of possible causes before intubation. In some patients, postoperative intubation is not required and it is possible to follow a more conservative plan of therapy. In others intubation is not a benign procedure and carries some risk, and necessitates an intensive care unit admission.

Again, I would like to thank Dr. Tousignant for bringing his previous article to our attention.

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Incorrect analysis of data leads to incorrect conclusions

To the Editor:

Recently, Aye *et al.* compared cardiac output (CO) estimation by visual inspection *vs* thermodilution during cardiac surgery.[1] They utilized Bland and Altman analysis[2] appropriately, but overlooked the first step of the method, thus invalidating their interpretation of the results.

This statistical approach involves two stages.[2,3] First, a decision must be made as to how large a difference between the two methods is permissible while still supporting the conclusion that the two methods are interchangeable. This decision is often arbitrary, based on clinical judgment. Second, results are plotted as described in the article. The two methods are judged to interchangeable if the limits of agreement (±2 SD of the mean difference between the two methods) do not exceed the chosen acceptable difference (the *shaded area* in the Figure).

Given the normal range of CO and the inherent variability of thermodilution CO determination, we determined a difference ≤1 L·min^{-1} (or ± 0.5 L·min^{-1}) between the two methods would be clinically acceptable. Based on the data presented in the article, we calculated the anaesthetist's evaluation ranged from 2.45 L·min^{-1} below to 3.63 L·min^{-1} above thermodilution CO measurement, far exceeding the chosen acceptable difference of ± L·min^{-1}. Only 13 (approximately) of the 35 data points (37%) are within the chosen acceptable difference.

Whatever our beliefs may be regarding the value of pulmonary artery catheterization to improve patient outcome, we must conclude that visual inspection and thermodilution are not interchangeable methods to determine CO during cardiac surgery.

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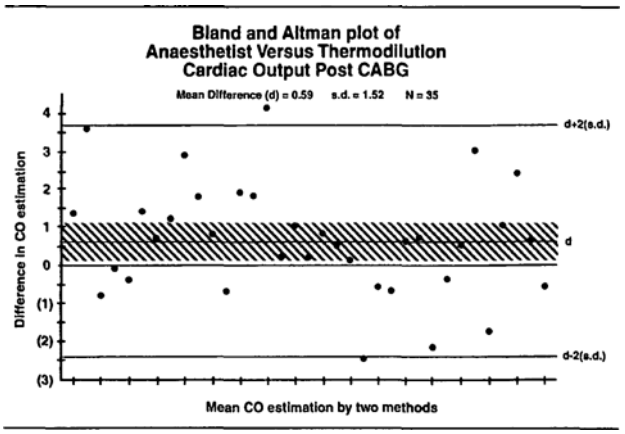

FIGURE Bland and Altman plot reproduced from the article by Aye *et al.* comparing the anaesthetists' subjective estimates *vs* thermodilution determination for CO.[1] We added the shaded area representing the difference chosen to be acceptable while still supporting the conclusion that the two methods are interchangeable (0.5 L·min^{-1} above and below the mean difference i.e., bias of 0.59 L·min^{-1}). The limits of agreement (± 2 SD) exceed the shaded area, indicating the two methods are not interchangeable.

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2 *Bland JM, Altman DG.* Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986; 1: 307–10.

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REPLY

"If error is corrected whenever it is recognized as such, the path of error is the path of truth."

(HANS REICHENBACH)

We thank Hardy, Belisle and Gravel for their insightful interest in our paper.[1] We did use the Bland-Altman[2,3] statistical approach to test the comparability of the surgeons' visual inspection estimates vs the thermodilution measurement and again for the anaesthetists' visual inspection estimates vs thermodilution. A correlation coefficient would not be appropriate for this type of analysis as this correlation statistic is not a measure of agreement between two measures, but of association.

Thermodilution is considered to be the gold standard for measuring cardiac output. Nevertheless, cardiac output measurements after cardiopulmonary bypass may have errors of 15–50%,[4] which is greater than the inherent variability quoted by Hardy et al.: i.e., both thermodilution and visual inspection are "noisy" measures.

