THRIVE

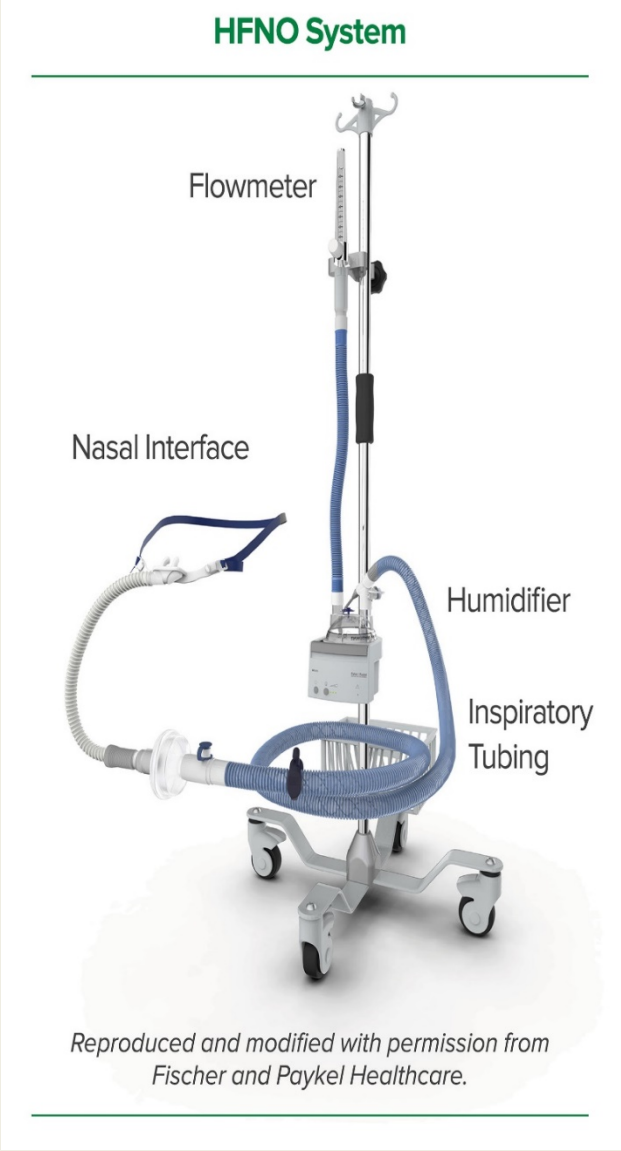
Is it the answer to managing the obstetric airway?

Overview

- What is THRIVE?
- In which situations is THRIVE currently being used or investigated?
- What aspects of managment of the obstetric airway might lend themselves to the application of THRIVE
- What evidence is there for THRIVE in obstetric anaesthesia?
- What does the future hold?

What is THRIVE?

- **T**ransnasal **H**umidified **R**apid **I**nsufflation **V**entilatory **E**xchange
- Based on high-flow nasal oxygen therapy (HFNO) commonly used in Critical Care
- Physiological method to extend the safe apnoea time in anaesthetised patients
- First described in a landmark paper by Patel and Nouraei in 2015
- «…has the potential to transform the practice of anaesthesia by changing the nature of securing a definitive airway in emergency and difficult intubations from a pressurised stop-start process to a smooth and unhurried undertaking»



How does THRIVE work?

- Increases apnoea time in anaesthetised patients
- Apnoeic oxygenation……for longer than facemask pre-oxygenation and low-flow nasal oxygen during apnoea
- Non- tidal ventilation gas exchange sets THRIVE appart from traditional apnoeic oxygenation
- Standard apnoeic oxygenation is limited by hypercarbia and respiratory acidosis, rise in pCO_2 0.35 to 0.45 kPa/min
- Rise in pCO_2 in THRIVE 0.15 kPa/min
- Flow dependent dead space flushing

How is THRIVE/HFNO currently being used?

