Statistical Methodology for Comparison of Cardiac Output Measurements "Bland-Altman Analysis"

What is a Bland-Altman analysis?

Bland-Altman analysis is a statistical method which allows the clinician to compare two different measurement techniques.[1] The Bland-Altman graph plots the difference between two techniques against their averages (Figure 1).

The resulting scatter diagram allows the clinician to determine:

- Bias – average difference, ideal bias = 0
- Precision – 1 Std. Dev. that describes range for 65% of comparison points
- Limits of Agreement – 2 Std. Dev. that describes the range for 95% of comparison points

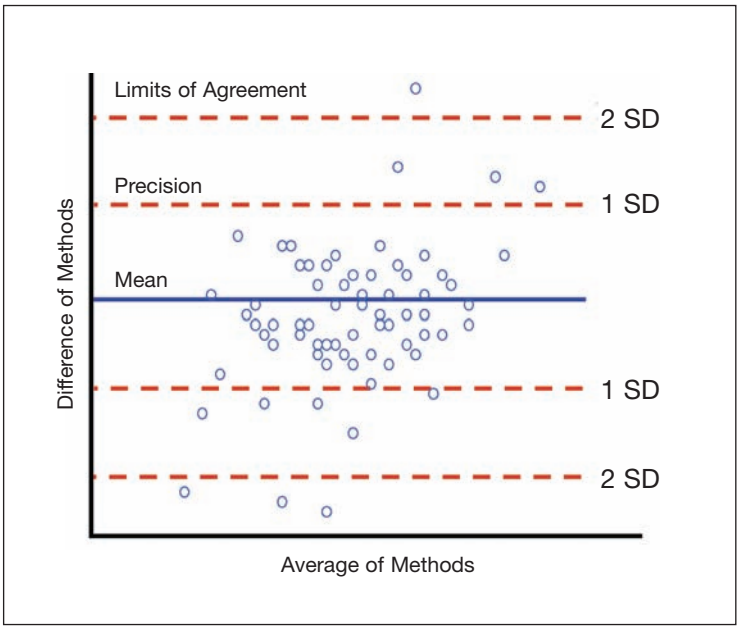

Figure 1

How do you use Bland-Altman to compare Cardiac Output (CO) measurement techniques?

Bland-Altman analysis is typically used to compare measurement techniques against a reference value, especially when the reference value may not have a true gold standard. Bland and Altman suggest that when a new technology has bias and precision comparable with the previous technology, then it may be accepted in the clinical setting:

> *"We want to know by how much the new method is likely to differ from the old; if this is not enough to cause problems in clinical interpretation we can replace the old method by the new or use the two interchangeably."*[1]

More recently, Critchley and Critchley assert that a new CO measurement technology be accepted when its limits of agreement are within ±30% of the reference standard.[2]

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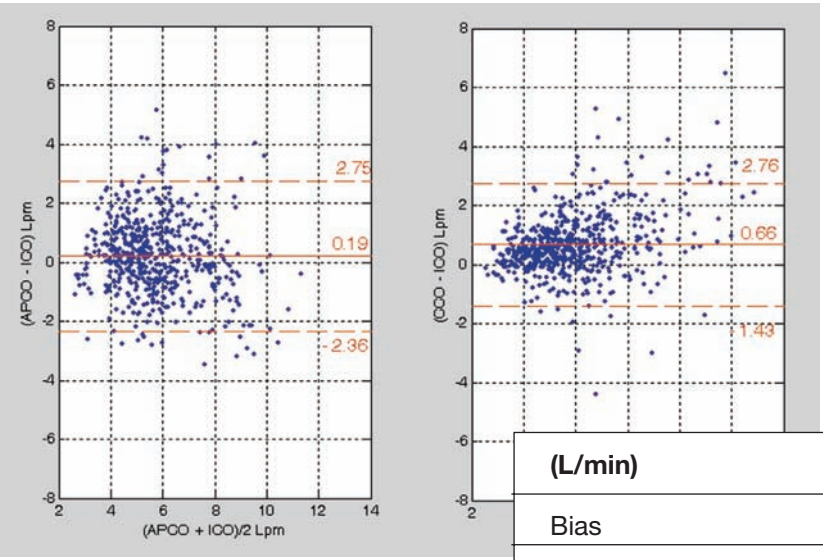
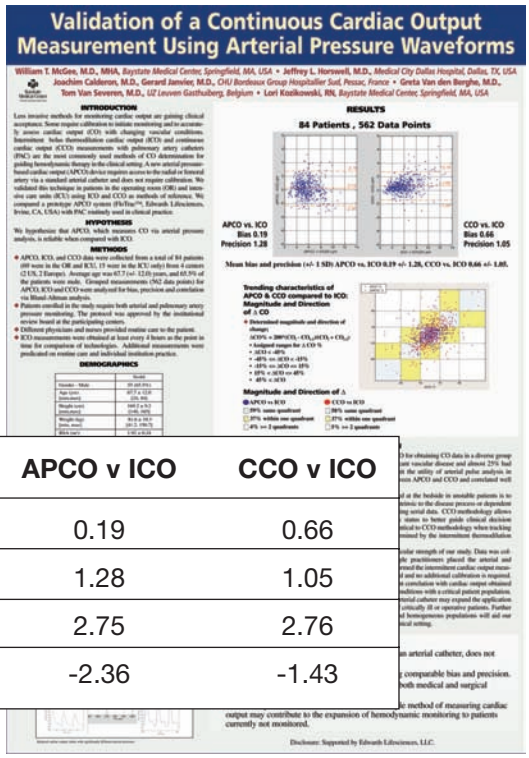
Why not use simple correlation instead of a Bland-Altman analysis?

While correlation (r or r2) shows the comparison between two different measurements, it may not be appropriate to use when comparing CO measurements.[2] This is because correlation is best used when the reference method is low in error. However, all CO measurement techniques have an inherent error. Thus, correlation may not necessarily demonstrate accurate performance of a CO technique.

Example: William T. McGee, MD, MHA[3]





(L/min)	APCO v ICO	CCO v ICO
Bias	0.19	0.66
Precision (±)	1.28	1.05
Limits of Agreement (+)	2.75	2.76
Limits of Agreement (-)	-2.36	-1.43

References:

1. Bland JM, Altman DG. Statistical method for assessing agreement between two methods of clinical measurement. The Lancet. 1986 Feb 8;1(8476):307-10.
2. Critchley LAH, Critchley JAJH. A meta-analysis of studies using bias and precision statistics to compare cardiac output measurement techniques. J Clin Monit 1999; 15: 85-91.
3. McGee WT. Validation of Continuous Cardiac Output Measurement Using Arterial Pressure Waveform. Abstract, ISICEM 2005.

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