Correspondence

Heparin reversal protocol

To the Editor:

The number of ways of manipulating the coagulation system during and after cardiopulmonary bypass must approximate the number of cardiac anaesthetists. However, Bull *et al.*¹ showed that protocols for heparin administration and reversal based on patient age, height, weight or BSA were inadequate. They suggested the use of a heparin dose-response plot created by measuring activated clotting time (ACT) to maintain safe anticoagulation and to predict the dose of protamine required for heparin reversal.² This requires the construction of a graph. I offer the following formulae based on their technique.

Consider the Figure, where x represents an ACT result and y the corresponding dose of heparin.

Let

A = (x_0 , 0); the control ACT, no heparin

B = (x_1 , y_1); following the first heparin dose

C = (x_2 , y_2); following a second heparin dose

D = (x_d , y_d); representing the last ACT prior to reversal, and the remaining heparin.

Bull averages $\overline{AB}$ and $\overline{AC}$ by bisecting $\angle BAC$ to produce $\overline{AD}$, which he calls the heparin dose-response line. What Bull does with his graph can be accomplished with simple algebra.

First, say that you know A and B and want to arrive at a

FIGURE Relationship of ACT result to heparin requirement. See text for explanation.

point (x_n , y_n) where $x_n = 480$ seconds and $x_1 < 480$ seconds. Since (x_0 , 0), (x_1 , y_1) and (x_n , y_n) are colinear, then

$$\frac{y_n - 0}{x_n - x_0} = \frac{y_1 - 0}{x_1 - x_0}$$

and

$$y_n = y_1 \cdot \left(\frac{x_n - x_0}{x_1 - x_0} \right)$$

Using this formula, any desired ACT can be achieved. The additional heparin required is $y_n - y_1$.

Now, at the end of bypass, when you want to reverse the heparin (assuming the patient is normothermic), you need to determine D (x_d , y_d), where x_d is the last ACT. Since $\overline{AD}$ bisects $\angle BAC$, then the slope of $\overline{AD}$,

$$m_{\overline{AD}} = \frac{m_{\overline{AB}} + m_{\overline{AC}}}{2}.$$

Since

$$m = \frac{\Delta y}{\Delta x}$$

then

$$\frac{y_d - 0}{x_d - x_0} = \frac{\frac{y_1 - 0}{x_1 - x_0} + \frac{y_2 - 0}{x_2 - x_0}}{2}$$

This becomes

$$y_d = \frac{x_d - x_0}{n} \left(\frac{y_1}{x_1 - x_0} + \frac{y_2}{x_2 - x_0} \right)$$

y_d is the amount of heparin remaining in the circulation. If all y values are in units of 1000 IU, then simply multiply y_d by the protamine neutralizing factor (PNF) to determine the dose of protamine required.

If one feels that averaging more of Bull's lines will produce a more accurate dose-response line, the formula can easily be adapted:

$$y_d = \frac{x_d - x_0}{n} \left(\frac{y_1}{x_1 - x_0} + \frac{y_2}{x_2 - x_0} + \dots + \frac{y_n}{x_n - x_0} \right)$$

These two formulae can easily be permanently programmed into a handheld computer so that all the anaesthetist need do is type in the x and y values. This circumvents the need to draw out a graph for each case.

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- 2 Bull BS, Huse WM, Brauer FS, Korpman RA. Heparin therapy during extracorporeal circulation II. The use of a dose-response curve to individualize heparin and protamine dosage. *J Thorac Cardiovasc Surg* 1975; 5: 685-9.

Prolonged bleeding from epidural insertion site

To the Editor:

We wish to report the interesting case report of a patient who developed prolonged bleeding from the skin puncture site during continuous epidural anaesthesia for labour.

The patient is a 35-year-old Gravida II, Para I, who presented in labour with vital signs of BP 140/90, HR 80, temperature 36°C, urine analysis negative. She was in excellent health and was taking no medications. She requested an epidural for pain relief and a 16-gauge Tuohy epidural needle was inserted at the L₄₋₅ interspace after local infiltration and a skin puncture made with a 17-gauge needle. The epidural needle was inserted without difficulty and the catheter was placed without incident. Twelve ml of 0.25 per cent bupivacaine was injected in two doses of 3 + 9 ml. The epidural catheter was fixed with Opsite® and adhesive tape and the patient was comfortable. Prior to the next top-up dose (about one hour), the nurse noted that the patient was "soaked" in blood, the source of which appeared to be the epidural site. The estimated blood loss from this cause was about 200 ml. When the Opsite® was removed and the skin examined, to our surprise, there was a small artery bleeding, and bright red blood was spurting from the skin puncture site. Pressure was applied for ½ hour without effect, so we removed the catheter and placed a purse-string suture around the puncture site. A second epidural was established at L₃₋₄, uneventfully. No further bleeding occurred and no complications arose as a result of the incident. The patient subsequently underwent a Caesarean section. The suture was removed 48 hours later and no

further bleeding was seen. Perhaps an alternative could have been to leave in the first catheter and put a suture around it. Coagulation testing done subsequent to this event was found to be normal.

We have not encountered such a problem before and have not read of it in the literature. We wonder if anyone has been in a similar situation and what others would do. It is not uncommon to see some bleeding at the site of an epidural, but the bleeding is self-limited. This may warrant frequent inspection of the epidural insertion site.

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Epidural blood patch in treatment of chronic headache

To the Editor:

We read with interest the article by Parris¹ regarding the use of epidural blood patch in treating chronic headache which resembled post-dural puncture headache. We recently reported a case of spontaneous low-CSF pressure headache treated successfully with an epidural blood patch² and would like to add our experience in reviewing this condition.

The spontaneous onset of postural headache was first described by Schaltenbrand in 1938.³ He termed the syndrome "spontaneous aliquorrhoea," and proposed three possible mechanisms to explain its occurrence: (1) diminished CSF production, (2) increased CSF absorption and (3) CSF leakage.

Subsequent case reports suggest that leakage is the most likely cause. Nosik⁴ in 1955 was able to demonstrate leakage through a tear in the dural sleeve of a lumbar nerve root during myelography. Labadie in 1976,⁵ using lumbar isotope cisternography was unable to demonstrate an actual site of CSF leakage; however, the rapid disappearance of dye from the subarachnoid space and the rapid appearance of isotope in the bladder suggests that CSF leakage into the epidural space was occurring. Baker in 1983⁶ reported two cases, and one of these was successfully treated with an epidural blood patch. This was the only previous case of spontaneous low CSF pressure headache to our knowledge to have been treated with an epidural blood patch.