- HFNO in self-ventilating critical care patients
- First anaesthesia reports in 2015- patients with difficult airways
- THRIVE for tubeless anaesthesia
- THRIVE as a method of pre-oxygenation during rapid sequence induction of anaesthesia and apnoeic oxygenation during intubation
- THRIVE during awake fibreoptic intubation, emergency tracheostomy
- THRIVE for preoxygenation and reducing desaturation during intubation of critically sick patients
- THRIVE during sedation for endoscopic procedures in high risk patients requiring sedation
- THRIVE during electroconvulsive therapy
- THRIVE for reducing hypooxia during induction of anaesthesia in children
- Some experince in obstetric patients

The obstetric airway

- Reduced FRC and higher oxygen consumption result in shorter time to desaturation despite pre-oxygenation
- Increased incidence of failed intubation-mortality 1:90 failed intubations due to hypoxia and aspiration
- Aspiration risk- avoidance of mask ventilation
- Reduced training opportunies- increased intubator stress
- Rapid conversion to general anaesthesia during Cesarean section
- Sick parturients may be less tolerant of lying flat during Cesarean section under regional anaesthesia.
- Hypoventilation and airway obstruction at emergence also results in mortality

Pre-oxygenation

- HFNO may acheive comparable levels of preoxygenation to facemask in non-obstetric adult populations
- «Hands-free» pre-oxygenation in obstetric GA is an attractive concept
- Studies of HFNO in term gravidas not in labour and not receiving GA would indicate that EtO_2 >0.9 is not uniformly achieved

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High-flow humidified nasal preoxygenation in pregnant women: a prospective observational study

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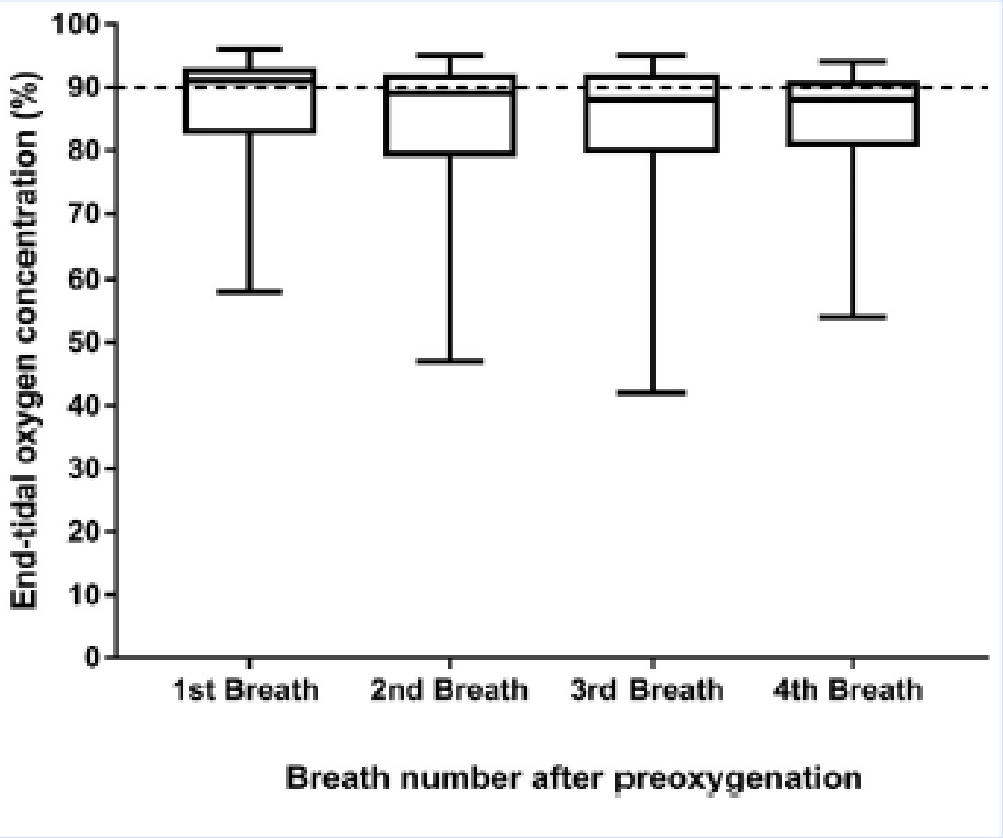

Fig 1. End-tidal oxygen concentration with the first four breaths after preoxygenation with Optiflow™. This figure shows the changes in the concentration of expired oxygen over a four-breath time period in the 73 women, presented as box plots. The line in the middle of the box is the median, and the whiskers extend to the minimum and maximum values. The critical level of 90% is shown with a dashed line. The box extends from the 25th to 75th percentile.

