An Introductory guide to the AISYS CS2 ventilator for ICU staff who may be expected to use this ventilator in the context of the current COVID 19 pandemic.

Disclaimer: These ventilators are designed for the provision of anaesthesia and not for long term ventilation of the critically ill patient and are therefore being used outwith their licensed indications. This is acknowledged on the NHS Lothian clinical risk register.

A Gibson March 2020

For those of you who are familiar with the AISYS CS2 ventilator as an anaesthetic machine see below. For those who are not familiar with the machines should move to page 3 and read this document in full.

Initial ventilator settings

FiO2 100%

Total Flow rate – 4 L/min if using Low flow(with soda lime) and 8L/min if you are using high flow (without soda lime).

Mode – SIMV VCV – note there is no autoflow function with this mode of ventilation unlike the Drager ICU ventilators

TV – initialy 400ml and then adjusted to lung protective ventilation using ulnar ruler.

Resp Rate – 24 breaths per minute

Pressure support - 5 cmH2O

PEEP – 10cm H2O – not COVID 19 patients are likely to require an increased level of PEEP

I:E ratio 1:1.5

Ventilatory goals

PaO2 > 8kpa

PaCO2 – no limit but aim to maintain H+ < 60

Peak inspiratory pressure < 30cmH2O

Do not increase TV in order to achieve increased minute ventilation without discussion with ICU consultant.

Troubleshooting hypoxaemia in COVID 19 patients

Diuretics aiming neutral to negative fluid balance.

Increase PEEP

Consider Neuromuscular blocking drugs by bolus and then consider if infusion likely to be beneficial

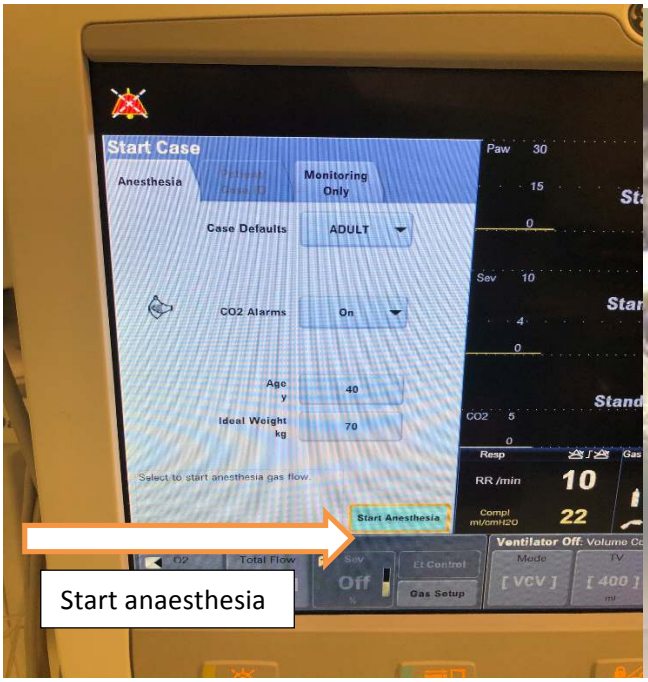
Prone ventilation

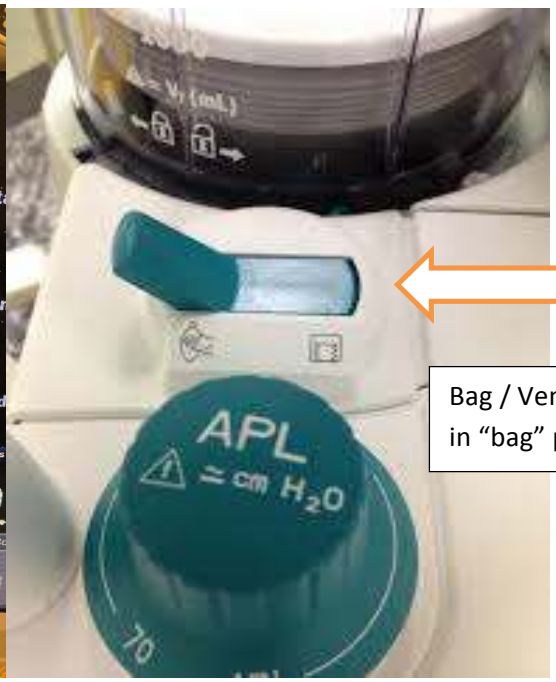
To turn on the system turn the system switch(highlighted by the red arrow below) to on and confirm that the mains indicator light is green (green arrow).

