CORRESPONDENCE

AXILLARY BRACHIAL PLEXUS BLOCK: CHOICE OF TECHNIQUE?

Sir,—I would like to add to the discussion of the excellent review by Brockway and Wildsmith concerning the factors which influence axillary brachial plexus block [1]. I use and teach the Winnie perivascular technique [2], advancing the tip of a short-bevelled needle as far centrally as possible, maintaining digital pressure over the axillary artery distal to the injection site, and returning the arm to the patient's side following needle withdrawal so that the head of the humerus does not impede the upward flow of local anaesthetic [3].

Whilst working in the U.S.A., I was taught that palpation of a "hot-dog" in the axilla following injection of local anaesthetic implied successful injection into the brachial plexus sheath, whereas a "hamburger" indicated a subcutaneous injection and probable failed block. My own, seemingly natural, addition to the Winnie technique has been to maintain digital pressure over the artery after the arm has been returned to the side, and with the fingers of the opposite hand massage the "hot-dog" towards the axilla until it is no longer palpable. The pressure of these fingers is continued for 5—10 min.

For the past 4 years I have taught this technique to visiting anaesthetists attending the annual Bristol Regional Anaesthesia Techniques course. I use a volume of 40 ml and, until the second advent of prilocaine, I used 1.25% lignocaine with 1:20000 adrenaline. I felt that this was the maximum concentration of lignocaine that should be used when teaching trainees who are about to attend examinations, in order to keep within a safety margin of 7 mg kg\(^{-1}\) for an adult. Each arm was tested for completeness of sensory block below the elbow and supplementation used where necessary. Each year I performed one of the blocks, but otherwise blocks were undertaken by the course participants. Over the 4-yr period, there were 20 (69%) completely successful blocks, of which eight were for surgery in the radial nerve territory. In three patients whose block was supplemented by light general anaesthesia, two blocks were for carpal tunnel release in patients with rheumatoid arthritis who had previous operations which were undertaken under general anaesthesia (table I).

The results of this short series are not outstanding, but the technique is sufficiently reliable in inexperienced hands that it continues to be taught as the method of choice.

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REFERENCES

BODY TEMPERATURE AND ANAESTHESIA

Sir,—"Body Temperature and Anaesthesia" [1] reviews conventional opinion on the cause and prevention of surgical hypothermia. However, recent work on environmental heat exchange [2] suggests that the authors' recommendations for preventing hypothermia are insufficient.

Body temperature decreases when heat loss exceeds heat production which, under general anaesthesia, is about 40 W m\(^{-2}\) (1 W = 3.6 kJ h\(^{-1}\)). The authors have calculated heat loss as the change in body heat content of a two-compartment model [3]. However, this model has never been validated in surgical patients, especially those in whom a major body cavity is exposed to the environment [4]. In our experience, based on the direct measurement of heat loss, the model fails to estimate

<table>
<thead>
<tr>
<th>Sensory block below elbow</th>
<th>Nerve territory of surgery</th>
<th>Radial</th>
<th>Median</th>
<th>Ulnar</th>
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<tr>
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<td>MCNF</td>
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<td>Median</td>
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<td>8</td>
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<td>Total</td>
<td>3</td>
<td>3</td>
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TABLE I. Success of axillary brachial plexus block amongst Bristol Regional Anaesthesia Techniques course participants 1986–89. LCNF = lateral cutaneous nerve of forearm; MCNF = medial cutaneous nerve of forearm.
heat loss accurately in surgical patients. Nevertheless, the model contains an important clinical concept: that body heat is distributed unevenly between a "core" and a "shell". This implies that "normothermia", a normal core temperature, does not guarantee a normal body heat content. The "afterdrop" in core temperature that follows cardiopulmonary bypass rewarming is a common example of uneven heat distribution.

We have measured environmental heat exchange directly with Heat Flux Transducers [5] and have confirmed the published values for heat exchange coefficients [2, 6-8]. The combined coefficient for the principal mechanisms of heat loss, radiation and convection, at air velocities \( \leq 0.2 \text{ m s}^{-1} \), is \( 10 \text{ W m}^{-2}\text{°C} \) of temperature gradient between the patient, or his coverings, and the environment. Therefore, for a gradient of 10 °C, the heat loss by radiation and convection alone is 100 W m\(^{-2}\). This is much greater than the 10-W m\(^{-2}\) heat loss (67 kJ h\(^{-1}\)) quoted in this review.