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Original Article

High-flow nasal oxygen vs. standard flow-rate facemask pre-oxygenation in pregnant patients: a randomised physiological study*

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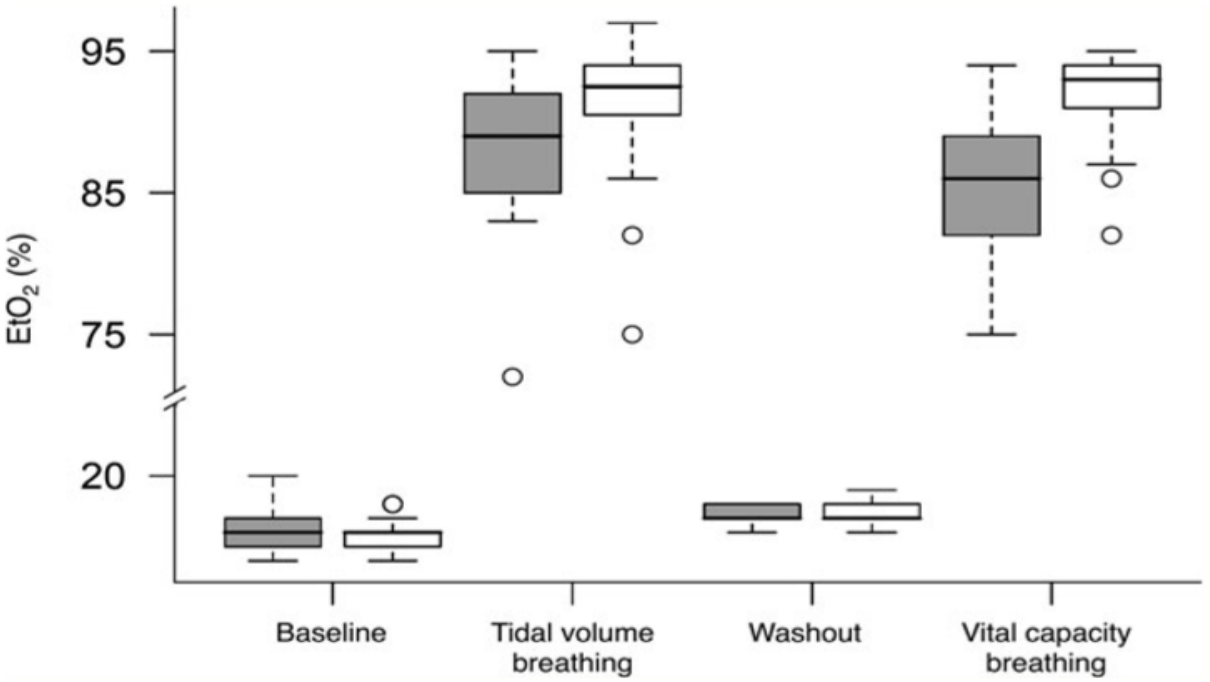

Figure 3 Boxplots of end-tidal oxygen concentration for high-flow nasal oxygen (grey) and standard flow rate facemask (white) at each time-point. The solid horizontal lines indicate the medians, the boxes extend to the IQR, the whiskers extend up to 1.5 times the IQR and the outliers beyond are indicated by hollow circles. EtO_2, end-tidal oxygen concentration.

How effective is facemask pre-oxygenation?

Rapid sequence induction

Check airway equipment, suction, intravenous access

Optimise position – head up/ramping + left uterine displacement

Pre-oxygenate to $F_{ET}O_2 \geq 0.9$/consider nasal oxygenation

Cricoid pressure (10 N increasing to 30 N maximum)

Deliver appropriate induction/neuromuscular blocker doses

Consider facemask ventilation (P_{max} 20 cmH_2O)

- Studies indicate that 75-95% pregnant women pre-oxygenate adequately
- Air entrainment is common (Russell et al 2008, Porter et al 2011)
- Pre-oxygenation for a set time rather than observing ETO_2 is common (Diacon et al 2012)

Table 1. Comparison by $F_{ET}O_2$ monitoring of three preoxygenation techniques in pregnant women

	Preoxygenation technique		
	3-min tidal volume breathing	4 deep breaths	8 deep breaths
$F_{ET}O_2$ at the end of preoxygenation	$89 \pm 5^*$	83 ± 6	$90 \pm 6^*$
Number of patient reaching an $F_{ET}O_2 \geq 90\%$ at the end of preoxygenation	$15/20^*$	3/20	$15/20^*$

All values are expressed as mean ± SD.

$^*P < 0.05$ versus 4 deep breaths.

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Pre-oxygenation vs. apnoeic oxygenation in obstetrics

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What about apnoeic oxygenation?

