

Arteriovenous blood gas agreement in intensive care patients with varying levels of circulatory compromise

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TO THE EDITOR: We read with great interest the recent article by Hynes and colleagues.¹ We commend the authors for their study but would like to draw attention to points that limit interpretation of their results, and caution against their conclusions.

The authors use the standard Bland–Altman method to evaluate agreement between arterial and venous blood gases in various haemodynamic conditions. The original paper by Bland and Altman, from *The Lancet* in 1986, showed that a simple graph of differences between two methods of assessment versus their mean difference (bias) could be used to assess agreement.² Agreement is deemed to be good if the range of “95% level of agreement” is small. Thus, calculation and interpretation of the 95% level of agreement are of paramount importance.

We believe that the reported agreement between arterial and venous blood gas measurements is less than stated in the article by Hynes and colleagues, for the following reasons:

- Box plots show that differences in measurements are skewed, not normally distributed as is required for the Bland–Altman method. Data should have been transformed before carrying out analysis to avoid miscalculation of the 95% level of agreement.
- Many patients had more than one pair of blood gas samples taken (50 patients and 117 paired blood gas samples). Analysis of repeated paired measurements as independent measurements will have given rise to an inaccurately small 95% level of agreement. Bland

and Altman and others have proposed methods for performing this analysis correctly.^{3–5}

- The 95% level of agreement for pH appears to be too wide to conclude that there is good agreement. For example, if a patient’s venous pH is 7.31, the 95% level of agreement for the expected arterial pH would range from 7.29 to 7.40.
- There is an error in Table 2: the bias for pH should be -0.04 , not -0.40 .

Therefore, we believe clinicians should not consider this article as providing good evidence for agreement between arterial and venous blood gases.

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- 1 Hynes D, Bates S, Loughman A, et al. Arteriovenous blood gas agreement in intensive care patients with varying levels of circulatory compromise: a pilot study. *Crit Care Resusc* 2015; 17: 253-6.
- 2 Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986; 1: 307-10.
- 3 Bland JM, Altman DG. Measuring agreement in method comparison studies. *Stat Methods Med Res* 1999; 8: 135-60.
- 4 Myles P, Cui J. Using the Bland–Altman method to measure agreement with repeated measures. *Br J Anaesth* 2007; 99: 309-11.
- 5 Carstensen B, Simpson J, Gurrin LC. Statistical models for assessing agreement in method comparison studies with replicate measurements. *Int J Biostat* 2008; 4: Article 16.

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IN REPLY: We thank Nanjaya and Pilcher for their insightful comments. Our pilot study¹ was designed to add to the sparse data on this subject, to promote discussion and to encourage further research. We are very aware of its limitations, which we freely acknowledge in the article. We agree that analysis of repeated paired measurements as independent measures may artificially influence the 95% level of agreement. We noted that a limitation of the study was that most patients had more than one sample and that no adjustment was made for this. Blood gas analysis is only part of the information clinicians use to make decisions. What constitutes clinically acceptable agreement is subjective and may vary with different patient groups, conditions and clinical settings. The subjectivity is reflected

in the assertion of Nanjaya and Pilcher that the 95% agreement level is too wide for us to conclude, from pH, that there is good agreement; an assertion not supported by any published evidence. In Table 2, the bias for pH should indeed have been -0.04 .

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- 1 Hynes D, Bates S, Loughman A, et al. Arteriovenous blood gas agreement in intensive care patients with varying levels of circulatory compromise: a pilot study. *Crit Care Resusc* 2015; 17: 253-6.