

Pericardial Hemorrhage



An unspecified amount of bleeding and severe hypotension usually suggests hypovolemic shock, but that is not always the case.

This exercise is taken from a case developed by R. Summers (1996). Quoting Dr. Summers

A 23 year old man arrived by ambulance after gunshot wounds to the neck and chest. The patient presented awake, confused and combative, with a heart rate of 120 beats/min, a respiratory rate of 20 breaths/min, and no audible blood pressure.

This patient was severely hypotensive but did not respond to aggressive fluid therapy. Finally, cardiac ultrasound revealed pericardial hemorrhage, presumably caused by a bullet or fragment. A pericardial drain was inserted and the man made a satisfactory recovery.

The Pericardial Hemorrhage Protocol

We'll now recreate the clinical setting. Click Restart to reestablish initial conditions and then record the control data. Go to Pericardium. Slide the pericardial hemorrhage sidebar over to extreme. Click the pericardial hemorrhage switch to on. Advance the solution 10 minutes at a time to 30 minutes, collecting data every 10 minutes.

We are interested in the acute effect of the hemorrhage on hemodynamics and the subsequent compensations that help to maintain oxygen delivery.



Pericardial Volume (mL)

Arterial Pressure (mmHg)

Cardiac Output (mL/Min)
Heart Rate (/Min)
Stroke Volume (mL)

Left Ventricle EDV (mL)
Left Ventricle EDP (mmHg)

Sympathetic Nerve Activity

Plasma Renin Activity

Time	0	10	20	30	1
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	Min	Min	Min	Min	Hour
Pericard. Volume					
Arterial Pressure					
Cardiac Output					
Heart Rate					
Stroke Volume					
LV EDV					
LV EDP					
Symp Nerves					
Plasma Renin					

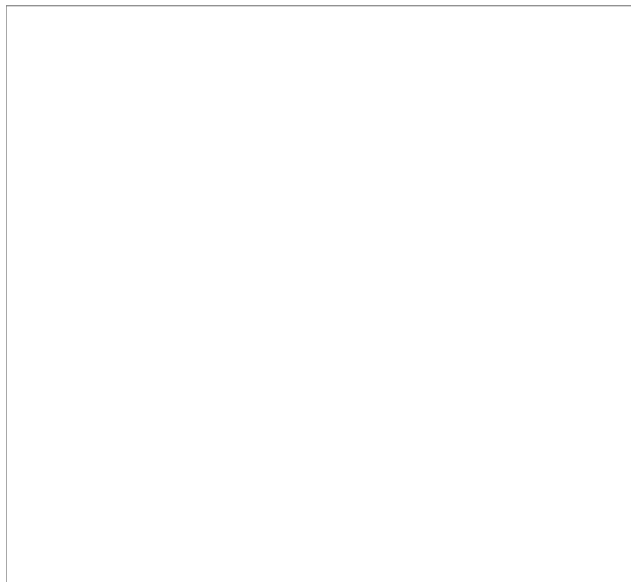
Wrapup

You can advance time to 1 hour to gauge the severity of the situation. Then go to Misc. Treatments or Pericardium and install a pericardial drain.

Supporting Evidence

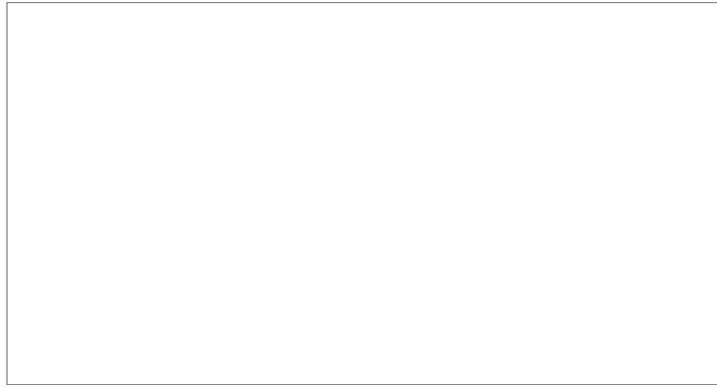
Several experimental studies provide data that is consistent with this simulation. These data are typically collected from canine protocols. Pericardial hemorrhage is simulated using saline or air injection into the pericardial space. Severity is reported as pressure increase.

Cardiac output and stroke volume decrease with increased pericardial fluid (Isaacs *et.al.*, 1954; Metcalfe *et.al.*, 1952). Decreased flow does not initially lead to decreased arterial pressure (Metcalfe *et.al.*, 1952) presumably due to reflex support.



While transfusion will increase cardiac output in a normal subject, it has almost no effect on cardiac output when there has been a pericardial hemorrhage (Isaacs *etal*, 1954).





This would explain the patient's lack of response to administered fluids.

References

Isaacs, J.P., E. Berglund and S.J. Sarnoff. Ventricular function. III. The pathologic physiology of acute cardiac tamponade studied by means of ventricular function curves. *Am er. Heart J.* 48:66-76, 1954.

Metcalfe, J., J.W. Woodbury, V. Richards and C.S. Burwell. Studies in experimental pericardial tamponade. Effects on intravascular pressures and cardiac output. *Circulation* 5:518-523, 1952.

Summers, R.L. Evidence-based medicine vs. scientific reasoning. *Acad. Em er. Med.* 3:183-184, 1996.

