Scenario XML Files

BioGears can be used to simulate various physiological scenarios. The Common Data Model (CDM) provides a Scenario structure that can contain a set of instructions that can be used to drive BioGears. Below you can see :

- How a scenario is structured in XSD Schema
- XML examples of all the actions, conditions, assessments supported by BioGears

A Scenario is a 'canned' instruction set with requested data to be output in a comma delimited file that is executed by the engine and will produce the same results data. 'FATAL' is used below to note boundary cases that will result in a fatal exception, stopping the engine.

If you would like execute scenarios, the CDM contains a class, SEScenarioExec (https://www.biogearsengine.com /documentation/class_s_e_scenario_exec.html), that can execute any scenario with a physiology engine that implements the PhysiologyEngine (https://www.biogearsengine.com/documentation/class_physiology_engine.html) interface. The Toolkit (https://www.biogearsengine.com/documentation/_toolkit.html), also provides example scenario files and can also execute scenario files.

An example of a basic scenario file is shown below.

```
 1  <?xml version="1.0" encoding="UTF-8"?>
 2  <Scenario xmlns="uri:/mil/tatrc/physiology/datamodel" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsdVersion="v16.12" contentVersion="BioGears_6.0.1-beta" xsi:schemaLocation="">
 3    <Name>InitialStableState</Name>
 4    <Description>Start the engine at a state, this is for debugging said state</Description>
 5    <EngineStateFile>./states/StandardMale@0s.xml</EngineStateFile>
 6
 7    <DataRequests>
 8      <DataRequest xsi:type="PhysiologySystemDataRequestData" Name="HeartRate" Unit="1/min"/>
 9      <DataRequest xsi:type="PhysiologySystemDataRequestData" Name="RespirationRate" Unit="1/min"/>
10      <DataRequest xsi:type="PhysiologySystemDataRequestData" Name="OxygenSaturation" Unit="unitless"/>
11
12      <DataRequest xsi:type="GasCompartmentDataRequestData" Compartment="Carina"     Substance="Oxygen"
          Name="PartialPressure" Unit="cmH2O" Precision="0"/>
13      <DataRequest xsi:type="GasCompartmentDataRequestData" Compartment="Carina"
          Substance="CarbonDioxide" Name="PartialPressure" Unit="cmH2O" Precision="1"/>
14
15      <DataRequest xsi:type="LiquidCompartmentDataRequestData" Compartment="Aorta"     Substance="Oxygen"
          Name="PartialPressure" Unit="mmHg" Precision="1"/>
16      <DataRequest xsi:type="LiquidCompartmentDataRequestData" Compartment="Aorta"
          Substance="CarbonDioxide" Name="PartialPressure" Unit="mmHg" Precision="1"/>
17    </DataRequests>
18
19    <Action xsi:type="AdvanceTimeData">
20      <Time value="2" unit="min"/>
21    </Action>
22  </Scenario>
```

The scenario allows for a name and description, but this is not used in execution. The scenario contains the following execution information:

- What engine state to use
- A list of values to return from the engine
- A list of actions to execute over the course of the run

Patient File and optional conditions

While it is recommended to use an Engine State when running a scenario, you do have the option to initialize the engine with a Patient File and optional conditions. The specified patient file refers to an XML file containing PatientData (https://www.biogearsengine.com/documentation/group__patient__patient_data.html) information. Replace the <EngineStateFile> tag with the <InitialParameters> tag like this:

```
 1 <?xml version="1.0" encoding="UTF-8"?>
 2 <Scenario xmlns="uri:/mil/tatrc/physiology/datamodel" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsdVersion="v16.12" contentVersion="BioGears_6.0.1-beta" xsi:schemaLocation="">
 3   <Name>Anemia30</Name>
 4   <Description>Anemia onset, leading to 30% reduction in hemoblogin content</Description>
 5   <InitialParameters>
 6     <PatientFile>StandardMale.xml</PatientFile>
 7     <Condition xsi:type="ChronicAnemiaData">
 8       <ReductionFactor value="0.3"/>
 9     </Condition>
10   </InitialParameters>
```

Patient Conditions

Conditions give instructions to the engine to apply certian changes to the engine to simulate the specified conditions. The following are links to the Condition class specification along with XML examples of conditions that can be used in making your own scenarios.

