Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

described are generic in principle and anticipated to be applicable to any sized anaesthesia department. All actions undertaken should align with the hospital emergency or pandemic management plan and pharmacy policies, address interdepartmental implications, and undergo regular reassessment of appropriateness and applicability.[7] It is envisaged that this would be adaptable to future pandemics, outbreaks, natural disasters, and mass casualty events that will continue to challenge hospital resource management. Disaster preparation and response requires a coordinated, collaborative, and organised approach and this structured toolkit provides a pathway to this.

Declarations of interest

The authors declare that they have no conflicts of interest.

Disclaimer

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2020.05.027.

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Does prolonged propofol sedation of mechanically ventilated COVID-19 patients contribute to critical illness myopathy?

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Keywords: COVID-19; critical illness myopathy; ICU; myopathy; propofol

Editor—ICUs are challenged by the large numbers of coronavirus disease 2019 (COVID-19) patients needing mechanical ventilation and other specialised ICU therapies. A special feature of COVID-19 pneumonia is that patients often require prolonged periods of mechanical ventilation (1–4 weeks)[1] compared with usual ICU patients. This demands a well thought strategy for sedation of these patients. Propofol is the mainstay drug for ICU sedation worldwide, such that it is now so widely used during the COVID-19 pandemic that there is a shortage in many countries.

Low-grade myotoxicity can be associated with prolonged (weeks) exposure to propofol in the ICU. ICU patients in our hospital are currently diagnosed using standard electroneurography and electromyography techniques together with biochemical analyses of myosin content in muscle biopsies since the hallmark of critical illness myopathy (CIM) is the preferential loss of the molecular motor protein myosin. The early increase in spontaneous EMG activity (fibrillation potentials and positive sharp waves), together with low amplitude compound muscle action potentials in response to supramaximal stimulation of motor nerves, indicates a peripheral origin of the muscle paralysis, but does not distinguish between the spontaneous EMG activity observed after motor neuron loss and the muscle membrane defect associated with CIM.

In both clinical and experimental studies where patients and animals have been exposed to long-term (10 days) controlled mechanical ventilation, all patients and animals developed CIM (i.e. preferential loss of the molecular motor protein myosin[2–5]). In accordance with this, we see a dramatic increase of CIM in survivors of severe COVID-19 who have been exposed to long-term mechanical ventilation. The mechanisms underlying CIM are multifactorial, remain incompletely understood, and include immobilisation and mechanical ventilation *per se* with associated lung injury and release of factors affecting peripheral organs including muscle. Our current research is focusing on mechanisms underlying CIM and interventions targeting CIM.[3,6–8]

During neurophysiological assessments of patients with CIM, we frequently observe an increased number of spontaneous fibrillation potentials and positive sharp waves in propofol-treated patients. We conducted a pilot experimental study almost two decades ago (not published) in which five pigs were mechanically ventilated and anaesthetised under intensive care conditions for 5 days (the study was approved by the Uppsala Review Board for Animal Experimentation (C105/3). Two pigs received low and two high rates of propofol infusion (2–4 mg kg^{-1} h^{-1} and 12 mg kg^{-1} h^{-1}, respectively). One control animal was anaesthetised with thiopental. Sedation included a morphine infusion (0.8 mg kg^{-1} h^{-1}), and muscle relaxation was not used. Simultaneous electrophysiological measurements and collection of muscle samples from the biceps femoris muscle were performed on the first and final days of the study; the muscle biopsies were analysed by immunocytochemistry and *in situ* detection of DNA fragmentation. Motor nerve conduction velocities did not change over time, but in all propofol-treated animals there was a significant increase in the amount of spontaneous EMG activity in the biceps femoris muscle. On Day 5, serum protein positive muscle fibres were observed in the propofol-treated animals, most prominently in cross-sections from the high-dose propofol animals. Muscle cells were observed with intense intracellular staining of serum proteins together with signs of apoptosis (Fig. 1). Mean plasma creatine kinase concentration increased from 4.1 μkat L^{-1} the first day to 25 μkat L^{-1} on Day 5 in propofol-treated animals, supporting a muscle membrane defect. None of these effects was observed in the thiopental-sedated animal. The study was unfortunately not finished because of a lack of financial support.

