

# Fick's Principle of Cardiac Output Measurement

~ GOLD STANDARD SINCE 1870 ~



Adolf Eugen  
**Fick**  
1829-1901

The principle:

" the total uptake of (or release of) a substance by the peripheral tissues is equal to the product of **the blood flow to the peripheral tissues** and the arterial-venous concentration difference (gradient) of the substance."

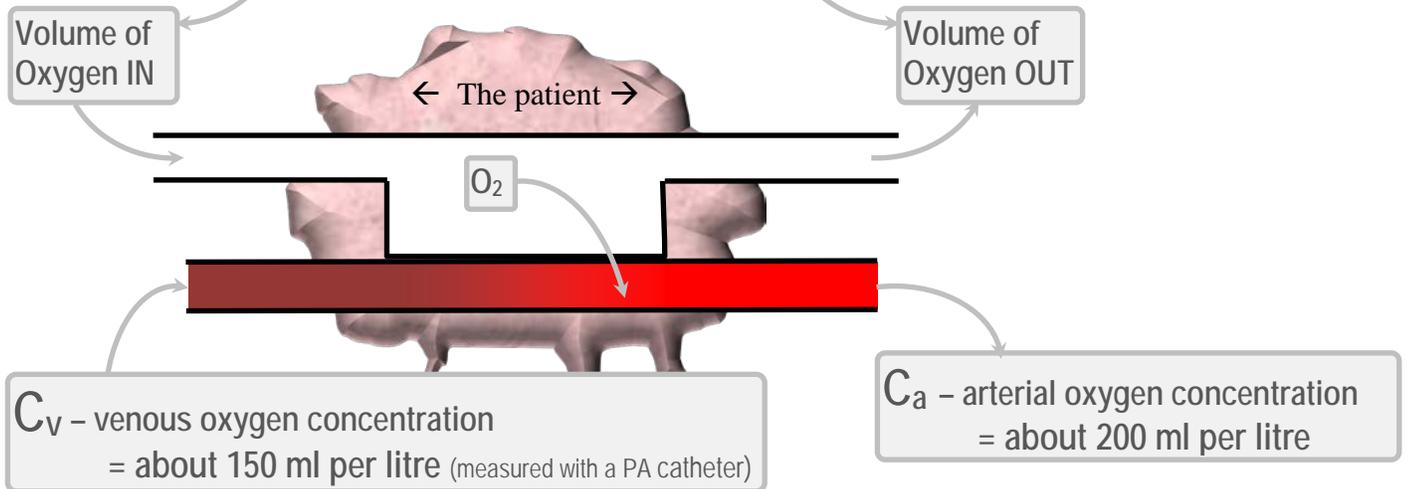
It is the blood flow we are interested in: this is cardiac output. This method is the purest and most accurate means of estimating the cardiac output. It is not confused by low output states, valvular regurgitation, shunts or arrhythmias. The major source of error is the act of measuring the amount of exhaled oxygen, and the change in cardiac output over the period of measurement. In practice, it is too fiddly to apply outside the laboratory. Also, ICU patients have inflamed lungs whose parenchyma consumes oxygen and confuses the issue further.

The meat of it:

VO<sub>2</sub>, the oxygen consumption, is simply the difference between the inspired and expired O<sub>2</sub>. You can measure it with an exhaled gas collection bag.

You can also estimate it. Conventionally, resting metabolic consumption of oxygen is

- 3.5 ml of O<sub>2</sub> per kg per minute, or
- 125ml O<sub>2</sub> per square meter of body surface area per minute



$$VO_2 = (CO \times C_a) - (CO \times C_v)$$

Where CO = cardiac output in Litres per min.

$$CO = \frac{VO_2}{C_a - C_v}$$

So, in a normal person, with a body surface area of 2m<sup>2</sup> and thus with a VO<sub>2</sub> of 250ml per minute,

$$CO = \frac{250ml}{200ml - 150ml}$$

$$= 250 / 50$$

$$= 5 \text{ L/min}$$