Guideline for the use of Nitric Oxide on Transport

This guideline is for use by healthcare staff, at CoMET undertaking critical care retrieval, transport and stabilisation of children, and young adults.

CoMET is a Paediatric Critical Care Transport service and is hosted by the University Hospitals of Leicester NHS trust working in partnership with the Nottingham University Hospitals NHS Trust.

The guidance supports decision making by individual healthcare professionals and to make decisions in the best interest of the individual patient.

This guideline represents the view of CoMET, and is produced to be used mainly by healthcare staff working for CoMET, although, professionals, working in similar field will find it useful for easy reference at the bedside.

We are grateful to the many existing paediatric critical care transport services, whose advice and current guidelines have been referred to for preparing this document. Thank You.

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Education and Training

1. Annual Transport team update training days
2. Workshops delivered in Regional Transport Study days/ Outreach

Monitoring Compliance

What will be measured to monitor compliance	How will compliance be monitored	Monitoring Lead	Frequency	Reporting arrangements
Incident reporting	Review related Datix	Abi Hill – Lead Transport Nurse abi.hill@uhl-tr.nhs.uk	Monthly	CoMET Lead Governance Meeting
Documentation Compliance	Documentation Audit	Abi Hill – Lead Transport Nurse abi.hill@uhl-tr.nhs.uk	3 Monthly	CoMET Lead Governance Meeting

Background

Inhaled Nitric oxide (NO) is well established as a highly effective selective pulmonary vasodilator synthesized by the enzyme nitric oxide synthase (NOS) by endothelial cells.

NO is a gas molecule that diffuses freely from the endothelium to vascular smooth muscle cell, that leads to pulmonary vasodilatation.

Nitric oxide is currently used in newborns with Primary Pulmonary hypertension (PPHN) or congenital heart diseases associated pulmonary hypertension.
In paediatric and adult patients, there is no evidence of benefit of NO in acute respiratory syndrome or hypoxic respiratory failure. Despite the improvement of PaO2/FiO2 in the first 4 days of the treatment, there is no reduction in mortality or other outcomes.

Indication for Use

Neonates:

- Primary Pulmonary Hypertension
- Congenital heart diseases associated with Pulmonary Hypertension
- Congenital Diaphragmatic Hernia
- Neonatal Pulmonary Hypoplasia

Paediatrics:

- **Not recommended for routine use in paediatric ARDS**
- Documented pulmonary hypertension
- Severe right ventricular dysfunction
- In severe cases of paediatric ARDS as a bridge to extracorporeal life support

When used, assessment of benefit must be undertaken and measured against the risks to minimise toxicity

Contraindications

- Methemoglobin reductase deficiency
- Glucose 6 phosphate dehydrogenase deficiency
- Neonates dependent on right-to-left shunting of blood

Administration

- Optimise ventilation and ensure strategy and mode is appropriate for underlying disease
- Calculate Oxygen Index and record SpO2 before commencing Nitric Oxide (NO):

$$\frac{\text{FiO2 (\%)} \times \text{MAP}}{\text{PaO2 (kPa)} \times 7.5}$$

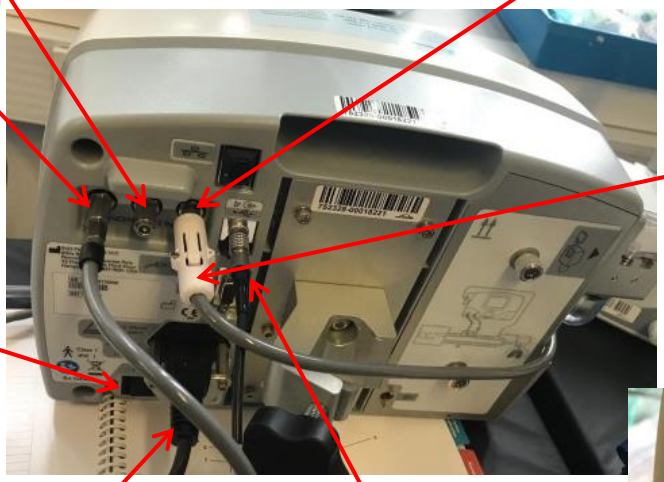
- Before commencing NO, if possible the patient should have an echocardiography assessment to assess pulmonary arterial pressures and evaluate right ventricular function - **If not, do not delay commencing NO**
- Commence NO at 20ppm and assess SpO2
- After 30 minutes of administration, calculate Oxygen Index and if no improvement, stop NO therapy
- If discontinuing NO, beware of transient drop of SpO2 due to rebound pulmonary hypertension

