

Scenario Overview

The asthma attack scenario simulates physiology during an asthma attack and after administration of a beta-agonist. This scenario highlights the ability of the BioGears® physiology engine to simulate asthma and inhaled-drug administration.

Base Physiology	Insults and injuries	Assessments	Interventions
A 40 year old female with a history of asthma.	Asthma attack	RR EtCO2 fraction (PetCO2 is equally common in the literature) HR BP SpO2 PFT	Inhaled beta agonist (albuterol)

Scenario Narrative

Segment 0	Engine initialization period.
Segment 1	A 40 year old female with a history of asthma is having lunch with a friend when she begins to have an asthma attack. She reaches for her inhaler when she realizes that she left it at home. She decides to try to "ride it out," but soon realizes that she is having a moderate to severe attack. The woman asks her friend to take her to the nearest medical treatment facility.
Segment 2	Ten minutes later the woman arrives at the MTF. The doctor administers albuterol.
Segment 3	The woman begins to feel better. The attending provider orders a pulmonary function test.

References

Publications:

See BioGears normal physiology validation (validationData.xlsx)

- 1 Adams, Jason Y., Mark E. Sutter, and Timothy E. Albertson. "The Patient with Asthma in the Emergency Department." *Clinical Reviews in Allergy & Immunology* 43.1-2 (2012): 14–29. CrossRef. Web.
- 2 Mountain, Richard D., et al. "Acid-base disturbances in acute asthma." *CHEST Journal* 98.3 (1990): 651-655.
- 3 Nowak, Richard M. et al. "Arterial Blood Gases and Pulmonary Function Testing in Acute Bronchial Asthma: Predicting Patient Outcomes." *Jama* 249.15 (1983): 2043–2046. Print.
- 4 Papiris, Spyros et al. "Clinical Review: Severe Asthma." *Critical Care* 6.1 (2001): 30. Print.
- 5 Raimondi, Guillermo A., et al. "Acid–base patterns in acute severe asthma." *Journal of asthma* 50.10 (2013): 1062-1068.

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)	BioGears HeartRate (BPM)	HeartStrokeVolume (mL/Beat)	BioGears HeartStrokeVolume (mL/Beat)	MeanArterialPressure (mmHg)	BioGears MeanArterialPressure (mmHg)	SystolicArterialPressure (mmHg)	BioGears SystolicArterialPressure (mmHg)	CardiacOutput (mL/min)	BioGears CardiacOutput (mL/min)	RespirationRate (Breaths/min)	BioGears RespirationRate (Breaths/min)	OxygenSaturation (fraction)	BioGears OxygenSaturation (fraction)
0	0	60	Initialization (Advance time 1 minute)	Standard initialization buffer for scenarios. At the end of this segment this patient is in a resting physiological state. For validation references this segment see the biogears documentation on resting physiology validation.	72	72	55-100	75	87	95	100-120	114	5600	5600	12 - 20	18	0.97 - 0.99	0.97
1	60	600	Begin Asthma Attack (Severity 0.7)	At the end of this segment patient has been suffering from an asthma attack for 10 minutes	Increase [1]	75	Decrease [S2] Decrease is expected with increased heart rate	74	Increase [1]	95	Increase [1] Pulsus Paradoxus (decrease with respiration) [S2]	114	Increase [1]	5600	Increase [1, 5]	24	Decrease [1]	0.96
3	660	300	Administer Albuterol (Albuterol inhaler used correctly, 90.0 ug dose, nozzle loss fraction 0.04)	At the end of this segment the patient feels better because she has inhaled a beta agonist (specifically albuterol).	Decrease [1]	91	No Change [S2]	64	Decrease [1]	96	Decrease [1]	112	No Change [S2]	5750	Decrease [1, 5]	19	Increase back to baseline [1]	0.98
2	960	60	Pulmonary Function Test	Pulmonary Function Test														
End	1020		End Scenario															

NOTE: Normal values for PFT given for reference

Note: No neurological effects modeled as of 11/29/2016. Many of the cardiac effects are a result of behavioral effects. [S2] Therefore, these effects will not be present until the BioGears neurological model is implemented.

End-Tidal CO2 fraction (unitless)	BioGears EtCO2 (unitless)	PaO2 (mmHg)	BioGears PaO2 (mmHg)	PACO2 (mmHg)	BioGears PaCO2 (mmHg)	pH	BioGears pH	ExpiratoryReserveVolume (L)	BioGears ExpiratoryReserveVolume (L)	ForcedVitalCapacity (L)	BioGears ForcedVitalCapacity	ForcedExpiratoryVolume (L)	BioGears ForcedExpiratoryVolume (L)	ForcedExpiratoryFlow (L/min)	BioGears ForcedExpiratoryFlow	FunctionalResidualCapacity (L)	BioGears FunctionalResidualCapacity (L)	InspiratoryCapacity (L)
0.053	0.03	95	91	40	40	7.4	7.4	1.1		4		3.37		5.117		2.4		3.63
Decreased peak [3]	0.03	71.5 ± 12 [3]	83	35.8 ± 6.9 [3]	45	Increase [2],[5]	7.38											
Back to baseline [5]	0.03	78.0 ± 12.7 [3]	92	32.3 ± 4.6 [3]	40	Decreasing back to baseline [2],[5]	7.43											
								Decreased or Normal [52]	1.078	Normal [52]	No Output	1.12 [3]	No Output	Decreased [3, 5]	No Output	Increased [52]	2.239	Normal [52]

BioGears InspiratoryCapacity (L)	InspiratoryReserveVolume (L)	vinspiratoryReserveVolume (L)	MaximumVoluntaryVentilation (L)	BioGears MaximumVoluntaryVentilation	PeakExpiratoryFlow (L/min)	BioGears PeakExpiratoryFlow	ResidualVolume (L)	BioGears ResidualVolume (L)	SlowVitalCapacity	BioGears SlowVitalCapacity	TotalLungCapacity (L)	BioGears TotalLungCapacity (L)	VitalCapacity (L)	BioGears VitalCapacity (L)	LungVolumePlot	BioGears LungVolumePlot
	3.16		171.1		443		1.4				6.5		4.35		See BioGears Documentation	
3.567	Normal [S2]	3.134	Decreased [S2]	No Output	176.2 [4]	No Output	Increased [S2]	1.16	Normal [S2]	No Output	Increased [S2]	5.81	Normal [S2]	4.64	See BioGears Documentation	