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Unique Cause for 60-Cycle Interference

To the Editor:—Essential anesthesia monitoring equipment causes tremendous frustration of anesthesiologists and technicians when it does not work properly. Sixty-cycle electrical interference is a common problem encountered with electrocardiograph monitors in the operating room. Sixty-cycle noise usually originates from an external source, such as lights, motors, alternating current cables, *etc.* Noise may also originate from internal resistance within circuits or a broken 60-Hz filter. We had severe 60-Hz interference occurring in several operating rooms not traceable to any external source. All monitors in this operating room suite are older Datascope 2000 series units (Datascope, Paramus, NJ). Exhaustive evaluation of the monitors and cables could not locate the problem. Curiously, when inducing 60-cycle interference with a simulator, some monitors blocked the noise, whereas other did not. By systematically swapping circuit boards from a good unit, we isolated the problem to the "Refresh Memory" board, not the electrocardiograph circuit board. After closer examination, we found the problematic circuit boards had a switch not described in the service manual. On some units, the switch ("S1") was in the IN position,which filters noise, and on other units, it was in the OUT position. Other units did not have this switch on the circuit board.

Our query prompted further research at Datascope that discovered this switch was incorporated into units originally intended for international shipment. Some countries have line voltage frequency 50 Hz or 60 Hz. Under the 50-Hz conditions, the frequency response to the display must be changed from 40 Hz to 20 Hz. The internal switch limits the frequency response of beam deflection on the screen. Because the electronic filter controlled by this switch also filters 60-Hz noise, the manufacturer decided the switch should be in the "IN" position. Circuit boards labeled "K" (the company's designation) or higher have this switch.

In this cost-conscious era, we use monitors longer than ever before and frequently use older units in nonoperating room anesthesia sites. When anesthesia equipment malfunctions, our predictable response is to seek the purchase of new ones. Hopefully, this simple discovery will ease some of those 60-cycle headaches and add years of service to valuable equipment. In addition, with the replacement of an inexpensive picture tube and basic servicing, these popular and user friendly monitors can be brought back to crisp, "like new" condition.

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In Reply:—The observations of the authors are correct, from the strictly empirical standpoint. I wish to note, however, that interference filters are most effective when the interference source is limited. (Sometimes easier said than done)

The obvious prevention is low impedance patient connection and minimal length cables, ideally placed at random angle (not parallel) to other power and signal cables. This technique minimizes the cross talk between noise sources.

The secondary defense against unwanted interference pick up and amplification is a good front-end amplifier, characterized by high Common Mode rejection characteristics. The 2000A monitor exhibits a 90–100 DB Common Mode rejection. This is the point where approximately 90% of the effective noise immunity is obtained. It is well worth the effort to test, calibrate, or repair this section before postprocessing filters are introduced.

Postprocessing filters, such as the one found in the monitor's Re-

fresh Memory board, will clean up the visible display of the signal, but with substantial side effects. One of the most obvious symptoms is the elimination or attenuation of all signals in the noise source and the physiologic signal within the band width of the filter. In practical terms, the 50-cycle filter will reduce or remove the pacer pulses from the QRS complex display (we have provided a distinctly separate path for pacer detection and display). Due to inherent time constants in the filters, the QRS complex will tend to "wonder" on the screen, extending artifact recovery times.

We have standardized on this filter because, on the whole, the benefits are justifiable. I believe that an understanding of the subject matter and prevention of the root causes will benefit this and other users.

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Radicular Irritation after Spinal Anesthesia

To the Editor:—In their recent article concerning transient radicular irritation, Pollock *et al.*[1] incorrectly represented our earlier work. They wrote that our study of the neurotoxic potential of commercially available local anesthetics used for spinal anesthesia in sciatic nerves[2] "showed that 5% hyperbaric lidocaine, 0.5% tetracaine, and 0.75% bupivacaine caused nonreversible ablation of the stimulated compound action potential." Although it is true that 5% lidocaine and 0.5% tetracaine abolished the compound action potential, 0.75% bupivacaine did not.

This is important, because the reports of cauda equina syndrome after continuous spinal anesthesia implicate lidocaine and tetracaine, but not bupivacaine.[3,4] In addition, lidocaine, but not bupivacaine, produces the so-called transient radicular irritation syndrome.[1,5-9] In our study,[2] 0.75% bupivacaine, the highest concentration of bupivacaine used clinically, did not cause nerve injury. It is our opinion that bupivacaine is probably the safest local anesthetic for intrathecal use because it is the only local anesthetic that, to our knowledge, has not caused neural injury in patients, and it shows the least toxicity from intrathecal infusions in rats[10,11] or exposure to isolated nerves *in vitro*.[2] In addition, intrathecal infusions of clinical concentrations of bupivacaine are nontoxic in dogs.[12,13]

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