth drop, we find that we want to use both parameters at the same time.

We had not used O2 Consumption earlier. This was done in part because we were keeping things simple and are introducing things incrementally. However, this now affords us an opportunity to use multiple parameters simultaneously (again which normally would be expected to occur) to achieve the same objective.

We will also need several other parameters we have not used so far. We will need to set the eyes to closed by using the ‘Conditions’ tab. We will need to change the EKG to have PVCs using the Cardiac Rhythm Override parameter which is found under ‘Cardiovascular---‘Heart’ menu. .

We know that in real life, not all PVCs result in the same pulse beat (and sometimes no beat at all). Therefore, adding PVCs affects actual heart rate, and BP. We will want to make this sort rhythm change before changing other parameters as the programming is such that this rhythm change will affect how the other parameters will work.

First go ahead and change the EKG to ‘Sinus with 10% PVCs’ by using the ‘Heart’ menu under the ‘Cardiovascular’ tab. Click ‘Cardiovascular’ followed by clicking the [up and down arrows](#) beside the default ‘Catheters’ menu to get to the “Heart” menu. Click on “[Heart](#)” and scroll down to ‘[Cardiac Rhythm Override](#)’ and click on it. You will have a menu pop up with a variety of EKG choices. Scroll down to find ‘[Sinus with 10% PVCs](#)’ and click on it. You should see the EKG change at this point.

We know that we would like next to change the BP before making heart rate adjustments. While still under the ‘Cardiovascular’ tab, click on [up and down arrows](#) beside the “Heart” menu. Next click on “Systemic” to get to the menu with ‘[Venous Capacity Factor](#)’. Make adjustments to achieve desired BP.

We will need to go back to the “Heart” menu to make our heart rate change. Click on “[Heart Rate Factor](#)” and make adjustments needed to reach target heart rate.

Next close the eyes using the 'Condition' tab by clicking on that tab and scrolling down to 'Eyes: Blink Control'. Click on "Eyes: Blink Control" and you will see a menu pop up. Select 'Eyes Closed' by clicking on the dot.

To get the desired effect we need to:

- increase shunt fraction (to .5),

- increase oxygen consumption (to 300)

- set the condition for 'eyes' to closed.

- Set Cardiac Rhythm Override to: Sinus with 10% PVCs

- Increase VCF to 1.8

- Set Heart Rate Factor to

Click on "No IM Epinephrine given" to highlight it. Click on the submenu 'Scenario' and scroll down to "New Event" as before. Click on "New "Set" Event". Repeat 6 more times.

[Alternative method to populate the "New "Set" Events" needed for a given State is to use the Edit / Copy / Paste function and copy existing parameters you have already put into the scenario. You can then go and change the values as needed. Since we are using many of the same parameters each time, you find it quicker to cut and paste ones already present and use 'New "Set" Events' to add in the new parameters.]

Set these parameters as above in the State "IM epinephrine Given". Close the patient and scenario and reopen both. Move from 'Baseline' to 'No IM epinephrine Given' and watch the transition taking note on how the vital signs change. The flow should be smooth without large fluctuations. Today, the changes in vital signs look good without changing over time so we will not add in 'over time'.

We would like to be able to go to the final State from any State in the scenario. We should also see how the transition looks from this State, (No IM epinephrine) to the final State, (IM epinephrine Given). So while we are still in the 'No IM epinephrine Given' State use the 'go to' function to move to the 'IM epinephrine Given' State and watch the transition.

This looked good, so no further changes to any parameter or to time adjustment needs to be made.

Since we cut and pasted earlier, we should have the same transition as done for "Baseline": "If epinephrine \geq 0.01, then go to "IM epinephrine given"

State two is now complete. And our scenario is finished! Time to Save!!

We will want to now try this on the simulator. There can be some differences between the virtual mode and actual simulation. For one, the patient monitor, despite calibration, typically reads a few points below (across the board) than the computer. Also, you want to see how the simulator is reacting to the

changes given. For instance, are the breath sounds where you want them. You will also want to 'run through' the case at least once to see if it rolls out as envisioned. There is almost always some changes to be made to fine tune the case. Here, we find that we need to go back and have his eyes open in the "IM Epinephrine Given" State to undo that change made in the "No IM Epinephrine Given" State.

Congratulations!! You have just successfully programmed and patient and a scenario to go with that patient!

h. Modifying An Existing Scenario.

We have some students we would like to challenge more using an asthma case. Our starting point would be to look and see if such patient and scenario already exists so we look through the existing folders----why it is important to name your case for what it is.

We find the scenario 'Asthma Case, Faculty Development' in the 'Shared' folder and it looks like a good starting point, but we want to tweak it some.

You decide that want the patient to get sicker and the students have to intubate him and sort through problems that can result from this particular patient being intubated and on a ventilator. [Also, when they intubate him, if they are really sharp they will give Ketamine---so you are going to give bonus points for that.]

It will be easy enough to do with the current scenario as we can use the "No IM epinephrine Given" State as the initial presentation to the students.

For this case you decide to add in this additional flow:

The blood pressure drops to 60s systolic after intubation which will respond to 2 L of fluid (back to 95 systolic and they should keep giving fluid) if the RR is 10 or fewer. However, if they have RR of 11 or greater, the pressure will stay down despite all efforts, (although the pulse oximeter will come up).

If the students are flailing, we will help them out by noting that the ventilator keeps alarming as the pressure is too high. Just lowering the inspiratory volume (although it should be 450 or less) will not quiet the alarm. The rate must also go down. If the students are progressing well, we can add in 'people issues' by having the respiratory therapist argue that the rate is too low and the patient is getting acidotic, (which will be true.) The student should, respectfully, point out that they are using permissive hypercapnea to prevent barotrauma.)