- No clinical studies in pregnancy
- Some experience with HFNO and obesity- ? surrogate for reduced FRC and issues maintianing upper airway
- Some experience with HFNO in paediatrics- ? Surrogate for increased oxygen usage
- Physiological modelling in pregnancy indicates increased time to desaturation, also in models of labour and obesity

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Pre-oxygenation and apnoea in pregnancy: changes during labour and with obstetric morbidity in a computational simulation

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Table 2 Results of pre-oxygenation investigation (pre-oxygenation was not studied in the combined obesity/labour subjects).

	Average pregnant*	Labour	BMI 50	BMI 35	Sepsis	Hypo-volaemia	Anaemia	Pre-eclampsia	Twins
Time to achieve 95% of maximum change in $P_{\bar{E}}O_2$; min : s	1 : 37 [1 : 23–1 : 52]	0 : 47	1 : 10	1 : 24	1 : 11	1 : 37	1 : 36	2 : 07	1 : 27
Time to achieve 99% of maximum change in $P_{\bar{E}}O_2$; min : s	3 : 14 [3 : 13–3 : 24]	2 : 02	2 : 28	2 : 49	2 : 33	3 : 33	2 : 59	4 : 03	2 : 49
Percentage of maximum change in $P_{\bar{E}}O_2$ after 2 min; %	96.6 [95.9–97.1]	98.9	98.2	97.5	98.0	96.4	96.8	94.5	97.3

BMI 50/35, body mass index 50/35 kg.m^{-2}.
*The 'normal' range for pre-oxygenation in pregnancy from our previous study [1] is given in square brackets.

Table 3 Results of apnoea investigation (terminal decline measured over final 6 s to 40%).

	Average pregnant*	Labour	BMI 50	BMI 35	BMI 50 & labour	BMI 35 & labour	Sepsis	Hypo-volaemia	Anaemia	Pre-eclampsia	Twins
Time taken to fall to S_aO_2 < 90%; min : s	4 : 52 [3 : 43–6 : 1]	3 : 27	2 : 36	3 : 56	1 : 38	2 : 46	3 : 34	4 : 44	4 : 51	7 : 09	4 : 39
Time taken to fall from S_aO_2 90% to 40%; min : s	0 : 34 [0 : 32–0 : 45]	0 : 26	0 : 26	0 : 32	0 : 21	0 : 27	0 : 43	0 : 39	0 : 37	0 : 48	0 : 31
Rate of terminal decline of S_aO_2; %.s^{-1}	2.9 [2.2–3.4]	3.7	4.6	3.1	5.0	4.2	3.3	2.6	2.6	1.9	2.8

BMI 50/35, body mass index 50/35 kg.m^{-2}.
*The 'normal' range for apnoea in pregnancy from our previous study [2] is given in square brackets.

Anaesthesia 2016, 71, 1077–1080 doi:10.1111/anae.13563

Original Article

Apnoeic oxygenation in pregnancy: a modelling investigation*

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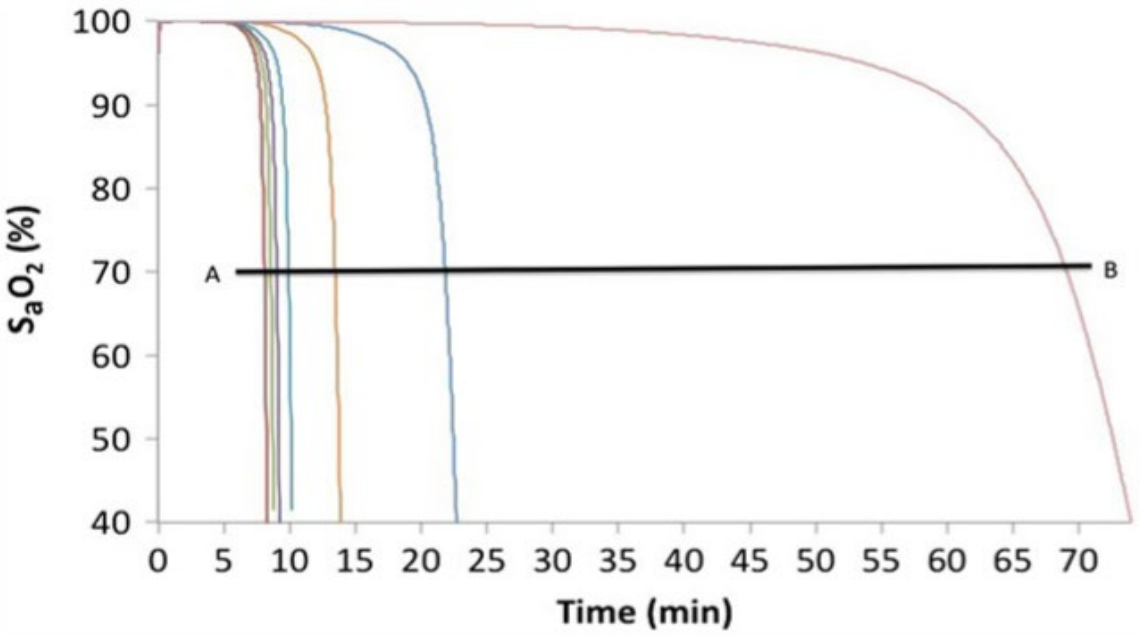

