stage of labour, but towards the end of labour when delivery is anticipated in 20 minutes, and the patient is judged to be "at the end of her tether," a single-shot technique may be used. We submit that the "catheter and test dose technique" significantly delays the onset of relief in these patients and thus causes unnecessary pain and distress, without the proven benefit of an increase in safety margin.

There are occasions as well when because of technical difficulty we are thankful to have identified successfully the epidural space with the Tuohy needle. At this point, some of us would not wish to risk traumatising a blood vessel in the epidural space prior to injection of a dose of local anaesthetic sufficient to provide pain relief.

We are reluctant therefore to completely abandon an otherwise excellent technique. The incidence of complications when a test dose is given is similar to the incidence when a "single-shot" epidural technique is used. We will continue to practise and to teach the use of the single-shot epidural in those situations where we believe that they are indicated.

Stephen H. Rolbin MD FRCPC

Ernest Hew MD FRCPC

Steven Dain MD FRCPC

Department of Anaesthesia

Mount Sinai Hospital

600 University Avenue

Toronto, Ontario

M5G 1X5

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The epidural test dose and the identification of rare events

To The Editor:

In the review article, "The epidural test dose in obstetrics: is it necessary?", Dain *et al.*¹ evaluated the use of epinephrine 15 µg as a test for inadvertent intravascular injection during the performance of an epidural anaesthetic. The false positive rate was quoted as 12 per cent (i.e., specificity = 88 per cent). Dain *et al.* then concluded that "this implies that in 12 per cent obstetrical patients, the catheter would be removed unnecessarily." This statement is wrong; in fact a much higher percentage of

patients would be misdiagnosed as having an intravascular injection.

The correct analysis using the data given in the review article is as follows. The incidence of intravascular placement of an epidural catheter is 0.01 to 4 per cent. Using the midpoint figure, the probability of intravascular placement in any one patient is two per cent, in the absence of any information from test doses.

In a random group of 100 patients, then, only two will have intravascular placement. Since the sensitivity of the test is 50 per cent (given in the article), one of the two will test positive. On the other hand, of the 98 patients with correct epidural placement, 12 will have a positive test (because of the false positive rate).

This means that in 100 patients, 13 will have a positive response to testing for intravascular placement. However, in only one of these thirteen will the positive test actually predict a real catheter misplacement, i.e., the positive predictive value of this test is 1/13, or only 7.7 per cent.

In contrast, 12 of 13 patients, or 92.3 per cent, will have had their catheters removed unnecessarily. This figure, which is much higher than that of Dain *et al.*, implies that the routine use of a test dose for intravascular injection is even less useful than they suggest.

Note that this conclusion is for the use of a test dose as a means of detecting intravascular injection. For test doses to detect subarachnoid injections, the predictive value can be shown to be much higher, and therefore to be more useful.

The above analysis suggests several interesting points regarding the use of a clinical test as an indicator or predictor of the occurrence of an event. Firstly, the sensitivity or specificity of the test is commonly confused with its positive predictive value. Sensitivity can be defined as the probability of obtaining a positive test result if the event under test is already known to have occurred; similarly, specificity is the probability of getting a negative test if the event is known to have not occurred. Since the occurrence or non-occurrence of an event is not known in clinical settings, sensitivity and specificity are not parameters with direct interpretations at the bedside. On the other hand, the positive predictive value is the probability of the occurrence of the event if the test is positive; this is obviously of more immediate clinical relevance. The three parameters are related, as the previous calculations showed, or more elegantly by use of Bayes' theorem.

Secondly, unlikely occurrences remain unlikely even in the face of a positive test, unless the test has a specificity close to 100 per cent. In the case of epidural test doses, the pre-test probability of intravascular injection, two per cent, increases only to 7.7 per cent after a positive test response.

More generally, the predictive value of a test is related by Bayes' theorem to the pre-test probability of the event. This implies that the usefulness of a clinical test rests partially on the patient population for which it is used. For example, since the incidence of accidental intravascular injection can be expected to be higher if there was a preceding "bloody tap," test doses may be useful in this circumstance, as suggested by Biehl.²

William C. Torn MD FRCPC
Department of Anaesthesia
Toronto Western Hospital
Toronto, Ontario
M5T 2S8

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REPLY

Thank you for allowing us to comment on Dr. Tom's letter. The data analysis he presents is correct, although he incorrectly attributes the study to us¹ rather than to Cartwright et al.²

Dr. Tom's discussion in graphic form, assuming a two per cent probability²⁻⁵ of accidental intravascular injection, a sensitivity of 50 per cent,¹ and a specificity of 88 per cent⁶ is as follows: in 1000 Patients:

	Intravascular injection	No intravascular injection	Total
Positive test	10	118	128
Negative test	10	862	872
Total	20	980	1000

Therefore the catheters of 128 patients would be removed, 118 (92.2 per cent) unnecessarily.

The predictive value of a positive test dose would be 10/128 or only 7.8 per cent. Furthermore, as the pre-test probability of an intravascular placement of a catheter is so low, any test is poor unless both the sensitivity and the specificity approach 100 per cent.

A diagnostic test is of most use when the pre-test probability is 50 per cent, its usefulness declining as the pre-test probability approaches 0 to 100 per cent.

Thank again for allowing us to address this oversight.

Steven L. Dain MD FRCPC
Stephen H. Rolbin MD FRCPC
Ernest Hew MD FRCPC
Department of Anaesthesia
Mount Sinai Hospital
600 University Avenue
Toronto, Ontario
M5G 1X5

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