You are going to need three additional States: 'Post Intubation' and 'Ventilator ≤ 10 ' and "Ventilator ≥ 11 " between the 'No IM epinephrine Given' and the "IM epinephrine Given" states. Fortunately, there is one 'unused' state in between. You go to 'Editor' mode and open the scenario. You add a State

which is going to show up below the “IM epinephrine Given’ State. Add another State which will appear below the first. Using the cut and paste feature move all of the parameters from ‘IM epinephrine Given’ to the last State. Label the last State: ‘IM epinephrine Given’. You now have three ‘unused’ States in a row and will want to label them top to bottom as : Post Intubation’, “Ventilator Rate ≥ 11 ” and “Ventilator Rate ≤ 10 ”.

h. Program the ‘State’.---“Post Intubation”

For this State we have the patient becoming very hypotensive post intubation. We are shooting for a BP of 60s systolic. To do this will mean increasing venous capacity factor. We may need to use the Elastance parameters also to achieve the systolic and diastolic split. Intubation will improve saturation, so shunt fraction and oxygen consumption will need to come down. PVCs will resolve once perfusion is addressed. We would like to have the following vital signs: RR 40, HR 150, BP ~67/40s, SPO2 85%.

To do this we will start with our patient in ‘Player’ mode and in the “No IM Epinephrine Given” State. We will not need any additional parameters and can make changes to the same parameters we have been using to achieve desired condition. Go a head and try this.

After some adjustment you should come up with similar parameters and values:

- Venous Capacity Factor to 2.0 over 1 minute
- Baroreceptor Gain (Overall) to 0 over 1 minute
- Elastance: Extrathoracic Arteries to 1.1 over 1 minute
- Elastance: Intrathoracic Arteries to 2.8 over 1 minute.
- Shunt Fraction to .33
- Oxygen consumption to 200 over 1 minute
- Heart Rate Factor to 1.62
- Cardiac Rhythm Override---no change.

This will mean under ‘Events’ for “Post Intubation” we will need to set seven parameters in the same manner as before. The copy / paste function will speed this up. You will have to be in “Editor” mode.

At this point, we should also have the same Transition of :
“If epinephrine ≥ 0.01 , then go to “IM epinephrine given”
Again, cut / paste is the fastest way to add this in.

Because the simulator will respond to volume the operator is going to have to cognizant of the volume given and where the BP is and make adjustments as indicated to keep the BP in line with the scenario. This is the sort of discussion the instructor and operator need to have before starting the case.

i. **Program the 'States'**---“Ventilator Rate >10” and “Ventilator Rate ≤10”

Here the goal is to get the proper ventilator settings for this severely bronchially constricted patient whom is having very poor gas exchange. For this scenario, proper ventilator settings are important. We will set up two States to represent the patient's condition by using 10 as the break point.

Note: the tidal volume will also have to be ≤ 450 which will also be used to advance the scenario. Since there are multiple and dynamic factors occurring, the operator will have to be listening to what is being done before advancing the scenario. Here the use of a single Transition point is not going to work well.

The more dynamic and the more complicated the scenario is, the more variables there are. As variables increase, programming a Transition becomes increasingly difficult. It is vital that the Operator and the Instructor have dialogue prior to running a case in order for the case to progress when it should.]

Depending on which rate the student sets up, we will use the 'Go to' function to move the scenario to that State.

For our scenario, the lung function will be the same regardless of which ventilator rate the student selects. So once we figure this out, we will have it for both States. His Peak Inspiratory Pressure is going to be in the 30s at a minimum.

To simulate the lungs and function for this patient we will need to use several parameters we have not used before which affords us an opportunity to explore the respiratory side of the simulator more.

Our patient is going to be 'stiffer' to ventilate with air trapping occurring. We will use the Lung Compliance Factor (both left and right lungs) as the primary means of increasing inspiratory pressure.

He is also going to move less air and his Functional Residual Capacity (FRC) is going to increase. We are also going to use the Distended Chest Wall Compliance Factor and the Chest Wall Compliance Factors and drop them to help simulate the 'stiffness' as FCR increases. These factors will also help to increase inspiratory pressure. These new parameters are located under the 'Respiratory' tab and "Lungs' menu.

The student's actions are going to have a great impact on vital signs, which is fine and even more life like. Also, we are not looking to have an exact Target Values, but more of a range. However, we do want to establish that the SPO2 is improving some so we will set a Target value of SPO2 93%

with the idea that we can not improve better than this until we resolve the airway constriction with epinephrine.

We can give sedation and neuromuscular blockers to the simulator and it will respond in kind. The patient's RR will be zero as result of the initial neuromuscular blockers the students will give to intubate the patient. Thus, we do not need to adjust the Respiratory Rate Factor.

Rate of breathing will therefore be dependant on what the student selects on the ventilator. Same is true for Tidal Volume. However, the result of the therapy chosen is going to be greatly different.

Initial BP will be unchanged from the Post Intubation State----and will improve with volume to 95 systolic but not above unless there are proper ventilator settings. When the correct ventilation is selected, we will use the VCF to increase the BP. We will also use VCF to keep the BP depressed until that time. [Regardless of what the ventilator is set at, the students must still continue to give volume until the BP is 'adequate' (100 systolic).]

To figure out what and how much we need to change things we are going to start with the patient: Asthma Case, Faculty Development open in the "Post Intubation" State and make changes from there. Using this starting point and these parameters, try making the changes needed to reach this patient's condition. Note: in order to ascertain whether or not the PIP is correct, will require working outside of the virtual mode we have been in. This means that the simulator has to be on, intubated and on a ventilator. Ventilator Settings need to be: TV of 450, CMV 11 for the State --- "[Ventilator Rate \$\geq 11\$](#) ". Ventilator Settings should be 500 and CMV 10 for the State "[Ventilator Rate \$\leq 10\$](#) "

After some time and trial you should come up with the following:

- Left Lung Compliance Factor 0.15
- Right Lung Compliance Factor 0.15
- Functional Residual Capacity 3000
- Distended Chest Wall Compliance Factor 0.24
- Chest Wall Compliance Factor 0.24

This will give a PIP of ~32 for higher ventilator settings and ~25 for lower settings.

