

Scenario Overview			
<p>The Soldier Multi-Trauma Showcase Scenario simulates the injuries that a Combat Medic or other caregiver may encounter on the battlefield. This scenario highlights the ability of the BioGears® physiology engine to simulate multiple insults occurring simultaneously. We have incorporated a tension pneumothorax with a massive hemorrhage. The tension pneumothorax is itself a combinatory insult, affecting both the respiratory and cardiovascular systems. Combining the tension pneumothorax with the blood loss from the hemorrhage pushes and eventually exceeds the limits of the homeostatic control mechanisms.</p>			
Base Physiology	Insults and injuries	Assessments	Interventions
A 22 year old physically fit male soldier. No known complicating factors.	Trauma which causes massive hemorrhage and tension pneumothorax.	Heart Rate Bleeding Rate Blood Pressure Distal Pulse Respiration Rate Oxygen Saturation	Tourniquet Needle Decompression Narcotics Fluid Resuscitation Transfusion
Scenario Narrative			
Segment 0	Engine initialization period.		
Segment 1	A team of soldiers is conducting a presence patrol through a small village in a troubled country. As they pass a mud wall, an improvised explosive device detonates injuring one of the soldiers. The squad medic was with the other team in another part of the village, and she reaches the casualty one minute after the onset of injury.		
Segment 2	The medic goes to work immediately, attempting to stop the hemorrhage with direct pressure while she assesses the casualty for other injuries. After one minute of assessment, the medic suspects a tension pneumothorax. She instructs a combat life saver to continue direct pressure on the hemorrhage while she prepares to treat the tension pneumothorax.		
Segment 3	The medic treats the tension pneumothorax by performing a needle decompression. The three inch needle is inserted immediately, and the medic spends the next four minutes finishing and assessing the effectiveness of the procedure.		
Segment 4	The medic notices that the combat life saver is unable to effectively control the bleeding with direct pressure. She applies a tourniquet stop the hemorrhage. The medic spends 30 seconds inspecting the tourniquet application and preparing an intravenous infusion.		
Segment 5	The medic initiates a bolus intravenous infusion of isotonic saline.		
Segment 6	The medic also administers five milligrams of morphine intravenously to control the casualty's pain. She advises the ranking military person on the scene to call a CASEVAC and continues supportive care.		
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SMEs:			
S1	Rodney Metoyer - Former Army Combat Medic		
S2	Bryan Bergeron, M.D. -President, Archetype Technologies, Inc.		
Key			
		Good Agreement with data/trends	
		Agreement with most trends, some deviations from validation data/trends	
		Some major disagreements with validation data/trends	

