O_2

Oxygen and ABG

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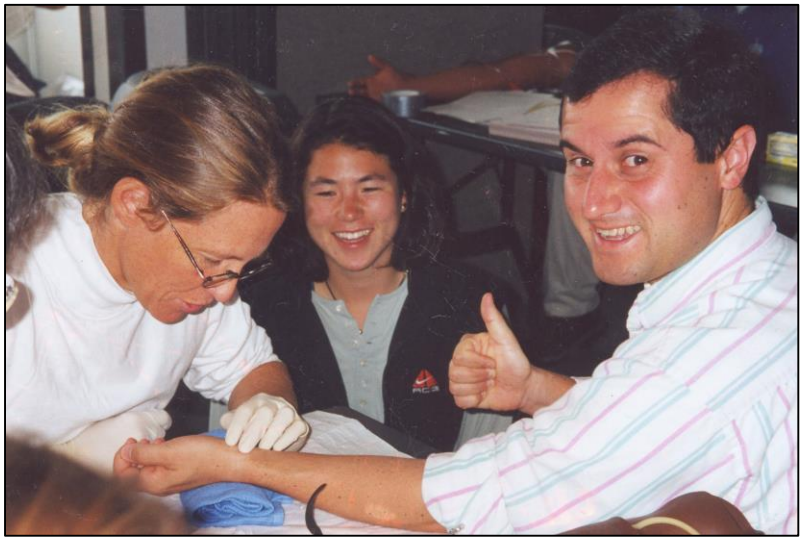
SIMPLY
FINALS

Oxygen and ABGs… Simply in 10 cases

- Recap of:
  - ABG interpretation
  - Oxygen management
- Some common concerns
  - A-a gradient
  - Base Excess
  - Anion Gap
  - COPD patients
  - CPAP/BiPAP



SIMPLY FINALS

First Case…

- 68yo man walks into A&E with mild breathlessness and productive cough. He has no PMH.

What would be your management?

- ABCDE
- Ex- talking to you, no signs of distress, creps in left base

BP 118/70 HR 105 RR 20 Sats 91%

SIMPLY FINALS

Oxygen Therapy

STEP 1: HOW IS THE PATIENT?

68yo. No PMH. Mild SOB/cough. RR 20 Sats 91% OA

Is the patient critically ill or 0_2 Sats <85% ?

NO

Is patient at risk of hypercapnia?

		Target Sats	Starting Device
NO	→	94-98%	Nasal Cannula (2-6L/m) or Face Mask (5-10L/m)

… and do an Arterial Blood Gas

Face Mask
Variable O_2 of 35-60%.
Flow 5-10 L/min

Nasal Cannulae
Variable O_2 of 24-50%
Flow 2-6L/min

Case 1: Arterial Blood Gas

		Normal values
pH	**7.43**	*(7.35 – 7.45)*
pCO_2	**4.0 kPa**	*(4.7 – 6.0 kPa)*
pO_2	**11.1 kPa**	*(>10kPa)*
HCO_3	**24 mmol/L**	*(22-26 mmol/l)*
BE	**0 mmol/L**	*(+/-2.0 mmol/l)*

