Optiflow THRIVE and Nasal High Flow (NHF) oxygen therapy

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Approved by	**SCSD Theatre and Anaesthetics Governance Meeting**
Date of Approval	**16th August 2023**
Date of next review This is the most current document and is to be used until a revised version is available	**16th August 2026**

Aim and scope of Standard Operating Procedure

THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) is a technique used to increase the margin of safety for securing a definitive airway. It has been shown to prolong safe apnoea time and reduce the rate of carbon dioxide accumulation in airway management. It can also be used for tubeless airway surgery for appropriately selected procedures and appropriately selected patients [1,2]

Target Staff Categories

Anaesthetic staff

Critical care staff

Theatre staff (i.e. anaesthetic nurses and operating department practitioners)

Key Amendments

Date	Amendment	Approved by
16th August 2023	New document approved	SCSD Governance

Background

Nasal High Flow oxygen (NHF) is oxygen delivered via the nasal route at flow rates beyond peak inspiratory flow rates of 30-40L/min [2]. It is delivered to a spontaneously breathing patient to aid preoxygenation, sedation, general anaesthetic with spontaneous ventilation and maintenance of oxygenation post-extubation. This differs from THRIVE therapy delivered to an apnoeic patient to maintain oxygenation during intubation or to facilitate an extended period of apnoea for tubeless airway surgery [1].

Physiology

The physiology of these techniques differs depending on whether the patient is apnoeic or spontaneously breathing. NHF oxygen results in an increased FiO2 and positive airway pressure of 0.7cmH20 per 10L/min flow rate, which improves respiratory mechanics and causes pharyngeal dead-space washout. The physiological mechanism behind THRIVE in the apnoeic patient is less well understood. Apnoeic oxygenation and apnoeic ventilation is thought to be due to the interaction between cardiogenic oscillations (movement of blood in the pulmonary vessels causing compression and expansion of small airways) and turbulent supraglottic flow vortices generated by the oxygen delivered at high flow rates. This is proportional to the set THRIVE flow rate. The generation of positive airway pressure during THRIVE is minimal in comparison to the spontaneously ventilating patient [1].

The prerequisite for apnoeic oxygenation is that 100% oxygen is delivered in an airway that remains open and that full denitrogenation has been accomplished. Provided that those criteria have been fulfilled, oxygen saturation has been maintained for time periods as long as 65 min. The limiting factor for the duration of apnoeic oxygenation is not oxygenation but rather an increase in CO_2 [3].

The rate of carbon dioxide increase with THRIVE is 0.13-0.15 kPa /min EtCO2, 0.21 kPa/min PvCO2 and 0.24 kPa/min PaCO2, in comparison to the 0.35-0.45 kPa rise when low flow oxygen is applied during apnoea [3]. There is still however a near linear rise in CO2 over time of which THRIVE only clears about 10% [2].

Apnoea times will vary from patient to patient and factors contributing to this include:

- alveolar oxygen content at the end of preoxygenation
- effectiveness of the mechanism adding oxygen to the reservoir
- factors affecting the oxygen cascade (VQ mismatching), transport (diffusion capacity) and cellular uptake, as well as the patient's metabolic rate[3].
- Factors affecting Functional residual capacity (FRC) and therefore alveolar oxygen content e.g. obesity, pregnancy, paediatrics, restrictive lung disease, patient positioning.

Having a patent airway, high FiO2, a high flow rate and a good stroke volume are amongst the factors that improves the effectiveness of adding oxygen to the reservoir during the apnoeic period. An increased metabolic rate will increase oxygen consumption and shortens the apnoea period in the critically unwell, paediatric, obstetric and obese populations, as well as any patient in a hypermetabolic state e.g. pyrexia, thyrotoxicosis etc. [1].

During the early stage of the COVID-19 pandemic, there were concerns around aerosol generation while using HFNO. Subsequent studies have shown that HFNO did not increase aerosol generation when compared to oxygen delivered via more traditional methods, such as nasal cannulae, a non-rebreathe mask and non-invasive ventilation (NIV) and is lower than in regular respiratory activities, such as talking, shouting, exercising and coughing. There is currently no convincing evidence to say that HFNO increases the risk of COVID-19 infection to healthcare workers with appropriate PPE [1] and this has been removed from the list of aerosol generating procedures in England [4].

