SASA COVID-19 UPDATE

SASA SOUTH AFRICAN SOCIETY OF ANAESTHESIOLOGISTS

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Guidelines on the use of anaesthesia machines as ICU ventilators

The anticipated massive increase in demand for ventilators in the context of the COVID-19 pandemic may result in the need to use anaesthesia workstations/ventilators for the ventilation of critically ill patients.

SASA recognises this need and has engaged with the manufacturers of the commonly deployed anaesthesia workstations, namely Draeger, GEMedhold and Mindray. They have raised concerns largely in line with those of the SASA COVID-19 working group. These are listed below

1. Off-label use
   The use of anaesthesia workstations for long term ventilation is an off-label use of the equipment - however, given the nature of the crisis the FDA has confirmed that there is no intention to object to the use of these devices in this role.

2. Interface differences
   The software interface on anaesthesia workstations is generally different to those seen on ICU ventilators. There may be requirements to confirm settings. When anaesthesia workstations are employed for ICU ventilation it is imperative that staff who will be operating these are sufficiently trained in the use of the software interface.

3. Prevention of CO2 Rebreathing
   Anaesthesia workstations should always be operated with CO2 absorber attached, except when these are being changed. It is critical to prevent CO2 rebreathing and in order to prevent rapid exhaustion of soda lime and buildup of significant moisture in the circuit fresh gas flows up to 150% of minute volume are recommended. Staff operating these units should be given guidance as to the use of FiO2 monitoring and the potential for this being very different from the set oxygen concentration.

4. Audio Alarms and settings
   It should be appreciated that anaesthesia workstations are designed for supervised use. As such, the alarm volumes and alerts may be insufficient to be heard in an ICU environment. It is critical that these are adjusted appropriately and that patients are not left unattended while being ventilated and that staff operating these units are appraised of this potential risk.

5. Nebulisation and active humidification
   Anaesthesia ventilators do not have facility for inline nebulisation - application of this may result in failure of ventilation. The use of active humidification with anaesthesia workstations is not encouraged.

6. Leak Compensation
   Anaesthesia ventilators do not compensate for circuit leaks. Operators should be trained to monitor bellows position and adjust fresh gas flows as required

7. Increased Oxygen consumption
   Anaesthesia ventilators generally use oxygen as a driving gas. Users should be aware that this may dramatically increase oxygen use at a facility. Many can be adapted to use medical air but this modification needs to be performed by an authorized technician.

Further information on the use of anaesthesia ventilators during the COVID-19 pandemic may be found at the following locations:

GE Health Care
Draeger
Mindray - Instructional video here
Getinge

PRACTICAL ADVICE FOR THE USE OF ANAESTHESIA VENTILATORS IN THE ICU SETTING

1. Any concerns with the machine or ventilation should be escalated to anaesthetic staff who have familiarity.
2. Leave the machine in ventilator mode - do NOT switch to bag mode.
3. Vaporisers should be removed from the anaesthesia machine when used as a critical care ventilator.
4. Do NOT adjust or use the APL valve - this is for manual ventilation only.
5. Total gas flow should be at LEAST 6 litres per minute or 50% of the minute volume, whichever is greater - this is to prevent rebreathing and rapid soda-lime exhaustion.
6. The Anaesthetic machine MUST be used with an HME/F filter which must be changed every 24 hours.
7. Provided high quality filters are used, scavenging is not required.
8. High inspiratory pressures, High FiO2 requirement or high ETCO2 should prompt a filter change before consideration given to proning patient
9. Visible water collecting in the circuit must be drained - this is to prevent increased resistance to ventilation and bubbling caused by gas flow which may be sensed as a patient inspiratory effort leading to increased ventilation and dyssynchrony.
10. Sodalime must be changed every 24 hours - should be done by anaesthetic staff.
11. Suctioning may empty the bellows - please check these after suctioning and increase gas flow temporarily to refill if necessary.

12. If the bellows are empty - the oxygen flush can be used to fill them BUT this is NOT recommended. Also, do NOT use to give patients 100% oxygen - the flow and pressure delivered are too high and may cause lung damage.
13. The machine will alarm for a checkout every 24h. This can be ignored.
14. Dependent on Anaesthesia workstation ventilator capability, patients may require deeper levels of sedation when ventilated with anaesthesia machines compared to traditional modern ICU ventilators. A significant number of modern anaesthesia ventilators are able to provide ICU modes of ventilation.
15. These machines should be reserved for patients who are easy to ventilate.
16. It is advisable to have at least one anaesthetist au fait with anaesthesia ventilators available at all times to assist with troubleshooting should the need arise.

