CLINICAL INVESTIGATION

Apnoeic oxygenation in morbid obesity: a randomised controlled trial comparing facemask and high-flow nasal oxygen delivery

John Schutzer-Weissmann[1,2,*], Thomas Wojcikiewicz[1,3], Anil Karmali[1,4], Asta Lukosiute[1,5], Ruoyi Sun[1], Rafiq Kanji[1,5], Ahmed R. Ahmed[1,6], Sanjay Purkayastha[1,6], Stephen J. Brett[1,6] and Jonathan Cousins[1]

[1]Imperial College Healthcare NHS Trust, London, UK, [2]The Royal Marsden Hospital NHS Foundation Trust, London, UK, [3]Royal Surrey NHS Foundation Trust, Guildford, UK, [4]London North West University Healthcare NHS Trust, Harrow, UK, [5]Guy's and St Thomas' NHS Foundation Trust, London, UK and [6]Department of Surgery and Cancer, Imperial College London, UK

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R_2 Kiattisak / Lt.Col.Dr.Krisana

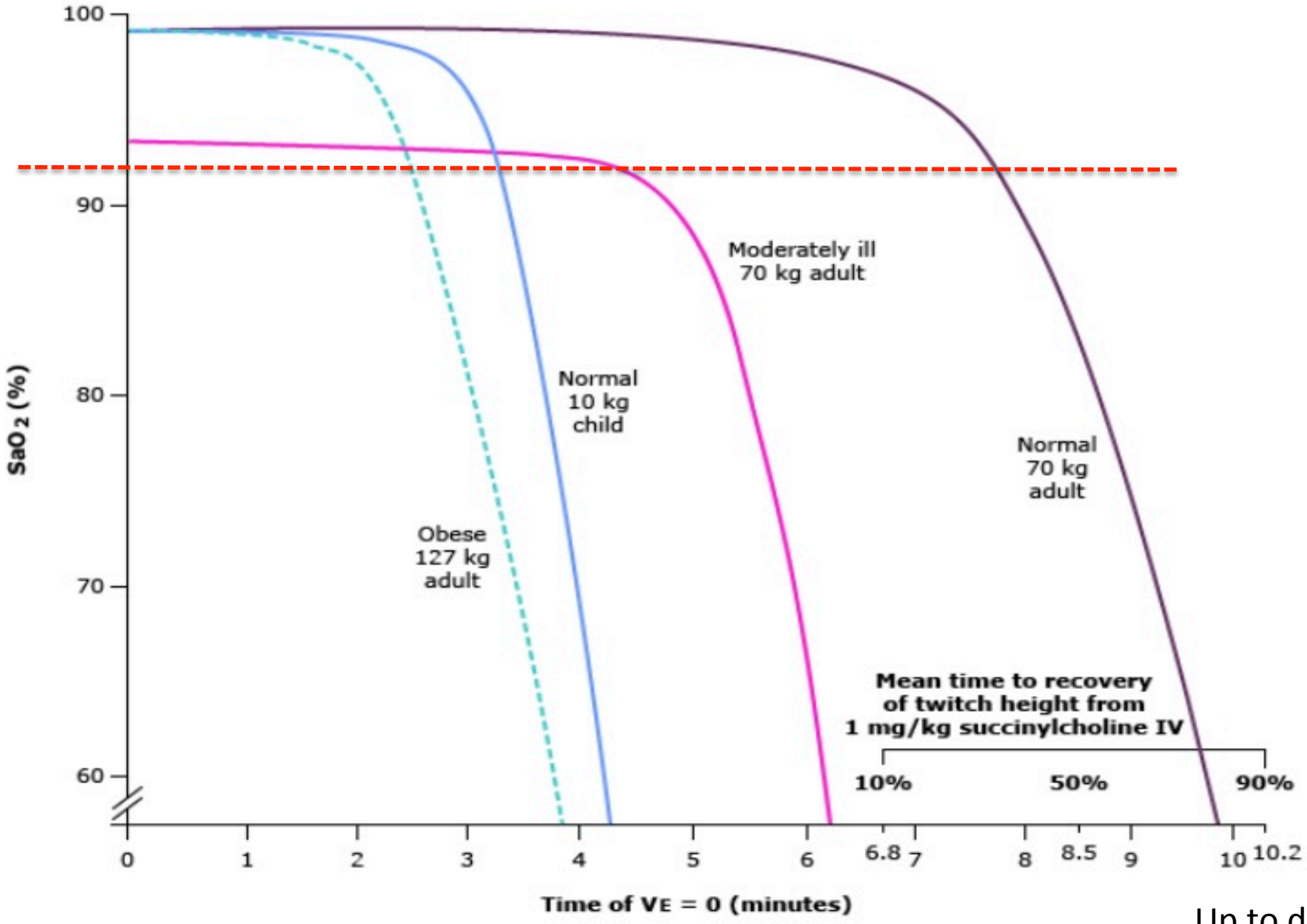
Background

- Obesity is a risk factor for airway-related incidents during anaesthesia [>25% in UK]
- *High-flow nasal oxygen* are more efficient with higher flow rates of oxygen delivered closer to the lung
- !! Effectiveness in the obese population is uncertain

Background

- *Safe upper limit of apnoea* in the presence of morbid obesity may be as low as 5 min
- In this study, we explored the safe upper limit of apnoea in morbidly obese patients

Time to hemoglobin desaturation with initial fractional alveolar oxygen concentration = 0.87



Up to date

This study

- Compare the effect of oxygen flow rate and proximity of fresh gas flow to the respiratory epithelium on the duration of apnoea

- Primary outcome was the time to arterial haemoglobin oxygen desaturation to 92%

Methods

Design

- Randomized controlled trial
- Approved by Bloomsbury Research and Ethics Committee
- Conducted in a tertiary centre between October 2018 and September 2019
- Two experienced bariatric anaesthetists

Methods

- Participants
  - Recruit during a bariatric surgical clinic
- Inclusion criteria
  - Patients aged 18-65 yr with BMI > 40 kg/m^2
- Exclusion criteria
  - Inability to give informed consent
  - Significant cardiac, peripheral vascular or respiratory disease
  - Nasal obstruction
  - Predicted difficult facemask ventilation or intubation