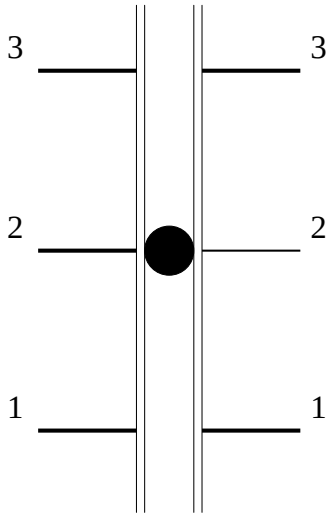
CO_2 low and not acidotic

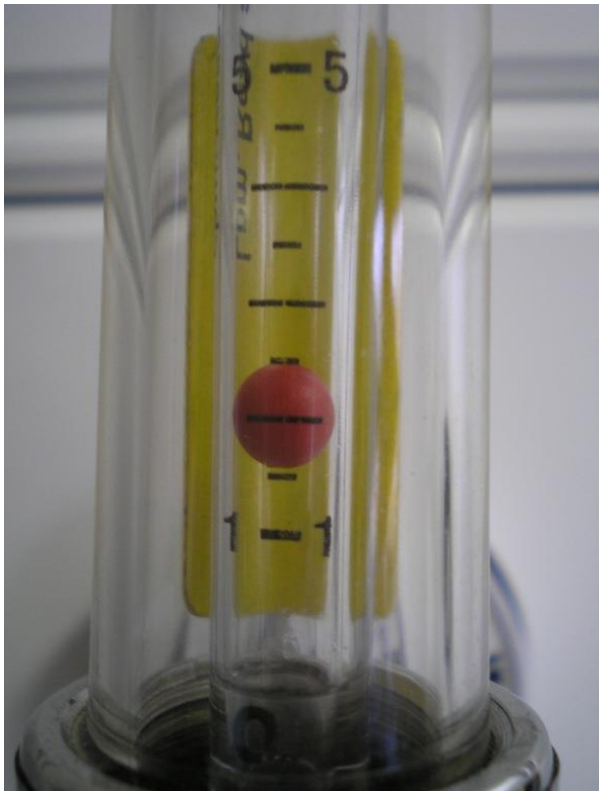
Keep with target sats 94-98%

(continue to treat as low risk hypercapnia)

SIMPLY FINALS

Oxygen Flow Meter





SIMPLY FINALS

Prescribe

DRUG	OXYGEN (Refer To Trust Oxygen Policy)	
Circle target oxygen saturation **88-92%** **94-98%** **Other___**	STOP DATE	
Starting device/flow rate 2-4 L/min, NRM **PRN / Continuous**		
	PHARM	
(Saturation is indicated in almost all cases except for palliative terminal care)		
SIGNATURE / PRINT NAME	DATE 06/03/19	

SIMPLY FINALS

Case number 2…

A 68yo man comes by ambulance to A&E. Wife called ambulance as concerned that husband very unwell and breathless.

Has known COPD (states similar to previous exacerbation)

What would be your management?

- ABCDE
- Ex: distressed, widespread polyphonic wheeze

BP 125/85 HR 120 RR 29 Sats 78%

SIMPLY FINALS

Oxygen Therapy

STEP 1: HOW IS THE PATIENT?

68yo COPD. SOB. Wheeze. RR 29 HR 120 Sats 78% OA.

Is the patient critically ill or 0_2 sats <85% ?

YES

Variable O_2 of 60-80%
ALWAYS at 15 L/min flow
Effective for short term treatment
Uncomfortable as high flow

High Flow/Non Re-breath Mask
15 L/min oxygen

Then do Arterial Blood Gas

HYPOXIA KILLS

ABG of our unwell case…

68yo, acute exacerbation of his known COPD

What does this ABG show?

pH	7.20	*(7.35 – 7.45)*
$PaCO_2$	10.9 KPa	*(4.7 – 6.0 kPa)*
$Pa0_2$	7.6 KPa	*(>10kPa)*
HCO_3	30 mmol/l	*(22-26 mmol/l)*
BE	3.0	*(+/-2.0 mmol/l)*
(on 15L/min)		

Type 2 respiratory failure
Acidosis- Respiratory
Compensating- Metabolic

SIMPLY FINALS

STEP 2: ASSESS OXYGENATION

ON AIR: PaO_2 should be >10 kPa

OR

ON OXYGEN: <10kPa less than the % inspired concentration

e.g. 15 L/min delivers approx. 50-60% O_2 so should have PaO2 of ~40

Respiratory Failure

- **Type 1** ONE Problem PaO_2 <10kPa
- **Type 2** TWO Problems PaO_2 <10kPa
  $PaCO_2$ >6.0kPa

SIMPLY FINALS

Case 3

70yo man walks into A&E with breathlessness and productive cough. She has known COPD and has had previous ITU admissions with *“problems with the gases in my blood”*

What would be your management?