A shunt fraction of 0.2 worked well with this.

We next need to figure out the BP. BP stayed down and even dropped some with these ventilator settings. We can leave the VCF at 2.0 for the State 'Ventilator Rate ≥ 11 ' as this worked well enough. .

A little adjusting shows that we can raise the BP to an acceptable range nicely by lowering the VCF to 1.7 and we will put this in the “Ventilator Rate \leq 10’ State.

At this point, we need to populate the Events for each State. Five of these parameters are new and we can not take advantage of the cut and paste function and will have to add five ‘New “Set” Event’s. You will have to use Editor—Scenario---Events---;New Set Events to populate the first ventilator State. The cut and paste feature will make populating the second ventilator States much faster. These new parameters are located under the ‘Respiratory’ tab and “Lungs’ menu. Cut and paste will be the quickest way to add VCF and SF to both States---then change the value.

Save your work!.

Now you need to test the whole scenario to see just how it rolls out using the simulator. The Simulator will have to be on and the Rack connected to the computer.

Open the patient and the scenario and allow for the patient to make changes at each State before going to the next State.

Give the appropriate therapy indicated for each State. Watch and see how the values change. If the Target Values are off in a particular State, go a head and change the parameters to see what needs to corrected. Make notes as you go.

We note that because the simulator senses and reacts to oxygen, our SPO2 is value higher than in virtual mode when oxygen is given.

As a result we find that, we need to adjust the Shunt Fraction up (to 0.38) to take into account oxygen being given and we also need to leave the O2 Consumption at 250. This would be for the Post Intubation State.

Also, we would like the Venous Capacity Factor in the State “Ventilator Rate > 11” to be a little higher, (2.1) to keep the BP from getting too high.

Similarly, we need to adjust the Shunt Fraction up to 0.50 to keep the SPO2 constant in the State “Ventilator Rate < 10”.

In order for our final State (“IM epinephrine Given”) to work, we need to undo or nearly undo all of the changes we made in our three new States. Some of these are already taken into account as they are the same parameters we had been using. However, we will need to add-in and modify those five new lung parameters in the final State.

Go into Editor mode and make the changes. Rerun to check these changes. If everything looks good, then you are now ready to try this on your students!.

E Factors For Success: (More Tips From the Trenches)

1) General:

- It is important to test any programming prior to starting a simulation even if changes seem small.
- Transitions can be nice and work well. Keep in mind that they only work if the specified patient condition is reached or treatment is performed. When the students are performing well this works as designed. However, when the correct thing is not done the scenario will stay at that state---you may have to advance the scenario manually using 'Next'..
- Scenarios are usually written from the perspective that the care given will be correct. Since the students are learning, they will not always do the correct thing and in fact will do adverse if not bizarre things. It is therefore, a good idea to consider possible alternate pathways that the scenario can go and program for the more likely untoward events.
- Think also about when teaching points either have been reached or lost and it is time to advance or stop the scenario. These sorts of notes should accompany the scenario.
- When you reach the end of a scenario, you can close that scenario by clicking on "Close" under the same menu you opened the scenario. The computer will ask you if you want to save changes---**do not save changes**. If you save them, you will be making changes to the patient and / or scenario. The case will not work properly the next time
- (The METI preprogrammed patients and scenarios are in a 'read only' mode and the programming will not allow you to save changes.)
- Some authors have written scenarios that actually open and begin to run in baseline. It is therefore, important to have looked over the day's cases and scenarios prior to beginning. Fortunately, there are only a few of these. All of the METI scenarios open in baseline without affecting the simulator.

2) Skipping States within a scenario:

- Unless there are only minor changes in the skipped states, the patient that has skipped states is going to be the same, period. Often that patient is very different and not usually where you want the 'patient' to be.

- Skipping states can have it's advantages. It can move the case faster. You can also sometimes use this to keep the patient from crashing as the last step often is designed return the patient to 'normal' or stable by undoing all or most of the of the changes.

3) Going back to the top of the scenario:

- It is possible to use the 'Go To' function to 'restart' the scenario by going to the top of the scenario. However, the way most scenarios are written, this does not work as the patient has had changes made to his condition as he went through the scenario the first time and is no longer in the baseline state the scenario is written for.
- As a general, rule, going back up in a scenario will cause the scenario to not work well at all, (and usually fail from the start).
- Therefore, when you want to rerun most scenarios, this almost always means you have to close not only the scenario, but the patient as well and reboot them both

4) Failsafe State:

- Along this line, you may want to consider programming in a 'failsafe' state as a bail out. The state would undo all changes and return the patient to baseline state.
- From the failsafe state, it could be possible to use the "Go to" button to go back up and restart the scenario at the beginning without closing and rebooting the entire case.
- Do not use baseline as the failsafe state. You want to be able to open multiple scenarios at one time and have them sit in baseline ready to go.

5) Running one scenario behind another:

- As an Operator, you can open multiple scenarios all at the same time and they will sit in baseline without making changes to the mannequin. This allows the Operator to open all of the scenarios he /she is going to use in a given case and be able to quickly open each one as needed---a nice feature.
- It is important to understand that the patient often is not back to exactly where he started at the beginning of a scenario. This means a second scenario has to account for this when written. It also means that scenarios usually have to be run in a specific order or the simulation will not work.
- Sometimes an instructor will want to skip a scenario and just use the second or third scenario for that case. Just as skipping a step during a scenario changes how the case will go, so does skipping a scenario affect

how a case will unfold. General rule of thumb, if a case is crafted to run scenarios in a certain order, it should be run in that order.