Primary outcome

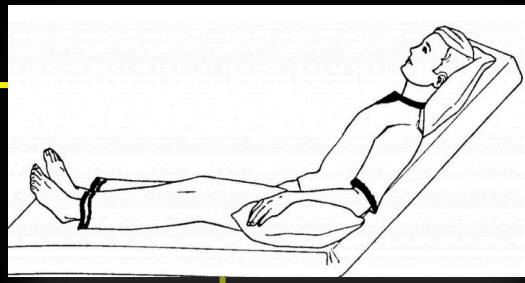
Time to arterial haemoglobin oxygen desaturation to 92%

Secondary outcome

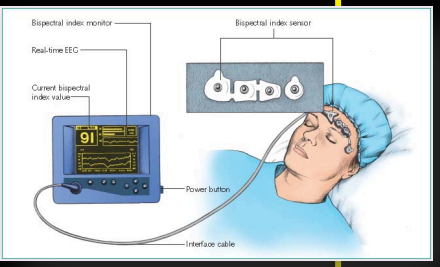
Measured arterial oxygen and carbon dioxide tension during apnoea

Random participants to HFNO or facemask oxygen groups

Balance participants : diagnosed OSA using CPAP between groups



In operating room

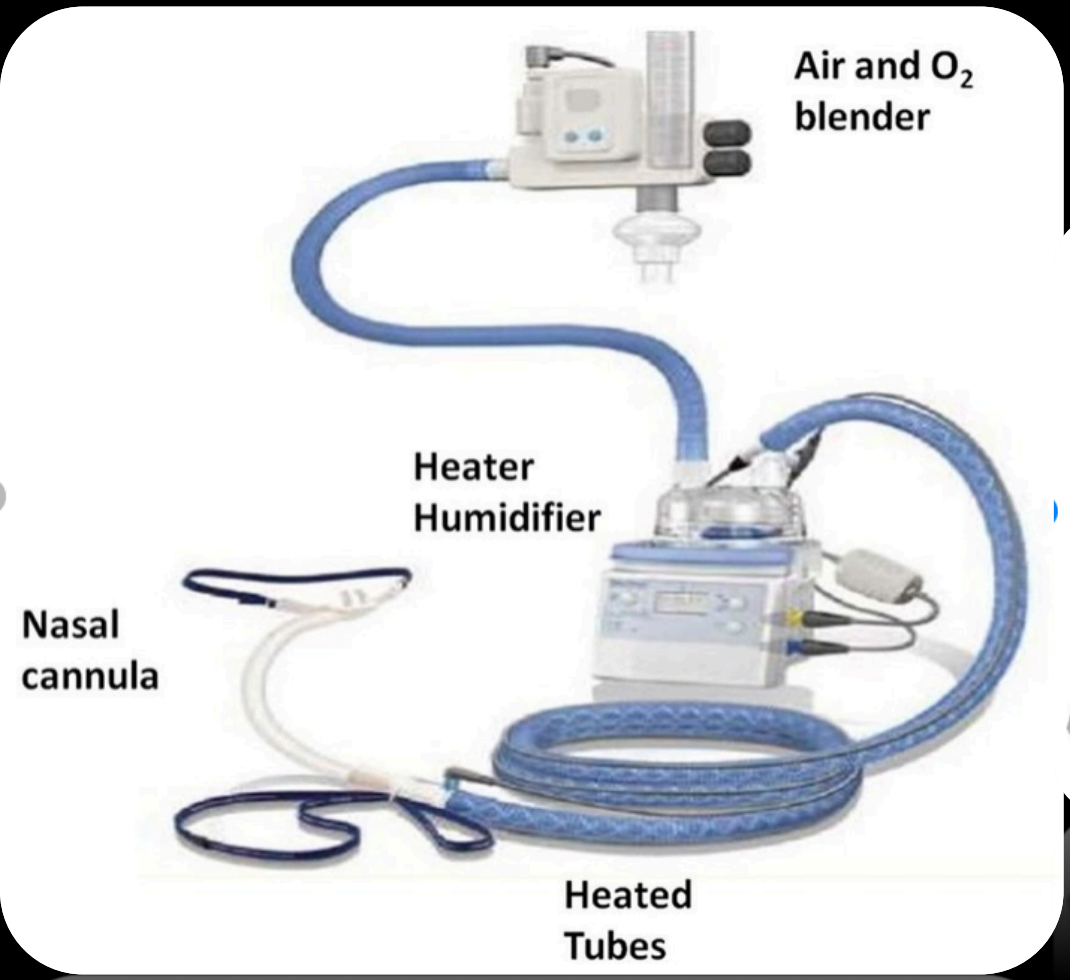


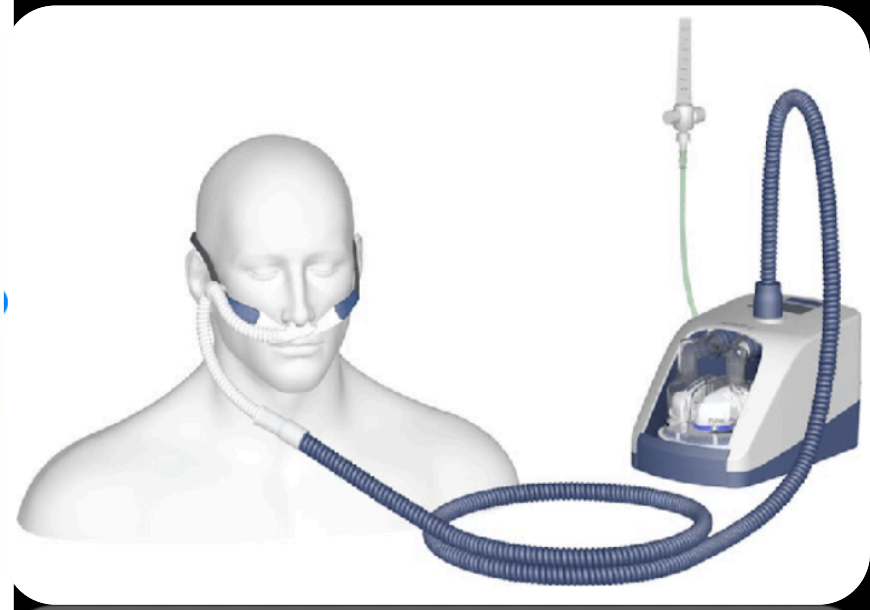
- Position at 45 º mid thoracic incline
- Standard monitoring, bispectral index [BIS]
- Invasive arterial blood pressure monitor
- Preoxygenation 3 min with VC in both groups

