**Fick’s Principle of Cardiac Output Measurement**

- Gold Standard since 1870 -

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:**

**VO₂**, the oxygen consumption, is simply the difference between the inspired and expired O₂. 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 O₂ per kg per minute, or
- 125ml O₂ per square meter of body surface area per minute

**CV** – venous oxygen concentration

= about 150 ml per litre (measured with a PA catheter)

**CA** – arterial oxygen concentration

= about 200 ml per litre

**VO₂ = (CO x CA) – (CO x CV)**

Where CO = cardiac output in Litres per min.

**CO = \[ \frac{VO₂}{CA- CV} \]**

So, in a normal person, with a body surface area of 2m² and thus with a **VO₂** of 250ml per minute,

\[ CO = \frac{250ml}{200ml-150ml} \]

= 250 / 50

= 5 L/min

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From Bersten and Soni’s "Oh’s Intensive Care Manual", 6th Edition