Anatomic Shunt: Calculation

Anatomic shunt refers to blood that bypasses the lungs, does not participate in gas exchange, and returns to the systemic circulation partially deoxygenated. All patients have some degree of anatomic shunt due to things such as thebesian veins, bronchial veins, and V/Q mismatch, specifically V/Q<1. The first two are typically low enough that they can be ignored. V/Q mismatch is a dynamic process heavily influenced by ventilatory parameters, disease timeline, and cardiovascular parameters such that it is also rarely calculated..

However anatomic shunt is often calculated in those with congenital heart disease who have mixing of systemic and pulmonary blood. The derivation of this formula would take more than 1 page but the end result is as follows:

$$\mathbf{Qp/Qs = (S_{ao}O_2 - S_{cv}O_2)/(S_{pv}O_2 - S_{mv}O_2)}$$

Where Qp=pulmonary cardiac output, Qs=Systemic cardiac output, $S_{ao}O_2$=Systemic arterial saturation (can be taken from peripheral ABG or pleth), $S_{cv}O_2$=Mixed venous saturation (if there is mixing at the atrial level, may need to be drawn separately from IVC and SVC and then combined), $S_{pv}O_2$=Pulmonary vein saturation (can be assumed to be 100% if no pulmonary disease), and $S_{mv}O_2$=Mixed venous saturation (taken from pulmonary artery).

As a way to remember this formula: you can see how the numerator of the formula approximates oxygen utilization by the body and the denominator approximates oxygen addition to the blood.

Further reading: Nasr VG, Dinardo JA. The Pediatric Cardiac Anesthesia Handbook. Wiley, 2017, New York.