Use the touchscreen and comwheel shown below to navigate windows. All changes to settings need to be confirmed by pressing the com wheel.

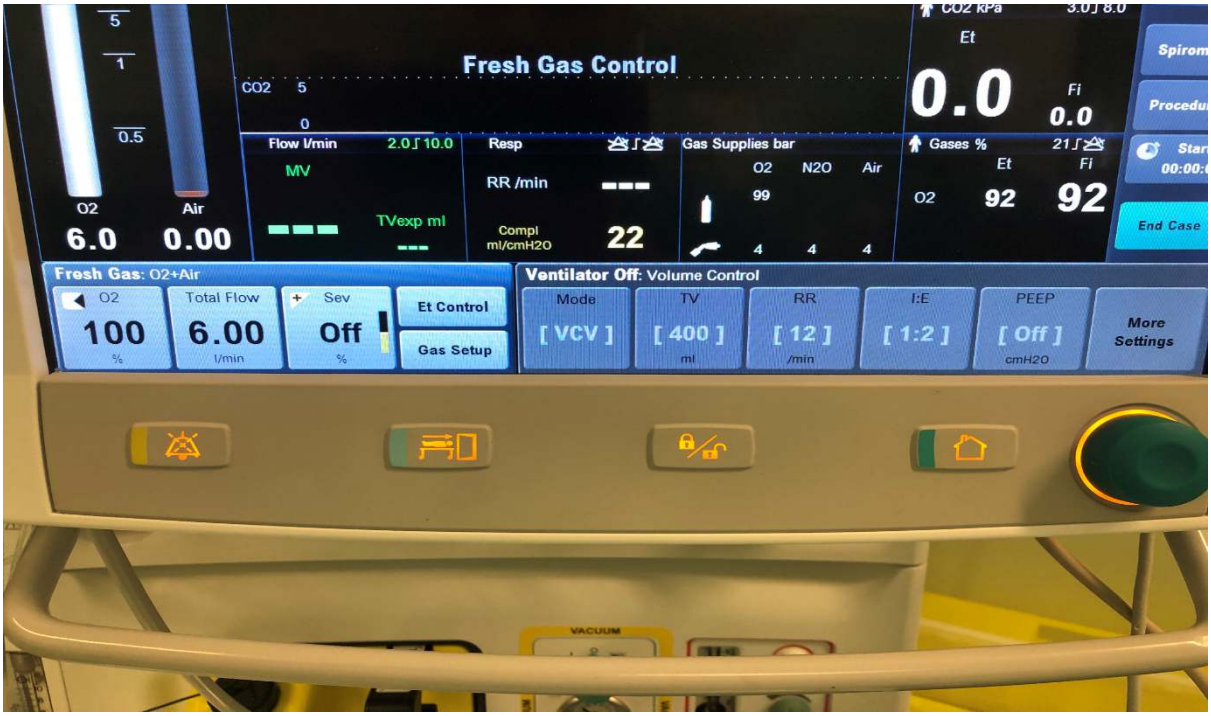
Use the start case menu to initiate gas flow to the ventilator.

After you select the start case menu you will be shown the window below with the option to customise the default settings. Ensure bag / vent switch is toggled to bag (see picture below) and do not make any changes on this window but select “start Anaesthesia”





Following this you will be confronted with the screen below and you are **NOT** yet ventilating the patient. These are the machines default settings.