Nitric set up on the CoMET Transport Trolley

The Connections at the back of the INOmax machine

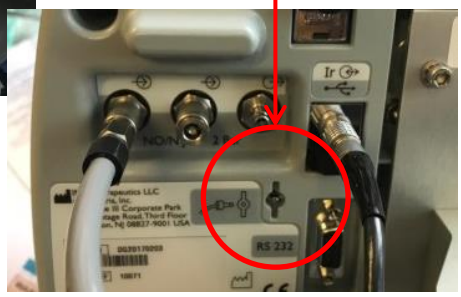
Grey wire (from the cylinder dial to the INOmax Gas Inlet) - Delivers Gas to the INOmax (One of these per cylinder)

Grey wire with white hub (from the blender to the INOmax Gas Outlet) - Delivers gas to the INOblender



'Purge port' - Remove grey wire from gas inlet and purge/depressurise using this (underneath white hub - see below)

Power switch

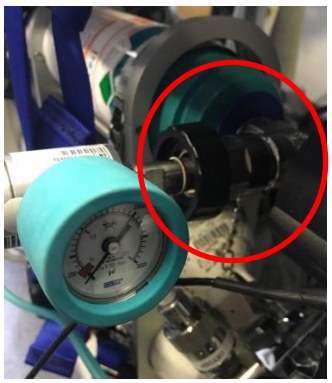


Mains plug

Black wire from Infrared cap to INOmax machine

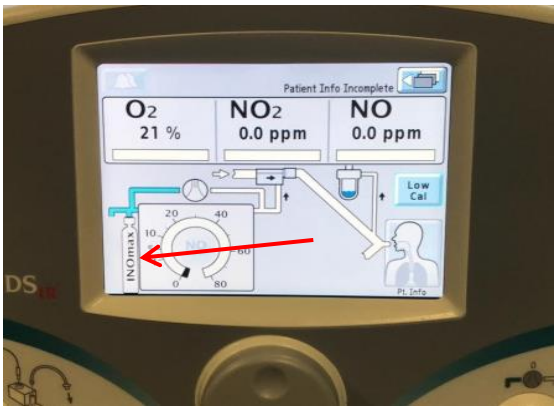
Daily Check - To be Completed Every Day in Acute Weeks

A) Check all connections



- Ensure the high pressure regulator is connected to the cylinder

- Ensure black infrared cap (which is connected to the back of the INOmax machine with the black cable) is connected onto the top of the cylinder (This should then identify that there is a cylinder present on the screen as below)

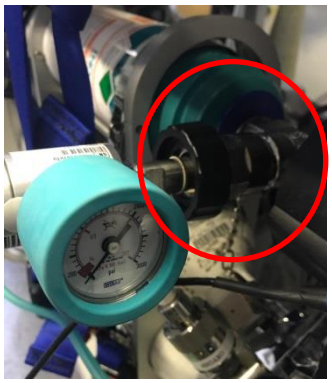


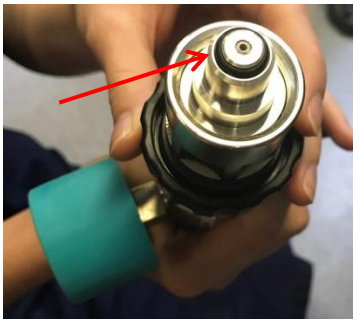
B) Perform high pressure leak test

- Turn the valve (using the infrared cap shown above) a full 360^{o} anti-clockwise to turn on the cylinder. You should see the needle on the dial move to display how full the cylinder is
- Then turn the valve clockwise to close the cylinder
- Wait 30 seconds, observing the needle for a pressure drop

(The needle should not drop - if it does, this indicates that there is a fault with the 'o-ring' seal and it will need replacing)