Segment Number	Start Time (s)	Segment Duration (s)	Event (to begin segment)	Notes (End Segment Expected Physiology to right)	HeartRate (BPM)	BioSensors HeartRate (BPM)	HeartStrokeVolume (ml/beat)	BioSensors HeartStrokeVolume (ml/beat)	BloodVolume (ml)	BioSensors BloodVolume (ml)	MeanArterialPressure (mmHg)	BioSensors MeanArterialPressure (mmHg)	SystolicArterialPressure (mmHg)	BioSensors SystolicArterialPressure (mmHg)	DiastolicArterialPressure (mmHg)	BioSensors DiastolicArterialPressure (mmHg)	CardiacOutput (L/min)	BioSensors CardiacOutput (L/min)	HemoglobinContent (g)	BioSensors HemoglobinContent (g)	MeanCentralVenousPressure (mmHg)	BioSensors MeanCentralVenousPressure (mmHg)	RespirationRate (Breaths/min)	BioSensors RespirationRate (Breaths/min)	OxygenSaturation (Fraction)	BioSensors OxygenSaturation (Fraction)	TotalVolume (ml)	BioSensors TotalVolume (ml)	TotalLungVolume (ml)	TotalLungVolume (ml) [Measured as peak over 10 seconds]
0	0	60	Initiation (Advance time 1 minute)	An initial period to facilitate observation of changes	60 - 100 [51]	86	55.3 to 93.3 [3]	77	5500 [7]	5591	70 - 105 [13]	95	100 - 140 [31]	114	60 - 90 [13]	73	5000 (at rest) [30] Elevated due to increased HR [51]	6628	13.2 - 17.3 g/dL Blood [5]	851	3-4 [6]	4.3	12 - 20 [1]	16	0.95 - 0.99 [14]	0.97	500 [11]	598	2800 [11]	2655
1	60	60	Begin Tension Pneumothorax (Left Side, closed, severity 0.75) Begin Massive Hemorrhage (Right Leg, rate 350 ml/min)	Massive hemorrhage from the right leg, 350 mL/min based on common femoral artery volumetric flow rate. See graphic. Noted 200ml loss at the end of this segment (Class B hemorrhage). Tension pneumothorax has progressed untreated for 2 minutes.	*25% increase [9] Tachycardia [14]	91	Decrease [51]	67	5350	5250	NC or decrease [16] Compensatory Mechanisms Keep it at Baseline Values [52]	93	Moderate Decrease Acutely [32] Decrease, but not completely collapse [31]	110	No Change [52]	74	Decrease [51]	6243	799	798	Increase [6]	4.00	40 [4] 14-20 [9] Tachypnea [22] [2] [14]	14	Decrease [4] [2] [14] [12]	0.96	*25% Decrease [22]	321	*70% of Baseline [52]	1950
2	120	60	Non-tourniquet bleeding control (Manual pressure induces hemorrhage to 50 ml/min)	A pressure dressing or manual pressure is applied to attempt to control the bleeding, 750 ml of blood loss at the end of this segment (Transitioning from Class B hemorrhage). Tension pneumothorax has progressed untreated for 3 minutes.	*25% increase [9] Tachycardia [14]	103	No Change [52]	57	5100	5250	NC or decrease [16] Compensatory Mechanisms Keep it at Baseline Values [52]	95	No Change [52]	110	No Change [52]	75	Stress-induced slight elevation [52]	6400	799	790	Increase [6]	4.00	40 [4] 14-20 [9] Tachypnea [22] [2] [14]	17	Decrease [4] [12] Plateau [22]	0.94	*25% Decrease [23]	395	*70% of Baseline [52]	1982
3	180	240	Needle Decompression	A needle decompression procedure is applied on the affected side.	90 - 110 [51]	102	Increases [52]	65	4900	5028	Compensatory Mechanisms Keep it at Baseline Values [52]	94	NC or Slight Increase [52]	111	No Change [52]	75	Stress-induced slight elevation [52] Increase with the Needle Decompression [51]	6250	765	759	Decreasing, but not to baseline [51] NC or Slight Decrease [52]	4.00	Back to Baseline [52]	17	Increase > 0.95 [20]	0.97	Back to Baseline [52]	450	*50% of Baseline [52]	1960
4	420	30	Tourniquet Application (Hemorrhage completely controlled, rate 0 ml/min)	A tourniquet is applied to the hemorrhaging leg. Note: this action only stops bleeding. There is not currently a tourniquet model in the "BioSensors" engine. For the systemic effects of tourniquet application please see (White et al 2012) and (Brown et al 2012). At the end of this segment (Class B hemorrhage), at this point bleeding has stopped.	Possibly no significant change [19]	117.9 [12]	No change	65	4900	5200	No Change or Increase [23]	94	No Change or Increase [21]	112	No Change or Increase [21]	75	No Change	6250	791	759	Decreasing, but not to baseline [51] NC or Slight Decrease [52]	4.20	Back to Baseline [52]	17	Back to Baseline [52]	0.97	Back to Baseline [52]	420	*50% of Baseline [52]	1960
5	450	120	Intravenous Fluid Resuscitation (Saline, 500 ml at rate of 100 ml/min)	Saline is administered over 5 minutes at a rate of 100 ml/min.	Slight decrease because of partial correction of the hypotension. [51] Stress induced Moderate Tachycardia [52]	94	Increase with the increase in blood volume [51] Toward Baseline as perfused returns to normal [52]	66	5300	5280	INCREASE [8]	95	Increase [1] [17] Back toward baseline [51]	113	Increase [52]	75	Increase [52]	6500	791	759	Move toward Baseline [52]	4.50	Back to Baseline [52]	14	Back to Baseline [52]	0.96	Back to Baseline [52]	400	*50% of Baseline [52]	1925
6	570	160	Narcotics (Morphine) Administration (5 ml of morphine IV at concentration of 1 mg/ml)	A bolus of 5 mg of morphine is administered intravenously. The rest of the time in this segment is to allow the saline to finish and to observe.	Decrease [51] Decrease [18]	115	Toward Baseline [52]	80	5600	5700	Mild Decrease [18]	90	Mild Decrease [18]	110	Mild Decrease [18]	70	Mild Decrease [52]	7000	791	759	Mild Decrease [52]	4.50	15-20% Decrease [18]	12	NC [51] Decrease [5]	0.94	Moderate Decrease [52]	450	*50% of Baseline [52]	2000

Note: Blood Volume is a direct calculation

Note: Direct circulation based on blood loss and assumed homogeneity