

# Transporting Anesthesia Workstations to Hospitals for Use as Ventilators

Paul N. Austin, PhD, CRNA

Michael P. Dosch, PhD, CRNA

*Critical care ventilators (CCVs) are being used to mechanically ventilate patients with coronavirus disease 2019 (COVID-19) and respiratory failure. A shortage of CCVs has been reported in some areas of the country, however. The government, manufacturers, and professional organizations have offered guidance for repurposing anesthesia workstations with the integral ventilator for use as CCVs during the current COVID-19 pandemic. Ambulatory surgery centers (ASCs) are equipped with anesthesia workstations that may be suitable for using as CCVs, but many ASCs are freestanding, and their anesthesia equipment must be transported to the hospital where it is*

*needed. This report describes factors to consider when transporting anesthesia workstations from the ASC for repurposing as a CCV in the hospital. These ASCs may be located miles from the hospital, and care must be taken to select the most suitable anesthesia workstation, prepare it for the journey, and safely transport it. Goals include selecting the most suitable machine and ensuring the machine arrives intact and fully functional. A checklist is provided to help ensure important aspects of this process are accomplished.*

**Keywords:** Anesthesia machine, COVID-19, critical care ventilator, ventilator transportation.

Critical care ventilators (CCVs) are being used to mechanically ventilate patients with coronavirus disease 2019 (COVID-19) with respiratory failure. However, there is a shortage of CCVs in some areas of the country. The government, manufacturers, and professional organizations have offered guidance for repurposing anesthesia workstations with the integral ventilator for use as CCVs during the current COVID-19 pandemic.<sup>1-5</sup> Ambulatory surgery centers (ASCs) are equipped with anesthesia workstations that may be suitable for using as CCVs, but many ASCs are freestanding, and their anesthesia equipment must be transported to the hospital where it is needed.

It is preferable to move anesthesia supplies and equipment to the acute care hospital, rather than moving patients with COVID-19 or other critically ill patients to the ASC. Ambulatory surgical centers may lack the full complement of personnel, equipment, supplies, laboratory, and blood bank support needed for critically ill patients. Furthermore, ambulatory surgical centers may still be open, performing urgent surgery in patients who are not suspected of having COVID-19. This must be considered when contemplating transport of any equipment and supplies from an ASC to the hospital.

This report describes factors to consider when transporting anesthesia workstations from the ASC for repurposing as a CCV in the hospital. These ASCs may be located miles from the hospital, and care must be taken to select the most suitable anesthesia workstation, prepare it for the journey, and safely transport it. Goals include selecting the most suitable machine and ensuring that the

machine arrives intact and fully functional. A checklist (Table 1) is offered to help ensure that important aspects of this process are accomplished.

Anesthesia providers must assess anesthesia workstations for their suitability for long-term ventilation and must oversee their operation. Their setup, maintenance, alarms, monitoring, and principles of operation are markedly different than those of CCVs. Setup and operation of anesthesia workstations as CCVs are described elsewhere.<sup>5,6</sup>

## Suitability

Newer anesthesia workstations are very suitable, and are routinely used in operating rooms, to ventilate patients with severe lung disease. Older workstations could be used if absolutely necessary. It is not unusual for ASCs to have older, less suitable anesthesia workstations. Determining the suitability of a specific workstation is difficult because of the variability between models of the same workstation, so workstations must be carefully assessed for suitability by an anesthesia provider.