- Sometimes, (when changes are minor, or the patient has been put back to 'baseline' as part of the programming) scenarios can be run out of sequence.
- It is also possible to make changes on-the-fly and get the case to work. This requires the ability to look at the changes made and to return the patient to 'normal/stable' in short order.
- As a guide, look at the changes made by the programming. If there are a lot of changes or several large changes, then trying to make changes on the fly is most likely not going to work well.

6) Making Changes On-The-Fly:

- The best way to understand what parameters can be changed, to what extent, how they affect the physiology, and how to do this is to simply run some patients and cases. Practice, Practice, Practice.
- One point to note, under the **Cardiovascular** tab there are several sub menus one of which is **'Heart'**. Under the 'Heart' menu is a parameter called: **"Cardiac Rhythm Override"**. This can be utilized to keep a patient from crashing when the case is not going well. This will give the students time to recover and think and eventually 'save' the patient resulting is a more positive experience. Also, this can be a means to give the Operator time to make all of the changes that may be required to keep or get the scenario back on track.

III Appendix:

A Programming Tips

B Troubling Shooting:

Things can and do go wrong with the simulator. There are things that can be done to sort out where the issue resides: software and computer, mechanical functioning of the mannequin, instrumentation inside the rack, or Operator.

Operator: if you have started the simulator and opened the patient and scenario correctly, then you have almost completely eliminated Operator error which is nice to know. You still need to go over all that you have done to make sure you actually did it as you remember.

Computer and Software: Remember you are working with a computer. When not functioning correctly—reboot. It is the easiest and fastest thing to do and often works.

If the simulator is not “alive” make sure you connected the mannequin to the rack and software. [Easy to forget when you have opened the file and are in a hurry.]

If ETCO₂ does not show up on the Anesthesia patient monitor—reboot that monitor--it is a computer also.

Rack :

Make sure the gases are on and that you have 50 PSI coming from each tank to the rack.

If you do not have enough CO₂ the paCO₂ level will never reach 40 and the mannequin will not breathe as he is designed to respond to CO₂ level.

Mannequin:

Drug recognition module must be primed. Do not let the students drain the IV bag feeding the reader as you will lose your prime.

Most issues with drug administration are student in origin---they did not open or close the stopcock in the correct fashion.

The drug recognition module: ‘works sometime and not at others’. If the students are administering drugs correctly, and the system is primed the problem is generally with the stopcock switch. Turn the reader over and make sure the flat metal tab is both breaking the circuit and also clearing the circuit completely. If not, it will work intermittently. Defer to the Simulation Coordinator to readjust the switch.

C Agreement

- **The system should be left ready to go.** Meaning if you use it, you are expected to leave it ready for the next person.
- Participants in this program agree to abide by all policies and procedures of the Clinical Skills and Patient Simulation Center. Failure to do so will result in

suspension of this privilege---this is at the sole discretion of the Simulation Coordinator.

- On site, supervised participation in this program is required to receive the **‘Programmer’** level certification. This training will be done only by the Simulation Coordinator. Successful completion will require passing an assessment at the end of the training.
- Maintenance of Certification: (Currency and Proficiency)
 - The assessment will stand as a measure of the **Programmer’s** proficiency. As equipment changes, upgrades done, additional training will become necessary to continue to this certification.
 - Currency: If a **‘Programmer’** has not used the simulator in 9 months or greater, a Programmer will be required to come in and go through a demonstration of his/her proficiency.
- Without exception, the Simulation Coordinator will be responsible for overseeing all training and assessment.

D What this training is not:

- Operator training which is designed such that the participant can turn on, set up, operate, shut down, and trouble shoot minor basic problems as they arise.
- As an **‘Programmer’**, one should not be unzipping, or ‘going inside the mannequin’.
- It is possible to complete multiple certifications, however, one certification does not imply or confer successful completion of the other.

All persons trained at one certification are expected to know in general terms, what the other certifications entail. This helps one understand how and to what extent their own training extends (or does not extend).

E How To Set Up and Operate selected features

The following are responsibilities of an “Operator” and are not “Programmer” responsibilities. These are included here for informational purposes only---to help better understand the simulator when programming.

1) Defibrillation and Pacing

a) General

Defibrillation and pacing are important and relevant skills to learn and it is encouraged. Frankly, the students enjoy being able to do this.

- The **Operator** is solely responsible during electrical therapy for insuring proper pad placement---after all they are students and learning. This usually means stopping the scenario and inspecting the pads.
- When placing the pads, each pad should only touch their respective brass plate and nothing else. Otherwise this may arc and fry the system. Shorting out the mannequin will result in forfeit of Operator privilege.
- It is imperative to understand that the defibrillation and pacing are two different systems altogether in the HPS. [A 'real patient' has a single system so in this regard the HPS moves away from real life.]

The capacitors that absorb the energy are quite different. The pacing capacitor can only absorb a small amount of current—in milliamps just as a real pacer would deliver. It can not absorb the much larger current that is delivered through defibrillation which is measured in amps as opposed to milliamps. This **1000 fold difference** will fry the pacing capacitor. Thus each system has its own plates to put the pads on.

b) Defibrillation and Synchronized Cardioversion

- **Defibrillation and Cardioversion can **only** be done using the right upper chest to left axillary pad placement.** (Anterior-lateral placement)
- **DO NOT ATTEMPT FRONT TO BACK PAD PLACEMENT FOR DEFIBRILLATION and CARDIOVERSION.----The brass screw-ins (for the brass plates) in these locations are only for pacing and are connected to the much lower voltage capacitor.**
- The HPS is designed to be shocked by a monophasic defibrillator. This means that if you are using the software to automatically advance the scenario after a defibrillation or cardioversion, the programming will work as intended.