- ABCDE
- Ex- talking to you, no signs of distress, widespread polyphonic wheeze

BP 145/90 HR 105 RR 20 Sats 87%

SIMPLY FINALS

Case 3: Oxygen Therapy

70yo COPD. Mild SOB/cough. Wheeze. RR20 HR105 Sats 87% OA

Is the patient critically ill or 0_2 sats <85% ?

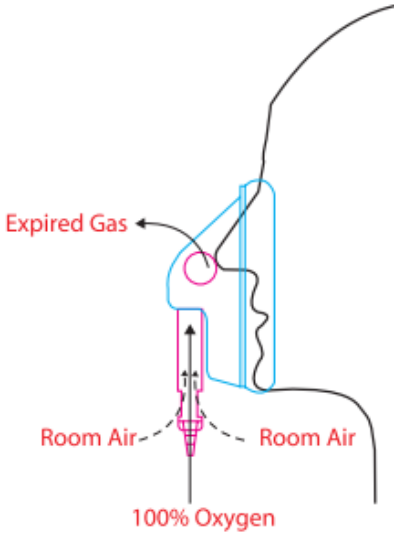
NO

Is patient at risk of hypercapnia?

	Target Sats	Starting Device
YES →	88-92%	Venturi 24%

… and do an Arterial Blood Gas

Venturi Mask
Deliver fixed oxygen
24-40%



Colour Coded Venturi Masks

Colour of Mask attachment	Oxygen (%)	Rate of Oxygen L/Min
Blue	24	2-4
White	28	4-6
Yellow	35	8-10
Red	40	10-12
Green	60	12-15

Prescribe

DRUG	**OXYGEN** (Refer To Trust Oxygen Policy)	
Circle target oxygen saturation **88-92%** **94-98%** **Other**___	STOP DATE	
Starting ~~device/flow~~ rate 24% Venturi ___ **PRN** **Continuous** 2L/min		
	PHARM	
(Saturation is indicated in almost all cases except for palliative terminal care)		
SIGNATURE / PRINT NAME	DATE 06/03/19	

SIMPLY FINALS

70yo COPD. Mild SOB/cough. Wheeze. RR20 HR105 Sats 87% OA

… Arterial blood gas

DO NOT STOP THEIR OXYGEN due to hypercapnia
HYPOXIA KILLS!

1

pH	7.42
pCO_2	7.1
pO_2	14.3
HCO_3	27

CO_2 elevated (>6.0kPa) and pH normal
Continue with target sats 88-92%

2

pH	7.38
pCO_2	5.9
pO_2	15.1
HCO_3	24

CO_2 normal and not acidotic
Change to target sats 94-98%
(Treat as low risk hypercapnia)