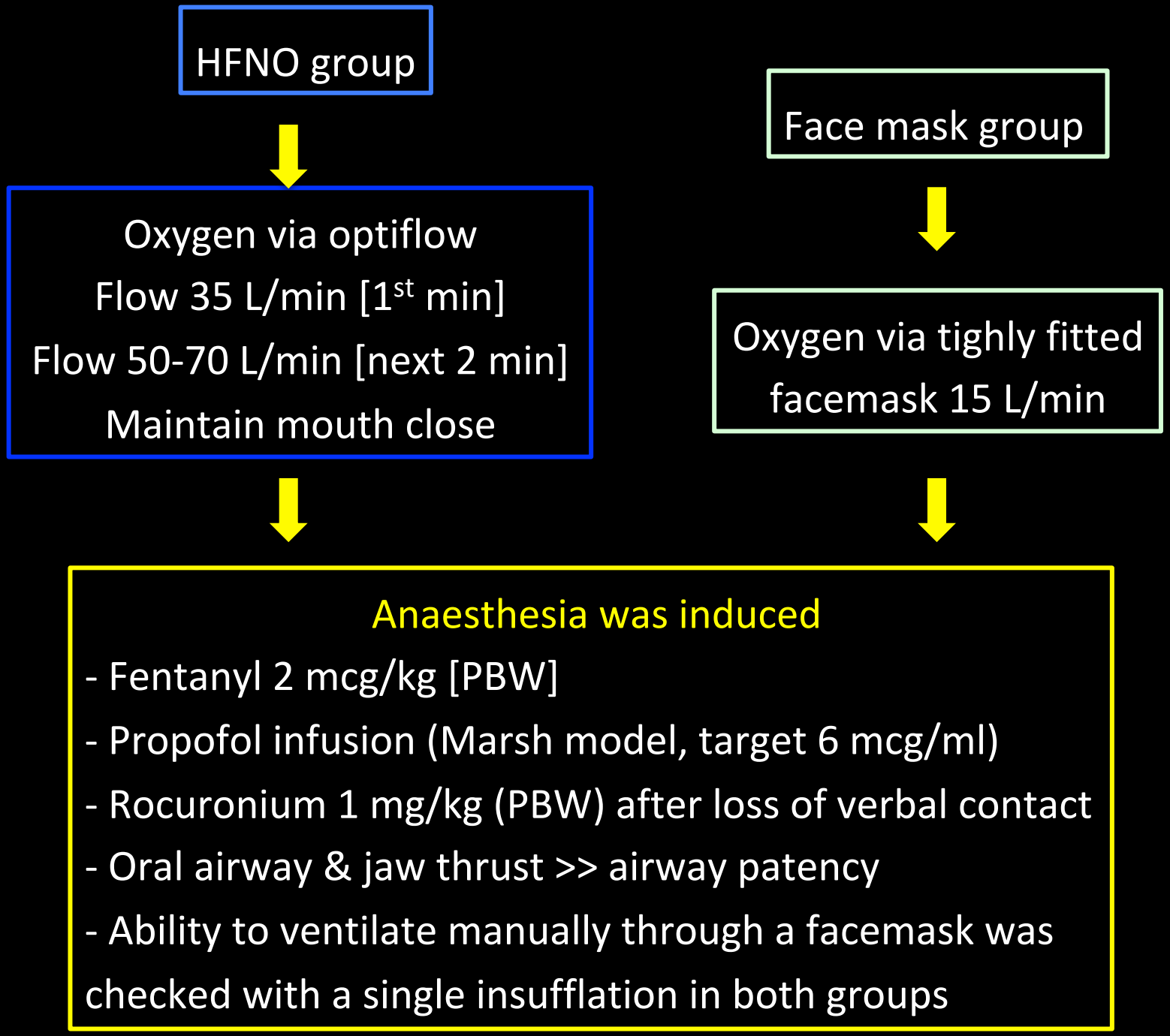
HFNO group

Face mask group

Optiflow [HFNO]






HFNO group
Face mask group
Oxygen via optiflow
Flow 35 L/min [1st min]
Flow 50-70 L/min [next 2 min]
Maintain mouth close
Oxygen via tighly fitted facemask 15 L/min
Anaesthesia was induced
- Fentanyl 2 mcg/kg [PBW]
- Propofol infusion (Marsh model, target 6 mcg/ml)
- Rocuronium 1 mg/kg (PBW) after loss of verbal contact
- Oral airway & jaw thrust >> airway patency
- Ability to ventilate manually through a facemask was checked with a single insufflation in both groups

- SBP was maintained within 20% of baseline
- Further rocuronium doses : apnea time > 10 min to ensure optimum intubating conditions
- Onset of apnoea : was defined as 1 min after rocuronium administration

- ABG sample
  - Baseline [before preoxygenation]
  - End of preoxygenation
  - Onset of apnea [TA]
  - 2,4,6,9,12 and 18 min if oxygen sat > 92%

Statistical analysis

- Sample size of 35 per group was calculated to provide adequate power [use 40 per group]
- Standard descriptive statistics : mean and SD or median and IQR and 95% CI
- Time to desaturation : Kaplan Meier curves
- Continuous data : independent t-test
- Data were collated using Excel 2016 & analysed using Prism 8.3.0