Chronic Anemia

Condition characterized by reduced red blood cells, which leads to reduced oxygen carrying capacity. Implemented by reducing the amount of hemoglobin in the blood.

```
 1 <Condition xsi:type="ChronicAnemiaData">
 2  <ReductionFactor value="0.3"/>
 3 </Condition>
```

COPD

Chronic Obstructive Pulmonary Disease (COPD) is an obstructive lung disease characterized by chronically reduced airflow into the lungs. Unlike asthma, the reduction in airflow does not generally improve with medication. When tissue damage occurs primarily in the airways, the condition is called chronic bronchitis. When tissue destruction is focused in the alveoli, the condition is called emphysema. COPD is a manifestation of both conditions, although one condition may dominate.

```
 1 Condition xsi:type="ChronicObstructivePulmonaryDiseaseData">
 2  <BronchitisSeverity  value="0.65"/>
 3   <EmphysemaSeverity   value="0.50"/>
 4 </Condition>
```

Chronic Pericardial Effusion

Pericardial effusion ("fluid around the heart") is an abnormal accumulation of fluid in the pericardial cavity. Because of the limited amount of space in the pericardial cavity, fluid accumulation leads to an increased intrapericardial pressure which can negatively affect heart function. A pericardial effusion with enough pressure to adversely affect heart function is called cardiac tamponade. Pericardial effusion usually results from a disturbed equilibrium between the production andre-absorption of pericardial fluid, or from a structural abnormality that allows fluid to enter the pericardial cavity. Normal levels of pericardial fluid are from 15 to 50 mL.

```
 1 <Condition xsi:type="ChronicPericardialEffusionData">
 2   <AccumulatedVolume value="500" unit="mL"/>
 3  </Condition>
```

Chronic Renal Stenosis

Narrowing of the renal artery.

```
1  <Condition xsi:type="ChronicRenalStenosisData">
2    <LeftKidneySeverity value="0.9"/>
3    <RightKidneySeverity value="0.9"/>
4  </Condition>
```

Chronic Ventricular Systolic Dysfunction

Impairment of the ventricular contraction, reducing the ability of the heart to pump blood.

```
1  <Condition xsi:type="ChronicVentricularSystolicDysfunctionData"/>
```

Consume Meal

```
1  <Condition xsi:type="ConsumeMealData">
2    <Meal>
3      <Water value="1.0" unit="L"/>
4      <ElapsedTime value="12.0" unit="hr"/>
5    </Meal>
6  </Condition>
```

Impaired Alveolar Exchange

Generic way to specify the effectiveness of alveolar exchange.

```
1  <Condition xsi:type="ImpairedAlveolarExchangeData">
2      <ImpairedSurfaceArea value="1.0" unit="m^2"/>
3  </Condition>
4
5  or
6
7  <Condition xsi:type="ImpairedAlveolarExchangeData">
8      <ImpairedFraction value="0.20"/>
9  </Condition>
```

Lobar Pneumonia

Lobar pneumonia is a form of pneumonia that affects one or more lobes of the lungs. As fluid fills portions of the lung it becomes more difficult to breath and the gas diffusion surface area in the alveoli is reduced.

```
1  <Condition xsi:type="LobarPneumoniaData">
2    <Severity        value="0.70"/>
3    <LeftLungAffected   value="0.00"/>
4    <RightLungAffected   value="0.67"/>
5  </Condition>
```

Initial Environment

Change environmental conditions before the simulation begins.

```
1   <Condition xsi:type="InitialEnvironmentData">
2     <Conditions>
3       <SurroundingType>Air</SurroundingType>
4       <AirVelocity value="0.0" unit="m/s"/>
5       <AmbientTemperature value="20.0" unit="degC"/>
6       <AtmosphericPressure value="525.0" unit="mmHg"/>
7       <ClothingResistance value="3.0" unit="clo"/>
8       <Emissivity value="0.9"/>
9       <MeanRadiantTemperature value="20.0" unit="degC"/>
10      <RelativeHumidity value="1.0"/>
11      <RespirationAmbientTemperature value="20.0" unit="degC"/>
12      <AmbientSubstance Name="Nitrogen">
13        <FractionAmount value="0.8576"/>
14      </AmbientSubstance>
```

```
15        <AmbientSubstance Name="Oxygen">
16          <FractionAmount value="0.142"/>
17        </AmbientSubstance>
18        <AmbientSubstance Name="CarbonDioxide">
19          <FractionAmount value="4.0E-4"/>
20        </AmbientSubstance>
21      </Conditions>
22  </Condition>
23
24  or
25
26
27  <Condition xsi:type="InitialEnvironmentData">
28      <ConditionsFile>Hypobaric3000m.xml</ConditionsFile>
29  </Condition>
```

Data Requests

Currently there are four supported types of data requests:

Physiology System Data

Physiology System data refers to all the data specified by SystemData and its derived types.