The following describes the basic characteristics of an anesthesia workstation most suitable for use in a patient with COVID-19. These characteristics are described in detail in guidance from professional organizations, and this guidance should be reviewed before determining whether a workstation is suitable.<sup>2-4,6</sup>

- Able to deliver oxygen and air.
  - Prolonged use of 100% oxygen is detrimental to the patient. Many older anesthesia workstations may deliver only oxygen and nitrous oxide.
- Has a ventilator that is capable of delivering volume-

Task	Accomplished
<b>Documentation</b>	
Carefully verify it is the workstation indicated for transport.	✓
Document and give a copy to the ASC representative of the following	✓
• Name, contact information, and agency or facility represented of both parties	
• Make, model, serial number of anesthesia workstation or workstations	✓
• Model, if known, of the ventilator that is attached to the workstation	✓
• Make, model, and serial number of any physiologic (ECG, blood pressure, pulse oximeter, end-tidal carbon dioxide) monitor	
• List of accessories and consumables transported (description and number)	
• Legal and financial concerns addressed and required documents complete	
This all can be prepared by the ASC before transport	
<b>Tasks by qualified ASC personnel or others before the workstation is moved; verified by transport personnel</b>	
Label the workstation and all accessories with at least the name of the ASC.	
Remove or drain the vaporizer or vaporizers.	
If ASC personnel are not available to drain the vaporizer, it is acceptable to transport the vaporizer filled, but the workstation must be kept <i>upright during transport</i> .	
Remove all tanks on the back of the anesthesia workstation	
Workstations vary. This video covering installing a tank may help with tank removal: <a href="https://www.youtube.com/watch?v=M0I4cnELdFs">https://www.youtube.com/watch?v=M0I4cnELdFs</a>	
Remove the blue nitrous oxide hose from the wall and from the workstation; this hose remains at the ASC.	
<b>Accessories included</b>	
Operator's manual or manuals	
High pressure oxygen, air and suction hoses attaching the workstation to the appropriate connection on the wall of the operating room	
The blue nitrous oxide hose <i>remains</i> at the ASC.	
Batteries for the oxygen sensor, if required	
Backup oxygen sensor parts and other parts of the workstation such as flow sensors that sometimes have to be replaced by the clinician	
<b>Consumables included</b>	
• Breathing circuits	
• Usually 2 long corrugated hoses connected together at 1 end with a Y connector, usually supplied with 1 circuit in a plastic bag	
• A filter may be attached to each hose	
• Heat and moisture exchange filter (HMEF); may be supplied with the breathing circuit	
• Anesthesia masks	
• End-tidal carbon dioxide sample tubing; may be supplied with the breathing circuit	
• Carbon dioxide absorbent	
<b>Considerations for the receiving hospital</b>	
Ascertain if there is a risk the workstation was used with patients with COVID-19 without proper filtration and workstation needs internal sterilization.	
Perform biomedical checkout.	

**Table 1. Checklist for Personnel Tasked to Move Anesthesia Workstations With a Ventilator to an Acute Care Hospital<sup>a</sup>**

<sup>a</sup>After determination by an anesthesia provider that the workstation is suitable for use as a critical care ventilator.

Abbreviations: ASC, ambulatory surgery center; COVID-19, coronavirus disease 2019; ECG, electrocardiogram.

controlled and pressure-controlled ventilation, and synchronized intermittent mandatory ventilation with pressure support, or the ability to emulate these modes.

o Ventilators that are less sophisticated and deliver only volume- or pressure-targeted ventilation could be sufficient as a lifesaving intervention.

- Provides compliance compensation and tidal volume delivery unaffected by fresh gas flow.
  - o Compliance compensation will facilitate delivery of the desired tidal volume by compensating for the compliance of the breathing circuit.

The receiving hospital must verify that proper precautions have been used if the workstation was recently used

## Accessories

- Breathing circuits
- Operator's manual for all equipment being transported (if available)
- High-pressure oxygen, air, and suction hoses (for scavenging) that are capable of attachment to pipeline sources
  - The nitrous oxide hose (may be blue) that often is attached to the back of the machine should be detached from the machine and *remain at the ASC* if possible.
- All emergency gas cylinders should be removed and *not be transported* with the machine. However, at least one emergency oxygen tank must be reinstalled at the hospital before use in order for most machines to pass the checkout procedure.
- Backup oxygen sensor parts and other parts of the machine such as flow sensors that sometimes have to be replaced by the clinician
- Physiologic monitor (ECG, blood pressure, oxygen saturation, respiratory rate, end-tidal carbon dioxide). The monitor may be separate from the anesthesia machine, and it should be determined before transport if the monitor will be transported. All accompanying hoses, cables, sensors, and blood pressure cuffs must be included. Sometimes the end-tidal carbon dioxide monitor is a separate device.