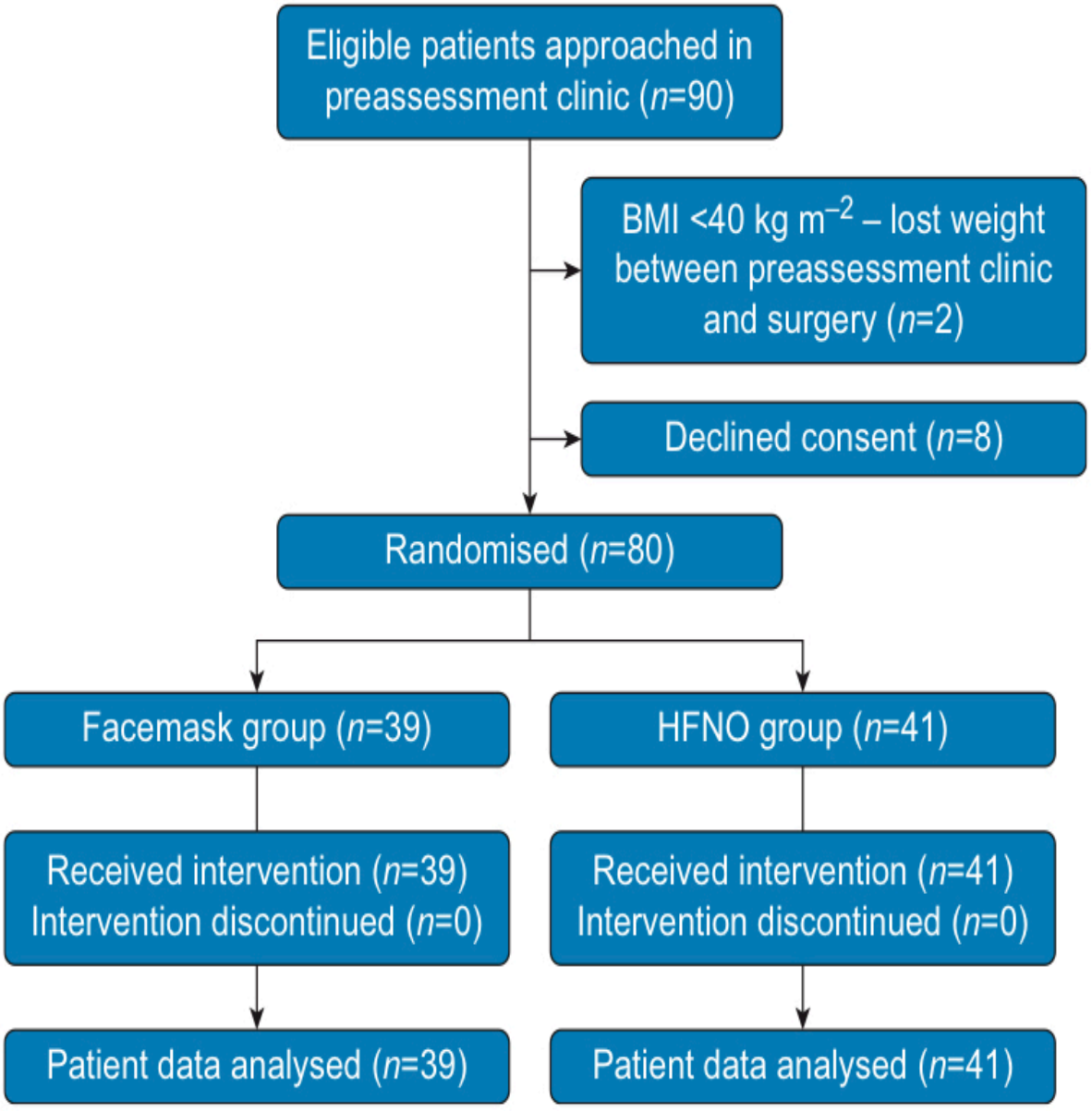


Fig 1. CONSORT diagram. CONSORT, Consolidated Standards of Reporting Trials; HFNO, high-flow nasal oxygen.

Result

	FM	HFNO
Participants	39	41
CPAP use	10	10
STOP-Bang score ≥5	10	13
Sex	31 F / 8 M	26 F / 15 M
Age (yr)	48 (38–54)	47 (36–55)
Weight (kg)	130 (122–139)	129 (118–144)
BMI (kg m^{-2})	46.7 (44.4–49.5)	46.6 (43–53.6)
Neck circumference (cm)	40.8 (38.8–44.3)	40.0 (38.0–46.0)
Waist/hip ratio	1.0 (1.0–1.1)	1.0 (1.0–1.1)
Smoker (current/ex/never)	2/13/24	0/16/25

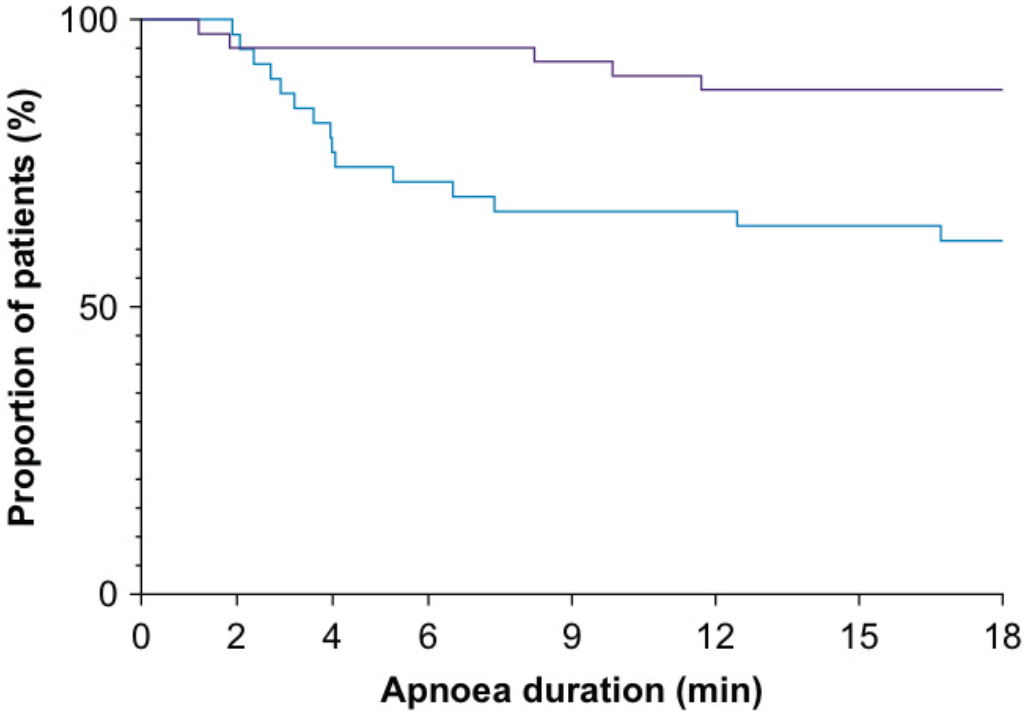
Result

Table 2 Pa_{o2} and Pa_{co2} before and during apnoea. Figures shown are mean (standard deviation) arterial oxygen and carbon dioxide tensions (kPa). TA, onset of apnoea; TA+x, apnoea duration where x denotes min after TA. Figures before apnoea (at baseline breathing air, and at the end of preoxygenation) include data from all participants in the high flow nasal oxygen (HFNO; where data are available, n=39) and facemask oxygen (FM, n=39) groups. During apnoea, figures include data only from the 60 participants who completed 18 min of apnoea (HFNO, n=36; FM, n=24). Comparisons were made using the independent t-test.