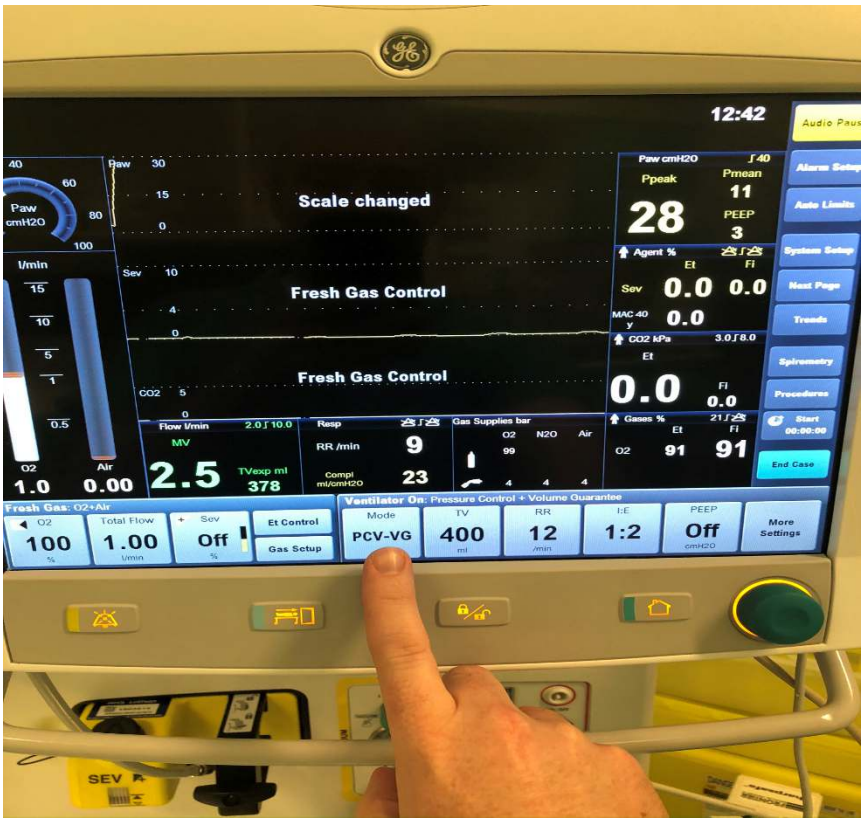


You should now move the bag vent switch to vent and you will begin to ventilate the patient using volume controlled ventilation (VCV) with FiO2 100%, a tidal volume of 400ml, a Resp Rate of 12 and NO PEEP.

