CPAP Devices for Emergency Prehospital Use: Looking Inside of It

To the Editor:

Prehospital use of CPAP reduces the mortality and intubation rate for patients with acute respiratory failure especially due to acute cardiogenic pulmonary edema.[1] Although it is considered in guidelines, the need for additional trained health workers, special equipment, and clinical evidence for effectiveness and cost-effectiveness limits widespread use.[1,2] The Boussignac CPAP facial mask is a compact CPAP system that has been used frequently in emergency services.[3,4] This system is simple, safe, and portable and requires only an oxygen source, so it can be used easily by paramedical personnel. Also, Boussignac CPAP has been shown to be effective for acute cardiogenic pulmonary edema in the emergency department.[3,4]

We read with great interest the RESPIRATORY CARE article by Brusasco et al[5] entitled "CPAP devices for emergency prehospital use: a bench study." The study evaluated and compared on a bench model the performance of 3 orofacial mask devices (Ventumask, EasyVent, and Boussignac CPAP system) and 2 helmets (Ventukit and EVE Coulisse). The efficiency of the devices was compared based on oxygen flow needed to generate a minimum air flow of 60 L/min at each CPAP setting. The authors found that only the EasyVent and EVE Coulisse achieved the required minimum level of air flow output needed to ensure an effective therapy under all CPAP conditions. This study definitely requires attention, since it provides valuable information for clinicians and prehospital medical staff about specific device performance features to optimize effective application of CPAP in prehospital and emergency settings. However, we think that there are some issues that deserve comment.

First, information about or comparisons of the cost of these devices were not given. It is essential to demonstrate the cost-effectiveness of prehospital CPAP to ensure its widespread clinical use. Cost-effective treatment strategies for acute cardiogenic pulmonary edema are needed to avoid the need for intubation and mechanical ventilation. Hubble et al[6] did a study to estimate cost-effectiveness of CPAP in managing prehospital acute cardiogenic pulmonary edema in an urban medical emergency system. They calculated and compared prehospital CPAP costs with hospitalization costs, including ICU stay. CPAP equipment constitutes the largest portion of calculated prehospital costs. Based on the theoretical cost-effectiveness analysis, they concluded that CPAP is a cost-effective prehospital treatment. The authors in this study obviously gave technical information and bench test results for these devices. However, we think that brief information about and comparison of the cost should be given, although this is not included in the aim of the study.

Second, we think that bench test effectiveness and efficacy of these devices cannot be adapted to clinical events. Not only the known patient-dependent variabilities of noninvasive ventilation but also prehospital application with its own difficulties and factors should be considered. The authors simulated tidal volume of 500 mL, inspiratory time of 0.8 s, expiratory time of 1.6 s, and breathing frequency of 25 breaths/min on each device to test the in vitro circuit. Nevertheless, given the diversity of prehospital clinical scenarios of respiratory failure, these parameters cannot simulate all patients with acute respiratory failure in the prehospital setting. Also, to achieve clinical success with prehospital use of these devices, paramedic training is necessary. The lack of training also may interfere with the effectiveness of the devices.[7]

This study provides valuable and useful information about technical effectiveness of 5 different commercially available mask devices developed for CPAP therapy in the prehospital setting. However, it does not reflect field- and patient-based differences that affect success. We recommend large randomized clinical studies for devices available for prehospital CPAP treatment.

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CPAP Devices for Emergency Prehospital Use: Looking Inside of It—Reply

In reply:

We thank Drs Salturk and Esquinas for their interest and comments on our paper entitled "CPAP devices for emergency prehospital use: a bench study."[1] We absolutely agree with them that this study only represents a technical basis for clinical studies, which are necessary to make recommendations for clinical use of CPAP devices under different pathophysiological conditions. We also agree that economic aspects are important, but this was beyond the scope of our bench study because the cost of devices may differ depending on the country and agreements between local health authorities

and manufacturers. In our hospital, the costs of the Ventumask and EasyVent, Ventukit, and EveCoulisse are very similar, respectively, whereas the Boussignac is the least expensive. However, based on the results of our study, the Boussignac device appears to perform more as a reservoir mask than as a CPAP device because of the low variable end-expiratory pressure, low airflow outputs, and high unadjustable F_{IO_2}. We concur with Drs Salturk and Esquinas that the impact of bench differences between CPAP devices on clinical outcomes needs to be determined in prospective trials.

