Sir,—We note from Dr Quinn’s letter that he concurs with our general finding that measurements from automatic non-invasive arterial pressure recorders differ consistently from auscultatory measurements, whether contemporaneous or not, made by midwives. The differences between his results and ours are small. We did not recruit specifically hypertensive patients, as we wished to study patients with a range of arterial pressures. The statistical methods which we used (Bland–Altman) are the most appropriate to identify factors which vary with the absolute arterial pressure. We detected no such variation. Unfortunately, Dr Quinn’s letter and references give us no opportunity to compare his methods or statistical analyses with ours. It is quite possible that differences between his values and ours are caused by dissimilar techniques.

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THORACIC ELECTRICAL BIOIMPEDANCE OR THERMODILUTION FOR MEASUREMENT OF CARDIAC INDEX

Sir,—Young and McQuillan compared cardiac index (CI) in critically ill patients with severe sepsis using thoracic electrical bioimpedance (TEB) and the so-called “golden standard”, thermodilution (TD). [1] To compare these two methods to obtain CI is akin to comparing apples and oranges. We have tested TEB against TD during IPPV [2], apnoea, large tidal volume, slow frequency, small tidal volume with high ventilatory frequencies [3], during PEEP-ventilation [4], in spontaneous breathing patients after operation [5] and in patients with sepsis [6]. At that time it was not usual to use the method of Bland and Altman [7] and we used correlation coefficients and regression analysis. In septic patients (n = 5), the correlation coefficient was r = 0.70; in patients with sepsis undergoing ventilation with a PEEP of 8 cm H₂O, the correlation was worse: r = 0.57.

There are important limitations to comparing TEB with the dilution methods such as Fick, dye or thermodilution, which have similar theoretical and practical problems. For example, the Stuart-Hamilton equation used for calculation of CI is correct only in continuous flow conditions [8], but flow is rarely continuous on the right side of the heart where TD measures impedance changes over a few seconds and calculates blood flow over 1 min. Possible faults in calculating CI may derive from: injectate volume, injectate temperature, injection time, temperature loss in the catheter wall or to the vessels during low-flow conditions, temperature changes during inspiration and expiration during artificial ventilation, particularly with large tidal volumes and increased body temperatures in septic patients, and recirculation [9]. TEB measures on the left side of the heart and values are averaged over 16 heart beats or over 1 min. During controlled ventilation there are sinusoidal variations in CI related to intrapulmonary pressure and venous return, which are more pronounced on the right side of the heart [10].

Young and McQuillan took expiration for TD measurements that use one point in this cyclical fluctuation. This improves reproducibility, but decreases absolute precision. For TEB, they used averaged values over 1 min. With such a design, it is not possible to compare CI values with both methods. Most importantly, it is not possible to assess the accuracy of the TD method when CI is great, because there is no absolute method of measuring cardiac output. For reasons noted above, the accuracy of the TD method must decrease when CI is increased. We found also that in septic states the mean thoracic impedance was small because of intrapulmonary shunting and non-cardiogenic oedema. Zₑ in the denominator of the equation of Sramek for calculation of CI influences absolute values of CI less because the dz-signal, with its first derivative in the numerator, changes in the same direction in the different thoracic fluid content states.

We have used TEB for several years for monitoring septic patients, with the result that we no longer use pulmonary artery catheters. It is the trend of change with medical treatment that is important and the TEB follows such changes accurately.

Cardiac index is only one of the haemodynamic variables obtainable. It is also possible to assess indices of contractility which are increased before there is clinical evidence of sepsis. Furthermore, it is possible to calculate peripheral resistance and, with the latest software, oxygen delivery and consumption.

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1. Young JD, McQuillan P. Comparison of thoracic electrical bioimpedance and thermodilution for the measurement of cardiac index in patients with severe sepsis. British Journal of Anaesthesia 1993; 70: 58–62.

Sir,—Drs Castor and Simon correctly outline the technical problems involved in the measurement of cardiac index using thermodilution, but miss the point of our paper.

