Remote Control and Monitoring of GE Aisys Anesthesia Machines Repurposed as Intensive Care Unit Ventilators

To the Editor:

The requirements of early intubation and prolonged mechanical ventilation in the management of patients with coronavirus disease 2019 (COVID-19) has created a shortage of intensive care unit (ICU) capacity and ventilators. Operating rooms and anesthesia machines¹ are being repurposed to care for these critically ill patients. Certain ICU ventilators, such as the Hamilton G5 (Hamilton Medical AG, Switzerland), permit their control monitor to be detached from the ventilator and extended outside the

room on an umbilical electrical cable, which allows “frequent ventilator adjustments while simultaneously decreasing the risk of exposure to staff.”² Although no studies have examined effects on clinical outcomes, the pragmatic benefits are evident: ICU staff need not be continuously present in the patient’s room, nor frequently don and doff scarce personal protective equipment to perform alarm checks and setting changes.

In light of this public health crisis, the U.S. Food and Drug Administration has issued guidance that anesthesia machine device modifications may be made that do not create undue risk.³ We now describe a novel, inexpensive modification to add umbilical cabling to GE Aisys and Aisys CS2 anesthesia machines (GE Healthcare, USA), allowing the same advantageous remote control and monitoring of ventilation.

The Aisys display unit control panel is anchored to a mounting plate on the boom arm by four small bolts (fig. 1, *left*). Three cables attach to the control panel, marked A, B, and C in figure 1 and *inset*. Loosening these bolts and cables allows the control panel to be detached. A is a DB15/male cable, which communicates with the electronic medical record. B is an HD26/male cable, which carries ventilator signals and data. C is a DB15/female cable, which provides system power.⁴ We have added and tested 50-foot

Fig. 1. Remote placement of the GE Aisys display unit control panel. The modification steps are highlighted at *left*, with *inset* engineering drawings modified from the *Aisys Anesthesia Machine Technical Reference Manual*. At *right*, an Aisys control panel is shown relocated outside of an operating room repurposed as an intensive care unit bay. The *rectangular highlight* indicates the original position of the control panel before detachment from the anesthesia machine.

Fig. 2. In the unlikely event of a disconnection of cable B (the System Signal Interface cable), a system malfunction message appears on the Aisys control panel screen. The machine must be powered down, the cable connection re-established, and the machine powered up again in order to resume mechanical ventilation. Meanwhile, the patient must be maintained with fresh gas from the Alternate O₂ Control and manual/spontaneous ventilation as illustrated on the error screen.

extensions to cables A, B, and C, permitting the detached control panel to be repositioned outside the operating room. Figure 1 (*right*) shows the remote control and monitoring of the ventilation of a mannequin within an operating room converted for ICU care. The cable extensions used were Amphenol Corporation 2 × Part #CS-DSDMDB15MF for A and C, and Part #CS-DSDHD26MF0 for B (Amphenol Cables On Demand, USA). When the anesthesia machine is returned to normal service, removing these extensions reverts the machine to its original configuration without a trace.

When properly coupled with supplied locking screws, accidental cable disconnection is extremely rare. If A becomes disconnected, data will not stream to the electronic medical record, and A should be reconnected. If B becomes disconnected, the control panel will display a system malfunction screen (fig. 2) and alarm audibly. If C becomes disconnected, the control panel will power down abruptly, and audible machine alarms will sound. To restart ventilator operation after disconnection of B or C, power down, reconnect the cable, and power up while manually ventilating as shown.

This modification allows anesthesiologists to interpret ventilator waveforms, adjust ventilation settings, ensure lung protective ventilation, and hear alarms at all times freely from outside the operating room. Personnel exposure and use of personal protective equipment are reduced, as anesthesiologists no longer need to enter the room for these frequent tasks. This modification can be performed without special tools or skills in 5 to 10 min.

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Competing Interests

Dr. Connor is a consultant for Teleflex, LLC (Wayne, Pennsylvania) on airway equipment design. This activity is

unrelated to the material in this letter. The other authors declare no competing interests.

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