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Cardiac Output

Simon L. Bacon

Department of Exercise Science, Concordia University & Montreal Behavioural Medicine Centre, CIUSSS-NIM: Hôpital du Sacre-Coeur de Montreal, Montreal, QC, Canada

Definition

Cardiac output (Q) is the volume of blood pumped out of the heart (specifically from the right and left ventricles) per minute. It is generally calculated as a function of heart rate and stroke volume (cardiac output = heart rate \times stroke volume). Average resting cardiac output is about 5 L/min (normal range 4–8 L/min) and tends to be slightly higher in men versus women. During acute exercise and mental stress, cardiac output increases. This increase can be as high as 35 L/min for exercise (in elite athletes) and 15 L/min for mental stress.

There are many methods of measuring cardiac output, which range from intracardiac catheterization (invasive) to arterial pulse tonometry (noninvasive). The Fick principle, which uses the measurement of oxygen consumption and the oxygen content of the arterial and venous blood, is considered the most accurate method of assessing cardiac output, though it is an invasive technique, which limits its utility. Great effort has been

placed into finding accurate reliable noninvasive methods of assessing cardiac output, such as dye dilution, ultrasound-based techniques, impedance cardiography, and, more recently, magnetic resonance imaging. Each one of these comes with both positives and negatives and the selection of one method over another needs to be made given the individual requirement for cardiac output measurement.

As cardiac output is driven by heart rate and stroke volume, the factors that control changes in these parameters also influence cardiac output. Specifically, parasympathetic and sympathetic activity and venous return influence cardiac output.

Cross-References

- ▶ [Autonomic Nervous System](#)
- ▶ [Blood Pressure](#)
- ▶ [Heart Rate](#)

References and Further Reading

- Berne, R. M., & Levy, M. N. (2001). *Cardiovascular physiology* (8th ed.). St. Louis: Mosby.
- Hall, J. E. (2015). *Guyton and Hall textbook of medical physiology* (13th ed.). New York: Elsevier.