1.4.2

Cardiac Measurements

If you look at the volume curve in the cardiac cycle graph above you will notice that ventricular volume changes from 120-130 ml at the end of diastole to 50-60 ml at the end of systole. We refer to these volumes, respectively, as the **end-diastolic volume (EDV)** and the **end-systolic volume (ESV).** The difference between them (EDV-ESV) is the **stroke volume** or the volume of blood pumped with each beat. In this example 120 ml – 50 ml =70 ml, therefore the stroke volume would be 70 ml/beat. If this person's heart rate were 70 beats per minute their heart would be pumping 4900 ml/minute (70 beats/minute X 70 ml/beat = 4900 ml/minute). The volume of blood that the heart pumps in one minute is the **cardiac output.**

Stroke Volume = End-Diastolic volume (EDV) – End-Systolic Volume (ESV)

Cardiac output (CO) = Heart rate (HR) X Stroke volume (SV)

CO = HR X SV

Cardiac output is expressed as ml/minute or L/minute. These numbers are what you might expect from a "typical" person at rest. During exercise EDV increases and ESV decreases resulting in an increase in stroke volume. In an untrained individual the stroke volume may increase from 70 ml/beat at rest to around 120 ml/beat during strenuous exercise. In contrast, the stroke volume of an elite cross-country skier can go from 70 ml/beat at rest to well above 200 ml/beat during strenuous exercise. Coupling this with the increase in heart rate and cardiac output can increase to as much as 22,000 ml/minute in the average person, with cardiac output in well trained athletes nearly twice this much.

One other measurement that is important in cardiac medicine is the **ejection fraction.** This is expressed as the percent of the EDV that is pumped each beat. In the example above, EDV was 120 ml and stroke volume was 70 ml, thus the ejection fraction is 58% (70/120 X 100). An ejection fraction above 55% is considered normal.

Ejection Fraction = (SV/EDV)