Intraoperative PEEP setting: should we measure the lung or the patient?

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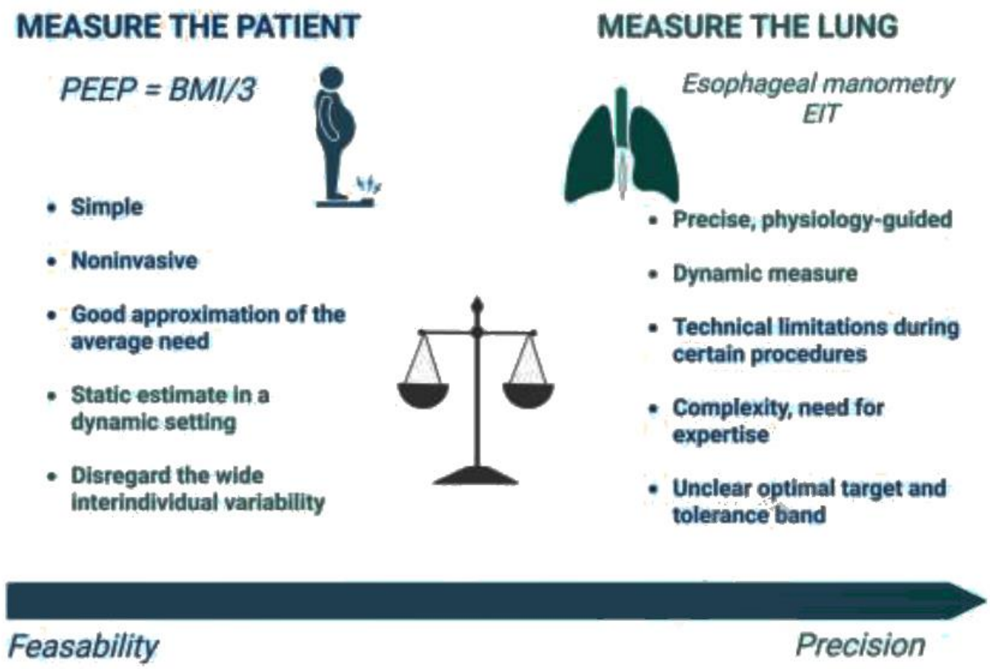
Over the past decade, the concept of individualizing perioperative ventilation has evolved from a physiological to a pragmatic clinical goal. Increasing evidence suggests that personalizing positive-end expiratory pressure (PEEP) in surgical patients can enhance its benefits while reducing the risk of collateral side effects [1], such as ventilator-induced lung injury (VILI) or, in its main clinical counterpart in the post-surgical setting, postoperative pulmonary complications [2, 3]. This might be particularly important in some categories of patients, such as those exposed to high intrabdominal pressures, steep Trendelenburg position, or with higher body mass index (BMI). Specifically, PEEP in patients with obesity has been shown to be effective in preventing pulmonary complications at all stages of the perioperative care [4, 5].

Despite the high level of physiological evidence supporting a personalized approach, the ideal target to be used to set PEEP remains to be established. In this context, a simple anthropometric formula, *i.e.*, BMI/3, has been suggested as a pragmatic way to personalize PEEP without additional equipment [6]. The advantages of this approach are clear: it is noninvasive, rapidly acquired, and already available before anesthesia induction. It can be useful as an initial PEEP setting in the operating room where time and attention compete with multiple priorities. Nevertheless, previous studies in both acute respiratory distress syndrome (ARDS) and surgical patients showed that the relationship between pleural pressure, superimposed pressure, and obesity is complex and nonlinear [7, 8]. Since chest-wall elastance, abdominal pressure, diaphragm geometry, and lung–chest wall coupling vary widely across individuals and across time [9], the "physiology-based" PEEP that avoids collapse and overdistension may diverge substantially from the "anthropometric PEEP" derived from BMI/3. Thus, in order to personalize PEEP in the operating room, should we measure the patient or the lung?

To investigate this question, Lentz *et al.* [10] evaluated how well this anthropometric formula performs as compared with esophageal pressure, in the present issue of *Anaesthesia Critical Care and Pain Medicine*. Across 109 included patients – 103 analyzed – undergoing laparoscopic abdominal surgery monitored with esophageal manometry, Lentz *et al.* studied the difference between the PEEP set following the BMI/3 rule and the PEEP set to reach 0 cmH2O of end-expiratory transpulmonary pressure (PL) [10]. In their interesting research, Lentz *et al.* show that the anthropometric rule (BMI/3) tends to capture the overall BMI group, but might fail to describe the interpatient variability [10]. While a fixed PEEP of 10 cmH2O estimated the end-expiratory PL target (with a ±2 cmH2O tolerance band) in 27% of the patients, the anthropometric rule only moderately increased precision, as only 37% of the patients (38/103) reached the end-expiratory PL target. It was not rare for a discordance to exceed 5 cmH_2O (33/103, 32%), reducing the sensitivity and the level of personalization [10].

Esophageal manometry monitoring has shown its usefulness in many clinical contexts, such as obesity [11], laparoscopic surgery [12], and ARDS [13]. In these contexts, the contribution of the chest wall to measured pressures can be so great that conventional ventilator readings become misleading. A high plateau pressure does not always mean alveolar overdistension but might simply reflect increased chest wall weight. Conversely, apparently "safe" airway pressures can conceal excessive pulmonary stress. Transpulmonary pressure thus provides a more refined physiological lens and paves the way for truly personalized ventilation. Lentz *et al.* showed that the manometry-guided PEEP varied from 0.3 to 30.3 cmH20, underscoring how heterogeneous the "optimal" PEEP can be between patients [10].

