Oxygen
“I’m 67 years old and 3 months ago my doctor diagnosed asthma and started me on an inhaler. “

“It’s not working and in any case I think it has run out.”

“Would I be able to come up and get some oxygen as I’m breathless and that’s what my neighbour has........she said I could borrow it if you cant see me today!”
Oxygen - there is a problem

Published audits have shown

• Doctors and nurses have a poor understanding of how oxygen should be used

• Oxygen is often given without any prescription

• If there is a prescription, it is unusual for the patient to receive what is specified on the prescription
Try and answer the following questions

The percentage of Oxygen that comes out of the end of nasal cannulae at a flow of 2L per minute is...

A 24%
B 28%
C 35%
D 40%
E 60%
F 80%
G 100%

One answer only is correct!
The percentage of Oxygen that comes out of the end of nasal cannulae at a flow of 6L per minute is...

A 24%
B 28%
C 35%
D 40%
E 60%
F 80%
G 100%

One answer only is correct!
When starting someone on 24% oxygen the minimum flow required to deliver this FiO2 is........

A  1 L/min
B  1.5 L/min
C  2.0 L/min
D  2.5 L/min
E  3 L/min

One answer only is correct!
If the flow through a 24% venturi mask is increased from 2L/min to 4L/min the % oxygen delivered......

A  stays at 24%
B  decreases to 21%
C  increases to 28%
D  increases to 35%
E  increases to 40%
F  increases to 60%

One answer only is correct!
Management in the acute setting

Delivery Devices

Management of Respiratory Failure

Prescribing
Guideline for emergency oxygen use in adult patients

British Thoracic Society
Emergency Oxygen Guideline Group
Oxygenation

There are 3 things that affect the oxygen delivery to a patient

Supply: from the wall or the Oxygen concentrator(s)

NB: this may be considered as 100% oxygen!
(although it is more like 93% from a concentrator)
The same supply........?

No!- remember that flow from an oxygen concentrator may not equate to that from a cylinder or wall supply

That doesn’t matter- you just need to work out what you need to maintain your desired saturations- more on this later!
Oxygenation: factor 2

Delivery to the patient

i.e. the type of delivery device you choose to use
Delivery Devices: deliver oxygen to patients!

Nasal Cannulae

Recommended in the Guideline as suitable for most patients with both type I and II respiratory failure.

2-6L/min gives approx 24-50% FIO$_2$

FIO$_2$ depends on oxygen flow and patient’s minute volume and inspiratory flow and pattern of breathing.

Comfortable and easily tolerated

No re-breathing
Low cost product
Preferred by patients *(Vs simple mask)*
Simple face mask
(Medium concentration, variable performance)

- Used for patients with type I respiratory failure.
- Delivers variable $O_2$ concentration between 35% & 60%.
- Low cost product.
- Flow 5-10 L/min

Flow must be at least 5 L/min to avoid $CO_2$ build up and resistance to breathing
(although packaging may say 2-10L)
• Best for controlled oxygen therapy (you can set the exact %O2 you want)

• It is therefore the method of choice for managing type 2 respiratory failure

• Less convenient for eating and drinking

• Requires more supervision (a mask on the forehead doesn’t deliver much O2 to the lungs!)

• Flow also important- (see later)

• May require high flow circuit to guarantee desired percentage (again- see later!)

Venturi System
Non-rebreath system

- Reservoir of oxygen
- One way valve to prevent inspiration and expiration of room air
- Requires flow of 15L per minute
- Usually a temporary measure whilst further assessment occurs
Oxygenation- factor 3

Demands of the patient

Measure the respiratory rate
Record the O2 sats
Measure Blood Gases

How sick is your patient?

??? Measure patient inspiratory flow???

Ever wondered why oxygen masks have holes on the sides??????- find out later
The Inspiratory Flow

What is your current inspiratory flow as you sit reading this?

i.e. when you take a normal breath in, how fast do you do it?

Answer: very slow (25-30 L/min)
Inspiratory Flow

Now imagine you’re in the middle of an acute attack of asthma or COPD.

How fast do you think your inspiratory flow might be then?

Answer: much higher than normal!! (up to 80-90 L/min!)
Inspiratory Flow: so why is this important?
The Venturi system has a minimum flow recommended for delivery of the desired \% Oxygen

2 L for 24%
4 L for 28%
8 L for 35%

But remember these are only minimum flows
<table>
<thead>
<tr>
<th>Venturi Colour</th>
<th>Oxygen (%)</th>
<th>Low Flow setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24</td>
<td>2 L/min</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>4 L/min</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>6 L/min</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>8 L/min</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>8 L/min</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>12 L/min</td>
</tr>
</tbody>
</table>

So.......

For any given percent of oxygen there is a minimum flow required

But.....

This minimum flow is worked out on “normal” people rather than those having an exacerbation of COPD!

This SOMETIMES matters....

Because sometimes they are breathing in at “fast” inspiratory flows
Delivering Oxygen from supply........

There is some fancy mathematics you can use to calculate the speed at which the oxygen passes through the venturi system and is breathed in by a patient.

\[
\text{Flow velocity } v_1 = \sqrt{\frac{2(P_1 - P_2)}{\rho(\frac{A_1}{A_2})^2 - 1}}
\]

The Bernouille Effect!
Just as well you don’t need to learn this eh!!!