We compared transthoracic impedance and thermodilution methods to measure cardiac index. We make no claims that thermodilution is a “gold standard” and, in fact, the statistical method of Bland and Altman that we used is specifically designed for comparing two methods of clinical measurement.
for the comparison of two methods of measurement when neither is the "gold standard," we make no claims as to which method provides the most accurate estimate of "true" cardiac index.

There is little doubt from our paper that the two methods are not interchangeable. If clinicians prefer to use the transthoracic impedance estimate of cardiac output to guide treatment, they should be aware that treatment procedures based on thermomodulation estimates of cardiac index cannot be used, and the procedures based on transthoracic impedance estimates of cardiac index will have to be derived.

When considering the relative inaccuracies of thermomodulation and transthoracic impedance estimates of cardiac index, it should be remembered that, for all the potential inaccuracies of thermomodulation, the central theory is sound. In the case of transthoracic bioimpedance, the impedance signal changes in a direction opposite to that predicted by the theory on which the monitor is based.

The theory on which the transthoracic impedance method is based does not stand up to critical examination.

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LONG-TERM BACKACHE AFTER EXTRADURAL OR GENERAL ANAESTHESIA FOR MANUAL REMOVAL OF PLACENTA

Sir,—Drs Vickers and May have identified backache as a common problem following childbirth and examined if it is an important sequela of extradural analgesia performed in labour by using a patient questionnaire [1]. They failed to consider other factors which might have a significant association with backache in postpartum patients. The other factors which were identified by MacArthur and colleagues (nulliparity, Asian race and younger maternal age) [2] should have been included in the questionnaire.

Heavy physical work, another factor which has been found to have strong correlation with persistent backache after childbirth, should also be included [3]. All these factors should then be included in a multivariate analysis to give a more accurate assessment of the contribution of extradural block in obstetric practice to long term backache.

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Before 1992, this unit used the 26-gauge Quincke needle, and the average incidence of PDPH was 14% (range 9–17%). For the past 12 months, some of the 25-gauge Whitacre spinal needle was implemented. Spinal anaesthesia was administered to a total of 210 women, 73% (154) of whom underwent Caesarean section, with either a single injection technique or a combined spinal-epidural technique; the remaining 27% (56) of spinal anaesthetics were single injection techniques for procedures such as manual removal of placenta, forceps delivery or cervical cerclage.

All patients were assessed 24 hours after insertion of the spinal anaesthesia for mobility, headache on ambulation, ability to void urine and resolution of the sensory and motor block. All patients were advised to contact the anaesthetist if they developed a headache after their discharge from hospital.

We were pleasantly surprised to have not documented headaches in the 210 spinal anaesthetics performed. This result supports the findings of the Bristol study with regard to the absence of PDPH associated with the use of the 25-gauge Whitacre needle in parturient women.

An advantage of the 25-gauge needle compared with the finer gauge needles is the greater rapidity with which cerebrospinal fluid appears in the hub of the needle, therefore reducing the potential hazard of unrecognized, and therefore repeated dural puncture. It would also appear that the "pencil point" of the Whitacre needle, which is claimed to separate rather than cut the fibres of the dura, is an advantage compared with the construction of the Quincke needle, whatever the gauge.

It now seems, therefore, that the use of the 25-gauge Whitacre needle makes spinal anaesthesia an acceptable technique as regards the low incidence of PDPH in parturient women, although continued audit of its use is necessary over a long period of time, with larger numbers of patients, to confirm this.

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KINKED INNER TUBE OF COAXIAL BREATHING SYSTEM

Sir,—Further to recent correspondence on inner tube disconnection and leaks in Mapleson D coaxial breathing systems [1] I wish to report on a further problem encountered with this type of system.

A new system was attached to the anaesthetic machine. On routine testing it was clear that the fresh gas flow was obstructed. Close inspection showed the reason. The kink is seen clearly in figure 1, which was produced using transillumination of the distal end of the circuit.

![Fig. 1. Kinked inner tube of a coaxial breathing system.](https://example.com/figure1.png)

This occurrence again demonstrates the importance of checking anaesthetic equipment before use.

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Kinked inner tube of a coaxial breathing system.