Optiflow vs Airvo [5]

	Optiflow	**Airvo**
Uses	Theatre	ITU/Recovery
FiO2	1.0	Variable
Circuits	Optiflow oxygen kit with blue tubing = multi-patient use for 24hrs once water poured in. To be used with white single use patient interface with filter (see below)	Also available as a 24hr multi-patient use circuit with separate patient interface (for eg recovery). OR A completely patient specific combined circuit and interface

Indications to use Optiflow

- Pre- and per-oxygenation to improve patient safety and prolong apnoeic time in patients with potentially or known difficult airways or in patients who are likely to desaturate quickly on induction of anaesthesia e.g. the obese and obstetric population.
- To improve patient safety during awake fibre-optic intubation or awake tracheostomy by reducing work of breathing, improving topicalisation, providing positive pharyngeal and end expiratory pressure and also improving safety of conscious sedation used to facilitate these procedures [6].
- To facilitated true tubeless airway surgery
- The use of NHF oxygen during procedural sedation improves oxygenation with reduction in airway interventions, improved CO2 clearance and provides of heated humidification.
- NHF oxygen can be used post-operatively to reduce post-operative pulmonary complications in high risk patients. This is better done by using the Airvo machine as you can adjust the FiO2.

Contraindications to Optiflow THRIVE or NHF oxygen

- Do not use with diathermy or laser (FiO2 cannot be reduced to safe levels).
- Do not use where CPAP would be contraindicated e.g. pneumothorax, bullous lung disease, craniofacial trauma.
- Do not use where nasal interfaces are contraindicated e.g. nasal obstruction or trauma.
- Prolonged airway surgery (where a “tubeless field” is required) [2].
- Caution with patient factors where intubation would be strongly considered e.g. severe reflux, obesity.

Tubeless airway surgery:

- Consider for optimal surgical access for short procedure such as microlaryngoscopy and biopsy.
- Discuss whether case is suitable at team brief in terms of duration, no need for diathermy, laser etc.
- Adjust technique to reduce apnoea time and risk of atelectasis.

Suggested technique [6]:

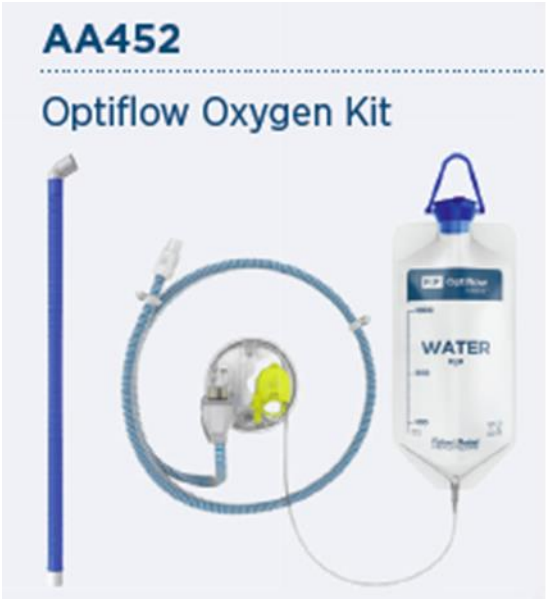
- Prepare for and induce anaesthesia in theatre.
- OptiFlow device, jet ventilator, airway trolley and anaesthetic machine ready for use - always be prepared for a plan B in the event of desaturation on THRIVE.
- WHO sign-in, IV access and monitoring attached, including depth of anaesthesia monitoring.
- Apply Optiflow THRIVE circuit with Optiflow Switch interface for pre-oxygenation with mouth closed and intermittent vital capacity breaths.
- WHO time-out performed prior to induction of anaesthesia with scrub staff and surgeons ready to start.
- TIVA induction.
- Anaesthetist maintains a patent airway with jaw thrust +/- guedel.
- Give two facemask breaths to check ease of ventilation (nasal cannulae need to be removed briefly if not using Optiflow *Switch* patient interface). Consider anaesthetic laryngoscopy if difficult direct laryngoscopy anticipated.
- Titrate TIVA and administer small dose muscle relaxant to avoid laryngospasm or coughing.
- Airway handed over to surgeon for pharyngo-laryngoscopy.
- Surgeon spray cords with lignocaine.
- Remain vigilant throughout and ensure surgical bronchoscope doesn't occlude Optiflow Switch interface tubing to cause flow diversion.
- On removal of surgical laryngoscope, surgeon maintains jaw-thrust until airway handed back to anaesthetist.
- To wake patient up - insert LMA and confirm ventilation. Reverse muscle relaxant and stop TIVA. Transfer onto Water's circuit and ventilate until spontaneous ventilation recommences and patient wakes (can alternatively Insert oropharyngeal airway +/- mask ventilation and allow to wake).