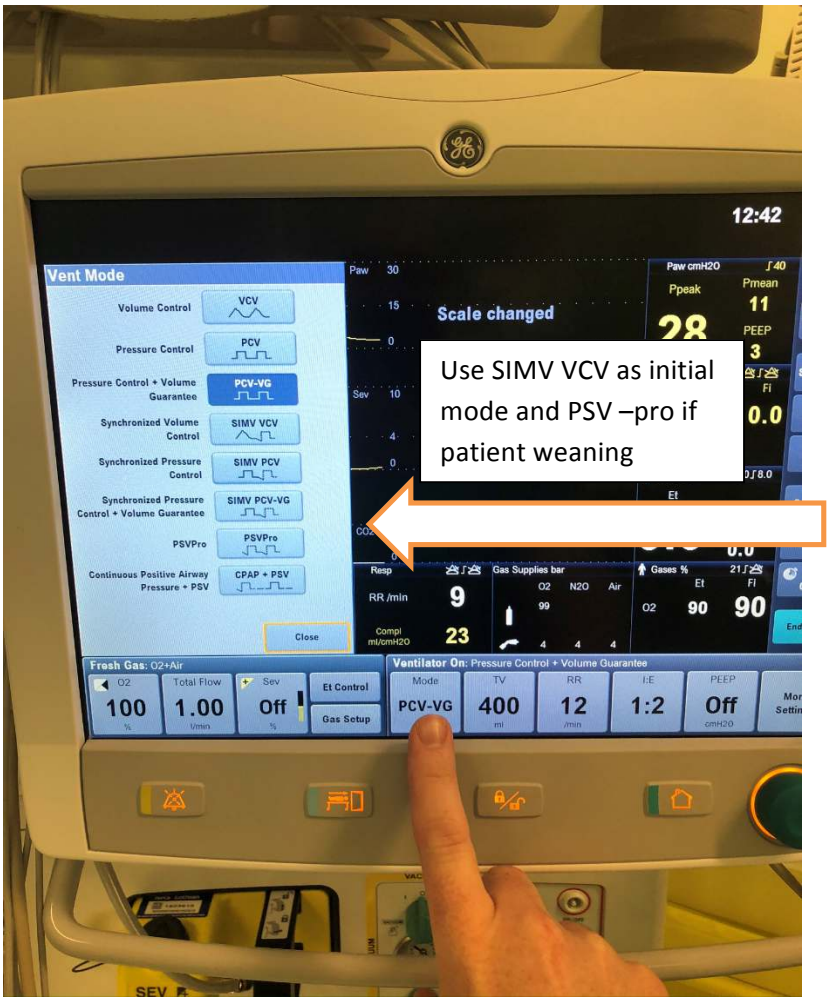
The mode of ventilation menu is accessed by selecting on the touch screen as shown below. The Modes of ventilation will be familiar to you although some of the names will be slightly different. They are listed below.

MODES OF VENTILATION

SIMV - VCV	Synchronised intermittent mandatory ventilation – volume controlled ventilation
SIMV - PCV	Synchronised intermittent mandatory ventilation – pressure controlled ventilation
SIMV – PCV -VG	Synchronised intermittent mandatory ventilation – pressure controlled ventilation – volume guaranteed
PSV pro	Pressure support ventilation
PCV VG	Pressure controlled ventilation – volume guaranteed
PCV	Pressure controlled ventilation
CPAP and PSV	Continuous positive airway pressure and pressure support ventilation
VCV	Volume controlled ventilation



The ventilator mode options are as shown in the picture below.