		Baseline	After preoxygenation	TA	TA+2	TA+4	TA+6	TA+9	TA+12	TA+15	TA+18
Pa_{o2}	HFNO	12.8 (2.4)	59.9 (8.1)	55.7 (7.2)	40.4 (8.1)	30.4 (8.1)	28.2 (8.2)	26.7 (7.3)	26.0 (7.2)	24.5 (6.7)	23.6 (6.7)
	FM	12.7 (2.3)	60.2 (9.4)	50.7 (9.9)	35.5 (11.6)	30.5 (11.1)	28.7 (10.2)	27.1 (9.9)	25.2 (9.4)	23.8 (9.1)	22.2 (8.3)
	P	0.978	0.978	0.249	0.422	1.000	0.999	0.999	0.999	0.999	0.987
Pa_{co2}	HFNO	5.3 (0.5)	4.5 (0.9)	6.5 (0.9)	7.1 (0.8)	7.7 (0.8)	8.2 (0.8)	9.0 (0.9)	9.6 (0.9)	10.1 (1.0)	10.7 (1.1)
	FM	5.3 (0.5)	5.0 (0.7)	6.6 (0.8)	7.1 (0.7)	7.8 (0.7)	8.3 (0.8)	8.9 (0.8)	9.5 (0.9)	10.0 (1.0)	10.6 (1.1)
	P	0.660	0.009	0.996	0.999	0.999	0.999	0.999	0.999	0.996	0.999

1 kPa ≈ 7.5 mmHg

Result



At risk	TA	TA+2	TA+4	TA+6	TA+9	TA+12	TA+15	TA+18
HFNO	41	39	39	39	38	36	36	36
FM	39	38	30	28	26	26	25	24

Desat patient

5

15

Fig 2. Risk of desaturation during apnoea. Proportion of study participants in HFNO (purple line) and FM (blue line) groups with oxygen saturation >92% during apnoea. Hazard ratio comparing FM and HFNO groups, 0.27 (95% confidence interval, 0.11–0.65; log-rank P=0.007). TA, onset of apnoea. TA+x, apnoea duration where x denotes min after TA; FM, facemask oxygen; HFNO, high-flow nasal oxygen.

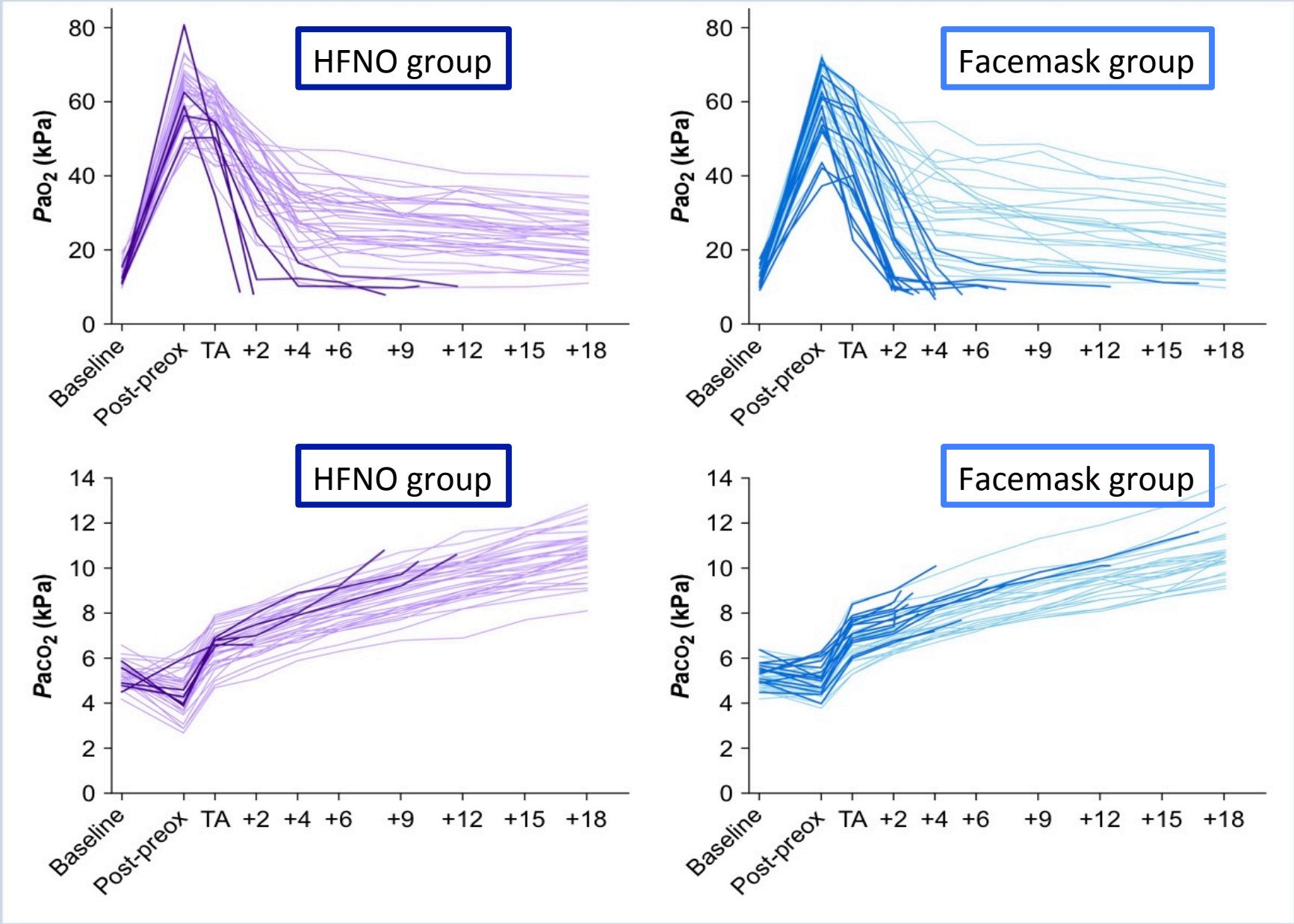
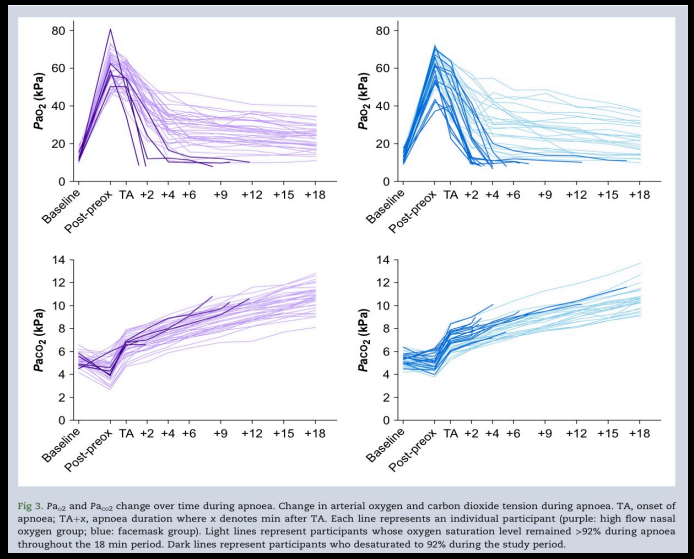