Equipment required

- F&P 950 Humidifier (permanently attached to stand)
  - Changed every 7 years

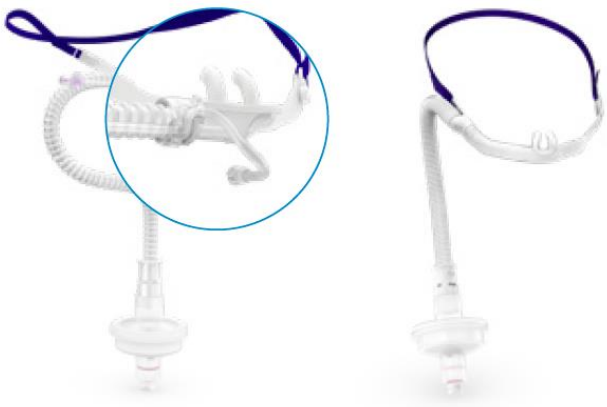
- F&P AA520 Flow diverter (permanently attached to stand)
  - Changed every 7 years

- The F&P AA452 oxygen kit/circuit = multi-patient use for up to 24 hours
  - Can be left set up for 7 days without water.
  - Should be replaced every 24hrs after water added, when visibly soiled or after use on highly infectious patient.
  - Should be wiped after each patient use with a Clinell universal wipe (green).



- Bottle of sterile water (no saline or glucose)

- Optiflow filtered nasal interfaces = patient specific for up to 24 hours (latex free)
  - AA031 - Optiflow Trace interface has a CO2 sampling line (ideal for sedation, but can be used for GA) – Not compatible with flow diverter.
  - AA041- Optiflow Switch interface comes in S/M/L (ideal for GA, but can be used for sedation)



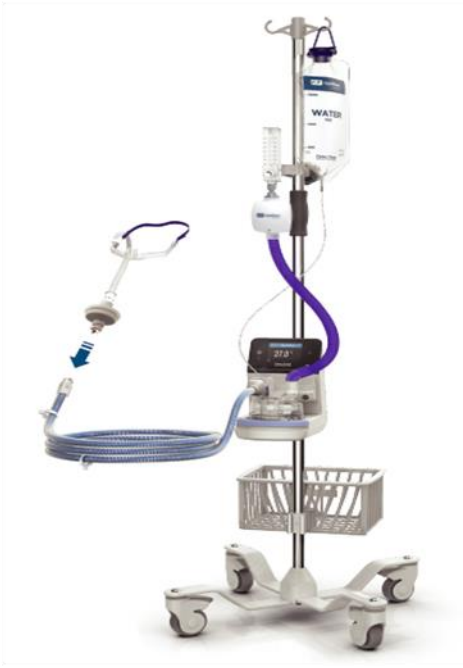
Optiflow Trace
AA031

Optiflow Switch
AA041

- Splitter for oxygen

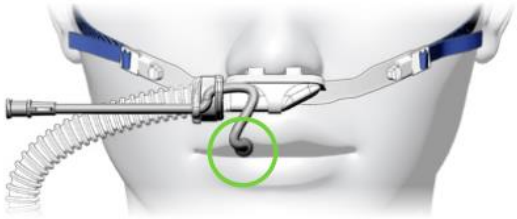
Optiflow Set-up

- Open AA452 circuit and fit water chamber into device
- Label circuit with date, day and time (as can be used for 24hrs)
- Fill water reservoir bag and replace cap (500ml is plenty)
- Hang water reservoir as high as possible (at least 50cm) above water chamber/heater/humidifier ensuring it never runs out of water
- Ensure water fills to below max level in water chamber
- Connect the water chamber to flow diverter
- Connect oxygen hose to wall oxygen, using splitter if only one port available, with second port then used for anaesthetic machine
- Plug into wall electric socket and switch on
- Turn flow up to 10L/min to start warming, allowing 4-5 minutes to reach 37°C
- Attach correctly sized nasal interface without creating a seal in the nares (allow a 2mm gap around the prongs to avoid barotrauma/gastric insufflation)
- Attach capnography line if using for Optiflow Trace for sedation

