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*In Reply:*—The letter of Young and McDonnell raises some important issues. They suggest that by using infusions of a mixture of morphine and bupivacaine instead of intermittent morphine boluses, the need for nursing education can be reduced. Although nurse education related specifically to injection technique might be reduced with such an approach, new factors would be added to the equation.

First, when using continuous infusions, nurses must learn to program, operate, and troubleshoot the infusion pumps. Second, we believe it is prudent to educate nurses with regard to the diagnosis of any potential problems associated with epidural analgesia, as well as appropriate precautions to prevent morbidity. For example, because patients can develop lower-extremity weakness or orthostatic hypotension when solutions containing local anesthetics are used, nurse education must be provided on these topics. Finally, we have demonstrated that epidural catheters do migrate into the subarachnoid space. Although a rare event, when solutions containing local anesthetics are infused, nurses must be taught about this risk, its significance, its early diagnosis, and its treatment.

To summarize, in our practice, nurse education would not be reduced by the exclusive use of epidural infusions containing morphine-bupivacaine mixtures or other agents.

Young and McDonnell also report the incidence of nausea and pruritus in their patients that persisted after standard treatment was administered. Obviously, this is different than reporting the incidence

of side effects requiring treatment, as was done in our paper.<sup>1</sup> Our quality-assurance monitoring data indicate an incidence of 3.5% persistent nausea and 2% persistent itching despite standard treatment—results that are similar to those of Young and McDonnell.

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## Jugular Venous Compression Helps To Identify the Source of Venous Air Embolism during Craniectomy in Patients in the Sitting Position

*To the Editor:*—The incidence of Doppler-detected venous air embolism (VAE) in patients undergoing suboccipital craniectomy while in the sitting position is approximately 45%.<sup>1</sup> Early detection and prompt treatment of VAE are important factors that limit morbidity and mortality secondary to VAE. Interventions that facilitate identification of the source of air entrainment should be helpful as surgical efforts are directed at closing the site of air entry. Theoretically, interventions that increase cerebral venous pressure, such as the application of positive end-expiratory pressure (PEEP) and jugular venous compression (JVC), should help to identify the source of air entry if venous pressure increases enough to convert air entrainment into hemorrhage from the open venous structure.<sup>2,3</sup>

We prospectively collected data from 47 patients who experienced one or more episodes of Doppler-detected VAE during suboccipital craniectomy while in the sitting position. During episodes that did not resolve in less than 3 min or for which the site of air entrainment was not readily evident, bilateral JVC was applied by an experienced neuroanesthesiologist. There were 98 episodes of VAE. JVC was applied in 73 episodes of VAE. The neurosurgeon observed bleeding from a venous structure, the surgical closure of which stopped further air entrainment, in 28 of the 73 episodes (38%).

Cerebral venous pressure can be increased by the application of PEEP. However, the application and release of PEEP may increase the

risk of paradoxical air embolism by altering cardiopulmonary hemodynamics.<sup>4</sup> Bilateral JVC should be applied carefully so as to avoid occlusion of the carotid vessels and should not be sustained because the increase in cerebral venous pressure can cause brain herniation through the craniectomy. We empirically use a 15-s limit.

Clinical data comparing the diagnostic efficacy of JVC and PEEP to identify the source of venous air entrainment are lacking. However, studies have shown that JVC is more effective than PEEP in increasing cerebral venous pressure when the head is elevated above the heart.<sup>2,3</sup> Based on our data, application of bilateral JVC is a moderately effective maneuver that facilitates identification of the source of VAE in patients undergoing craniectomy while in the sitting position. In our opinion, the administration of JVC is preferable to PEEP for the reasons cited above.

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