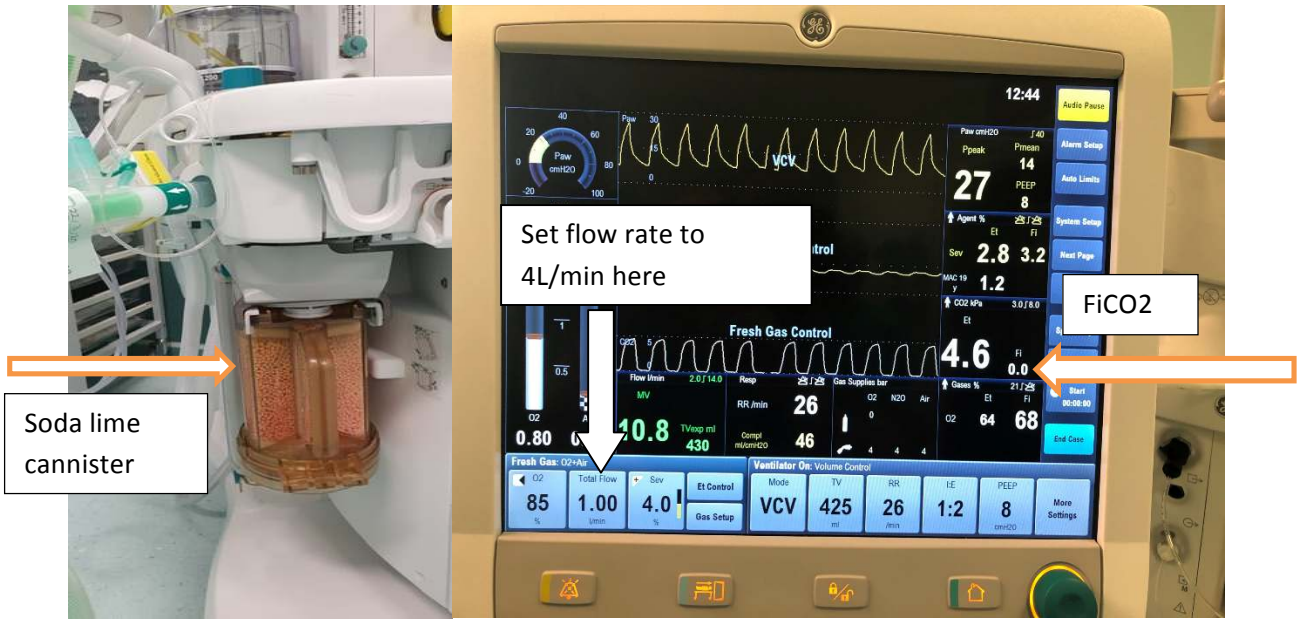


One significant difference between the AISYS CS2 and standard ICU ventilators is the requirement to set the ventilator flow rate.

With the presence of soda lime canisters in the circuit (see below) the flow rates can be set at a lower rate as expired CO2 is absorbed by the soda lime and not reinspired. Please note that soda lime becomes exhausted and needs changed on a regular basis. There are 2 indicators that this is occurring and these are

1- soda lime changes colour to demonstrate to what extent it has been used.

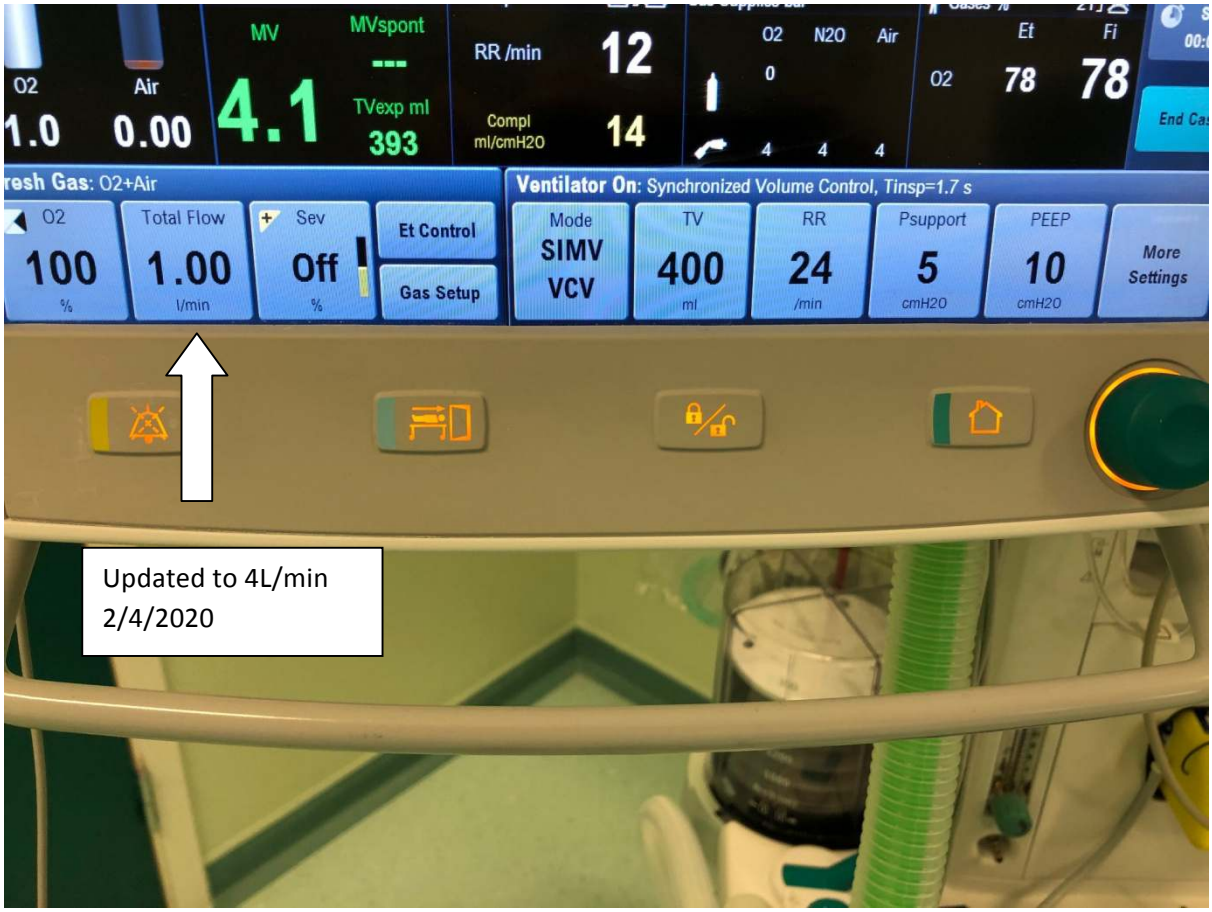
2- The Fi CO2 will begin to rise see picture below for where this information can be found.



