

Emergence and Postoperative Atelectasis: Comment

To the Editor:

I read with great interest the article by Östberg *et al.*¹ which provides clinically relevant information. The authors and the accompanying editorial² adequately mention the main limitation of the study (*i.e.*, findings are restricted to a healthy population undergoing low-risk surgery of relatively short duration). My concern relates to the data presentation and interpretation.

Outliers may affect results, assumptions, and conclusions. Labeling an observation as an outlier implicitly suggests that it is an unlikely observation, is not the result of natural variability, and that a similar observation is unlikely to occur in the future under comparable conditions. The authors provide no explanation for designating nine data points from eight patients (27% of all patients!) as outliers. In the absence of a possible explanation for why the outliers might have occurred, such an approach seems questionable. The fact that the outliers lie outside the ranges (fig. 2) would suggest that they were not included in the overall data analysis. Especially in studies with a rather small number of patients, it would be preferable to treat the outliers like all other data because those “extremes” may well reflect natural variability. In this context, the lack of the upper range whisker of the baseline values in the Zero PEEP [positive end-expiratory pressure] group (fig. 2) prevents an adequate assessment of how “extreme” the outliers really were. Overall, the rationale for designating certain observations as outliers remains unclear. At a minimum, the method of defining an outlier needs to be described, labeling of the observation as an outlier be justified, and the implication of using outliers be spelled out.

The authors interpret their findings as showing that postoperative atelectasis was small without effect on oxygenation. This interpretation is based on median values. However, the ranges of areas of atelectasis and $\text{PaO}_2/\text{FiO}_2$ ratios were large, reflecting considerable individual variability. The area of atelectasis increased by 7 cm^2 or more in two patients of each group. It would clinically be relevant to know the oxygenation status of these particular patients.

The statement that most patients had very small areas of atelectasis at baseline is not fully supported by the data. Two patients in the PEEP and three in the Zero PEEP group had baseline atelectasis areas of approximately 8.5 to 9.5 cm^2 (PEEP group) and 5.5 to 6.5 cm^2 (Zero PEEP group). This constitutes 17% of the entire population.

The overall evidence suggests a detrimental effect of an FiO_2 1.0 before extubation on the development of postoperative atelectasis. Why not abandoning administration of 100% oxygen before extubation altogether? Best practice may well consist of administering an FiO_2 of maximally 0.8 before emergence from anesthesia.^{3–5} A patient who requires an FiO_2 greater than 0.8 before extubation should probably not be extubated. “The knowledge is there! Yet, the tradition is long lived, and we still frequently practice 100% oxygen before extubation.”³

Competing Interests

The author declares no competing interests.

Hans-Joachim Priebe, M.D., Medical Center University of Freiburg, Freiburg, Germany. hans-joachim.priebe@uniklinik-freiburg.de

DOI: 10.1097/ALN.0000000000003204

References

- Östberg E, Thorisson A, Enlund M, Zetterström H, Hedenstierna G, Edmark L: Positive end-expiratory pressure and postoperative atelectasis: A randomized controlled trial. *ANESTHESIOLOGY* 2019; 131:809–17
- Domino KB: Pre-emergence oxygenation and postoperative atelectasis. *ANESTHESIOLOGY* 2019; 131:771–3
- Lindahl SG, Mure M: Dosing oxygen: A tricky matter or a piece of cake? *Anesth Analg* 2002; 95:1472–3
- Lumb AB: Just a little oxygen to breathe as you go off to sleep...is it always a good idea? *Br J Anaesth* 2007; 99:769–71
- Gordon RJ: Anesthesia dogmas and shibboleths: Barriers to patient safety? *Anesth Analg* 2012; 114:694–9

(Accepted for publication January 23, 2020. Published online first on February 20, 2020.)

Emergence and Postoperative Atelectasis: Reply

In Reply:

We appreciate Dr. Priebe's interest in our article.^{1,2} The existence of outliers is an inherent feature of biology, and respiratory pathophysiology and atelectasis formation is

certainly no exception to this rule. We can assure Dr. Priebe that all outliers were included in the analyses, which is also clearly stated in the Materials and Methods section. The statistical definition may vary, but according to the default setting in our statistical software, any observation that is 1.5 interquartile ranges below the first quartile or above the third quartile is deemed an outlier. In one of the boxplots in figure 2, no data point exists between the third quartile and 1.5 interquartile ranges, therefore no whisker is displayed. Furthermore, the nine outlier data points from eight patients are from two separate investigations, *i.e.*, from a total data set of 60 observations. The proportion of outliers is therefore 13% and not 27%.

The size of atelectasis is preferably discussed in terms of percentage of total lung area in a specific slice of the lungs. We insist that most patients had small atelectasis before awakening, with the median for all patients being only 1.3% of total lung area in a basal scan of the lungs,³ the most vulnerable parts. Indeed, five patients exhibited somewhat larger atelectasis: four of them still under 3% of total lung area and one with 4.1% of total lung area. These are not extreme numbers, but still statistically defined as outliers in our data, since nearly all other patients exhibited minimal atelectasis. Postoperatively, no single patient, outliers included, needed supplemental oxygen or had an oxygen saturation below 95%.

Knowledge on the effect of awakening with FIO_2 0.8 instead of 1.0 is still lacking. We would welcome evidence showing that awakening with FIO_2 0.8 results in even smaller postoperative atelectasis, and we particularly look forward to the resulting discussion whether it is worth shortening safe apnea time by 25% to achieve this.⁴ Meanwhile, we prefer providing our patients with a maximum oxygen reserve during awakening.

Competing Interests

The authors declare no competing interests.

Erland Östberg, M.D., Ph.D., Lennart Edmark, M.D., Ph.D.
Västerås and Köping Hospital, Västerås, Sweden.
erland.ostberg@regionvastmanland.se

DOI: 10.1097/ALN.0000000000003205

References

1. Priebe H-J: Emergence and postoperative atelectasis: Comment. *ANESTHESIOLOGY* 2020; 132:1287
2. Östberg E, Thorisson A, Enlund M, Zetterström H, Hedenstierna G, Edmark L: Positive end-expiratory pressure and postoperative atelectasis: A randomized controlled trial. *ANESTHESIOLOGY* 2019; 131:809–17
3. Hedenstierna G, Tokics L, Reinius H, Rothen HU, Östberg E, Öhrvik J: Higher age and obesity limit atelectasis formation during anaesthesia: An analysis of computed tomography data in 243 subjects. *Br J Anaesth* 2020; 124:336–44
4. Edmark L, Kostova-Aherdan K, Enlund M, Hedenstierna G: Optimal oxygen concentration during induction of general anesthesia. *ANESTHESIOLOGY* 2003; 98:28–33

(Accepted for publication January 23, 2020. Published online first on February 20, 2020.)