### Consumables sufficient for anticipated duration of use must accompany machine

- Breathing circuits with expiratory or expiratory and inspiratory filters. Rarely, but possibly, the filter is supplied separately.
- Filtration: Heat and moisture exchanger filters (HMEFs). Sometimes HMEFs come with the breathing circuit but often are supplied separately. HMEFs look very similar to heat and moisture exchangers; however, it is important to use an HMEF because the filter component is crucial. If the circuit has an HMEF installed, and the monitor gas is sampled on the machine side of the HMEF, no further filtration is required.
- Anesthesia masks of various sizes (sometimes supplied with the breathing circuit)
- Carbon dioxide absorbent, most often supplied as prefilled canisters. Absorbent is necessary for proper machine function, and it exhausts fairly quickly in use (as often as every 6-8 hr)
- End-tidal carbon dioxide sampling tubing
- Batteries for the oxygen analyzer, if required
- Any consumables associated with the physiologic monitor (eg, disposable blood pressure cuffs)

**Table 2.** Accessories and Key Consumables That Must Be Transported With the Anesthesia Machine From Ambulatory Surgery Center to Acute Care Hospital

Abbreviations: ASC, ambulatory surgery center; ECG, electrocardiogram.

to care for patients with COVID-19. If there is any doubt, internal components of the workstation will have to be sterilized according to the manufacturer's reprocessing instructions.<sup>7</sup> Evidence of current preventive maintenance should be sought. The workstation will likely be subject to the receiving hospital's process of safely using borrowed equipment.

### Accessories and Key Consumables

Key consumables and accessories necessary for operation of the anesthesia workstation (Table 2) should accompany the workstation. A workstation may be nonfunctional without a key accessory or consumable. These may be specific to the model of the workstation, and there is a strong concern that consumables at the hospital will be quickly exhausted.

Except for the nitrous oxide hose, the high-pressure gas hoses should be transported with the workstation. The fittings on the end of the hose that is attached to the wall-mounted pipeline gas supply receptacle may be different from the fittings used at the hospital. This risk should be accepted as the supply of these hoses may be limited at the hospital. These hoses may have to be replaced, and the original hoses should remain with the workstation.

### Pretransport Considerations

Once the anesthesia workstation has been determined to be suitable, all parties must ensure any legal and financial documents are processed. The ASC personnel (preferably an anesthesia provider) should

- Clearly mark the anesthesia workstation and non-consumable items with at least the name of the ASC.
- Drain or remove the vaporizers.
- Remove the emergency gas tanks.
- Be sure all high-pressure hoses are with the workstation except for the nitrous oxide hose.
- Ensure all requested accessories and consumables are identified and packaged.

### Transportation Precautions; Personnel and Equipment Requirements

Anesthesia workstations are equipped with wheels and are mobile. However, the workstations can weigh more than 100 kg (hundreds of pounds) and are somewhat top-heavy. The workstations can tip over and be damaged. Their footprint is approximately 0.9 × 1.2 m (3 × 4 ft) with an average height of 1.2 to 1.5 m (4-5 ft), but there is some variation. A sufficient number of transport personnel are necessary. A truck with a tall covered bed and a power lift

gate is best for safe transport. Crating the workstation is optimal but may not be necessary depending on how far it needs to be transported. The workstation must be secured in the bed of the truck. Personnel moving the workstation must be carefully supplied with information so the correct workstation is transported. "Considerations for Transport of Anesthesia Workstations From Ambulatory Surgery Centers to Hospitals" (Appendix) combined with the checklist (Table 1) and list of accessories and consumables (Table 2) may help ASC and hospital personnel when planning to move workstations.