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PEEP and Mechanical Ventilation: We Are Warned, We Cannot Ignore

To the Editor:

In an interesting study recently published in RESPIRATORY CARE, Natalini et al[1] analyzed in 186 subjects receiving mechanical ventilation (settings chosen by the attending physician) several potential causes of dynamic hyperinflation and intrinsic PEEP (auto-PEEP). Both intrinsic and extrinsic[2] auto-PEEP determinants as well as differences between low and high auto-PEEP cohorts (cutoff: 5 cm H_2O) were assessed. The results showed that expiratory flow limitation, the ratio between the expiratory time and the time constant of the respiratory system (T_E/τ_{RS}), the inspiratory resistance (R_{RS}), and body mass index not only were independently associated with auto-PEEP levels but also represented the strongest risk factors associated with auto-PEEP >5 cm H_2O. Surprisingly, T_E did not. The authors concluded that the ventilator settings play a marginal role in auto-PEEP generation in the absence of subjects' predisposing factors. As a clinical consequence, the authors suggested that auto-PEEP can be effectively reduced by acting on patients' respiratory mechanics impairment, with little/no additional effect obtained by breathing pattern manipulation.

We are indebted to the authors for several reasons. First, they pointed out the key role played by expiratory flow limitation in generating dynamic hyperinflation and auto-PEEP. As a matter of fact, their data show that <50% of actual auto-PEEP was accounted for by elastic and resistive properties of the respiratory system alone (comparing actual with theoretical auto-PEEP [ie, 1/maximum C_{RS} × trapped expiratory volume computed according to longest τ_{RS}]; data from Table 3). This reinforces the role of application of adequate CPAP levels to counterbalance auto-PEEP in the presence of expiratory flow limitation.[3] Second, they stressed the importance of treating patients receiving mechanical ventilation with medical therapy. In our experience, too many physicians forget that mechanical ventilation has no therapeutic role in improving patients' respiratory mechanics impairment[4]; it only equilibrates the imbalance between respiratory muscle force-generating capacity and increased respiratory work load,[4,5] providing time to recover from respiratory illness, facts that warrant concomitant bronchodilator use. Third, they suggest considering T_E/τ_{RS} ratio instead of T_E alone when setting the ventilator. In this line, we suggest that τ_{RS} should be directly measured[4] to account also for expiratory flow limitation, when present. In our opinion, few physicians recognize the relevance of setting T_E according to τ_{RS}. As a matter of fact, the breathing pattern was similar in both low and high auto-PEEP cohorts also in the present study.

This last fact is the cause of our major criticism of this worthy paper. The lack of relationship between auto-PEEP and T_E forced the authors to conclude that "manipulation of the breathing pattern might only have a negligible effect on the overall auto-PEEP value." However, this result depended mainly on the quite constant T_E imposed by the attending physicians in the face of a wide range of auto-PEEP levels.[1] To test auto-PEEP response to changing T_E, ad hoc protocols are necessary (eg, different T_E values tested in the same patient). Thus, the claim that breathing pattern manipulation has negligible effects on auto-PEEP sounds wrong and misleading and conflicts with the authors' seminal observation that T_E should be chosen according to τ_{RS}.

In conclusion, also thanks to Natalini et al,[1] enough knowledge is currently available to identify patients prone to develop significant auto-PEEP during mechanical ventilation, to treat its intrinsic causes (pharmacologically), and to prevent/attenuate its onset by manipulating the ventilator settings. We are warned, we cannot ignore…

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