We plan to set our **<u>initial flow rates at 4 litre / minute</u>** (50% of minute ventilation) to minimise the oxygen usage at a time of high demand. Flow rate is adjusted by selecting the flow rate menu shown above and adjusted by rotating the com wheel or selecting from the available default settings.

It is important to note that if we run out of soda lime and need to use the ventilators without it then we will need to increase flow rates to 8 litres per minute to wash expired CO2 out via the spill valve.

We will plan to use SIMV – VCV as our default initial setting as this is the mode that best corresponds to our usual ICU ventilator settings (note it does not use autoflow as would normally occur with the Drager ICU ventilators). We will select a tidal volume using the ulnar ruler posters and will in most instances need to increase resp rate with an initial setting of 24 breaths per minute being our preferred starting position. All patients should be ventilated with PEEP and an initial setting of 10cm H2O will be selected (note COVID 19 patients are likely to require additional PEEP to this). All settings will need to be adjusted to best optimise individual patient ventilation. Default settings are indicated below as a quick reference.



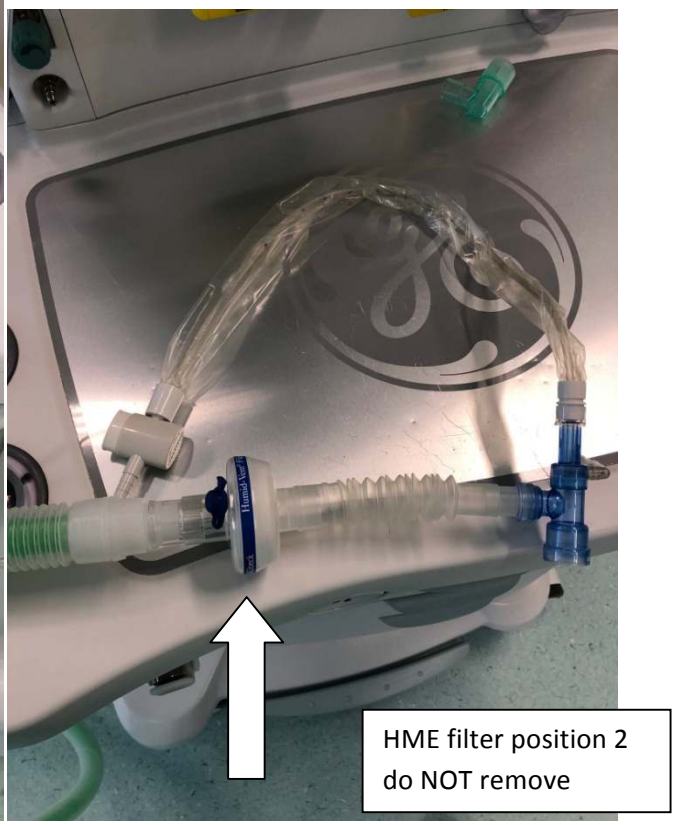
Our desired spontaneously breathing mode of ventilation will be PSV pro as unlike “CPAP and PSV” it incorporates an apnoea ventilation setting and is the safer of the 2 options. Note work of breathing when spontaneously ventilating will be more difficult for the patient due to the pressure and flow that needs to be generated to open the valves. Please take this into account when setting and adjusting ventilator support.