## Considerations at the Receiving Acute Care Hospital

Anesthesia and biomedical personnel should communicate directly with ASC personnel to confirm the details of the workstation, including fittings on the high-pressure hoses. Stakeholders such as critical care medicine and nursing, biomedical personnel, and anesthesia providers should consider carefully where these workstations will be used. For instance, the location must have wall-mounted suction capability, as the scavenger system may need to be attached to suction for proper ventilator operation. It is preferable that all patients ventilated with an anesthesia workstation are located in the unit or area to facilitate oversight by anesthesia providers.

The anesthesia workstation and any accessories should be assessed by the hospital's biomedical personnel. Everything should be examined for damage and proper function. Modifications and installation instructions for repurposing an anesthesia machine as a CCV are described elsewhere, and these directions must be carefully followed.<sup>2-4,6</sup>

## Conclusion

Anesthesia workstations can be transported from ASCs to acute care hospitals to be repurposed as CCVs to mechanically ventilate patients with COVID-19. Anesthesia providers must be fully involved in the entire process in order that optimal care be provided to patients during this pandemic.

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## AUTHORS

Paul N. Austin, PhD, CRNA, is a professor at Texas Wesleyan University, Fort Worth, Texas, and the coordinator of the research and anesthesia curriculum for the Doctorate of Nurse Anesthesia Practice Program at Texas Wesleyan University in Fort Worth, Texas.

Michael P. Dosch, PhD, CRNA, is professor and chair of nurse anesthesia and program administrator of the University of Detroit Mercy Program of Nurse Anesthesia in Detroit, Michigan. He has written extensively in the area of anesthesia equipment and related devices.

## DISCLOSURES

Use of the anesthesia workstation as a ventilator for critically ill patients is an off-label use of the device, is entirely the responsibility of the user, and should be carefully considered before implementation. Any recommendations herein should be subject to local peer review before implementation.

The authors gratefully acknowledge the helpful guidance and recommendations published by the American Association of Nurse Anesthetists, American Society of Anesthesiologists, Anesthesia Patient Safety Foundation, GE Healthcare, Food and Drug Administration, Draeger Inc, and other entities. This document has undergone peer review. Any misinterpretations or errors within this document are solely the responsibility of the authors. Some of the recommendations here are the authors' personal opinions, and do not reflect the opinion or policy of Texas Wesleyan University, the University of Detroit Mercy, or any other institution with which the authors are affiliated.

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## OTHER RESOURCES

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## Target Audiences

- Emergency planners
- Logistics and transportation personnel
- Ambulatory surgery center (ASC) anesthesia and nonanesthesia personnel
- Hospital anesthesia and nonanesthesia personnel

## Overview

This document addresses practical aspects of the transportation of anesthesia workstations (anesthesia workstations are also called anesthesia machines) with ventilators from ASCs to acute care hospitals to ventilate patients with coronavirus disease 2019 (COVID-19). See Table 1 for a checklist to help ensure safe and efficient transport of these devices.

Operation of all anesthesia workstations must be overseen by an anesthesia provider such as a Certified Registered Nurse Anesthetist (CRNA) or physician anesthesiologist. The operation of an anesthesia workstation is markedly different than a critical care or other type of ventilator. Setup, operation, and other aspects of repurposing anesthesia workstations as critical care ventilators are described elsewhere (see "Other Resources").

## Anesthesia Workstation Suitability for Repurposing as a Critical Care Ventilator

Ambulatory surgery centers often are equipped with anesthesia workstations. However, the suitability of the workstation for ventilating a patient with COVID-19 varies between workstations and even between models of the same workstation.

Newer workstations are very suitable and are routinely used in operating rooms to ventilate patients with severe lung disease such as that seen in patients with COVID-19. Older workstations could be used as a last resort. It is not unusual for ASCs to have older anesthesia workstations that are less suitable for use with patients with COVID-19. Determining the suitability of a specific workstation is difficult because of the variability between models of the same workstation, so workstations must be carefully assessed for suitability. Suitability can be determined only by a CRNA or physician anesthesiologist.

