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In Reply:—We thank Drs. Brull *et al.*, Shankar, and Nelson for responding to our case report of accidental intravascular injection of local anesthetic and epinephrine during ultrasound-guided perivascular axillary block.¹

The suggestions provided by Dr. Brull's group for improved safety during ultrasound-guided axillary block seem reasonable. The large case series of axillary blocks recently published by Dr. Brull *et al.* bears witness to their experience of significantly reduced (but not completely eliminated) rates of accidental intravascular injection with the adoption of ultrasound guidance compared with the blind transarterial or neurostimulator-guided techniques used and taught until recently at their institution.² Further large case series such as theirs, or the establishment of a complication registry will be needed to quantify the relative safety benefits of various preblock precautions and ultrasound-guided approaches to axillary blockade (including perivascular *vs.* perineural injection). However, there seems to be little doubt that future improvements in block safety lie in the optimal application of ultrasound training and imaging, and technical advances including echogenic atraumatic needles specifically designed for regional anesthesia.

To Dr. Shankar, the problems we wished to highlight in our case report include modification of anatomical relations by injection of local anesthetic leading to migration of the needle tip into a blood vessel, and the existence of small, compressible, low-flow veins that are difficult to detect with even the most sophisticated ultrasonic equipment, experienced operators, and careful scanning techniques. These problems may be mitigated by technical and educational improvements, but we wished to emphasize that continued adherence to traditional safety rules such as fractionated injection is necessary even in the ultrasound age of regional anesthesia. Blaming ultrasound guid-

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In Reply:—We appreciate the interest of Drs. Brull *et al.* and Dr. Shankar in our case report¹ and we welcome their comments. Obviously, however, the fact that these two groups have not yet experienced any severe complication during ultrasound-guided blocks is by no means proof that their suggestions can eliminate this risk. As well as long series, reports of incidents can be helpful in improving patient safety. Thousands and thousands of safe blocks were performed before the pivotal report of Albright² about deaths related to intravascular injection of local anesthetics, and 4 more years elapsed before the test dose technique of Moore and Batra³ was described. Ultrasound guidance is a recent step in regional anesthesia, and not all problems have yet been reported, discussed, and resolved. For example, the reports of inadvertent, painless, and uncomplicated intraneural injections during ultrasound-guided blocks have opened a new field of discussions in regional anesthesia.

However, we agree with most of the recommendations of Drs. Brull *et al.* and Dr. Shankar because they are logical. According to their

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ance for the complication we present in our report would constitute in our opinion a misinterpretation of the events we related.

Dr. Nelson brings up the interesting point that 75-100 mg lidocaine would not be expected to result in the neurologic symptoms presented in our report, and proposes the alternative diagnosis of hypertensive encephalopathy or reversible posterior leukoencephalopathy secondary to the epinephrine in the block solution. Although we agree that the dose of lidocaine administered intravenously was relatively small (due to fractionated injection with ultrasonographic confirmation), we believe the time course of our patients' symptoms (minutes, rather than days for the other evoked diagnostic possibilities) are more consistent with a high but transient peak concentration of lidocaine, possibly potentiated by the epinephrine in the solution.³

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comments, we can list some propositions to try to improve patients' safety during ultrasound-guided blocks.

First, as mentioned by Dr. Shankar, ultrasound is only a tool—a new tool for anesthesiologists. We have the obligation to learn and to train to use this new tool efficiently and safely.

Second, basic safety rules have to be respected, such as the respect of aseptic techniques in ultrasound-guided blocks, and even under ultrasound, patients should remain awake or only judiciously sedated.

Third, a preliminary large scout scan to visualize the nerves and neighboring structures, including a color flow study, is required. This is probably the better way to find the precise puncture site and to avoid unintentional vascular punctures.

Fourth, visualization of the needle tip is probably more important than visualization of the whole length of the needle. All needles are not created equal with regard to ultrasound,⁴ and in our experience, we found that the tip of Tuohy-like needles is more often identified on the

ultrasound monitor. Therefore, we prefer the use of such needles; however, this is not sufficient.

Fifth, VadeBoncouer *et al.*⁵ recently reported that an intravascular injection in the subclavian artery was detected in real-time by a grayish blush on the ultrasound monitor upon injection of the first milliliter of local anesthetic. Close observation of the monitor during injection is of course recommended, but the possibility of detecting an intravenous injection is not reported.

Sixth, visualization of the hypoechoic fluid bolus on the ultrasound monitor after 1 ml injectate is today the crucial safety point. If a real-time discernible extraneural hypoechoic image is not evident after injection of 1 (or 2) ml local anesthetic, that means that the needle tip is not located where we think it is, and injection should not be allowed. This is the new version of Moore and Batra's test dose.

Finally, the relative merits of the in-plane *versus* the out-plane approach are a matter of controversy between anesthesiologists, but as highlighted by Dr. Shankar, these two complicated blocks were performed by residents. That means that after the pioneer's age of artists individually skilled in ultrasound-guided blocks, we have to concen-

trate a large part of our efforts in teaching our residents; this is not a matter of controversy.

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