A biphasic defibrillator will test the resistance through the pads by sending current through the system just prior to shocking. If the HPS is in 'automatic advance' mode, this test current is enough to trip the software and advance the scenario prior to the defibrillation being delivered. When using a biphasic defibrillator you must take the automatic advance off and advance the scenario 'manually' using the appropriate software tab.

- The mannequin should not be shocked more than three times in succession as this will over heat the capacitor. The capacitor will dissipate the absorbed energy and the mannequin can be shocked again, however, do not exceed more than two shocks per minute.

c) Pacing:

- Similarly, **pacing can only be done using the front to back pad placement.** The brass plates for this therapy are not left in place. This prevents inadvertent frying of the pacing capacitor by incorrect pad placement during defibrillation.* If pacing is required the brass plates must be unscrewed from the defibrillation position and moved to the pacing positions. [Defibrillation is the more frequent therapy given so the mannequin is left set up for this therapy.]
- Thus the **Operator** needs to look ahead at the scenario and move the brass plates in advance for pacing and then immediately return them to the defibrillation (baseline) position when the scenario is over.
- Failure to return the brass plates to the defibrillation position with result in suspension of **Operator** privilege. If the pacing capacitor is fried as a result, the **Operator** will forfeit his/her privileges. If left in place and a subsequent **Operator** fails to notice and fries the pacing capacitor both **Operators** will forfeit their privileges.
- The mannequin does come with two sets of brass plates, which means pacing and defibrillation can be done in the same scenario without having to move the plates. It does mean that the pads would still have to be moved. Based on this and past experience it is better (and less confusing) to only have one set of studs on the mannequin at a time.
- Currently, no one is running a scenario that has both pacing and defibrillation in the same scenario. If someone has a case they desire to have both pacing and defibrillation in the same case, this needs to be cleared with the Simulation Coordination prior to running the case. Running such a case without approval will forfeit **Programmer** privilege.

*[When doing defibrillation, there is a several fold increase in difficulty of placing the pads on the mannequin and avoiding contact with the pacing studs in place. This means this should not be routine practice.]

2) Drug Recognition Module:

This is a module the students like, but sometimes have trouble operating. Most of the time there is something incorrect in how the medication was delivered versus a problem with the HPS. This is also the one area of the HPS that has more problems than others lending itself to being suspected as the problem.

a) Components:

- Medication Syringes: There are 61 medications that can be delivered. Each medication has a label with a bar code that can be put on the appropriate size syringe. Nearly all of these go on a ten ml syringe. The label also has the name of the medication and the concentration.

These syringes can be filled and refilled using, (and only using) distilled water. This helps to keep or at least slow the growth of mildew, etc in the tubing and collection system.

Note: most of these concentrations are standard concentrations that you would normally expect to find. However, not all of them are standard concentrations---a learning opportunity to stress the importance of always reading the label before administering a medication.

- Bar code scanner: This is a simple scanner you find on every cash register. The scanner will flash when reading the bar code on the medication syringe. This code tells the computer the drug and the concentration of the drug.
- Volume Syringes: Fluid administered from the medication syringe moves the barrel of one of two 50 ml glass syringes on the back of the rack. The change in direction represents a given volume.

Knowing the concentration and the volume the computer calculates the amount of medication given. The computer then adjusts the patient's vital signs in accordance with the amount of drug, how the drug should work and in the time the drug required for the medication to work.

- Three way stopcock: Two of the three positions are taken up by the fluid in from the IV bag and fluid out to the rack. The remaining position is open and where the medication syringes will screw on to be read by the bar code scanner. This open position is labeled '2'. The lever on top of the stopcock opens and closes the three positions to fluid flow. This lever should be left at the '1' position.
- To administer a medication: first fill a medication syringe with distilled water. Screw the syringe onto the stopcock and see if the scanner is flashing—thus reading the bar code. Note the bar code must be facing the scanner. Turn the lever from the '1' position to the '2' position. Administer the appropriate volume of fluid for the amount of medication desired. Move the lever back to the '1' position. Note: if the lever is not turned back to the '1' position, the computer will not know when you have finished and will not calculate a final volume/amount of medication. Without the calculated amount of medication, the computer will not adjust the vital signs.
- IV fluid bag and Collection Bag: These are used to keep the Drug Recognition system primed with fluid. Without a proper prime, the 50 ml glass syringe will not move respective to the volume given through the medication syringe. This means the amount of medication 'seen' by the computer will not be the same as administered. [Almost always less.]

The IV bag needs to have enough (distilled water) volume to last the

case. The IV tubing going to the stopcock must be full and free of air.

The tubing leading from the stopcock and going inside the mannequin must also be full and free of air. This tubing runs to the rack via the umbilical from the mannequin. The tubing leading up to the glass syringes must be full and free of air.

The rack will switch glass syringes when the first one is full. While the second syringe is being filled the rack will dump the fluid from the first syringe into an IV collection bag. The tubing to the collection bag does not require to be primed.

The collection bag will need to be emptied. If you are having increased resistance when administering medications, make sure the stop cock to the collection bag is open. If at first, you are able to give medications and then the resistance starts to build up and you find you need a great deal of pressure to administer the medication, you should suspect that the stopcock to the collection bag is closed.

3) BP Cuff:

This simulator is equipped with a BP cuff that is currently set up to function off the automatic cuff from the monitor.

Our set up does not utilize a pressure gauge for auscultating BP manually.