At this time, you do not need to specify the system name. The Name attribute should be set to a System Property name. (e.g., HeartRate)

```
1  <DataRequest xsi:type="PhysiologySystemDataRequestData" Name="HeartRate" Unit="1/min" />
```

Compartment Data

Compartments refer to all the data specified on Compartments. You can read more about compartments here (https://www.biogearsengine.com/documentation/physeng.html#CompartmentsInterface).

There are two amin types of Compartments, gas and liquid.

Data on the compartment itself: The Compartment attribute can be any of the enumerations defined by BioGears. The Name attribute should be set to a Compartment Property name. The Substance attribute is optional, and the if used the name will refer to a substance quantity property.

```
1  <DataRequest xsi:type="GasCompartmentDataRequestData" Compartment="LeftAlveoli" Name="Pressure"
        Unit="cmH2O"/>
```

```
1  <DataRequest xsi:type="GasCompartmentDataRequestData" Compartment="LeftAlveoli" Substance="Oxygen"
        Name="PartialPressure" Unit="mmHg"/>
```

```
1  <DataRequest xsi:type="LiquidCompartmentDataRequestData" Compartment="Aorta" Name="Pressure" Unit="mmHg"
        />
```

```
1  <DataRequest xsi:type="LiquidCompartmentDataRequestData" Compartment="Aorta" Substance="Oxygen"
        Name="PartialPressure" Unit="mmHg"/>
```

Environment (https://www.biogearsengine.com /documentation/class_environment.html) Data

Environment (https://www.biogearsengine.com/documentation/class_environment.html) System data refers to all the

data specified by EnvironmentData (https://www.biogearsengine.com/documentation /group__environment__environment_data.html) and its derived types.

```
1  <DataRequest xsi:type="EnvironmentDataRequestData"  Name="ConvectiveHeatLoss"  Unit="W"      Precision="2"/>
```

Equipment Data

System level data from a piece of equipment

```
1  <DataRequest xsi:type="EquipmentDataRequestData"  Type="ECG" Name="Lead3ElectricPotential"   Unit="mV"
       Precision="0"/>
```

Substance Data

Substance data is provided about a substance and its current state in the body and on specific anatomy compartments

```
1  <DataRequest xsi:type="SubstanceDataRequestData" Substance="Morphine" Name="PlasmaConcentration"
       Unit="ug/mL"/>
```

```
1  <DataRequest xsi:type="SubstanceDataRequestData" Substance="Morphine" Compartment="LeftKidneyTissue"
       Name="MassCleared" Unit="ug"/>
```

General Actions

Actions give instructions to the engine to define what happens over the course of a scenario. Everything from advancing time, to starting a hemorrhage, to administering a drug is an action of some kind. The following are links to the Action class specification along with XML examples of actions that can be used in making your own scenarios.

Advance Time

Execute the engine for the specified amount of time.

```
1  <Action xsi:type="AdvanceTimeData">
2    <Time value="350" unit="s"/>
3  </Action>
```

Serialize State

Save state of the engine to a file.

```
1  <Action xsi:type="SerializeStateData" Type="Save">
2     <Filename></Filename>
3   </Action>
```

Patient Insults

Acute Stress

Fight or flight. The body prepares to defend itself.

Severity value must be >=0.0 and <=1.0

A severity of 0 removes the action completely.

```
1  <Action xsi:type="AcuteStressData">
2    <Severity value="0.3"/>
3  </Action>
```

Apnea

Reduction of achieved tidal volume by inhibiting the respiratory breathing mechanism (i.e., muscles of respiration).

Maximum severity will stop breathing completely.