Fig 3. Pa_{o2} and Pa_{co2} change over time during apnoea. Change in arterial oxygen and carbon dioxide tension during apnoea. TA, onset of apnoea; TA+x, apnoea duration where x denotes min after TA. Each line represents an individual participant (purple: high flow nasal oxygen group; blue: facemask group). Light lines represent participants whose oxygen saturation level remained >92% during apnoea throughout the 18 min period. Dark lines represent participants who desaturated to 92% during the study period.

Discusssion

- From this study, morbid obesity does not preclude apnoeic oxygenation
- This is the largest RCT of apnoeic oxygenation in morbidly obese patients to date
- Maximum apnoea time : earlier studies was 10.5-14 min
- Suggesting that HFNO improves the efficiency of apnoeic oxygenation

Discusssion



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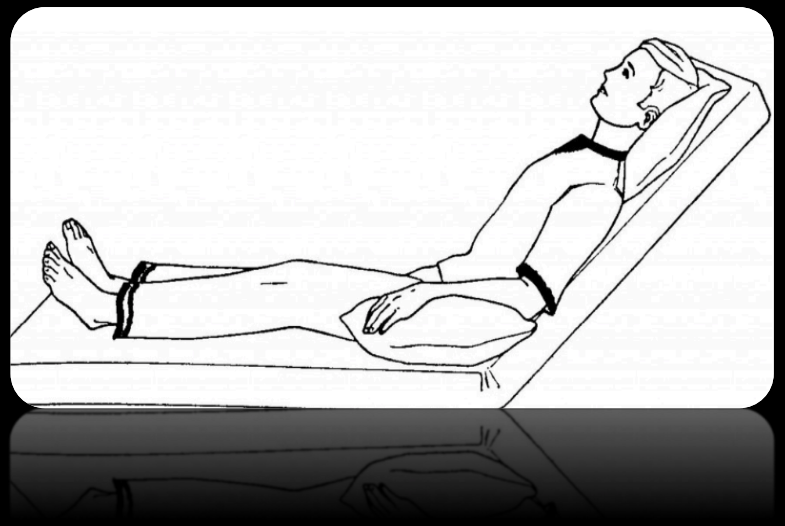
- PaO_2 trajectory during apnoea
  - Not linear
  - Initially decreasing rapidly before decreasing more slowly
- In obese patients
  - No study investigating facemask oxygen
  - Three have used HFNO : mean apnoea time ≈ 600-900 sec

Discusssion



- Position
  - In this study semi-recumbent with a 45^{o} mid-thoracic incline
  - Steeper than other studies : 30^{o},25^{o}or 20^{o}

    ‘ramped sniffing’ position or supine
- Evidence that position affect apnoea time

Strength

- This study conduct in a safe environment by experts in bariatric anaesthesia
- No monitor neuromuscular block But
  - Protocol dose of rocuronium (1 mg/kg) should have been adequate to prevent diaphragmatic movement
  - Additional rocuronium during apnoea at 10 min

Limitation

- Outcome limitation : choice of census point : 18 min
- Technical limitation : blood sampling method
  - Blood gas samples refrigerated until completion of an individual patient study run
- !! Samples analyse [≈ 2 min]

Limitation

- No direct visualisation of the airway

{ Oral airway & jaw thrust : check that manual ventilation was possible at the beginning of apnoea }

- Operator fatigue : prolonged jaw thrust

{ Most patients who desaturated : within the first 5 min }

Conclusion

- In experienced hands : apnoeic oxygenation is possible in morbidly obese patients
- High-flow nasal oxygen may reduce desaturation risk compared with facemask oxygen
- In both group : most of patient oxygen desaturation did not occur for 18 min

Conclusion

- First : patients may desaturate >> despite optimal preoxygenation and an adequate oxygen supply
- Second : suggests that apnoea is tolerable in most patients [>60%] using a standard anaesthetic facemask

Critical Apprasial

1. Were the following clearly stated:	Yes	Can't tell	No
• Patients	✓		
• Intervention	✓		
• Comparison Intervention	✓		
• Outcome(s)	✓		

Critical Apprasial

	Yes	Can't tell	No
2. Was the assignment of patients to treatments randomised?	✓		
3. Was the randomisation list concealed? Can you tell?	✓		
4. Were all subjects who entered the trial accounted for at it's conclusion?			✓
5. Were they analysed in the groups to which they were randomised, i.e. intention-to-treat analysis	✓		

