its postulated clinical benefit? After all, the recommended forces are derived from investigations in infant and adult cadavers performed in the 1970s and 1980s and from theoretical considerations. Thus, defining correct performance of CP as correct application of recommended forces is incomprehensible. In addition, it is unrealistic to expect that a given force will make the cricoid cartilage (a rigid tubular structure) reliably compress the esophagus (a semimobile, nonrigid tubular structure of varying thickness) against the vertebral body (a rigid structure with a curved surface) in the presence of large variations in neck anatomy and, at times, in intraluminal esophageal pressures (induced by regurgitation and vomiting). Depending on the underlying condition, in the individual patient the recommended forces will be adequate, too low, or unnecessarily high regarding occlusion of the upper esophageal lumen. The combination of variations in underlying conditions and the repeatedly documented incorrect application of CP by most anesthesiologists make the efficacy of this technique even more questionable.

The emphasis on CP as a reliable measure in reducing the risk of gastric regurgitation carries the risk of becoming complacent about the many other factors that are verifiably associated with regurgitation and pulmonary aspiration. A liberal indication for preoperative insertion of a nasogastric tube in case of suspicion of a "full" stomach (with or without removal of the tube before induction of anesthesia), aggressive pharmacologic prophylaxis aimed at reducing gastric volume and acidity, optimal patient positioning before induction of anesthesia, and rapid induction of a deep level of anesthesia and muscle relaxation to decrease the risk of coughing, straining and retching, and routine tracheal extubation in the lateral position in patients considered at risk for pulmonary aspiration are likely far more effective in preventing pulmonary aspiration than CP.

The criteria of the Airway Device Evaluation Project Team (ADEPT) of the Difficult Airway Society consider level 3b trial evidence (*i.e.*, single case-control or historical-control study) published in peer-reviewed scientific literature a *sine qua non* criterion for equipment evaluation.[7] As recently pointed out,[8] if CP were considered a new airway device, it would not be considered for further evaluation because level 3b trial evidence for its efficacy does not exist.

By today's standards, CP cannot be considered an evidence-based practice. By applying CP, we may well be endangering more lives by causing airway problems than we are saving lives in the hope of preventing pulmonary aspiration. In the absence of a documented beneficial effect on outcome, CP appears to be more a ritual than an effective measure.

Competing Interests

The author declares no competing interests.

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In Reply:

We thank Dr. Roth for his thoughtful comments about our article.[1] He makes the important observation that when assistants are asked to perform an additional duty, they tend to reflexively use their dominant hand. Therefore, he suggests that cricoid pressure (CP) should be applied with the nondominant hand, if there is any possibility that the assistant applying CP will be asked to perform an additional task. We agree with Dr. Roth's suggestion. Perhaps trainees should practice performing the CP maneuver using either hand so they can easily switch back and forth depending on the circumstances.

The letter by Dr. Priebe, beginning with the title and extending to the final paragraph, is an attempt to undermine the credibility of our review and to completely discredit the CP technique. We feel that Dr. Priebe's arguments are lacking in merit and are unfair because they are not objective and because they ignore the considerable experimental evidence on behalf of CP that was described in our review. To support his position, Dr. Priebe levels a series of criticisms of our review, which we will address.

Dr. Priebe claims that we only cite recent guidelines that indicate the common use of CP but fail to mention those

guidelines recently published by various national and international and professional societies, including those in Germany and Scandinavia, which no longer recommend routine application of CP. This criticism is without merit. First, we clearly state "it is no surprise that some airway experts and healthcare provider instructional programs no longer advocate the routine use of CP."[1] Indeed, we quote the 2010 updated guidelines for advanced life support,[2] which state "the routine use of CP is not recommended." Second, the view of the German Society of Anesthesia and Intensive Care is presented in the section of our review entitled "Cricoid Pressure in Pediatric Anesthesia."[1] Third, as is stated in our review, we favored articles from highly ranked, peer-reviewed journals, while online publications were excluded. Fourth, because of space limitations, we could only cite the clinical guidelines from a limited number of countries. Fifth, Dr. Priebe did not quote the Scandinavian Clinical Practice Guidelines[3] correctly. The guidelines state, "the use of cricoid pressure is not considered mandatory, but can be used on individual judgment." These guidelines state further that "If mask ventilation becomes necessary, cricoid pressure can be recommended because it may reduce the risk of causing inflation of the stomach."

Dr. Priebe also claims that we misinterpreted the findings of an investigation of a tactile single-use cricoid cartilage compression device.[4] In fact, we simply presented the conclusion of Taylor *et al.*[4] who performed the study; Taylor *et al.* concluded that "the operator can be assured that the cricoid force is between 30 and 35 Newtons." Dr. Priebe's additional criticisms of that study were stated in a previous letter to the editor.[5]

Dr. Priebe raises a question about the practicality of training clinical personnel to perform the CP technique. The published studies that we cited and our own experience attest to the effectiveness of CP simulation technology in mastering the technique. We recommend that an institution design a program that is suitable and convenient for its staff. We have found that the laryngotracheal model placed on a calibrated weighing scale[1] is very useful for training. The availability of such a model in the operating room or in the anesthesia simulation laboratory aids in solidifying trainees' retention of the CP maneuver. We have also found that the use of floor weighing scales is helpful in training residents to achieve the desirable cricoid force.[1]

Dr. Priebe erroneously states that the recommended cricoid force was derived from investigations in infant and adult cadavers in the 1970s and 1980s. In point of fact, after Wraight *et al.*'s initial recommendations,[6] clinical studies in adults demonstrated that the cricoid force required to occlude the esophageal entrance is approximately 30 Newtons.[7]

In our review, we acknowledge that numerous factors can influence the effectiveness of CP and that more studies are necessary to examine them. These factors include the method of application, contact point, deformability and surface area of the cartilage, distance and tissues between the cricoid cartilage and skin, size and location of the esophageal inlet, and the intraesophageal pressure.[1] Furthermore, we state that it is important that specific questions regarding the use of CP need to be answered[1]: Should a 30-Newton force be used in all patients? How should it be measured? Should a different force be used in children and morbidly obese patients? Is there a difference between men and women? Should the force be modified if a head up-tilt is used or when a nasogastric tube is placed before anesthetic induction? Some of these questions have been answered recently.[8,9] Obviously, if randomized clinical trials are to be performed, all the factors that tend to influence the effectiveness of CP must be taken into consideration. If this is not done, we may end up with misleading information that is difficult to interpret.[1]

As stated clearly in our review, CP is currently not the standard of care.[1] However, like other airway management techniques, when used, it should be performed appropriately. There are situations where CP (or the entire rapid sequence induction technique) may be undesirable.[1] In addition, some anesthesiologists are vehemently against the use of CP.[1,5] In these situations, other options are available to choose from if general anesthesia has to be administered. The role of preanesthetic nasogastric tube placement was addressed in our recent review.[9] Despite the many unanswered questions, our review of the literature suggests that when CP is used properly and judiciously, it is a safe and effective technique for preventing pulmonary aspiration. Dr. Priebe's proposal to totally reject CP is an extreme position that is not in line with current thought and clinical practice.

Competing Interests

The authors declare no competing interests.

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