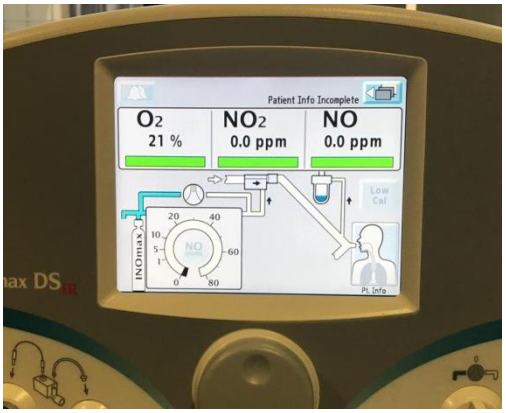
- If the needle does drop, please check the black 'o-ring' on regulator for damage/wear **(Please note - These do not need to be checked daily unless there is a problem and are checked monthly by MESU - check date on MESU sticker)**
- To check the black 'o-ring', remove the high pressure regulator from the cylinder by turning the black wheel:





C) Perform 'Low range Calibration' by pressing the 'Low Cal'button (This screen can be found in the second menu by pressing the button in the top right of the screen):

NB You need to press the 'Low Cal' button once on this screen, then again on the following screen:

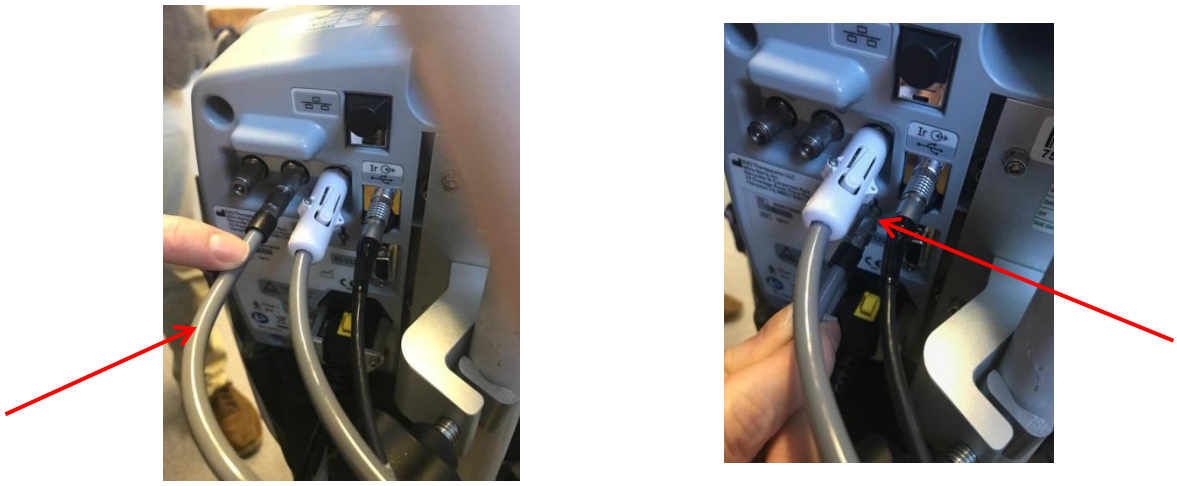


Once the test is complete you will see the three bars turn green

Then press the menu button in the top right of the screen to return to the main screen (Menu One)

Once these checks (A, B and C) are completed, the daily calibration is complete. If not using for a patient, depressurise the line at the back of the INOmax and store the INOmax away <u>on charge</u>.