The following describes the characteristics of an anesthesia workstation most suitable for use with a patient with COVID-19:

- Able to deliver oxygen and air.
  - Prolonged use of 100% oxygen is detrimental to the patient
- Has a ventilator that is capable of delivering volume-controlled and pressure-controlled ventilation and synchronized intermittent mandatory ventilation, pressure support, or the ability to mimic these modes.
  - Ventilators that are less sophisticated and deliver only volume- or pressure-targeted ventilation could be sufficient as a lifesaving intervention.
- Provides compliance compensation and tidal volume delivery unaffected by fresh gas flow.

The suitability of the anesthesia workstation is best determined before the decision is made to move the workstation. Personnel moving the workstation must be carefully supplied with information so the correct workstation is transported.

These workstations are equipped with wheels and are mobile. However, the workstations weigh more than 100 kg (hundreds of pounds), have a footprint of about 0.9 × 1.2 m (3 × 4 ft), and are about 1.2 to 1.5 m (4-5 ft) tall, with great variation. The workstations can tip over and be damaged. The workstation must be kept upright and not tipped during the entire transport. A sufficient number of transport personnel and equipment are needed. A truck with a tall covered bed and a lift gate is best

for safe transport. Crating the workstation is optimal but not necessary, depending on how it needs to be transported. The workstation must be secured in the bed of the truck.

## Consumables and Accessories

Key consumables and accessories necessary for operation of the anesthesia workstation (Table 2) should accompany the workstation. These may be specific to the model of the workstation, and consumables at the hospital may be quickly exhausted.

## Considerations for the Receiving Hospital

There are a number of setup considerations for the receiving hospital. For detailed directions, refer to the document by the *Anesthesia Patient Safety Foundation and the American Society of Anesthesiologists* (<https://www.asahq.org/in-the-spotlight/coronavirus-covid-19-information/purposing-anesthesia-machines-for-ventilators>). General considerations include the following:

- Location of the workstations.
  - Consider grouping on the same unit, facilitating coverage by anesthesia providers.
  - Availability of wall-mounted suction connection for scavenging, which is required for some workstations; others can safely have the scavenger disabled. If the scavenger is not properly addressed, unwanted positive end-expiratory pressure will build.
- There is a chance the high-pressure hoses for oxygen, air, and suction will not fit into the wall-mounted receptacles at the hospital.
- Anesthesia workstation ventilators are often driven by oxygen rather than electrically; this requirement is on top of the fresh gas flow.
  - Anticipate increased oxygen use.
  - The drive gas can be changed on some workstations from oxygen to air, but this must be done by a biomedical engineer.

## Other Considerations

- **Legal.** Once the anesthesia workstation has been determined to be suitable, all parties must ensure that any legal and financial documents are processed.
- **Sterilization.** The receiving hospital must verify proper precautions have been used if the workstation was recently used to care for patients with COVID-19. If there is any doubt, internal components of the workstation will have to be sterilized according to the manufacturer's instructions.
- **Maintenance Records.** Evidence of current preventive maintenance should be sought by ASC personnel. The workstation will likely be subject to the receiving hospital's process of safely using borrowed equipment.
- **Vaporizers.** Anesthesia workstations are equipped with devices (up to 3 per anesthesia workstation) called vaporizers, which turn the liquid general anesthetic agent into a vapor so the patient can inhale the vapor, producing general anesthesia. Vaporizers should be drained by qualified ASC personnel (nurse anesthetist or anesthesiologist) before transport.

Sometimes the vaporizer can be removed. Qualified ASC personnel may remove and store the vaporizers. If vaporizers are removed, qualified ASC personnel should be sure the workstation operates properly. If there is a question, just drain the vaporizer.

If no qualified ASC personnel are available, the anesthesia workstation can be transported with filled vaporizers remaining on the workstation so long as they are turned off. The workstation must be kept upright during the entire transport.

## Appendix. Considerations for Transport of Anesthesia Workstations From Ambulatory Surgery Centers to Hospitals