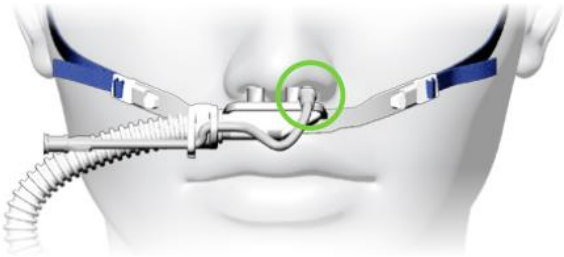


Recommended settings:

- Preoxygenation: 40-50L/min, ideally with patient's mouth closed to allow denitrogenation of lungs prior to induction.
- A mask can be used with the Optiflow Switch device due to presence of pressure sensing flow diverter.
- After induction and during intubation increase flows to 70L/min: maintain a patent airway by jaw thrust +/- oropharyngeal airway until intubation
- Discontinue once airway secured and ETT cuff inflated.
- For sedation use flows of 50-70L/min ensuring a patent airway at all times.
- For extubation, ensure patient is spontaneously breathing, apply interface and start flow at 40-50L/min once extubated.



OR



Tips, practical points and pitfalls:

- There are swing tags attached to the machines - please use these to remind yourself of step by step setup and use.
- Switch on Optiflow device before sending for patient to allow it to heat up and prepare in the same way when planning to extubate onto Optiflow.
- Ensure there is flow when connecting device to patient. There should be a change in sound and the saturations should go up [2].
- Before applying a face mask over a Optiflow circuit, ensure you have an Optiflow Switch circuit connected to a pressure sensing flow diverter (you cannot ventilate over a Optiflow Trace (with CO2 line) circuit.
- Be alert during tubeless airway surgery, as the surgical laryngoscope can compress the cannula, causing flow diversion [2]
- The Optiflow has no battery and can therefore not be used for transfer.
- Be aware that THRIVE may fail to prolong the apnoea time as anticipated and therefore extra vigilance is required in the obese population or during complete airway obstruction [2,6]

- Minimum alveolar concentration (MAC) of volatiles when used for maintenance of anaesthesia via face mask ventilation over the Optiflow Switch interface may be inaccurate and should thus be avoided [5].
- This product is not MRI safe [5].
- Even though Optiflow THRIVE is indicated to prolong apnoeic time in potentially difficult airways, it does not replace the decision-making around difficult airway management or the need for awake fibre-optic intubation or awake tracheostomy when indicated [6].
- Optiflow THRIVE is also not a rescue technique for desaturation in the apnoeic patient.

Local governance:

- Location:
  - Outside theatre 6 at WRH
  - In recovery at the Alex
- Lead ODP: currently Lubomir Hanis
- Consumables are kept in the back store cupboard by theatres 4 and 5 at WRH. Tbc at Alex.
- One set of consumables to be left in basket ready to set up, not necessarily set up at all times to avoid waste.

References:

1. Sud A, Patel A. THRIVE: five years on and into the COVID-19 era. British Journal of Anaesthesia, 126 (4): 768e773 (2021).
2. McNarry, Alistair. Jet ventilation and THRIVE. AAGBI ENT Anaesthesia Conference, London, February 21-22, 2023.
3. I.-M. Gustafsson and others, Apnoeic oxygenation in adults under general anaesthesia using Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE) – a physiological study, *BJA: British Journal of Anaesthesia*, Volume 118, Issue 4, April 2017, Pages 610–617.
4. A rapid review of aerosol generating procedures (AGP's). An assessment of the UK AGP list conducted on behalf of the UK IPC Cell. NHS. June 9, 2022.
5. Fisher & Paykel Healthcare: product literature.
6. Nouraei, R et al. Tubeless ventilation - THRIVE. *ENT and audiology news.* Spotlight on innovation. May/June 2018, vol. 27, no. 2.

*Both the DAS 2015 Intubation and the Obstetric guidelines refer to NHF oxygen for pre-oxygenation and to prolong apnoea time.

Supporting Document 1 - Equality Impact Assessment Tool

To be completed by the key document author and included as an appendix to key document when submitted to the appropriate committee for consideration and approval.

