definition, as there were so many variables in terms of how recruitment is achieved (eg, degree of pressure) and when the intervention is applied (intra vs post vs both). The literature is fraught with prejudice, with 8 of the 20 articles characterized as having a moderate or high degree of bias. There was also a wide variability, reflecting the lack of consensus as to what should be measured as an outcome of this sort of intervention. Of the 20 articles chosen, 6 measured hypoxic events, 12 measured $\text{PaO}_2/\text{FiO}_2$, and only 7 measured atelectasis (for what that's worth as a surrogate marker).

So why is this not on my radar? Although some form of lung recruitment works, I am bothered by the fact that I do not know what intervention I should do, when I should do it, and how I should measure it. It is also distant to my radar spectrum, as this intervention falls through the cracks of who takes responsibility for the outcome, possibly due to discontinuity between who intervenes and who sees the consequences. When we as surgeons intervene with a new valve, we take care to evaluate the impact on follow-up, but is there consistency between the

anesthetist that intervenes with lung recruitment and the immediate perioperative outcomes seen by an intensivist? This is a good example of an intervention that spans borders of responsibility and for which the system is perhaps not designed to pick up benefits as readily. Finally, it is not on my radar as this is a simple intervention that does not involve a gadget or some technique that reflects our surgical prowess.

This was a tough topic to cover, owing to the heterogeneity of the previously reported studies, and the authors deserve recognition for bringing it to light. They have highlighted that this is a cheap, simple intervention, and one can envision that a large trial could be designed to limit bias. Now that we see the potential to improve immediate pulmonary function, is the appetite there to go to the next step and see if this is associated with improved outcomes with robust relevant clinical measures?

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See Article page 171.

Commentary: We need a research agenda

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Postoperative pulmonary complications (PPCs) in cardiac surgery have a significant impact on patients' prognosis, and respiratory failure represents one of the most common causes of intensive care unit readmission for cardiac surgical patients.¹ Plenty of risk factors, such as the

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CENTRAL MESSAGE

Pulmonary recruitment may improve pulmonary outcomes; however, there is a need for uniformity of outcome definitions and maneuver treatments.

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underlying disease, prolonged general anesthesia, median sternotomy, direct lung surgical trauma, extracorporeal circulation, and blood transfusions, may induce pulmonary damage after cardiac surgery. Therefore, strategies aimed at reducing the burden of PPCs represent an important area of

research in cardiac surgery. Nevertheless, evidence of the effect of different lung-protective strategies during cardiopulmonary bypass is limited with regard to clinical outcome.²

In this issue of the *Journal*, Hu and colleagues³ report a meta-analysis of randomized controlled trials conducted to evaluate the effectiveness of recruitment maneuvers (RM) in patients undergoing cardiac surgery.³ RM reduced postoperative pulmonary atelectasis, hypoxic events, and pneumonia and improved PaO₂/FiO₂ ratios, without causing significant hemodynamic changes in terms of cardiac index and arterial pressure. The authors confirm the optimal level of recruited pressure of at least 40 cmH₂O to significantly reduce the incidence of pulmonary atelectasis compared with levels below this threshold.

This study provides concrete insights into the complex landscape of PPC prevention. RM is defined as a sustained or intermittent increase of airway pressure to open collapsed lung units. Even though RM is frequently performed during general anesthesia, there is lack of high-quality studies providing supporting evidence.⁴ This gap is related to the heterogeneity of maneuvers and outcomes chosen in different reports. Specifically, RM can be performed in different modalities, ventilator-driven or manually driven, with different pressure levels, duration, and timing. Furthermore, the definition of the outcome measures is highly variable across the studies.

Looking at the whole picture, we recognize that the management of mechanical ventilation during cardiac surgery remains an open issue, as described by a recent French nationwide survey.⁵ Among 460 cardiac anesthesiologists, this survey showed that pulmonary management procedures varied markedly from one

anesthesiologist to another, highlighting the importance of designing large clinical studies to identify best practice in pulmonary management.

In light of this finding, this study offers the opportunity to address the knowledge gaps and develop a research agenda that addresses (1) creation of a link between identification of the “high-risk” patient and a patient-tailored treatment plan; (2) definition of strong outcome measures (transient beneficial effects on oxygenation targets should translate into a sustained reduction of morbidity); (3) lung management during CPB (the “stop ventilation” technique is still the most widely used, with its inherent risk of prolonged pulmonary derecruitment); and (4) the role of minimally invasive cardiac surgery (minithoracotomy) in reducing PPCs.

In conclusion, Hu and colleagues have shown the importance of pulmonary recruitment during cardiac surgery and have provided input for a future research program.

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