

*In Reply:*

We appreciate the opportunity to review and respond to the letter to the editor by Culp, Brewster, and Wernicki, in response to our review article. We thank the authors for their complimentary remarks. We are also pleased that they chose to respond and emphasize the need for prevention and rescue of drowning persons to further improve the survival rate from this disaster.

They make the point that it is far more efficient and effective to prevent or interrupt the drowning process than to treat it after it renders the patient unconscious or even lifeless. We agree fully. Unfortunately, not all swimming pools have lifeguards in attendance. Further, although we believe that most lifeguards are superb in fulfilling their responsibilities, not all lifeguards are fully trained in lifesaving technique and basic cardiopulmonary resuscitation. In our experience, we have reviewed cases where some lifeguards did not give their undivided attention to their lifeguarding duties, whereas others were very lax in fulfilling their responsibilities. Still others tolerate pools with inadequate maintenance to where the pools themselves presented a hazard to swimmers.

We endorse the authors concluding paragraph "Drowning is a global problem that can be dramatically reduced by teaching people how to swim, by encouraging swimming in lifeguarded areas, and by improving field resuscitation techniques. Promoting attention to the entire continuum of the drowning prevention spectrum will result in the best possible outcome." We would add, however, that lifeguards should receive proper, extensive formal training, leading to certification as a lifesaver and in basic cardiopulmonary resuscitation. Further, lifeguards should remain conscientious and vigilant in carrying out their duties and in providing continuous attention to their responsibilities at all times.

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**Reference**

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## Residual Neuromuscular Blockade and Upper Airway Muscles

*To the Editor:*

I read with great interest the article by Herbstreit *et al.*<sup>1</sup> describing the effect of residual neuromuscular blockade on upper airway collapsibility in humans. The authors observed that upper airway integrity was impaired when the train-of-four ratio was maintained at the level of 0.5 or 0.8 with

rocuronium. In a former study in volunteers, I and others could not demonstrate any susceptibility to upper airway obstruction when the train-of-four ratio was maintained to 0.5 with an infusion of vecuronium.<sup>2</sup> In our study, decreased inspiratory negative pressure, which is known to exaggerate the possibility of upper airway collapse, was elicited by increasing ventilation during carbon dioxide rebreathing or by adding an inspiratory resistance. Breathing with pressure at airway opening held at a pressure from -5 to -40 cm H<sub>2</sub>O was also tested. No effect of partial neuromuscular blockade maintained at a train-of-four ratio of 0.5 on upper airway could be observed. When the upper airway pressure was progressively decreased to -40 cm H<sub>2</sub>O, no participant showed evidence of upper airway collapse or flow limitation at any time period. The main difference between the two studies is that subjects were breathing through a mouthpiece in our study<sup>2</sup> instead of a nasal mask in the study by Herbstreit *et al.*<sup>1</sup> Therefore, the flow limitation observed by Herbstreit *et al.*<sup>1</sup> may be related to resistance at the velopharynx rather than to an impaired compensatory response of the genioglossus muscle.

I agree with Herbstreit *et al.*<sup>1</sup> when they state that the upper airway muscles are more susceptible to neuromuscular blocking agents than the diaphragm. However, because the diaphragm is the most resistant muscle to neuromuscular blocking agents among all skeletal muscles, this comparison is not valid to point out a particular susceptibility of upper airway muscles to neuromuscular blocking agents. For example, the geniohyoid muscle, which also contributes to upper airway integrity, was shown to be more susceptible than the diaphragm but less susceptible than the adductor pollicis to mivacurium in humans.<sup>3</sup> Finally, as suggested by Herbstreit *et al.*,<sup>1</sup> further work on the function of other airway openers should be performed. In the future, for a rigorous evaluation of the effect of residual neuromuscular blockade on the function of upper airway muscles, the investigator should be blinded to the level of neuromuscular blockade.

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3. D'Honneur G, Slavov V, Merle JC, Kirov K, Rimaniol JM, Sperry L, Duvaldestin P: Comparison of the effects of mivacurium on the diaphragm and the geniohyoid muscles. *Br J Anaesth* 1996; 77:716-9

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We thank Dr. Duvaldestin for his comments regarding our article.<sup>1</sup> Dr. Duvaldestin points out that our assessor-blinded