concentrations >5 mmol litre^{-1} (adjusted odds ratio 3.02). We agree that there are many perioperative factors that may influence serum sodium and these findings suggest this is an area that requires closer scrutiny, as they may be amenable to targeted interventions.

This study captured 16, 216 admissions dating back to 1996. There have been significant changes in perioperative fluid management during this period, in particular the rejection of liberal fluid resuscitation to a more restrictive fluid strategy and replacement of normal saline with a balanced salt solution, as the default fluid for replacement therapy. In this context it would be interesting to know if the authors observed a change in attributable mortality ratios over the data period.

Of particular interest is the effect of chloride, delivered at higher concentrations with normal saline than 'balanced' crystalloids, and its role in developing hyperchloraemic metabolic acidosis. McCluskey and colleagues[2] have previously reported that postoperative hyperchloraemia (serum chloride >110 mmol litre^{-1}) is both common (incidence of 22%), independently associated with increased 30-day mortality (odds ratio 2.05, 95% CI 1.62–2.59) and associated with higher rates of postoperative renal dysfunction. This finding was also supported by Yunos and colleagues,[3] who observed higher rates of acute renal injury and renal replacement therapy in critically ill patients with a chloride liberal, compared with a chloride restrictive fluid administration strategy. Could the reported increase in mortality risk with hypernatraemia (adjusted odds ratio 3.02) compared with hyponatraemia (adjusted odds ratio 1.49), support the hypothesis that co-infused chloride may play a contributory role?

With such a robust dataset, we were also interested to know why the threshold of 5 mmol litre^{-1} was chosen? This is especially interesting as our lab has a measurement error of 4 mmol litre $^{-1}$ (2 SD) with the relatively modern Beckman Coulter analyzers. Would not a dose-response relationship between sodium derangement and mortality be more informative than an arbitrary dichotomous classification?

Declaration of interest

None declared.

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doi:10.1093/bja/aew009

Intraoperative ventilation: improving physiology, or preventing harm?

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Editor—With interest we read the recent publication by Wirth and colleagues,[1] in which they describe the results of a study that elegantly evaluated the effects of empirically set PEEP levels on intratidal compliance-volume profiles. They show that use of levels of PEEP of 7 to 8 cm H2O, compared with PEEP levels of 5 cm H2O, is associated with less intratidal recruitment and derecruitment, while use of PEEP levels lower or equal than 5 cm H2O is associated with intratidal recruitment and derecruitment, but rarely overdistention. Repetitive collapse and re-expansion of dependent lung parts is claimed to induce the release of pro-inflammatory mediators, leading to lung and distal organ injury.[2] Use of higher levels of PEEP, therefore, could prevent lung injury by attenuating pulmonary inflammation.

The findings of this study are in line with those of a recent randomized controlled trial in patients receiving ventilation during general anaesthesia for open abdominal surgery,[3] in which use of PEEP levels of 12 cm H2O, compared with use of PEEP levels of 0 to 2 cm H2O, was associated with a higher dynamic compliance of the respiratory system, at least suggesting augmented alveolar recruitment. However, in that trial development of postoperative pulmonary complications was similar in both groups. Absence of clinical benefit, (i.e. prevention of postoperative pulmonary complication) was also found in other trials.[4 5] These results all suggest that even though higher levels of PEEP may be associated with less intratidal recruitment and derecruitment, it may not improve postoperative outcome.

It is also important to keep in mind that use of high PEEP levels could compromise haemodynamics. Indeed, more clinically relevant episodes of intraoperative hypotension were seen in patients receiving ventilation with PEEP levels of 12 cm H2O, in the randomized controlled trial in patients receiving ventilation during general anaesthesia for open abdominal surgery mentioned above.[3]

Considering that higher PEEP levels do not seem to have a positive effect on the postoperative course, while potentially causing harm during surgery, an alternative approach for PEEP titration during general anaesthesia could be more attractive: 'intraoperative permissive atelectasis'.[6] Although controversial, in this approach PEEP levels are kept relatively low, to prevent alveolar overdistention and haemodynamic deterioration, but when hypoxemia develops, and provided that other causes have been excluded (e.g., hypotension, hypoventilation, pulmonary embolism), the FIO2 should be increased first, followed by

increase of the PEEP level. This strategy does not aim at improving physiology, but prevents potential harm: *primum non nocere*.

Declaration of Interest

None declared.

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doi:10.1093/bja/aew013

Reply from the authors

Individualized ventilatory strategy: ameliorate lung injury while preserving physiology

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Editor—In their response to our study[1] Hemmes and colleagues[2] refer to a recent clinical trial in which the effects of very high and very low levels of PEEP during open abdominal surgery were compared. In that trial, postoperative pulmonary complications were comparably high during both levels of PEEP. However, in several other studies using lung protective ventilation strategies, outcomes were better with higher than lower levels of PEEP. For example, in 56 patients undergoing open abdominal surgery, administration of 10 cm H2O PEEP was associated with better five-day postoperative pulmonary function compared with no PEEP.[3] In 400 intermediate and high-risk patients undergoing major abdominal surgery, lung-protective ventilation strategy including higher levels of PEEP was associated with improved outcomes and reduced healthcare utilization.[4] In a retrospective study including 29,343 patients, PEEP levels below 4 cm H2O were even associated with increased 30-day mortality.[5]

Our study showed that in anaesthetized patients with closed abdomen 5 cm H2O of PEEP were mostly insufficient to prevent intratidal recruitment/derecruitment,[1] and that slightly higher PEEP levels might well do so. However, the intention of our study was not to advocate the administration of generally higher PEEP levels, but rather to encourage individual titration of PEEP. Under specific circumstance (e.g. in the presence of low intra-abdominal pressure during open abdominal surgery) a PEEP of 2 cm H2O may well be adequate.

In their recent editorial, Hedenstierna and colleagues[6] have asked whether multicentre trials on postoperative pulmonary complications have been helpful. They conclude '. . . that we are still left with uncertainty'.[6] The answer is not to use predetermined fixed (low or high) PEEP in each patient. A successful ventilatory strategy will be adjusted to the individual physiology. The analysis of intratidal respiratory system mechanics presents a means of individualized bed-side titration of 'best PEEP'.[7] It takes into consideration both, respiratory mechanics and haemodynamics, and this way adheres to the principle *quantum satis* (as much PEEP as is needed).

Declaration of interest

None declared.

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