The Stewart-Hamilton Equation for measuring cardiac output by indicator dilution

The principle:
If you inject a known amount of a substance upstream, the change in its concentration downstream is related to the rate of the flow. The flow, or volume over time, in this case is the cardiac output.

The “known substance” is usually indocyanine green, a benign dye which is strongly protein bound and has a very rapid (~ 150sec) hepatic clearance.

A known volume of indicator is added to the stream of fluid... oh, lets call it blood.

The concentration of the indicator, as it passes by the detector, can be plotted as a curve of concentration over time.

This is the recirculation of indicator. The bloodstream is a circuit, and the dye will come around a second time. The concentration will not reach zero.

This is the interpolated curve, for a situation when there is no recirculation.

The meat of it:

**The Stewart-Hamilton Equation for indicator dilution:**

\[ Q = \frac{I}{\int C_i(t) \, dt} \]

Q = cardiac output
I = amount of indicator, in moles
\( C_i(t) \, dt \) = change in indicator concentration over time (area under the concentration curve)