Severity value must be >=0.0 and <=1.0

A severity of 0 removes the action completely.

```
1  <Action xsi:type="ApneaData">
2    <Severity value="0.3"/>
3  </Action>
```

Airway Obstruction

A blockage of the Airway leading to no respiration/air flow in or out of the body.

Severity value must be >=0.0 and <=1.0

A severity of 0 removes the action completely.

```
1  <Action xsi:type="AirwayObstructionData">
2    <Severity value="0.3"/>
3  </Action>
```

Asthma Attack

A common inflammatory disease of the airways where air flow into the lungs is partially obstructed. This attack is acute asthma, which is an exacerbation of asthma that does not respond to standard treatments.

Severity value must be >=0.0 and <=1.0

A severity of 0 removes the action completely.

```
1  <Action xsi:type="AsthmaAttackData">
2    <Severity value="0.3"/>
3  </Action>
```

Brain Injury

A non-localized traumatic brain injury.

Severity value must be >=0.0 and <=1.0

A severity of 0 removes the action completely.

Types : Diffuse, LeftFocal, RightFocal

```
1  <Action xsi:type="BrainInjuryData" Type="Diffuse">
2    <Severity value="0.3"/>
3  </Action>
```

Bronchoconstriction

Constriction of the airways in the lungs due to tightening of surrounding smooth muscle.

Severity value must be >=0.0 and <=1.0

A severity of 0 removes the action completely.

```
1 <Action xsi:type="BronchoconstrictionData">
2   <Severity value="0.3"/>
3 </Action>
```

Consume Nutrients

Consume nutrients into the body.

```
1  <Action xsi:type="ConsumeMealData">
2    <Nutrition>
3      <Carbohydrate value="390.0" unit="g"/>
4      <CarbohydrateDigestionRate value="0.5" unit="g/min"/>
5      <Fat value="90.0" unit="g"/>
6      <FatDigestionRate value="0.055" unit="g/min"/>
7      <Protein value="56.0" unit="g"/>
8      <ProteinDigestionRate value="0.071" unit="g/min"/>
9      <Calcium value="1000.0" unit="mg"/>
10     <Sodium value="1.5" unit="g"/>
11     <Water value="3.7" unit="L"/>
12   </Nutrition>
13 </Action>
```

Cardiac Arrest

Applies a non-specific cardiac arrest.

```
1 <Action xsi:type="CardiacArrestData"/>
```

Exercise

Increase the patient's metabolic rate leading to an increase in core temperature, cardiac output, respiration rate and tidal volume.

An intensity of 0 removes the action completely.

```
1 <Action xsi:type="ExerciseData">
2   <Intensity value="1.0"/>
3 </Action>
```

```
1 <Action xsi:type="ExerciseData">
2   <BorgScale value="10.0"/>
3 </Action>
```

Hemorrhage

A hemorrhage is the loss of blood escaping from the circulatory system. Typically, a healthy person can endure a loss of 10 to 15 percent of the total blood volume without serious medical difficulties.

The Compartment attribute can be any of the enumerations defined in the enumAnatomy enumeration.

FATAL: Cannot have bleeding rate greater than cardiac output or less than 0

```
1 <Action xsi:type="HemorrhageData" Compartment="RightLegVascular">
2   <Rate value="250" unit="mL/min"/>
3 </Action>
```

Pericardial Effusion

Pericardial effusion ("fluid around the heart") is an abnormal accumulation of fluid in the pericardial cavity. Because of the limited amount of space in the pericardial cavity, fluid accumulation leads to an increased intrapericardial pressure which can negatively affect heart function. A pericardial effusion with enough pressure to adversely affect heart function is called cardiac tamponade. Pericardial effusion usually results from a disturbed equilibrium between the production andre-absorption of pericardial fluid, or from a structural abnormality that allows fluid to enter the pericardial cavity. Normal levels of pericardial fluid are from 15 to 50 mL.

EffusionRate of the liquid

```
1 <Action xsi:type="PericardialEffusionData" >
2   <EffusionRate value="0.1" unit="mL/s"/>
3 </Action>
```

Tension Pneumothorax

A pneumothorax is an abnormal collection of air or gas in the pleural space that separates the lung from the chest wall.

Like pleural effusion (liquid buildup in that space), pneumothorax may interfere with normal breathing.