Please complete assessment form on next page;

NHS
Worcestershire
Acute Hospitals
NHS Trust

Herefordshire & Worcestershire STP - Equality Impact Assessment (EIA) Form
Please read EIA guidelines when completing this form

Section 1 - Name of Organisation (please tick)

Herefordshire & Worcestershire STP		Herefordshire Council		Herefordshire CCG	
Worcestershire Acute Hospitals NHS Trust	✓	Worcestershire County Council		Worcestershire CCGs	
Worcestershire Health and Care NHS Trust		Wye Valley NHS Trust		Other (please state)	

Name of Lead for Activity	**Susanna Hicks** **Linzi Wright**

Details of individuals completing this assessment	**Name**	**Job title**	**e-mail contact**
	James Hutchinson	**Anaesthetist**	**James.hutchinson7@nhs.net**
Date assessment completed	**24.8.23**		

Section 2

Activity being assessed (e.g. policy/procedure, document, service redesign, policy, strategy etc.)	**Title: Optiflow THRIVE and Nasal High Flow (NHF) oxygen therapy**			
What is the aim, purpose and/or intended outcomes of this Activity?				
Who will be affected by the development & implementation of this activity?	❑ ✓ ❑	Service User Patient Carers Visitors	✓ ❑ ❑	Staff Communities Other _____

	❑
Is this:	✓ Review of an existing activity ❑ New activity ❑ Planning to withdraw or reduce a service, activity or presence?
What information and evidence have you reviewed to help inform this assessment? (Please name sources, eg demographic information for patients / services / staff groups affected, complaints etc.	Local and national guidelines
Summary of engagement or consultation undertaken (e.g. who and how have you engaged with, or why do you believe this is not required)	Discussion at governance meeting
Summary of relevant findings	No impact

Section 3

Please consider the potential impact of this activity (during development & implementation) on each of the equality groups outlined below. **Please tick one or more impact box below for each Equality Group and explain your rationale**. Please note it is possible for the potential impact to be both positive and negative within the same equality group and this should be recorded. Remember to consider the impact on e.g. staff, public, patients, carers etc. in these equality groups.

Equality Group	Potential positive impact	Potential neutral impact	Potential negative impact	Please explain your reasons for any potential positive, neutral or negative impact identified
Age		x		
Disability		x		
Gender Reassignment		x		
Marriage & Civil Partnerships		x		
Pregnancy & Maternity		x		
Race including Traveling Communities		x		
Religion & Belief		x		
Sex		x		
Sexual Orientation		x		

Equality Group	Potential positive impact	Potential neutral impact	Potential negative impact	Please explain your reasons for any potential positive, neutral or negative impact identified
Other Vulnerable and Disadvantaged Groups (e.g. carers; care leavers; homeless; Social/Economic deprivation, travelling communities etc.)		X		
Health Inequalities (any preventable, unfair & unjust differences in health status between groups, populations or individuals that arise from the unequal distribution of social, environmental & economic conditions within societies)		X		

Section 4

What actions will you take to mitigate any potential negative impacts?	Risk identified	Actions required to reduce / eliminate negative impact	Who will lead on the action?	Timeframe
		.		
How will you monitor these actions?				
When will you review this EIA? (e.g in a service redesign, this EIA should be revisited regularly throughout the design & implementation)				

Section 5 - Please read and agree to the following Equality Statement

1. Equality Statement

1.1. All public bodies have a statutory duty under the Equality Act 2010 to set out arrangements to assess and consult on how their policies and functions impact on the 9 protected characteristics: Age; Disability; Gender Reassignment; Marriage & Civil Partnership; Pregnancy & Maternity; Race; Religion & Belief; Sex; Sexual Orientation

1.2. Our Organisations will challenge discrimination, promote equality, respect human rights, and aims to design and implement services, policies and measures that meet the

diverse needs of our service, and population, ensuring that none are placed at a disadvantage over others.

1.3. All staff are expected to deliver services and provide services and care in a manner which respects the individuality of service users, patients, carer's etc, and as such treat them and members of the workforce respectfully, paying due regard to the 9 protected characteristics.

Signature of person completing EIA	James Hutchinson
Date signed	24.8.23
Comments:	
Signature of person the Leader Person for this activity	
Date signed	24.8.23
Comments:	