If heat production supplies 40 W m\(^{-2}\), but environmental heat loss is 10 W m\(^{-2}\)°C, it is not surprising that the lower limit of the "thermoneutral" zone is 28 °C [9]. A 4 °C gradient from skin to environment maintains skin temperature in the "thermal comfort" range (32-34 °C) [10] and allows heat loss to balance heat production so that core temperature remains steady. However, this temperature imposes a thermal load that most surgeons do not accept, as while the patient is uninsulated (0.2 clo insulation units), the surgeon is heavily insulated (1.5 clo) and produces more heat.

As a first step, it would be more practical to insulate patients correctly. Surgical coverings reduce heat loss by 10-20 %, while formal insulation materials (one layer of "Thinsulate" = 1 clo) can reduce heat loss by 57 %. To be completely effective would require insulation of at least 2 clo. Other environmental factors are important: increased air velocity (laminar flow systems) markedly increases convective and evaporative losses, while radiant heat from operating lights decreases radiative losses but increases evaporative losses [11].

Warming and rapidly infusing i.v. fluids prevents their imposing a thermal load, but neither offsets environmental heat loss nor reverses an existing body heat deficit. If anaesthetic gases are 100 % humidified at 42 °C, with all the risks this entails, heat is saved by preventing evaporation and gained by condensation. However, for core temperatures from 37 °C to 20 °C, the sum of the heat saved and the heat gained is only 1.3 W m\(^{-2}\) litre of minute ventilation. Compared with the environmental loss, this is insignificant.

The heat supply of a warming mattress is limited by skin conductance, temperature gradient and contact area. One model can supply 41 W m\(^{-2}\)°C [2, 6] and therefore has the potential to double the heat available to a patient. The ability of this to maintain core temperature depends on the magnitude of the environmental heat loss. The potential heat supply of the heating equipment now available, expressed in W m\(^{-2}\)°C, is: warming mattress = 41; radiant heater = 7; hot air mattress at 0.2 m \(\text{s}^{-1}\) = 4.

The solution to the problem of surgical hypothermia lies in determining the patient's thermal balance by directly measuring heat production and heat loss. This allows the development of both appropriate thermal models for surgical patients and practical and effective methods to prevent surgical hypothermia.

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REFERENCES

Sir,—Thank you for the opportunity to reply to the letter from Drs English and Scott.

We agree that the two-compartment model of body heat is a simplification which has its limitations, some of which were discussed in our article, and applaud the efforts of Drs English and Scott to measure cutaneous thermal flux directly using heat flux transducers. However, this methodology has never been applied to surgical patients, and the particular configuration of transducers used by Drs English and Scott has never been validated as giving an accurate measure of total cutaneous heat flux [1].

Drs English and Scott maintain that a patient under general anaesthesia can tolerate only a 4°C temperature gradient with the environment because of poor insulation and a reduced metabolic rate. Accepting that heat production under anaesthesia is about 40 W m\(^{-2}\) (144 kJ m\(^{-1}\) h\(^{-1}\), 34.3 Cal m\(^{-1}\) h\(^{-1}\)) and assuming heat loss by other routes is minimal, thermal stability with a 4°C temperature gradient would require insulation of approximately 0.65 clo (0.49 °C kj\(^{-1}\) m\(^{-1}\) h\(^{-1}\); 0.117 °C Cal\(^{-1}\) m\(^{-1}\) h\(^{-1}\)).

A naked man in still air has a surface insulation of 0.2-0.75 clo depending on the degree of vasoconstriction present [2]. The layer of air around the body supplies another 0.8 clo [2] and surgical drapes might reasonably be expected to provide a further 0.5 clo (the same as a t-shirt and shorts). This total insulation of 1.5 clo would permit thermal stability in the presence of a 9.3 °C temperature gradient, and if the theatre is maintained at 24 °C the skin temperature could be 33 °C, that is in the middle of the thermal comfort zone.

We appreciate that many factors may have an adverse effect on this state of affairs (theatre ventilation systems, open