The Type attribute can be "Open" or "Closed"

The Side attribute can be "Left" or "Right"

Severity value must be >=0.0 and <=1.0

A severity of 0 removes the action completely.

```
1 <Action xsi:type="TensionPneumothoraxData" Type="Closed" Side="Left">
2    <Severity value="0.6"/>
3   </Action>
```

Patient Interventions

Chest Compression Force

Technique used when performing cardiopulmonary resuscitation. Application of external force to the chest cavity in order to pump blood through the heart.

Force is the specific magnitude to perform a compression with.

Note, that patient should be in Cardiac Arrest before performing CPR

```
1 <Action xsi:type="ChestCompressionForceData">
2   <Force value="100.0" unit="N"/>
3 </Action>
```

Chest Compression Force Scale

Technique used when performing cardiopulmonary resuscitation. Application of external force to the chest cavity in order to pump blood through the heart.

ForceScale value must be >=0.0 and <=1.0

Note, that patient should be in Cardiac Arrest before performing CPR

```
1 <Action xsi:type="ChestCompressionForceScaleData">
2   <ForceScale value="0.73"/>
3 </Action>
```

Chest Occlusive Dressing

Applies an occlusive dressing to either the left or right side of the chest. An occlusive dressing is an air and water-tight trauma dressing that provides immediate control of pressure and bleeding that occurs with an open pneumothorax.

The State attribute can be "On" or "Off"

Side is either Left or Right

FATAL: If the side specified does not have a pnumothorax

```
1 <Action xsi:type="ChestOcclusiveDressingData" State="On" Side="Left">
2 </Action>
```

Conscious Respiration

An ordered list of concious breath commands for the patient to preform.

This action can contain 1 or more commands :

- Force air into the lungs.
- Force air out of the lungs.
- Hold the patients breath. There will be no inflow or out flow of air during the specified period.
- Administer a substance through an Inhaler (https://www.biogearsengine.com/documentation/class_inhaler.html). This command will represent a single press of an Inhaler (https://www.biogearsengine.com/documentation /class_inhaler.html).

Commands will be processed in order. The first commands will be proceesed instantly When it has completed (run through it's Period), the next command will be processed. Other actions will be processed while these commands are processed or waiting to be processed. You may want to advance time for the sum of the command periods to ensure the body is doing what you expect it to.. Or not, depending on how you want the system to react.

```
1  <Action xsi:type="ConsciousRespirationData">
2    <Command xsi:type="ForcedExhaleData">
3      <ExpiratoryReserveVolumeFraction value="1.0"/>
4      <Period value="3.0" unit="s"/>
5    </Command>
6    <Command xsi:type="ForcedInhaleData">
7      <InspiratoryCapacityFraction value="1.0"/>
8      <Period value="5.0" unit="s"/>
9    </Command>
10   <Command xsi:type="UseInhalerData"/>
11   <Command xsi:type="BreathHoldData">
12     <Period value="10.0" unit="s"/>
13   </Command>
14 </Action>
```

Intubation

Insertion of tube.

Note: In order to 'turn off' an intubation, use'Off' as the Type

Types : Off, Esophageal, LeftMainstem, RightMainstem, Tracheal

```
1  <Action xsi:type="IntubationData" Type="Tracheal"/>
```

Mechanical Ventilation

Mechanically breathing for the patient, such as with a squeeze bag or other equipment.

You may provide Pressure and/or Flow.

If you do not provide GasFractions, the environment gas fractions will be used.

If you do provide Gas Fractions, they must add up to 1.

```
1  <Action xsi:type="MechanicalVentilationData" State="On">
2   <Pressure value="10.0" unit="cmH2O"/>
3   <Flow value="1.0" unit="mL/s"/>
4   <GasFraction Name="Oxygen">
5    <FractionAmount value="1.0"/>
6   </GasFraction>
7  </Action>
```

Needle Decompression

A 14-16G intravenous caninula is inserted into the second rib-space in the mid-clavcular line. The needle is advanced until air can be aspirated into a connecting syringe. The needle is withdrawn and the caninula is left to allow air flow out of the pleural space. This effectively converts the closed pneumothorax into an open pneumothorax.

The Side attribute can be "Left" or "Right"

The State attribute can be "On" or "Off" FATAL: If the side specified does not have a pnumothorax

```
1  <Action xsi:type="NeedleDecompressionData" State="On" Side="Left"/>
```

Urinate

Empty the bladder of its contents.