BREATHING CIRCUITS

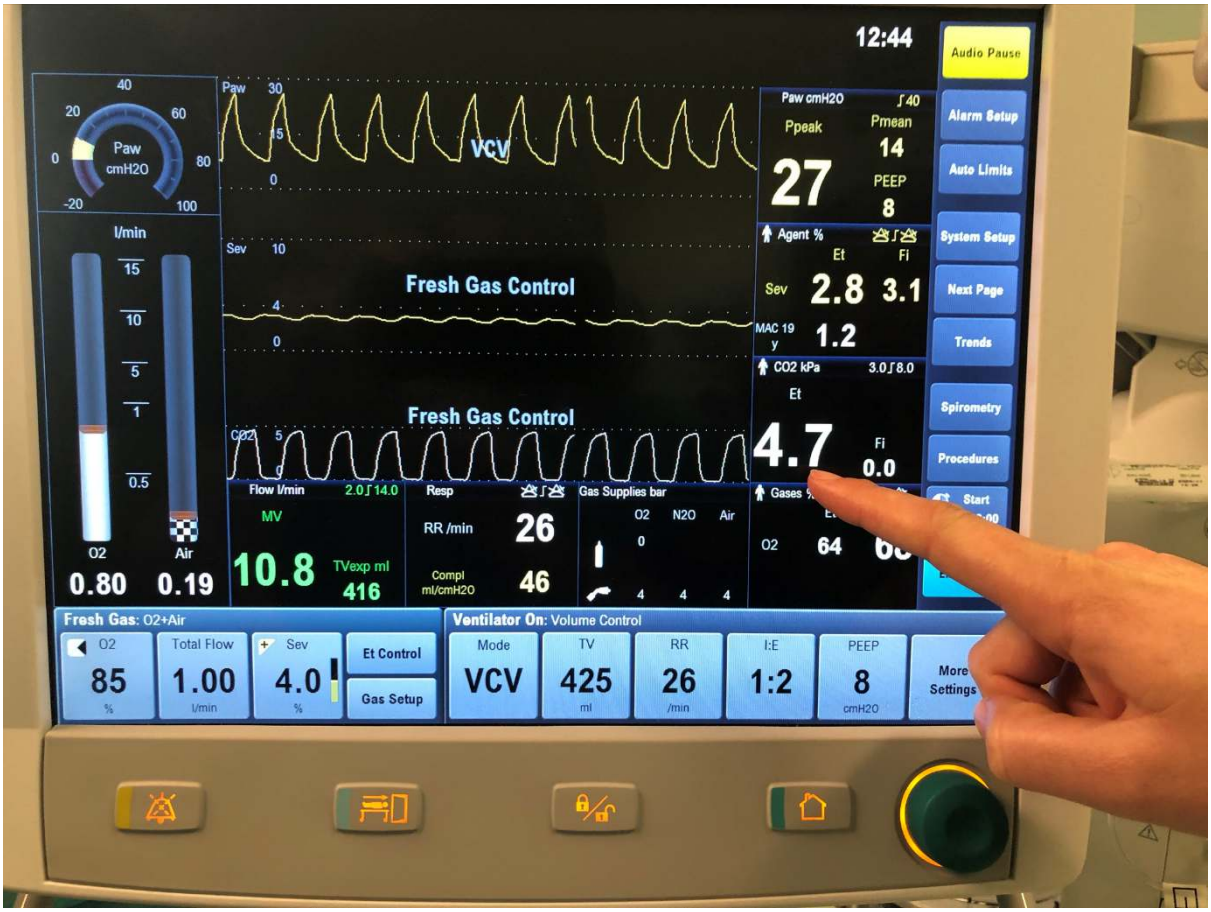
The AISYS CS2 works with a closed breathing system called a circle breathing system shown in the picture below.