TABLE OF VENTILATOR SPECIFICATION BY ANAESTHESIA MACHINE

Make/ Model	Ventilator Drive	P_{MAX}	RR_{MAX}	Maximum PEEP	V_T/MV_{MAX}	Spirometry/ Compliance/ Sensing
Draeger Apollo	E-Piston	70	100	20	1400/50	Y/Y/Y
Draeger Fabius	E-Piston	70	60	15	1400/25	N/Y/Y
Draeger Perseus	E-Blower	80	100	35	1500/50	Y/Y/Y
GE Aisys and Aisys C_2	P-Bellows	100	100	30	1500/120	Y/Y/Y
GE Avance and Avance C_2	P-Bellows	100	100	30	1500/120	Y/Y/Y
GE Carestation 6000 Series	P-Bellows					Y/Y/Y
Getinge Flow-i	P-Reflector	80	100	50		Y/Y/Y
Mindray Advantage	P-Bellows	100	100	30	1500/30	Y/Y/Y

P- Pneumatic. E-Electrical

The most capable anaesthesia machines should be utilised first. Start with a workstation whose ventilator can provide SIMV+PS using either a volume or pressure targeted mode of ventilation mixed with pressure support. Thereafter utilise less capable models. Realise that the ventilation capacity of most anaesthesia machines, even the most basic, should be sufficient as a life-saving intervention for the majority of patients.

CLEANING THE ANAESTHESIA MACHINE BETWEEN PATIENTS

Standard hospital procedures for COVID-19 decontamination should be sufficient for the reprocessing of anaesthesia workstations between patients provided breathing circuit filters have been used as directed. In this situation there should be no increased risk of passing COVID-19 to a subsequent patient via the anaesthesia machine. Should there be evidence of contamination of the internal surfaces of the breathing system, then the manufacturer's guidelines on decontamination should be followed.

SASA Quick Reference: Setup and Monitoring Instructions Anaesthesia Machine as an ICU Ventilator

With Thanks and adapted from American Society of Anesthesiologists™ apsf Anesthesia Patient Safety Foundation

SETUP

- Gas Supply check
  - Check connection to Central Gas supply ~4kPa.
  - Check backup oxygen cylinder is full.
  - Disconnect nitrous oxide hose from supply.
- Scavenger
  - Connect outlet to hospital scavenger system.
- Vaporizers
  - Remove or empty vaporizer (unless required for sedation).
- Configure machine with disposables
  - Filters
    - HMEF on airway, gas sampling on machine side.
    - Second (HEPA) filter on expiratory limb.
  - Large (Adult) reservoir bag
  - Gas analyser in line machine side of filter or side stream from filter
    - Oxygen and carbon dioxide
- Machine check self test
  - Compliance test with circuits and filters installed (repeat test if changed).
  - Confirm passes self test with no errors
- Check alarms and set appropriate limits for ICU patient, ensure volume set high.
  - Default limits may be different per machine than required in ICU patients
    - Inspired CO_2 alarm at 5 mmHg(0.6kPa).
    - Expired CO_2 alarm increased to allow for permissive hypercapnoea.
    - Adjust high and low pressure alarm limits.
    - Adjust Minute Volume, rate and FiO_2 alarm appropriate to patient.
- Set APL Valve to 0cm H_20

PRIOR TO USE

- Ensure
  - Manual ventilation device readily available
  - Suction connected and available
  - Machine preferably powered by UPS power and generator backup

INITIATE THERAPY

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- Fresh Gas Flow (FGF) Options
  - Option 1: Low fresh gas flow to conserve oxygen
    - Preserves humidity
    - CO2 absorbent must be available and maintained
    - Inspired CO2 Alarm must be set to 5 mmHg(0.6kPa)
  - Option 2: Fresh gas flow = Minute Ventilation
    - CO2 absorbent in place but does not need to be replaced (Increase FGF if inspired CO2 present)
    - Humidification essential (HMEF)
  - Setting Oxygen Concentration
    - Electronic flowmeters – set required concentration (FiO2)
    - Monitor delivered FiO2
    - Mechanical flowmeters
    - Air/Oxygen mix to deliver O2 concentration (use table or oxygen analyser) and flow required.
    - Inspired oxygen concentration must be monitored especially when using low flows – it will be less than set concentration
  - Set Ventilator according to patient needs to Critical Care principles advice per patient
    - Ventilation mode
    - Rate, Volume/ Pressure
    - I:E Ratio
    - PEEP
  - Start Ventilator
    - Select spirometry loop if available
    - Note Pressure and flow waveforms
    - Record monitored values

MONITORING SCHEDULES

- **Continuous**: Alarm monitoring enabled and mandatory
- **Hourly check**
  - CO2 Absorbent
  - Inspired Oxygen concentration
  - Inspired and expired CO2 concentration
  - Agent concentration if applicable as well as Vaporizer if agent being used.
  - Humidity and secretions (Filters and water traps)
  - Inspiratory Pressure
  - Tidal volume
  - Spirometry
- **4 Hourly Check**
  - HMEF change/ check
  - Increase FGF to MV or above for 15minutes
- **24 Hourly Check** – Machine Self test*

**Anaesthesia machine WILL NOT provide ventilation during the self-test. An alternate ventilation strategy that can be maintained for several minutes is required. Consider transport ventilator to maintain PEEP if manual ventilation bag not likely to be successful. Power to the machine should be cycled between every patient and at least every 25 days.*

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