Action to empty the bladder. if not emptied, it will empty and throw an event.

```
1  <Action xsi:type="UrinateData"/>
```

Substance Bolus

An administration of a substance that is given all at one time to raise its concentration in blood to an effective level.

The AdminRoute can be one of:

- "Intravenous"
- "Intramuscular"
- "Subcutaneous"
- "Oral"
- "Rectal"

- "Inhaled"

The Substance element should be set to a name of any of the Substances.

```
1 <Action xsi:type="SubstanceBolusData" AdminRoute="Intravenous">
2   <Substance>Succinylcholine</Substance>
3   <Concentration value="4820" unit="ug/mL"/>
4   <Dose value="30" unit="mL"/>
5 </Action>
```

Substance Compound Infusion Fluids

Continuous injection of a compound.

The Substance Compound element should be set to a name of any of the Substances Compounds.

Set Rate to 0 to remove Action

```
1 <Action xsi:type="SubstanceCompoundInfusionData">
2   <SubstanceCompound>Saline</SubstanceCompound>
3   <BagVolume value="500" unit="mL"/>
4   <Rate value="100" unit="mL/min"/>
5 </Action>
```

Substance Infusion

Continuous injection of a specific substance.

The Substance element should be set to a name of any of the Substances.

Set Rate to 0 to remove Action

```
1 <Action xsi:type="SubstanceInfusionData" State="On" AdminRoute="Intravenous">
2   <Substance>Succinylcholine</Substance>
3   <Concentration value="5000" unit="ug/mL"/>
4   <Rate value="100" unit="mL/min"/>
5 </Action>
```

Anesthesia Machine State

Anesthesia Machine Configuration

Action for controlling the machine.

NOTE: Each field is optional.

Connection can be one of : Off, Mask, Tube

Patient must be intubated to be connected as Tube

Anesthesia machine will be disconneted if intubation is removed.

Patient cannot be intubated to be connected as Mask

Anesthesia machine will be disconneted if patient is then intubated.

Cannot have inhaler and anesthesia machine on at the same time

```
1 <Action xsi:type="AnesthesiaMachineConfigurationData">
2   <Configuration>
3     <Connection>Mask</Connection>
4       <InletFlow value="5.0" unit="L/min"/>
```

```
5       <InspiratoryExpiratoryRatio value="0.5"/>
6       <OxygenFraction value="0.25"/>
7       <OxygenSource>Wall</OxygenSource>
8       <PositiveEndExpiredPressure value="1.0" unit="cmH2O"/>
9       <PrimaryGas>Nitrogen</PrimaryGas>
10       <RespiratoryRate value="16.0" unit="1/min"/>
11       <VentilatorPressure value="10.5" unit="cmH2O"/>
12       <OxygenBottleOne>
13         <Volume value="660" unit="L"/>
14       </OxygenBottleOne>
15       <OxygenBottleTwo>
16         <Volume value="660" unit="L"/>
17       </OxygenBottleTwo>
18     </Configuration>
19  </Action>
```

```
1  <Action xsi:type="AnesthesiaMachineConfigurationData" >
2    <Configuration>
3      <Connection>Off</Connection>
4    </Configuration>
5  </Action>
```

```
1  <Action xsi:type="AnesthesiaMachineConfigurationData">
2    <Configuration>
3      <LeftChamber>
4      <State>On</State>
5        <SubstanceFraction value="0.04"/>
6        <Substance>Desflurane</Substance>
7      </LeftChamber>
8    </Configuration>
9  </Action>
```

Anesthesia Machine Incidents

Oxygen TankPressure Loss

The active oxygen tank losses pressure.

The State attribute can be "On" or "Off"

```
1  <Action xsi:type="OxygenTankPressureLossData" State="On"/>
```

Oxygen Wall Port Pressure Loss

The wall port losses oxygen pressure.