3

pH	7.21
pCO_2	8.0
pO_2	7.8
HCO_3	30

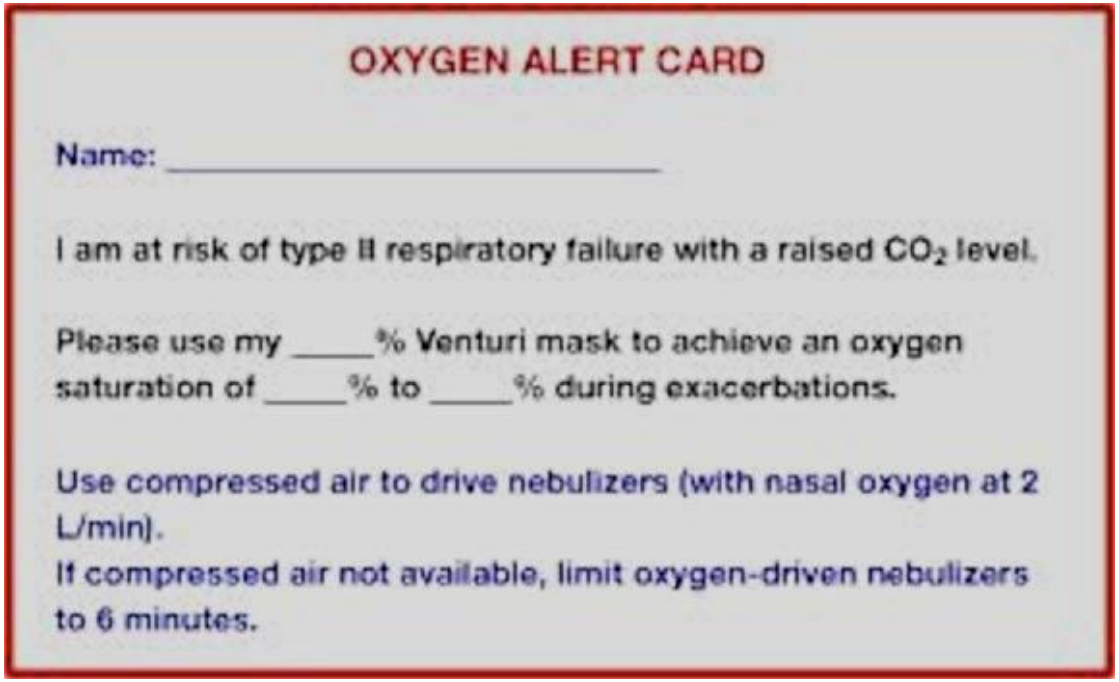
CO_2 elevated (>6.0kPa) and acidotic
Consider NIV … i.e. Get help!

Normal values
(7.35 – 7.45)
(4.7 – 6.0 kPa)
(>10kPa)
(22-26 mmol/l)
(+/-2.0 mmol/l)

Repeat ABG in 30-60mins

SIMPLY FINALS

Alert Card



OXYGEN ALERT CARD

Name: _____

I am at risk of type II respiratory failure with a raised CO_2 level.

Please use my _____% Venturi mask to achieve an oxygen saturation of _____% to _____% during exacerbations.

Use compressed air to drive nebulizers (with nasal oxygen at 2 L/min).
If compressed air not available, limit oxygen-driven nebulizers to 6 minutes.

Tracheostomy masks

Case 4

An 18-year-old insulin dependent diabetic is admitted to the emergency department. He has been vomiting for 48h and because he was unable to eat, he has taken no insulin.

Breathing spontaneously RR 35 /min SpO2 98% P 130 /min, BP 90/65 mmHg GCS 12 (E3, M5, V4)

What would you expect the ABG to reveal?

ABGs on 15l/min are:

- ↓ pH 7.01
- ↓ pCO2 2.9KPa
- ↔ pO2 36.6KPa
- ↓ HCO3 7mmol/l
- ↓ BE -21.9mmol/l
- Sats 100%

METABOLIC ACIDOSIS WITH PARTIAL RESPIRATORY COMPENSATION

pH	*7.35 – 7.45*
pO2	*>10 kPa on air*
PCO2	*4.7-6.0 kPa*
HCO3	*22 – 26 mmol/l*
BE	*+/- 2 mmol/l*

BM 30 mmol/l Urine ketones +++ in the urine

SIMPLY FINALS

STEP 3: pH
STEP 4: RESPIRATORY COMPONENT
STEP 5: METABOLIC COMPONENT

Normal pH = 7.35-7.45

$$pH \propto \frac{bicarb}{CO_2}$$

Take your time

Analyse pCO_2 and HCO_3 separately related to the pH

pCO_2 opposite way as pH *(high CO_2 = Acidosis)*

HCO_3 same way as pH *(high HCO_3 = Alkalosis)*

Beware of mixed and compensatory change

SIMPLY FINALS

Base Excess

Alternative to HCO3- but **SAME** information

Changes more acutely than bicarbonate

The normal base excess is +/- 2 mmol/l

- Base excess > +2 = metabolic alkalosis
- Base excess < -2 = metabolic acidosis

Case 5… Same hx as Case 4: DKA patient

18-year-old T1 DM unwell with DKA

Biochemistry on admission:

Na^+ 136 K^+ 4.8 Cl^- 101 urea 8.1

Reminder of the ABG:

pH 7.01 pCO2 2.9 pO2 36.6 HCO3 7 BE -21.9

What's the anion gap?