Figure 1. Intraoperative PEEP setting: measure the patient vs measure the lung PEEP: positive end-expiratory pressure, BMI: body mass index, EIT: electric impedance tomography.



Despite its physiological precision, esophageal pressure guidance is not easily implementable in clinical practice (Figure 1). Placement, calibration, and titration demand expertise, methodical checks [14]. Artifact and mediastinal weight can bias values, and the dynamic conditions of abdominal surgery (insufflation, changes in body position, or stepwise alterations in chest-wall mechanics) force repeated reassessment and occasional repositioning [15]. These pragmatic issues explain why esophageal manometry is a robust physiological tool rather than a clinical gold standard [16].

Moreover, uncertainty about the correct physiologic target compounds the implementation challenge. The EPVent trial proposed targeting positive end-expiratory transpulmonary pressure in ARDS patients [13], but subsequent work suggested that such a target can promote overdistension in an important subset of patients [17]. More recent proposals suggest keeping the end-expiratory transpulmonary pressure close to zero, frequently implemented as a tolerance band such as −2 to +2 cmH_2O [17]. Thus, the target chosen by the authors is in line with contemporary physiological understanding [10]. Importantly, these concepts were forged primarily in ARDS rather than in routine intraoperative care of patients with obesity [13, 18, 19]. Extrapolation from these static physiologic targets to the operating room must therefore be carried out carefully, especially when pneumoperitoneum and positioning shift pleural pressure in ways that ARDS trials did not model. The broader perioperative literature similarly tempers enthusiasm for universal recipes: neutral results of population-level strategies, such as fixed PEEP tables or universal driving pressure targets, remind us that average effects can mask individual benefit and harm [16, 20].

Furthermore, practical applicability in anesthesia is another limiting factor. Esophageal balloon is contraindicated or cumbersome in some upper gastrointestinal procedures, and even when placement is feasible, the signal must be interpreted in the moving target of laparoscopic pressure changes and Trendelenburg or reverse-Trendelenburg positioning [15].

As esophageal pressure, another regional physiology-based method, electrical impedance tomography (EIT), may offer a useful noninvasive surrogate for regional aeration and overdistension, complementing or substituting for esophageal manometry [21, 22]. Nevertheless, EIT in the operative room has its own constraints: belt positioning can conflict with surgical access, motion and draping may degrade signal quality, and interpretation requires training and workflow integration that are not currently standard. As with manometry, the promise is real, but the path to reliable routine use is incremental rather than instantaneous.

A pragmatic and wise approach may be, therefore, to wisely use the information provided by Lentz and colleagues to implement a subsequent clinical plan [10]. When advanced monitoring is not feasible or in case of patients or procedures with low probability of pulmonary complications, starting with BMI/3 [6] and complementing with ventilatory-based data can be a good strategy [23, 24]. In these cases, when precise fine-tuning is not available, BMI/3 could constitute a practical starting point rather than an alternative method. In high-risk patients, long surgeries, or when the BMI/3-based PEEP is insufficient to provide lung protection, advanced physiology-based tools such as esophageal manometry or electrical impedance tomography can provide valuable guidance for higher-stakes clinical decisions. Use manometry to target an end-expiratory transpulmonary pressure near 0 cmH_2O within a reasonable tolerance (±2 cmH_2O) [17], and/or supplement this information with EIT, which provides a real-time view of regional aeration to estimate dorsal collapse or ventral overdistension [24], guiding small PEEP adjustments and confirming the trade-offs implied by transpulmonary targets.

Moreover, the BMI/3 rule does not account for the dynamic changes in chest wall elastance that can happen during surgery, due to patient positioning or increased intraabdominal pressure [12, 15]. The accordance between advanced physiology and anthropometric rules in these conditions is yet to be explored. Reassessing respiratory signals after pneumoperitoneum and position changes, and again before emergence, is warranted to ensure coherence across global mechanics, regional ventilation, and hemodynamics. Unfortunately, such integration cannot be achieved through simple anthropometric data, given the variability in surgical positioning, intra-abdominal pressure, and patient-specific mechanics [16].

Finally, adjusting PEEP cannot be viewed solely through a pulmonary lens. Increases in intrathoracic pressure significantly impact cardiovascular function: reducing venous return, altering preload, and overloading the right ventricle [25, 26]. Hemodynamic stability and optimized volume status are therefore essential prerequisites for any PEEP titration-guided or any personalized PEEP technique.

In the operating room, both physiological trials and meta-analyses [2, 6] suggest that a personalized approach to PEEP improves oxygenation and compliance, particularly in settings with substantial extrinsic constraints. While robust outcome data are still lacking, the physiological rationale remains compelling. To the initial question, "should we measure the patient or the lung?", Lentz *et al.*'s findings may suggest a nuanced answer: BMI-based rules offer simplicity and accessibility, whereas physiology-based measurements provide precision [10]. The optimal approach likely lies in their thoughtful combination. While the coming years will determine which personalized approach to use and when, it is surely becoming clearer that a onesize-fits-all all cannot be an optimal strategy, both in the ICU and in the OR [27]. Finding the right balance between physiological precision and possibility of clinical broad implementation will be the next challenge, and surely the excellent research we discussed is going in this direction.

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