Figure 1 The effect of increasing oxygen concentration at the open glottis on S_aO_2 (%) during apnoea in the average term parturient (not in labour). Line A-B transects the following fractional inspired oxygen concentrations at the open glottis in order, left to right: 0.21; 0.28; 0.35; 0.4; 0.6; 0.8 and 1.0.

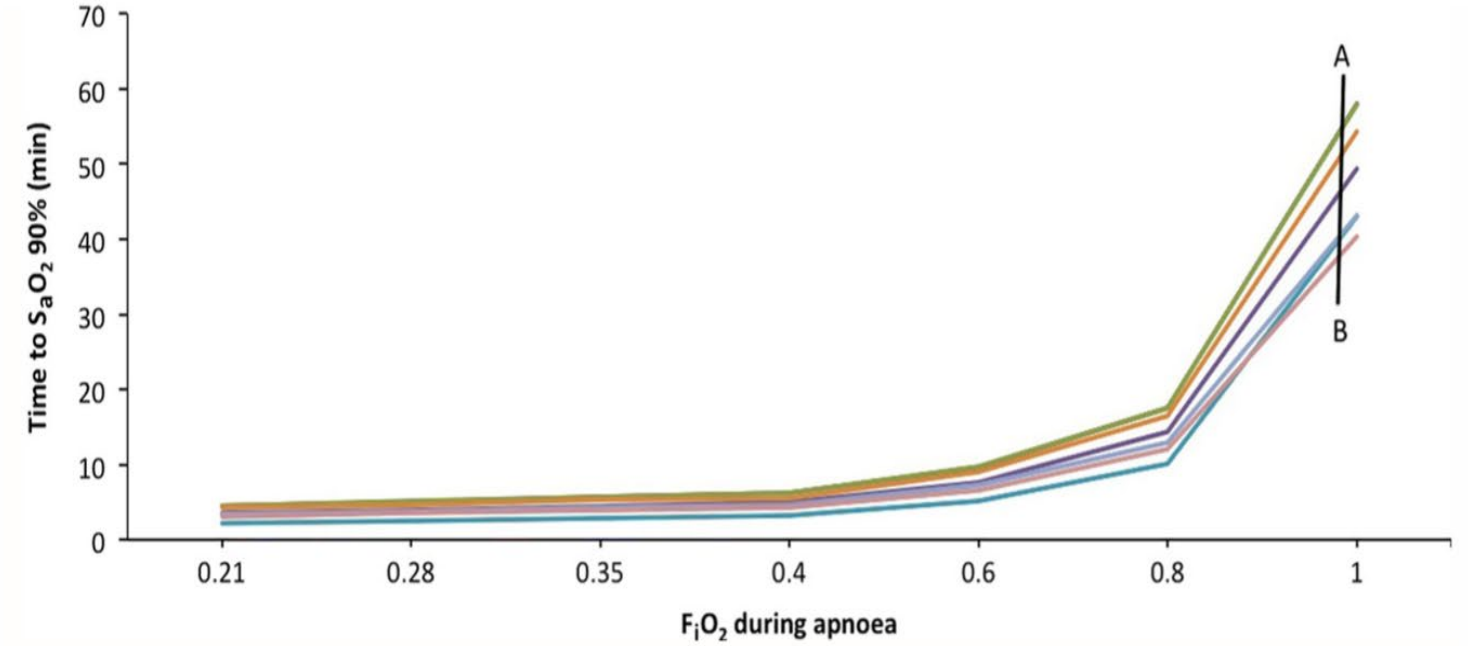

Figure 2 The effect of increasing oxygen concentration at the open glottis during apnoea on time to S_aO_2 90% in all models of pregnancy. Line A-B transects subjects in the following order, top to bottom: Average parturient: anaemia; twin pregnancy; BMI 35 $kg.m^{-2}$; sepsis; BMI 50 $kg.m^{-2}$; and average parturient in labour.