Does it fit with our diagnosis?

SIMPLY FINALS

Anion Gap

ONLY DO IN METABOLIC ACIDOSIS

- Calculates level of unmeasured anions

Anion Gap = ***MEASURED*** Positive ions **–** ***MEASURED*** Negative ions

= Na^+ **-** (Cl^- **+** $HCO3^-$)

<u>Normal = 6-12</u>

High anion gap

- Lactic / Keto- / Urate- acidosis

Normal anion gap

- Diarrhoea, Renal tubal acidosis

SIMPLY FINALS

Case 5 continued

Biochemistry on admission:

Na^+ 136 K^+ 4.8 **Cl^- 101** urea 8.1

Reminder of the ABG:

pH 7.01 pCO2 2.9 pO2 36.6 **HCO3 7** BE -21.9

What's the anion gap?

Anion Gap = Na – (Cl + HCO3)

Does it fit with our diagnosis?

Anion Gap = Na – (Cl + HCO3)

= 136 – (101 + 7)

= 28

HIGH ANION GAP

SIMPLY FINALS

Case 6

A 64yo lifelong smoker is seen in outpatients clinic with a 2 year history of worsening cough and exertional dyspnoea. Walks into clinic room.

ABG on room air:

- pH 7.37
- PaC02 6.9KPa
- Pa02 7.1KPa
- HCO3 33mmol/l
- Base excess + 8.9mmol/l
- Sats 89%

NORMAL VALUES

pH	*7.35 – 7.45*
paO2	*>10 kPa on air*
PaCo2	*4.7-6.0 kPa*
Bicarb	*22 – 26 mmol/l*
BE	*+/- 2 mmol/l*