However, it is possible to still palpate a systolic number by watching the count down on the monitor. You can also auscultate a systolic, however, you do not get a diastolic number as the pulse is easily heard all the way down.

Set up involves testing the cuff prior to beginning the training exercise. The manual cuff should correlate with the arterial line as you would normally expect a manual cuff to correlate with an invasive line.

4) Central Lines:

- This is one of the better features of the simulator as it very nicely demonstrates how all of the parameters are interlinked through the software.
- Start up involves opening Standard Man as the initial patient and calibration point for the simulator.
- Once up and functioning, you should zero the invasive lines. We are currently using: arterial, central venous pressure (CVP), and pulmonary artery pressure (PAP).
- These all can be zeroed together by pressing “Zero All” on the Phillips Intellivue MP70 monitor.
- Before pressing the ‘Zero All’ feature on the monitor, you must open, (as you would any invasive line), to room atmosphere as the zero point. To do this select the “**Cardiovascular**” tab. This opens a submenu and defaults to

“Cathereters” which is where you need to be. Select each of these lines in turn and select **‘Atmosphere’** to open them.

- Press the “Zero All” soft key on the monitor and wait. Once the zeroing is complete, close them by returning each catheter to their respective locations: Arterial line to **“Peripheral”**, CVP to **‘Intrathoracic’** and PAP to **“Pulmonary Artery”**.
- The numbers you see should match the numbers on the HUD. If the numbers are off more than a few points, then the monitor and simulator may need to be calibrated to one another. The system does require calibrating occasionally. Past experience shows this takes a minimum of an hour to calibrate and often closer to two hours. If you are about to start or in the middle of a training experience, more than likely this is not going to happen before you need it. If you have a really important training experience that you will be dependent on this feature, it is a word to the wise to come and check the read out well in advance.
- Because of the time requirement, the Simulation Coordinator monitors the system and does this calibration. The calibration software is on the **‘Administrator’** side of the HPS software, thus not readily accessible. Please inform the Simulation Coordinator, of any calibration needs.

5) The Microphone---‘The Voice of Stan’

- This is one of the more interactive features if not one of the most fun things. It helps the simulator come alive as the students must interact and answer questions, address concerns of the patient. Not to use this is to leave a lot out.
- Set up is easy and quick. Once the simulator is up and running, turn the microphone on. The switch is on the top of the Nady UB-16 transmitter. The on light will come on briefly and then go out if the battery has sufficient charge. If not, then the light stays on and you need to replace the two AA batteries. At this point, simply speak into the microphone and listen for the transmission to come from Stan. The speaker is located on the left side at the top of the neck.

6) Chest Compressions:

Invasive catheters will reflect waveforms that are amplitude dependent based on the effectiveness of chest compressions. The more effective the compressions the greater the amplitude on the waveforms and the higher the resultant numbers. The concentration of exhaled CO₂ is proportional to chest compression effectiveness and automatically increases when resuscitation is successful.

There is no real set up required for this. The invasive lines should all be zeroed when the simulator is turned on. These numbers seen should closely match the

respective numbers seen on the Heads UP Display, (HUD). The gas analyzer must also be on.

7) Needle Decompression:

This is software driven and requires little set up.

- Go to the “**Condition**” Tab and select “**Trauma**” then select “ **Needle Decompression**”.
- Select “**Enable**” By selecting ‘**Enable**’ the system will direct air pressure to the internal reservoir inside the mannequin.
- The system is now primed and ready for needle decompression. When a needle is inserted into the permanent decompression site this will depress a valve and air will escape. You should hear a hissing sound. If not the valve is not appropriately pressed.
- Decompression requires a 14 gauge needle that is 3 to 6 cm long.

Set Up:

If you expect to utilize this feature, you should test this prior to running a simulation.

8) Thumb Twitch:

The right arm, (also the ‘IV arm’) accommodates a Peripheral Nerve Simulator. The simulator will detect the stimulus pattern, emitted by the PNS, (single twitch, train-of-four, and tetanus). The simulator will generate the appropriate thumb twitch in response to pattern and type and level still present of the paralytic administered.

Set up involves testing before beginning the training exercise. Occasionally the 9 volt batter in the PNS will need to be changed.

9) GU System

- a) Urine output: Both the adult and peds mannequin will put out urine. The system will have to be primed first in order to do this.
- The system is primed with distilled water.
 - The system is not left primed and will thus require priming each time.
 - Note: if food coloring is used to ‘dye ‘ the distilled water, this must be flushed out once done as the coloring will crystallize onto things and clog the system up.
 - The first thing you will need to do is to move the mannequin as close to the wall as possible. You will need to do this in order to have enough umbilical reach so you can move the rack out to get behind it where all of the connections are.

- Priming the system requires that the orange 'GI' tubing going to the mannequin be connected to the peristaltic pump on the back of the rack. To do this first make sure the rubber peristaltic tubing has been properly set on the pump. The tubing is left in place, however, you should check placement before starting.
 - Flip the attachment lever down and lift the hood casing up.
 - Place the peristaltic tubing over the wheel mechanism and close the hood. [Note the end of the tubing with the connection for the orange tubing must be on the left side of the pump.]
 - Secure by placing the attachment lever to the up position.
 - Pull open the black clips on either side of the wheel mechanism and thread the tubing into place.
 - Attach the peristaltic tubing to the orange tubing going into the hydraulic umbilical going to the mannequin. [Note: the orange tubing if left connected together so you will have to disconnect the tubing from itself to be able to access the connection you will need.]
 - Attach the other end of the peristaltic tubing to the IV urine supply bag. This bag can hang from one of the two hooks on the back of the rack.
 - Place a 14-16 foley in the mannequin.
 - You are now ready to prime the system. Go to the **"Fluid"** tab and open fluids. Go to the far right and select **"Urine Output"**. Use the slide bar to select a high output to speed the priming. (Up to 999 mls/hr). Hit **'Set'**. Once you see 'urine' coming out the foley you are primed. Select '0' and set. You are now ready to go.