Therefore, there are errors with the gold standard within this context, and the nature of clinical boundaries for estimate acceptance is arbitrary.

We do agree with Hardy et al. and, as stated by Bland and Altman,[2] that measurement methods may only be used interchangeably if the raw data is within ± 2 standard deviations of the mean of the differences (differences between the gold standard and the estimates) and this would not be clinically important.

We appreciate the clinical interpretation of Hardy et al. and believe that the readers will benefit from their comments. We do not recommend aborting the thermodilution method for measuring cardiac output. However, we shall continue to inspect the heart visually after cardiopulmonary bypass.

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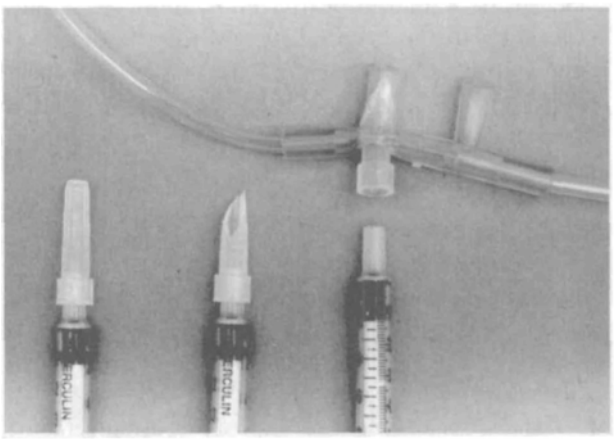

FIGURE 1 Required equipment

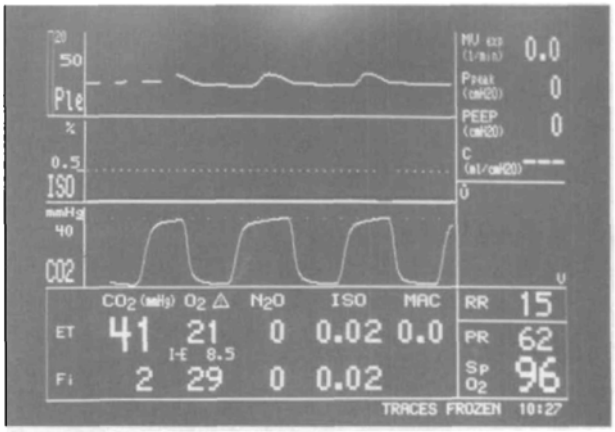

FIGURE 2 $ETCO_2$ waveform

A simple method with no additional cost for monitoring $ETCO_2$ using a standard nasal cannulae

The monitoring of end-tidal CO_2 ($ETCO_2$) can provide useful information about respiratory rate and rhythm in a spontaneously breathing sedated patient. Commercially produced special nasal cannulas offer the ability to simultaneously measure carbon dioxide during administration of oxygen (Salter Labs). Although previously described modified standard nasal cannulas for this purpose were already relatively simple and inexpensive,[1,2] the method described here is even easier to modify with no additional material cost involved.

Figure 1 illustrates the simple steps to utilize any clean unused syringe cap in modifying a standard nasal prong set. The tip of syringe cap is cut at 45 degree to provide a sharp opening. This cap is simply inserted perpendicularly through the plastic tubing and threaded into the lumen of one cannula with the help of any syringe. The CO_2 sampling tube is then easily fitted on to the cap. The waveform showed in Figure 2 was obtained during quiet breathing with 3 L. 2 flow in a sedated patient. This waveform was almost identical to the one obtained using the commercial product in the same patient. This device is found to be simple to prepare using a readily available syringe cap. The size of cap is large enough to fit tightly in the lumen to allow good CO_2 sampling from this lumen during oxygen administration to the other nostril. The relatively large opening of the cap can reduce occlusion of the sampling tubing due to water droplets or kinking when compared to use other smaller size IV catheter as previously described.[1] The monitoring also does not