1. TYPE 2 RESPIRATORY FAILURE
2. RESPIRATORY ACIDOSIS
3. METABOLIC COMPENSATION (CHRONIC)

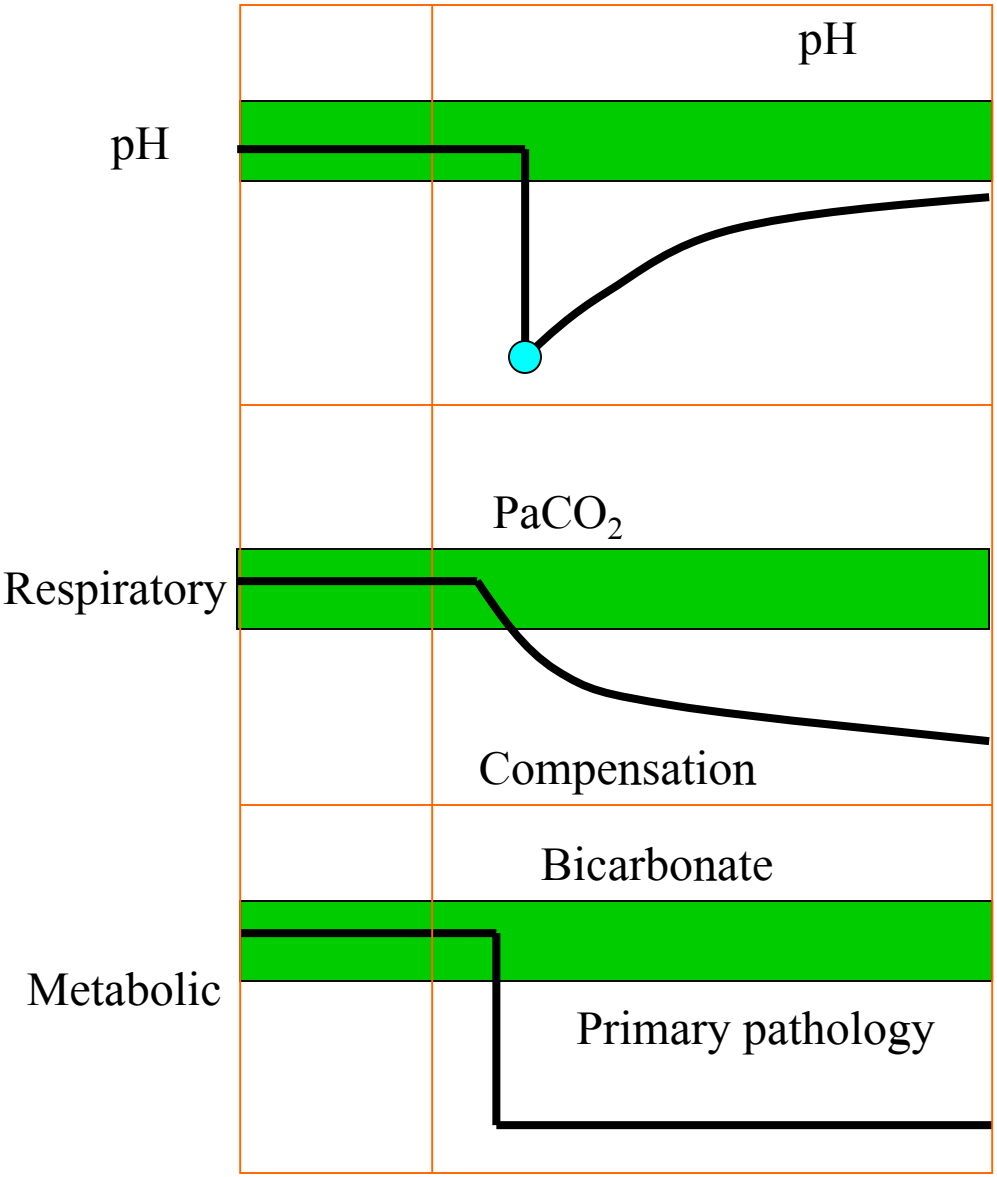
SIMPLY FINALS

Compensation

Response to correct initial problem

Will not "over" compensate

Respiratory = quick
Metabolic = slow



HYPER VENTILATION

METABOLIC ACIDOSIS

SIMPLY FINALS

Case 7 : Same hx as Case 6

A 64yo lifelong smoker is seen in outpatients clinic with a 2 year history of worsening cough and exertional dyspnoea. Walks into clinic room.

1. **Type 2 RF**
2. **Respiratory Acidosis with Metabolic Compensation (chronic)**

Would you expect this patient to have high / low / normal Aa gradient?

SIMPLY FINALS

A-a Gradient

- Evaluates the CAUSE of **hypoxaemia**
- Measure of the difference between **A**lveolar oxygenation and **a**rterial oxygenation

- **Normal Aa = extra-pulmonary problem, for example:**
  - Hypoventilation (Neuromuscular disorders / CNS disease / sedation)
  - Low inspired FiO2 (high altitude)

- **Raised Aa = intra-pulmonary problem, for example:**
  - R to L shunt (CCF / ARDS)
  - V/Q mismatch (PE / COPD / pneumonia / pneumothorax / asthma / atelectasis)
  - Alveolar hypoventilation (interstitial lung disease)

- Normal = 5-10

- *A-a gradient = PaO2 – FiO2 x (760-47) – (PaCO2/0.8)*

SIMPLY FINALS

Case 8

A 78yo man attends A&E with a 3 month history of weight loss and a sensation of 'early fullness' on eating. This is now associated with a four day history of worsening 'projectile' vomiting.

ABG on room air

- ↑ pH 7.62
- ↔ PaC02 4.8KPa
- ↔ Pa02 12.6KPa
- ↑ HC03 54.8mmol/l
- ↑ Base excess + 20.9mmol/l
- Sats 96%

NORMAL VALUES

pH	*7.35 – 7.45*
paO2	*>10 kPa on air*
PaCo2	*4.7-6.0 kPa*
Bicarb	*22 – 26 mmol/l*
BE	*+/- 2 mmol/l*

METABOLIC ALKALOSIS

WHAT COULD THE CAUSE BE?