- When finished you must flush the system with a liter of clear distilled water to remove all of the food coloring or dye put into the 'urine'. Again, setting the urine output to a high rate will speed the process.

- Shut down is the reverse process.
 - Disconnect the orange tubing from the peristaltic tubing and place the orange tubing in a catch basin allowing gravity to drain the tubing from the mannequin. [Note, a foley must be in the mannequin in order for air to entrain and gravity to work.] You will also want to place a towel under the peristaltic pump to catch the fluid that drains from it and catch any other water that escapes.
 - Gently blow air through the orange tubing using a large syringe to remove the remaining fluid. (A cath tip syringe can be placed into the foley.)
 - The orange tubing can be left disconnected until next use to assist drying. A note needs to be placed on the door of the rack to alert the next Operator of this status. The orange tubing should be reconnected to itself when urine output is not being utilized.
 - Remove the foley.

While we do not generally use the IV arm, an Operator should know how to set it up. The arm will require priming with blood. First locate the gallon jug that the blood is in. This may be on the counter, but most likely is on the floor next to the HVAC in the server room.

- To prime the arm:
 - Fill an IV bag and connect the IV tubing to the IV tubing located in the neck region, (right side).
 - Connect a drain bag ,(second IV bag) to the IV drain.
 - Open the IV bag and prime---you will want some elevation as this is gravity fed.
 - When you see blood coming into the drain bag and are no longer seeing air bubbles, the arm is primed.

- When done you should flush the arm. This procedure is the same as the fill procedure, except replace the blood solution with clear distilled water. Flush until the fluid in the drain bag runs clear. This may take a liter or more.

- Vein and skin replacement: this is a technician level procedure, so as an **Operator** you are not responsible for this. You are responsible for reporting any leaks that will eventually occur even though the 'veins' are self healing.

11) Chest tube:

To use this feature requires priming the system. Note: this is not left set up primed.

- To Prime:
 - Fill an IV bag with simulated blood. Do not use the standard blood used elsewhere in this Simulation Lab and in the IV arm as this is too thick and will clog the system. Put up to 5 cc of red food coloring in an IV bag of distilled water.
 - Connect this bag to the white "Trauma" hose at the back of the rack.
 - Locate the special chest tube priming hose supplied with the mannequin. Lubricate with silicone and insert into the chest tube opening on the mannequin making sure to engage the valve at the base of the access site. This will open the valve and allow you to access the reservoir.
 - Open the "**Condition**" tab. You have two choices in the submenu: 'Assessment and 'Trauma'. ('Assessment" is the default setting and will show so you will have to click on the arrow to the right of '**Assessment**' to get to the '**Trauma**' menu. Select '**Chest Tube Enable**'. Once this tab is open select '**Prime**'.
 - Check for leaks during the priming process.
 - Once the chest tube is flowing, set the **Chest Tube Enable** parameter back to '**Disable**' (from 'Prime'.)
 - Open the back of the rack and locate the 'Trauma flowmeter' in order to zero it. This is the black box on the back of the rack. Zero by pressing the black button on the bottom left hand corner as you are looking at it from the back of the rack. (There may be some fluctuation of the readings you

see, for example 0.0 to 0.3 to 0.5 which is normal.) Once the meter reads zero you are ready to use the software to drive the process during your simulation.

- Using the Software:
 - Under the '**Condition---'Trauma'** Tab set '**Chest Tube Enable**' to "**Enable**"
 - You will want to adjust the following to fit your specific scenario: '**Chest Tube Flow Rate**', and '**Chest Tube Air Leak**'.
 - Under '**Respiratory---"Lung"**' set "**Intrapleural Volume**" to the the desired amount for your scenario.

- Clean up:

This is pretty much going to be the reverse: .

 - Disconnect 'blood' IV bag and replace the 'blood' IV bag with clear distilled water IV bag. Use a towel to catch any fluid that drips. Note: you will have to open the system by placing a chest tube into the mannequin.
 - Open '**Condition'---"Trauma"** tab
 - Set to "**Prime**" and flush until clear. You will need a catch basin under the chest tube on the mannequin.
 - Look for leaks, report any leaks to the Simulation Coordinator.
 - Using a cath tipped syringe placed into the chest tube, blow out the remaining water from the system. You will have to first disconnect the IV flush from the white 'Trauma' tubing on the back of the rack and place the catch basin under the 'Trauma tubing'.

12) Pericardiocentesis:

- This starts with first priming the chest tube
 - Prime the pericardiocentesis site using the software. To do this select '**Conditon**' tab, next select "**Trauma**" sub menu, next select "Pericardiocentesis Enable", and under this select "**Prime**".
 - Once done, under the same "**Pericardiocentesis Enable**" tab, move from "**Prime**" to "**Enable**".
 - Using a 20 ml syringe and a 16-18 gauge needle, (10-15 cm long) aspirate fluid until you get all of the air out of the system. [Needle should be inserted at the pericardiocentesis access port.]
 - The system is primed and ready to be used.

- Clean up:
 - Remove the chest skin and locate the pericardiocentesis mechanism.
 - Remove the red tape.
 - Replace the 'pericardial fluid' bag with clear distilled water.
 - Under the "**Pericardiocentesis Enable**" tab select "**Prime**" and flush the system.
 - Locate the "Trauma Features Drainage Tube" and attach it to the pericardiocentesis drain fitting inside the mannequin's belly.

- Select “**Pericardiocentesis & Chest Tube/Disabled**” ---do not select “**Prime**”.
- Using a syringe push air through the system until no water is observed exiting.
- Reassemble the pericardiocentesis
- Replace the chest skin per procedure.