<u>How to Depressurise the INOmax</u>

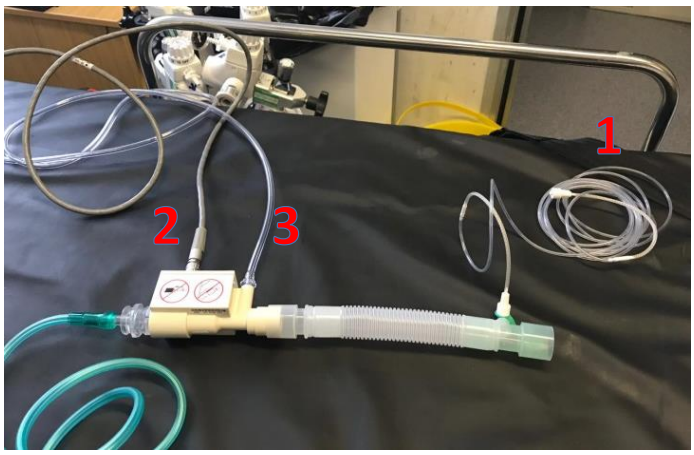


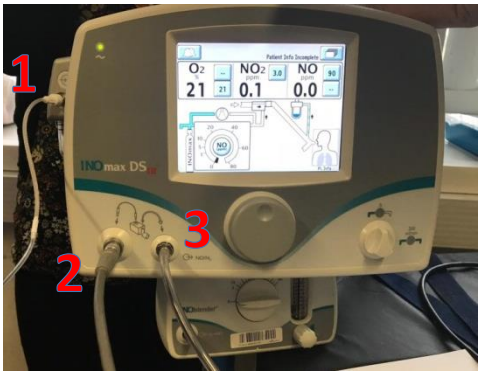
Remove grey wire from gas inlet and place it into the depressurise port on the back of the INOmax.

Before connecting to a patient, the following Calibration needs to be completed.

D) Perform purge and alarm verification

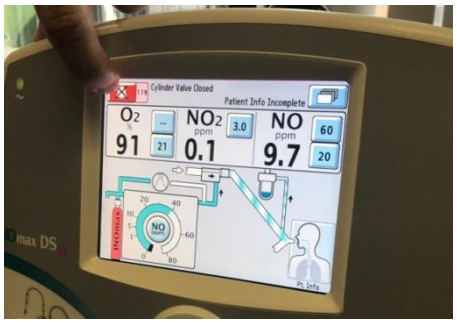
- Assemble connectors and tubing as follows, and connect wires to INOmax to the corresponding number:





- Ensure cylinder valve is closed
- Connect green tubing to wall or oxygen cylinder (DO NOT USE CYLINDER FROM TROLLEY)
- Set oxygen flowmeter to 10LPM
- Set INOmax dose to 40ppm using the round dial on the front of the machine, pressing it in to confirm

'Cylinder Valve Closed' Alarm will occur and you will see the following screen:



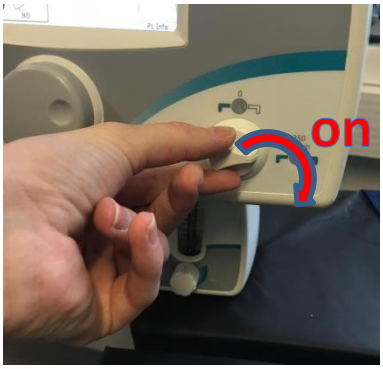
Wait until **'Low NO/N2 Pressure'** alarm activates and the needle on the cylinder dial has dropped to zero - this indicates the purge is complete.

- Open cylinder valve and turn INOmax dose to zero, you will see the following screen:

At this point do not close the cylinder valve!

E) Perform Backup delivery test

- Leave green oxygen tubing connected to wall or oxygen cylinder (DO NOT USE CYLINDER FROM TROLLEY)
- Ensure oxygen flow meter is still set to 10LPM
- Turn Backup delivery on by turning the switch clockwise to the '3 o'clock position'



- Backup ON alarm should be activated:

- Verify values are within range:

NO = 14-26ppm NO2 = ≤1.0ppm

- Turn backup delivery OFF by turning switch anti-clockwise to the '12 o'clock position'

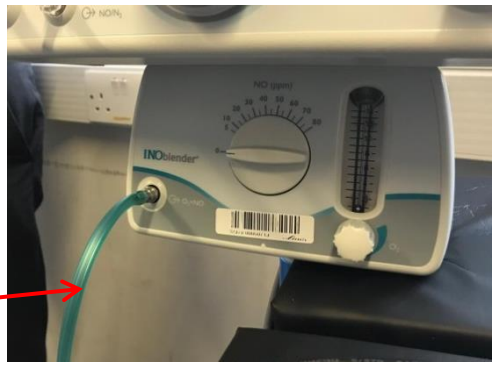
F) Complete INOmax DSIR Performance test

- Ensure oxygen flow meter is still set to 10LPM
- Set INOmax dose to 40ppm using the round dial, pressing to confirm
- Verify values are within range

Acceptable NO Value - 35-45ppm (right of screen) Acceptable NO2 Value - <1.5ppm (middle of screen) FiO2 - 95% +/- 3% (left of screen)