SIMPLY FINALS

Case 8 (alternative history)

A 3 week old baby is brought to A&E with projectile vomiting and poor weight gain.

ABG on room air

- ↑ pH 7.62
- ↔ PaC02 4.8KPa
- ↔ Pa02 12.6KPa
- ↑ HC03 54.8mmol/l
- ↑ Base excess + 20.9mmol/l
- Sats 96%

WHAT IS THE MOST LIKELY CAUSE?

SIMPLY FINALS

Case 9

pH	7.21
pCO2	7.3 kPa
pO2	5.9 kPa
HCO3	14.6 mmol/L
BE	-7.9 mmol/L
Sats	76%

NORMAL VALUES

pH	*7.35 – 7.45*
paO2	*>10 kPa on air*
PaCo2	*4.7-6.0 kPa*
Bicarb	*22 – 26 mmol/l*
BE	*+/- 2 mmol/l*

Type 2 Respiratory Failure
MIXED ACIDOSIS
Both Respiratory and Metabolic component

Cause?

SIMPLY FINALS

Case 10: CPAP or BiPAP?

You are FY1 on August 2nd 2017

Nurse calls…

"68yo COPD patient becoming unwell and now very short of breath.

What would you like to do doctor, CPAP or BiPAP?"

What would you do??

SIMPLY FINALS

Case 10: Management

- ABCDE
- Give high flow O2

- See the notes / involve the patient
- Hx / Ex

- Basic investigations – ABG, ECG, Bloods, CXR

- Institute initial management

- Get Help!

Non-Invasive Ventilation

Avoids intubation.
Can easily apply & remove.

Contraindications

- Patient declines- is uncomfortable
- Patient very confused
- High aspiration risk
- Facial trauma

Should show ABG or clinical improvement within 2 hours

SIMPLY FINALS

Non-Invasive Ventilation

CPAP (Continuous)
Oxygenation

Type 1 RF
e.g. LVF/CCF
Chest wall trauma

Continuous pressures
"Breathing into wind tunnel"

BiPAP (Bi-Level)
Ventilation

Type 2 RF
e.g. COPD with Acidosis
Decompensated OSA

IPAP/EPAP pressures
"Senses inspiration"
Pushes O_2 in and CO_2 out

Long term Oxygen Therapy

- Indicated in Chronic hypoxaemia
  - pO2 consistently <7.3kPa or 7.3-8.0 with polycythhaemia / peripheral oedema / nocturnal hypoxaemia / pulm HTN
  - Also indicated in nocturnal hypoventilation / palliative care
- Background lung disease e.g. COPD/CF/bronchiectasis/CCF

- Need smoking cessation
- Use for >15hrs / day
- Increases survival

SIMPLY FINALS

ABG interpretation: 5 step approach

STEP 1	HOW IS THE PATIENT?
STEP 2	ASSESS OXYGENATION
STEP 3	pH- ACIDOSIS VS ALKALOSIS
STEP 4	RESPIRATORY COMPONENT
STEP 5	METABOLIC COMPONENT

Summary

- Make sure you look at the clinical scenario
- Be systematic and always use a system to analyse
- Hypoxia kills

SIMPLY FINALS

Respiratory

Acidosis (PaCO2>6.0kPa)

Hypoventilation

T2 RF-Impaired gas exchange

- COPD
- Heroin OD
- Chest wall defect
- Resp. muscle weakness
  e.g. G.Barre

Alkalosis (PaCO2<4.7kPa)

Hyperventilation due to

- Anxiety
- Hypoxemia
- Metabolic acidosis
- Neurologic Lesions
- Trauma
- Infection

Metabolic

Acidosis (HCO3 <22mmoll/l)

- DM Ketoacidosis
- Urate acidosis (Renal failure)
- Lactic Acidosis
  Decreased perfusion
  Severe hypoxemia/sepsis
- Drugs (e.g. Salicylates)

Anion gap

Alkalosis (HCO3 >26mmoll/l)

- XS loss (e.g. Vomiting)
- Ingestion of alkali