13) DPL:

It is unlikely that you will be required to set this up but is included in the off chance you might need to utilize it. If this is required, you need to review the set up with the Simulation Coordinator as more than likely neither of you are current on this set up. The reservoir will hold up to a liter of fluid.

- Prepare the fluid composition appropriate for the sort of tap per scenario using sterile, or distilled water.
- Roll the chest skin back to expose the abdominal area.
- Remove the red tape over the DPL slit.
- As this will place fluid, (a lot) inside the mannequin with all of its electronic equipment it is imperative that there are no leaks. First fill the reservoir with air and observe for leaks---reservoir is able to hold air pressure. To do this insert a needle and fill with air from a syringe. Once full, you may have to replace the red tape to effectively check air pressure.
- Once satisfied about leaks, fill with fluid observing for leaks as you go.
- Replace the red tape when full to insure a seal.
- You are now ready to go.

Clean up;

Using a syringe, remove the fluid taking precautions not to puncture the reservoir. This may be best done with suction tubing set and a suction unit.

E Complete Start Up and Shut Down Procedure

The following are responsibilities of an “Operator” and are not “Programmer” responsibilities. These are included here for informational purposes only---to help better understand the simulator when programming.

1) Power On:

1) Turn the ‘**Rack**’ on first.

This is a black toggle switch on the bottom left. Push the top in to “On”.

2) Turn the computers on.

Desk top Mac This is a round silver push button located to the bottom left. It is above the USB ports and headset jack. It looks pretty innocuous and more like a symbol than a button.

Mac Laptop is located on the second shelf of the beige rolling cart. Power

button is a push button located above the keyboard and to the right.

3) Open the **HPS Program**

Click on “HPS User”. You will then have to enter the case sensitive password:

4) Start up the programmed patients from the Default setting of **“Standard Man”**

There are two ‘Meti Men’ on the tool bar the bottom of the screen. Click on the one at on the right. This will open the “Patients@localhost” screen. Click “Open”. Patients are listed alphabetically. Scroll down and click on “Standard Man”

5) **Connect** to the Rack

You are running in ‘virtual mode’ at this point, meaning ‘Stan’ has not come alive. To make the manikin breathe, etc. you will need to connect the manikin to the rack.

Before you connect, you need to turn on the gases. You must turn on all four gases; oxygen, nitrogen, CO₂, and air. Use the main knob on top of each tank and turn counterclockwise several turns until the gages are pressurized. All four should show and output to the Rack of 50 psi or the system will not operate correctly.

Note the amount of gas in each tank with careful attention to air (and oxygen). The system uses air to drive the manikin, if you have less than several hundred pounds of air you have a good chance of not getting through you first scenario. In short the manikin uses a lot of air. He also consumes oxygen, but not to the extent of air. If you have any N₂ or C₀₂ you probably can run for hours.

The system should be left ready to go. Meaning if you use it, you are expected to leave it ready for the next person and change empty or near empty tanks out before you leave. They are located in the storage closet---room ‘1047’. This is locked and you will need to get the keys out of the top draw of the fiberoptic cart.

Once the gases are on and the amount checked you are ready to connect. To do this you must click on “**Connections**” to the top right of the ‘patient screen’. A side tab will open to the right. At the top of the blank field you need to see: ‘**HPS 394**’. This may not appear initially as the computer and rack are ‘talking’ to each other. It should come up in a few seconds. Only after you see HPS 394 can you proceed. Click on **HPS394** then ‘Connect’ at the bottom of the tab.

After clicking ‘Connect’, you should hear the rack cycle. Stan’s eyes will open briefly and he will take a breath. The system will then do an internal calibration check before starting to function. Post calibration check, Stan’s eyes will stay open and he will start to breathe and function.

You should QC Stan before any exercise, meaning, is his chest rising normally, pulses present, eyes open, etc. Any problems need to be reported in writing to the Simulation Coordinator.

Congratulations, you have made it and ready to go. Close “Standard Man” and open desired patient.

2) Shut Down Procedure

(Basically the reverse of Power up---gases last)

1) Close the **patient**

First click ‘Disconnect’ located on the top left of the patient screen. Then click ‘Stop’. You will see a command asking you if you want to save----click ‘Don’t Save’.

2) Quit **HPS**

Click on “**HPS**” on the topmost toolbar. Click ‘Quit HPS’ at the bottom of the screen that comes up.

3) Shut Down the **computer**

Click the ‘Apple symbol’ on the topmost toolbar. Click on “Shut Down” from the

screen that pops up. The computer will shut down. As this is a Mac, you will not have to wait long for the computer to shut down---nice!

4) Turn off the **Rack**

Push the toggle switch down to 'off'.

5) Turn off and vent **tanks**
Do Not Leave tanks on---
they will leak down

First, note the pressure in each tank. Close the main valve on the top of the tank by turning clockwise until tight.

Open the small valve on the "Y" of each regulator by turning counter clockwise. When the pressure has come to zero and there is no more gas venting, close the small valve.

Change out any tanks that are empty or near empty.

Check the pressure in any 'new' tanks, then close and vent these as well. You are done---close doors, thank you.

3) Comparison of On and Off procedure

Power up Procedure

- 1) Turn the '**Rack**' on first.
- 2) Turn the **Desk top Mac** on.
- 3) Open the **HPS Program**
- 4) Start up the programmed patients from the Default setting of "**Standard Man**"
- 5) **Connect** to the Rack

Shut Down Procedure

- 1) Close the **patient**
- 2) Quit **HPS**
- 3) Shut Down the **computer(s)**
- 4) Turn off the **Rack**
- 5) Turn off and vent **tanks**