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In Reply:

The concern raised by Petrenko *et al.* regarding the possibility of delirium and cognitive dysfunction with methylphenidate administration is based on a hypothesis and not on data reported from humans receiving the drug. A review of the literature suggests that delirium and cognitive dysfunction are uncommon when methylphenidate is administered to patients under general anesthesia.

In 1958, Christensen[1] reported his experience administering intravenous methylphenidate to enhance recovery from barbiturate general anesthesia for dental procedures. The only side effect reported was insomnia in a "few" patients who received relatively high doses of methylphenidate (40–50 mg) late in the day. There was no mention of delirium or cognitive dysfunction. In fact, the author wrote that "patients move out of the office rapidly and of their own power. Moreover, because of Ritalin, they are more alert on leaving the office, and we have little fear of their not getting home safely."

In the same year, Gale[2] reported the effects of intravenous methylphenidate on recovery from thiopental and nitrous oxide general anesthesia. On average, across all dose ranges of methylphenidate, the patients who received methylphenidate had significantly faster recovery compared with controls. The incidence of postoperative crying and "excitement" was unchanged between the control group and methylphenidate group.

In 1961, Roberts[3] reported the results of a double-blind study on the effects of intramuscular methylphenidate administered on the way to the recovery room after surgery. Six of 174 patients in the methylphenidate group and three of 120 patients in the placebo group had either restlessness, crying, or thrashing around.

In 1980, Dodson and Fryer[4] conducted a study to test the effects of methylphenidate on patients under halothane or fentanyl anesthesia. The authors reported that four of 31 patients who received methylphenidate were crying and restless, whereas none of the 32 control patients who received placebo exhibited this side effect. One patient who received methylphenidate had an unexplained episode of catatonia that resolved spontaneously after 40 min. This is the only study that suggested a higher incidence of undesirable behavioral side effects with methylphenidate administration.

All the aforementioned studies have shortcomings such as small sample size, no standardized anesthetic regimen, lack of patient randomization, and/or lack of clearly defined behavioral endpoints. There is no human data for methylphenidate administration during propofol general anesthesia, but in our opinion the available evidence (particularly Gale's study with thiopental,[2] which is arguably the most similar anesthetic to propofol) suggests that methylphenidate is unlikely to cause delirium or cognitive dysfunction.

In our study using adult rats, we found that administration of methylphenidate during continuous propofol general anesthesia induced an electroencephalogram pattern that was consistent with arousal, yet distinct from the baseline awake state.[5] However, we did not conclude that the electroencephalogram "showed signs of overactivation" as Petrenko *et al.* state. Although methylphenidate administration during continuous propofol general anesthesia decreased delta power (fig. 5C),[5] the peak power after methylphenidate was at a lower frequency than the baseline awake state (fig. 5D), suggesting that neurophysiological features of both the anesthetized and awake states were present. This makes intuitive sense, because an anesthetizing dose of propofol was still present when methylphenidate was administered.

In humans, the $T_{1/2}$ for clearance of methylphenidate from the brain is 90–120 min,[6] suggesting that the activity of methylphenidate is likely to persist long after the effects of propofol have dissipated. Therefore, although rebound hypersomnolence after methylphenidate may occur several hours after administration, potentiation of this phenomenon by residual propofol is highly unlikely.

In conclusion, the available data do not support methylphenidate causing cognitive dysfunction and delirium if it is administered to induce emergence from general anesthesia. On the contrary, available data suggest that methylphenidate could be administered safely to anesthetized patients in the immediate postsurgical period. There are specific instances when it could be very useful. For example, methylphenidate may find use as a "rescue" drug for patients induced with propofol, who cannot be ventilated or intubated, as it increases both arousal and respiratory drive.[7] Methylphenidate may also be useful at the end of prolonged total intravenous anesthetics with propofol (*e.g.*, for complicated spine surgeries that require neurological monitoring), after which patients often have delayed emergence. Having a drug that restores arousal and respiratory drive in the anesthesiologist's armamentarium would improve the safety of propofol administration as well as efficiency in the operating room. Nevertheless, while the available data suggest that methylphenidate administration to patients under propofol anesthesia would be safe, further research is needed to define the therapeutic benefits and possible side effects of this drug combination.

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Utility of Near-infrared Spectroscopy for Assessing Cerebral Oxygen Saturation during Beach Chair Position

To the Editor:

We read with interest the article by Jeong *et al.*[1] on cerebral oxygen saturation measured by near-infrared spectroscopy (NIRS) and jugular venous bulb oximetry during shoulder surgery in the beach chair position. Their results showed a significant lower jugular venous bulb oxygen saturation during beach chair position in the propofol–remifentanil group compared with the sevoflurane–nitrous oxide group. This difference between the two groups was not found for NIRS-measured cerebral oxygen saturation, which led the authors to conclude that NIRS cannot be recommended for assessing cerebral oxygenation during beach chair position.

The authors explain the lack of agreement between cerebral oxygen saturation measured by NIRS and measured with jugular bulb oximetry by emphasizing on the inherent limitations of the NIRS technology, such as the assumed constant arterial/venous ratio and the contamination by extracerebral blood flow and by other tissues that are not the tissues of interest. We would like to suggest an alternative explanation for the observations. In a recent study by Klein *et al.*,[2] it was demonstrated that propofol has a differential effect on the cerebral vessels, and that propofol preserves cerebral oxygen saturation in the frontal cortex, which is the measurement site of NIRS. Therefore, the finding that oxygen saturation measured by NIRS does not differ between the sevoflurane–nitrous oxide and the propofol–remifentanil group, and it does with jugular venous bulb oximetry, could be attributable to the fact that NIRS measures oxygen saturation in the frontal cortex, whereas jugular venous bulb oximetry measures global cerebral oxygen saturation.

Another concern relates to the fact that the authors used the original Bland-Altman method to assess whether cerebral oxygen saturations measured by jugular venous bulb oximetry or by NIRS were interchangeable. However, this Bland-Altman technique accounts for independent data, not for repeated measurements over a period of time, such as in this study. For both the linear regression and Bland-Altman analysis performed in this study, a technique that accounts for the within-patient–dependent data is mandatory. Consequently, the agreement estimation might have been obscured by the use of repeated-measures data.[3]

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