Critical Apprasial

6. Were subjects and clinicians 'blind' to which treatment was being received, i.e. could they tell?	Yes	Can't tell	No ✓
7. Aside from the experimental treatment, were the groups treated equally?	✓		
8. Were the groups similar at the start of the trial?	✓		

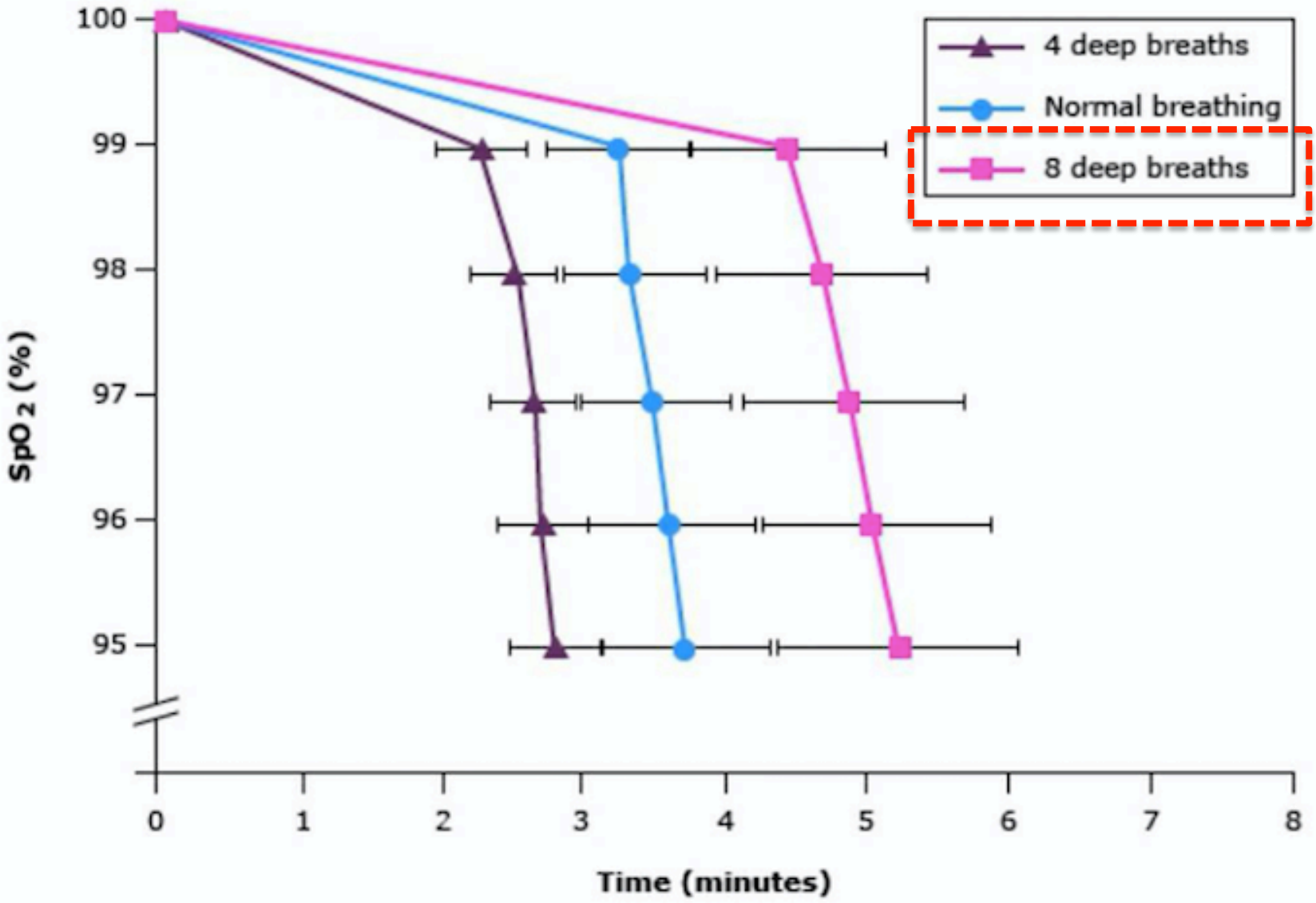
Critical Apprasial

9. How large was the treatment effect? Consider • How were the results expressed (RRR, NNT, etc).	?
10. How precise were the results? Were the results presented with confidence intervals?	yes

Critical Apprasial

	Yes	Can't tell	No
11. Do these results apply to my patient? • Is my patient so different from those in the trial that the results don't apply? • How great would the benefit of therapy be for my particular patient?	✓		✓
12. Are my patient's values and preferences satisfied by the intervention offered? • Do I have a clear assessment of my patient's values and preferences? • Are they met by this regimen and its potential consequences?	✓ ✓		

Oxygen desaturation with different preoxygenation techniques



ราคาเวชภัณฑ์ รพ.รร.6

					ราคา
เวชฯ	900PT501	900PT501(561) ADULT HEATEI	1	หม้อน้ำ	2921
เวชฯ	OPT844	FH OPT844/944 OPTIFLOW NA	1	HFNO	1046
เวชฯ	OXY301	OXYGEN MASK WITH RESERV	1	Face mask	70
เวชฯ	OXY201	OXYGEN CANNULAR 1 SET 2.1	1	Nasal cannular	21

Propofol models TCI

- Use LBM [Lean body mass] >> not proper obese
  - Marsh model : collect data pediatric population
  - Schnider model : weight, height, age
- !! Eleveld models !!
  - Using TBW
  - Best suited for TCI in obese & morbid obese patients

TABLE 18.1 Common Weight Scalars (Modified Added Modified Fat-Free Mass)

Name	Equations
Ideal body weight	Male: 50 kg + 2.3 kg for each 2.54 cm (1 inch) over 152 cm (5 ft) Female: 45.5 kg + 2.3 kg for each 2.54 cm (1 inch) over 152 cm (5 ft)
Corrected body weight	IBW + 0.4 × (TBW–IBW)
Lean body mass	Male: $1.1 \times TBW - 128 \times (TBW/Ht)^2$ Female: $1.07 \times TBW - 148 \times (TBW/Ht)^2$
Fat-free mass[66]	Male: $(9.27 \times 10^3 \times TBW)/(6.68 \times 10^3 + 216 \times BMI)$ Female: $(9.27 \times 10^3 \times TBW)/(8.78 \times 10^3 + 244 \times BMI)$
Pharmacokinetic mass[46,47]	$52/[1+(196.4 \cdot e^{-0.025\ TBW} - 53.66)/100]$ (fentanyl only)
Modified fat-free mass[28,36]	FFM + 0.4 × (TBW–FFM)

BMI, Body mass index; *FFM*, fat free mass; *Ht*, height in centimeters; *IBW*, ideal body weight; *LBM*, lean body mass; *TBW*, total body weight in kg.