The State attribute can be "On" or "Off"

```
1  <Action xsi:type="OxygenWallPortPressureLossData" State="On"/>
```

Anesthesia Machine Failures

Expiratory Valve Leak

A leak in the expiritory valve.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="ExpiratoryValveLeakData" State="On">
2    <Severity value="0.5"/>
3  </Action>
```

Expiratory Valve Obstruction

An obstruction in the expiritory valve.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="ExpiratoryValveObstructionData" State="On">
2    <Severity value="1.0"/>
3  </Action>
```

Inspiratory Valve Leak

A leak in the inspiratory valve.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="InspiratoryValveLeakData" State="On">
2    <Severity value="1.0"/>
3  </Action>
```

Inspiratory Valve Obstruction

An obstruction in the inspiritory valve.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="InspiratoryValveObstructionData" State="On">
2    <Severity value="1.0"/>
3  </Action>
```

Mask Leak

A leak in the mask.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="MaskLeakData" State="On">
2    <Severity value="1.0"/>
3  </Action>
```

Soda Lime Failure

A soda lime failure.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="SodaLimeFailureData" State="On">
2    <Severity value="1.0"/>
3  </Action>
```

Tube Cuff Leak

A leak in the tube cuff.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="TubeCuffLeakData" State="On">
2    <Severity value="0.5"/>
3  </Action>
```

Vaporizer Failure

The vaporizer fails.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="VaporizerFailureData" State="On">
2    <Severity value="0.25"/>
3  </Action>
```

Ventilator Pressure Loss

The ventilator losses pressure.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="VentilatorPressureLossData" State="On">
2    <Severity value="1.0"/>
3  </Action>
```

Y Piece Disconnect

The Y Piece becomes disconnected.

The State attribute can be "On" or "Off"

Severity value must be >=0.0 and <=1.0

```
1  <Action xsi:type="YPieceDisconnectData" State="On">
2    <Severity value="1.0"/>
3  </Action>
```

Inhaler State

Inhaler Configuration

Action for configuring the inhaler.

FATAL: Cannot have inhaler and anesthesia machine on at the same time

```
1  <Action xsi:type="InhalerConfigurationData">
2    <Configuration>
3      <Substance>Albuterol</Substance>
4      <MeteredDose value="90.0" unit="ug"/>
5      <NozzleLoss value="0.04"/>
6    </Configuration>
7  </Action>
```

Environment

Environment Configuration State

Change environmental conditions.

NOTE: Each field is optional.

```
1   <Action xsi:type="EnvironmentChangeData">
2     <Conditions>
3       <SurroundingType>Water</SurroundingType>
4       <AirVelocity value="0.0" unit="m/s"/>
5       <AmbientTemperature value="10.0" unit="degC"/>
6       <AtmosphericPressure value="760.0" unit="mmHg"/>
7       <ClothingResistance value="0.01" unit="clo"/>
8       <Emissivity value="0.0"/>
9       <MeanRadiantTemperature value="22.0" unit="degC"/>
10       <RelativeHumidity value="1.0"/>
11       <RespirationAmbientTemperature value="22.0" unit="degC"/>
12       <AmbientSubstance Name="Nitrogen">
13         <FractionAmount value="0.7901"/>
14       </AmbientSubstance>
15       <AmbientSubstance Name="Oxygen">
16         <FractionAmount value="0.2095"/>
17       </AmbientSubstance>
18       <AmbientSubstance Name="CarbonDioxide">
19         <FractionAmount value="4.0E-4"/>
20       </AmbientSubstance>
21     </Conditions>
22   </Action>
```

Thermal Application

Create an external heat source.

You must provide at least 1 activity, but up can also apply upto all 3 in one action.

```
1   <Action xsi:type="ThermalApplicationData">
2     <ActiveHeating>
3       <Power value="500" unit="BTU/hr"/>
4       <SurfaceAreaFraction value="0.2" unit="unitless"/>
5     </ActiveHeating>
6     <ActiveCooling>
7       <Power value="500" unit="BTU/hr"/>
8       <CSurfaceArea value="0.1" unit="m^2"/>
9     </ActiveCooling>
10     <AppliedTemperature>
11     <State>On</State>
12       <Temperature value="30" unit="degF"/>
13       <SurfaceAreaFraction value="1.0" unit="unitless"/>
14     </AppliedTemperature>
15   </Action>
```

```
1  <Action xsi:type="ThermalApplicationData">
2    <AppliedTemperature>
3      <State>On</State>
4        <Temperature value="140" unit="degF"/>
5        <SurfaceAreaFraction value="0.9" unit="unitless"/>
6    </AppliedTemperature>
7  </Action>
```

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