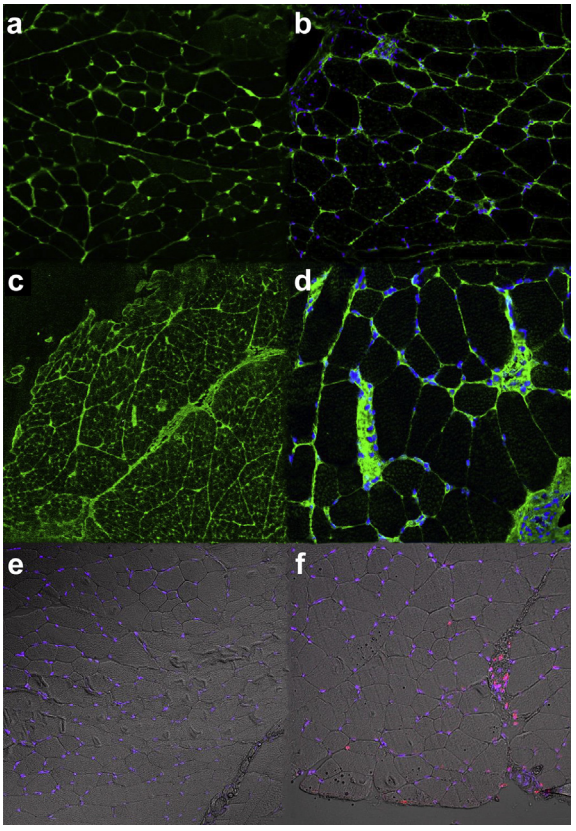

Fig 1. Intracellular localisation of serum proteins in animals exposed to propofol. (a) Shows a section at Day 1 from an animal that received a high-dose propofol treatment. Serum proteins (green) are present in small capillaries and between individual muscle cells. (b) A section after 5 days of treatment shows serum proteins in the cytoplasm of a few necrotic muscle cells. An increased number of nuclei (blue) are also present. (c) A low magnification displays some muscle cells with internal serum protein (arrows). (d) A high magnification of an area from (c). (e) (f) TUNEL (Terminal deoxynucleotidyl transferase dUTP nick end labeling) staining shows apoptotic nuclei in sections from musculus. biceps femoris from a high-dose propofol-treated animal at Day 1 and Day 5.

Although not conclusive, these pilot data take on new relevance with the now frequent finding of ICU survivors of COVID-19 suffering from profound muscle weakness after discharge from ICU. These findings suggest that prolonged use of propofol infusions may not be appropriate as the first-line choice for sedation in adult COVID-19 patients undergoing mechanical ventilation.

Because of the increased risk of propofol infusion syndrome in children (in part as a result of impaired oxidation of fatty acids[9]), regulatory bodies (US Food and Drug Administration and European Medicine Agency) have imposed

restrictions to the use of propofol for sedation in paediatric ICUs.[10] A more general myotoxic effect is also hypothesised after the occurrence of severe myalgia even after brief procedural sedation, and propofol infusion syndrome, often a lethal condition that involves rhabdomyolysis, can also occur in adults.[11] In a UK survey on paediatric ICU sedation practices, propofol was only used in 2.6% of patients, all more than the age of 4 yr, and not exceeding 2 mg kg^{-1} h^{-1}.[12] Thus it is possible to perform long-term sedation without the use of propofol, a fact that may explain the relatively rare occurrence of CIM in children.[13]

In conclusion, as with so many other issues relating to COVID-19 we need to discuss and perhaps re-evaluate our practice. Prolonged propofol infusions may not be in the best interest of COVID-19 ICU patients. We are currently planning a study of the occurrence of CIM in survivors of COVID-19 intensive care. We hope that others will follow suit and perform relevant neurophysiologic investigations (e.g. electroneurography, electromyography, and muscle biopsies) in cases of suspected CIM.

Declarations of interest

The authors declare that they have no conflicts of interest.

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Cardiac arrest precipitated by succinylcholine in a patient with COVID-19. Comment on *Br J Anaesth* 2020; 125: e255–7

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Keywords: cardiac arrest; COVID-19; critical care; neuromuscular blocking agent; respiratory failure; succinylcholine

Editor—We read with interest the report by Sigurdsson and colleagues[1] describing cardiac arrest secondary to ventricular tachycardia after succinylcholine use for rapid-sequence induction (RSI) and tracheal intubation in the ICU. This occurred after a failed extubation in a patient requiring mechanical ventilation for 17 days owing to respiratory failure as a consequence of severe acute respiratory syndrome (SARS)-coronavirus 2 (SARS-CoV-2) infection. The cause of the arrhythmia appeared to be hyperkalaemia, and

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