Circle breathing system

In order to reduce the potential for contamination we will run with 2 HMEF filters located in the positions highlighted below. We do not plan to routinely change circuits unless necessary.



In line capnographs are not required as the AISYS uses a sidestream capnograph and displays ETCO2 on the ventilator monitor and not on the mindray monitor as shown below.



Solutions to known challenges

Checkout

By default, the Aisys CS2 will ask for a "checkout" after 12hrs and display a warning message.

This message is intended to remind users to conduct a Pre Use check out procedure after 12 hours under normal clinical use.

The message has no impact on the performance or reliability of the machine or its operating system. There is no requirement to reboot or conduct a checkout. We cannot change or alter the 12hour message. Simply acknowledge and cancel the message. The maximum time an Aisys CS2 machine can stay on is 49 days.Users would be expected to carry out a pre-use check and reboot after this 49 day time period.

Soda lime

As mentioned earlier we will be using the ventilators with soda lime and this will require to be changed on up to 3-4 occasions in 24 hours depending on the patients minute ventilation and End tidal CO2 production. You should enlist the assistance of an ODP or anaesthetic nurse to assist with this.

Disconnection of ventilators

Should a ventilator become disconnected then the machine will alarm and the patient should be reconnected to the breathing circuit. However the AISYS uses a bellows style ventilator and these bellows will empty at the point of disconnection. Upon reconnecting the patient flow rates should be increased for a short period ie until the bellows have completely reinflated before then being reduced back to baseline settings. Please do not use the O2 flush system as this has the potential to induce barotrauma.

Suctioning

The use of closed suction will cause the ventilator bellows to collapse when flow rates are set at 1L/min. Prior to suctioning the flow rates should be increase to 10 L/min and then returned to 1L/min following the completion of the suctioning procedure. Suctioning should only be undertaken when clinically indicated. The ventilator is likely to alarm during suctioning and this alarm can be cancelled.

Moisture in breathing circuit

Routine monitor of the HME filter should reduce the risk of this. It may however be necessary to change the circle breathing circuit and this should only be undertaken when ODP / anaesthetic nursing staff area available to assist. Temporarily increasing flow rates should aid in "drying the circuit" and should be considered if moisture accumulation is significant.

Safety warning

Vaporisers should not be mounted on the AISYS CS2 system when being used for ICU patients unless in exceptional circumstances when the ventilator will be manned by an anaesthetist and scavenging systems must be active and in situ. Vaporisers are shown below. If you are asked to operate an AISYS CS2 with these in situ then please contact an ODP or anaesthetic nurse who will be able to assist you in removing them safely.

Unable to drive bellows

"unable to drive bellows" is an alarm that may occur frequently with low oxygen flow rates. In order to overcome this please increase oxygen flow rate until bellows are completely filled again and then assess the circuit for any potential leaks. Once bellows are reinflated return flow rates to 1 litre /min if the problem recurs then increase flow rates and leave them increased and call for help from anaesthesia consultant or ICU medical staff.

Falling FiO2

When low fresh gas flow are used, it is possible that the oxygen demands of the patient are not being met by the replacement gas flow. If the FiO2 measured in the circuit is lower than the target that has been set by the bedside team, fresh gas flow should be increased by 0.5l/min and the FiO2 re-checked in 5 minutes. If the difference persists, flow rates should be increased to 8L/min and then discussed with the medical team.

Breaking the circuit in COVID positive patients

The presence of the bacterial/viral filter at the patient end of the circuit will reduce risk to staff should the circuit need to be broken proximal to it. This risk can be reduced further by clamping the COETT. The COETT should be clamped during inspiration, and fresh gas flow paused. Once the circuit has been reconnected, the ventilator can be restarted and the COETT unclamped.