TABLE 18.2 Dosing Weights Based on Various Dosing Scalars (Values Per K Johnson)

	176-cm (6 FT) Male	
	68 kg BMI = 22	185 kg BMI = 66
Dosing Scalar	**Dosing Weight (kg)**	**Dosing Weight (kg)**
Total body weight (TBW)	68	185
Ideal body weight (IBW)	72	72
Corrected body weight (CBW)	70	117
Lean body mass (LBM)	56	62
Fat-free mass (FFM)	55	88
Modified fat-free mass (MFFM)	60	127

BMI, Body mass index (kg/m^2).

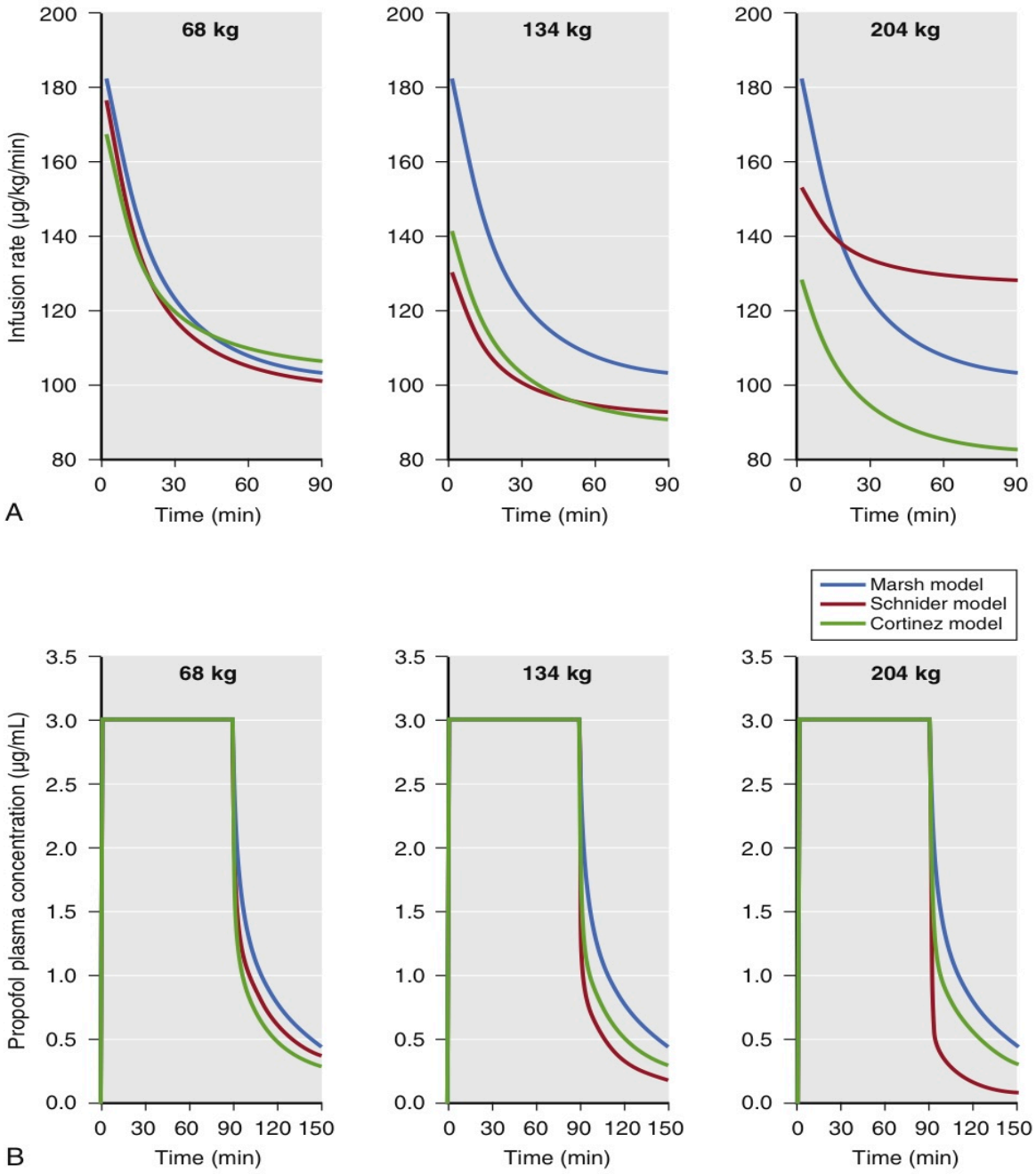


Fig.18.34 Simulations of a 90-minute propofol target-controlled infusion set to achieve and maintain a plasma concentration (Cp) of 3 µg/mL using four different published propofol pharmacokinetic models: Marsh and associates,[31] Schnider and associates,[32] Cortinez and associates,[36] and Eleveld and associates.[36,38] Simulations assumed 40-year-old males who are 176 cm tall and weigh 68, 134, or 204 kg. (A) Propofol infusion rates for each model at each weight. (B) Propofol plasma concentrations predicted by each model for each weight.

BOX 58.2 STOP-Bang Questionnaire

1. Snoring: Do you snore loudly (loud enough to be heard through closed doors)?
2. Tired: Do you often feel tired, fatigued, or sleepy during day-time?
3. Observed: Has anyone observed you stop breathing during your sleep?
4. Blood pressure: Do you have or are you being treated for high blood pressure?
5. BMI: BMI more than 35 kg/m^2?
6. Age: Age over 50 years old?
7. Neck circumference: Neck circumference >40 cm?
8. Gender: Male?

High risk of OSA: Yes to ≥3 questions.
Low risk of OSA: Yes to <3 questions.
BMI, Body mass index; *OSA*, obstructive sleep apnea.