Clinical experience with HFNO in obstetrics 1

- 2015 Glasgow
- Nullip presented at 35/40 with URTI
- Increasing hypoxia over the next hours, SpO_2 91% 15L O_2 Hudson mask
- HFNO used to ameliorate respiratory distress
- Em LSCS, HFNO + FM pre-oxygenation 3 mins
- SpO_2 > 97% throughout
- Extubated 8 hours pp on ITU

Clinical experience with HFNO in obstetrics case 2

- 2015 Glasgow
- Term multip with BMI 75 presented for eI LSCS
- Successful CSE, HFNO as soon as block sited
- Positioned on Oxford HELP pillow with LLT
- SpO_2 99-100% 40-60L/min and FiO_2 0.5-0.9, no dyspnoea occured
- Normal oxygen saturations were maintained until a trial of discontinuation in the recovery room- HFNO recommenced and maintained until regress of neuraxial block

Clinical experience with HFNO in obstetrics case 3

- 2016 London
- Term multip with BMI 60 presented for eI LSCS
- CSE, positioned with Oxford HELP pillow and LLT plus HFNO 30L/min and FiO_2 1.0
- Spinal failed, epidural top-up achieved adequate block
- Asystole one hour in; HFNO increased to 60L/min, FM oxygen with maintanence of airway patency, chest compressions and 1mg epinepherine. ROSC after 60 seconds, SpO_2 99%. Regained full conciousness within minutes
- THRIVE believed to have provided apnoeic oxygenation and may have avoided need for intubation

Clinical experience with HFNO in obstetrics case 4

- 2017 Dallas
- Primip 29/40 admitted with ARDS, SpO_2 80% room air
- Em LSCS under GA
- HFNO 70L/min FiO_2 1.0 started in theatre, improved dyspnoe, SpO_2 95% within 5 mins
- No desturation during intubation, but required FiO_2 0.85 throughout surgery
- Post op treated for influenza B and underwent balloon dilatation of severe mitral stenosis
- Extubated day 7

Clinical experience with HFNO in obstetrics- case 5

- 2018 Dublin
- Primip with congentital muscular dystrophy, severe restictive lung disease on home BiPAP,likely difficult intubation, surgically corrected scoliosis with extensive instrumentation of TL-spine.
- Presented 25/40 with chestpain, weightloss and dehydration
- Em LSCS 30/40 due to deteriorating respiratory status.
- Anxiety and lack of co-operation precluded awake FOI.
- HFNO 50L/min and dexmetatomidine well tolerated during PO and induction. No desaturation despite no FM ventilation and 3 intubation attempts.

The future

- Studies point towards less adequate pre-oxygenation with HFNO….
- But this may also be the case in non-obstetric patients…
- And it seems also in the pregant population that apnoeic oxygenation may be the key factor
- Large clinical studies unlikely…..
- But clinical experience is building….

As with many obstetric situations, expert opinion and consensus statements may provide guidance in the future.....

1011: Current Trends of High Flow Nasal Cannulae System in Obstetric Anaesthesia

Joanna Haynes

In 2015, the Obstetric Anaesthetist Association (OAA) together with the Difficult Airway Society published guidelines for the management of difficult and failed tracheal intubations in Obstetric anaesthesia. Within the safe obstetric general anaesthesia algorithm, the recommended target for preoxygenation is an end tidal oxygen level of more than 90% with a suggested role of nasal oxygenation to facilitate this. The use of high flow nasal cannulae (HFNC) systems are well established in neonates, and increasing evidence has shown a positive role in difficult airway management in the non-obstetric population.

The obstetric patient presents a unique challenge not only due to the physiological and anatomical changes that occur in pregnancy, but also due to fact most GAs are undertaken in highly stressful, time pressured circumstances. HFNC is likely to be invaluable in the airway management of such a complex and unique group of patients; however, there remains little report of its use in obstetric anaesthesia with no nationally accepted guidelines.

This survey's primary aims are to identify the current prevalence of HFNC in obstetric units, the trends and indications of its use, and the protocols adopted by units using HFNC. We would also like to obtain a consensus on the value of HFNC in obstetric anaesthesia and identify any potential pitfalls or obstacles for its implementation in routine practice.

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Dr Bruce Allan

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