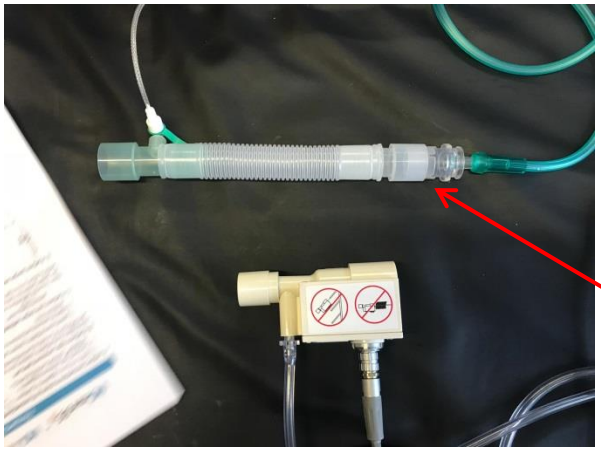
- Turn the INOmax dose to zero, pressing dial to confirm

G) Perform INOblender Test



- Ensure oxygen hose at the back of the INOblender is Attached to the wall or oxygen cylinder
- Remove the pre-use set-up oxygen tubing (green tubing) from the oxygen flowmeter and connect it to the front of the INOblender

- Remove the injector module from the Pre-use set up and reconnect the adapters as shown below:



(Injector Module Originally here)

- On the INOblender, set the Nitric Oxide dose to 40ppm and the oxygen flow to 10LPM

Acceptable NO value - 32-48ppm (right of the screen)

- Verify values are within range on the INOmax DSIR:
- Turn the dose and flow to zero and remove the pre-use set up from the INOblender

The INOmax DSIR is now ready to connect to the patient

Warning: If not connecting to patient/starting therapy within 10 minutes, turn the cylinder off and depressurize the INOmax regulator (depressurise on the back of the INOmax)

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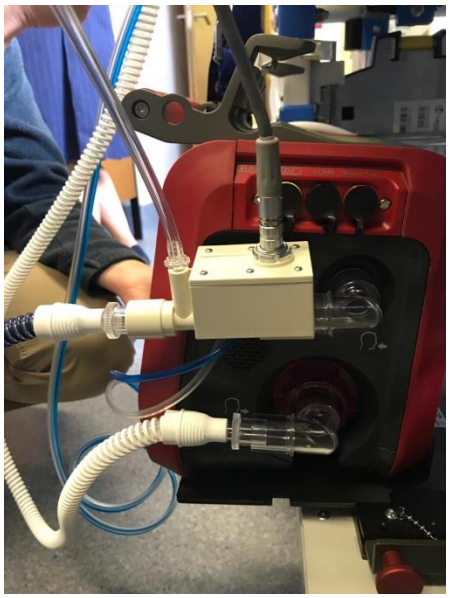
Connecting the Module to the Hamilton Ventilator

Connecting the Module to the Neonatal Circuit

The module needs to be placed on the Inspiratory limb of the tubing (Blue tubing) as shown:



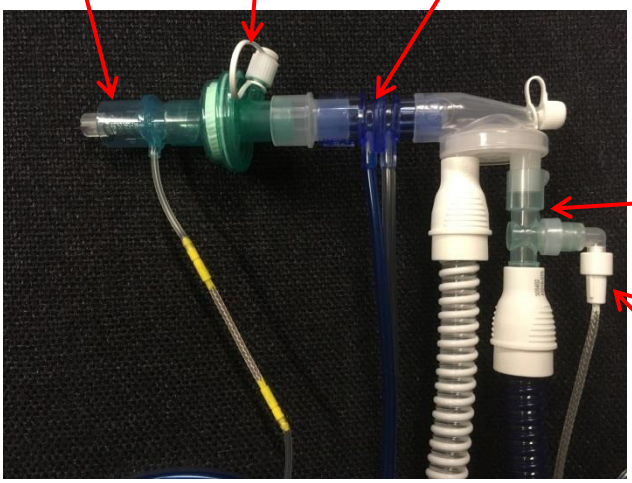
(In cases where you need to deliver Nitric Oxide, the filter needs to be positioned on the patient end of the blue tubing)

At the patient end of the tubing, this is what the connection should look like:

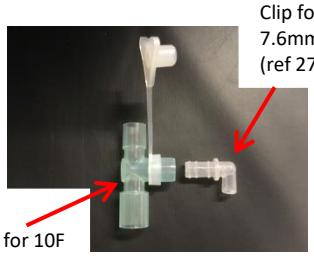
CO2 Monitor

Filter

Flow sensor



Luer elbow, Clip for 7.6mm port (ref 2710000)



Straight Connector for 10F - 10M - 7.6mm port for use with intersurgical 10mm flextube only (ref 1663000)

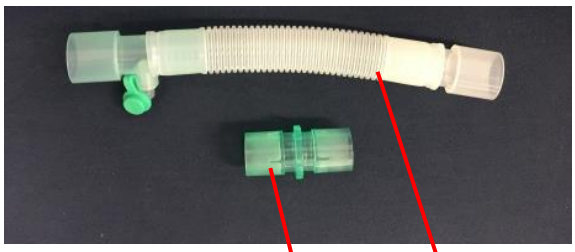
T-Piece to connect Monitoring line (Comes in two pieces as above)
Must go on <u>Blue</u> Inspiratory Limb
Please note, you can also use the clear adaptor from the nCPAP line included in the circuit

Monitoring line attached to INOmax

Connecting the Module to the Paed/Adult Circuit

In order to connect the module to the adult circuit, it needs to look like this:

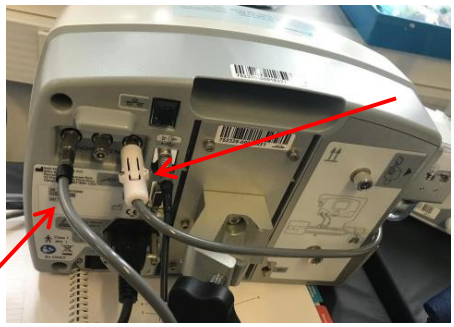
You will need to remove the elbow from the inspiratory port and use the following equipment to attach the injector module onto the adult circuit:

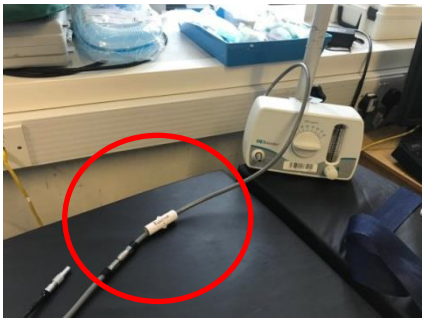


(Please note, the elephant tubing used for testing should not be used for this. There is an elephant tubing in a sealed packet in the Nitric pouch which can be opened and used)

How to use the INOblender Independently to Bag a Patient

Connect the two grey wires (from gas inlet and gas outlet) together as shown below:





- To bag the patient using Nitric Oxide, connect the oxygen extension from the back of the INOblender to an oxygen cylinder, and the bagging circuit to the silver port on the front of the INOblender
- Dial to 20ppm (or to the required dose)
- Deliver breaths to the patient
- Do not forget to turn off the flow and NO once finished.

Bagging circuit attaches here

Top tips!

- The INOmax is only set up for 800ppm cylinders - Double check that this is the size you have!
- Change the filter between patients as Single Patient Use only (on back left of INOmax)
- The water trap can be reused so just needs to be washed in between patients (below filter)
- Once the Pre-Use Check has been completed, the INOmax is good for use for **12 hours**
- If the INOmax fails the Low Calibration tests (ie the bars turn red and not green) or the INOmax DSIR Performance tests, repeat the test, and if it fails a second time then it will need a High Calibration test to be performed
- High Calibration tests are carried out routinely every month. It is also the time to check and change the 'o-ring' if necessary.
- Frequent checking of the 'o-ring' by use on the daily checks will increase risk of wear and tear and damage.
- Once the cylinder gets to 200 psig, please replace it. This is done by removing the High pressure regulator and putting it onto a new cylinder. There are spare ones kept with the gas cylinders.
- FYI - The back up delivery switch delivers 250ml/minute of flow, but the amount delivered depends on the ventilator flow - To work out the exact ppm being delivered, use the following calculation:

  Concentration of cylinder (800) / 4 / Flow rate (LPM)

- When connecting the cables, line up the small red dots on the cable and the connector.
- Keep INOmax plugged in at all times – if you need to remove it, you will need to use a screwdriver to remove the bracket (kept in the kit bag).