The size of the hole through which the oxygen from the supply passes is wider as the percentage you want to give increases.
All this means that you can work out how fast a particular percentage of oxygen is being delivered to a patient.
<table>
<thead>
<tr>
<th>Venturi Colour</th>
<th>Oxygen (%)</th>
<th>Low Flow setting</th>
</tr>
</thead>
<tbody>
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</tr>
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</tr>
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<td></td>
<td>35</td>
<td>8 L/min</td>
</tr>
<tr>
<td></td>
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<td>8 L/min</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>12 L/min</td>
</tr>
</tbody>
</table>

So for each of these percentages of oxygen at these flows we can work out the speed at which the oxygen arrives at the patient’s mouth.
<table>
<thead>
<tr>
<th>Venturi Colour</th>
<th>Oxygen (%)</th>
<th>Low Flow setting</th>
<th>Total gas delivered at low flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24</td>
<td>2 L/min</td>
<td>52 L/min</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>4 L/min</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>6 L/min</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>8 L/min</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>8 L/min</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>12 L/min</td>
<td>24</td>
</tr>
</tbody>
</table>

The term used is “Total Gas Delivered”

As the percentage increases the speed the gas arrives at the mouth decreases. ....

...because the hole for the particular venturi mask gets bigger as you increase amount of oxygen you want to give
Why bother about all this............?
Well remember your patient with an exacerbation of COPD?

They may have an inspiratory flow (i.e. be breathing in) at a rate of 80L/min

If you put them on 24% venturi at 2L/min....

<table>
<thead>
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<th>Oxygen (%)</th>
<th>Low Flow setting</th>
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</thead>
<tbody>
<tr>
<td>24</td>
<td>2 L/min</td>
<td>52 L/min</td>
<td></td>
</tr>
</tbody>
</table>

They will receive their oxygen at a rate of 52L/min
What will happen...........?

<table>
<thead>
<tr>
<th>Venturi Colour</th>
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<th>Total gas delivered at low flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24</td>
<td>2 L/min</td>
<td>52 L/min</td>
</tr>
</tbody>
</table>

The flow to the patient is 52L/min

They will suck in air (21% oxygen!) through the holes in the side of the mask!

The patient is breathing in at a flow of 80L/min

This will “dilute” the 24%!!
How do I prevent this?

Remember that you can increase the flow from the oxygen supply

<table>
<thead>
<tr>
<th>Venturi Colour</th>
<th>Oxygen (%)</th>
<th>Low Flow setting</th>
<th>Total gas delivered at low flow</th>
<th>High Flow setting</th>
<th>Total gas delivered at high flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>2 L/min</td>
<td>52 L/min</td>
<td>4 L/min</td>
<td>102 L/min</td>
<td></td>
</tr>
</tbody>
</table>

If you increase the flow from 2L-4L/min then you increase the speed to the patient to 102L/min
What will happen...........?

<table>
<thead>
<tr>
<th>Venturi Colour</th>
<th>Oxygen (%)</th>
<th>High Flow setting</th>
<th>Total gas delivered at high flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24</td>
<td>4 L/min</td>
<td>102 L/min</td>
</tr>
</tbody>
</table>

The flow to the patient is 102L/min

This overcomes the speed at which the patient is sucking air in and so no air comes through the mask holes to dilute the 24% oxygen

The patient is breathing in at a flow of 80L/min

Your patient gets 24% Oxygen!!!
The same principle applies no matter what percentage oxygen you are giving.
### Venturi Colour

<table>
<thead>
<tr>
<th>Venturi Colour</th>
<th>Oxygen (%)</th>
<th>Low Flow setting</th>
<th>Total gas delivered at low flow</th>
<th>High Flow setting</th>
<th>Total gas delivered at high flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>24</td>
<td>2 L/min</td>
<td>52 L/min</td>
<td>4 L/min</td>
<td>102 L/min</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>4 L/min</td>
<td>45</td>
<td>6 L/min</td>
<td>68 L/min</td>
</tr>
<tr>
<td>Orange</td>
<td>31</td>
<td>6 L/min</td>
<td>47</td>
<td>8 L/min</td>
<td>63 L/min</td>
</tr>
<tr>
<td>Yellow</td>
<td>35</td>
<td>8 L/min</td>
<td>45</td>
<td>10 L/min</td>
<td>56 L/min</td>
</tr>
<tr>
<td>Red</td>
<td>40</td>
<td>8 L/min</td>
<td>33</td>
<td>12 L/min</td>
<td>50 L/min</td>
</tr>
<tr>
<td>Green</td>
<td>60</td>
<td>12 L/min</td>
<td>24</td>
<td>20 L/min</td>
<td>40 L/min</td>
</tr>
</tbody>
</table>

If you increase the flow at a particular percentage you can speed up delivery of oxygen to the patient without affecting the percentage delivered.
But I can’t measure inspiratory flow!!!

True: but you can measure respiratory rate!

And you can ask a patient: “Do you think you are getting this oxygen?”
Are you still struggling with this??????

Checkout next slide
Assessing whether flow is important.....

1. Go and see your patient on 24% oxygen and measure their respiratory rate.

2. If it is >25 per minute and ask them, “Do you feel as though you are getting that oxygen?”

3. If they say, “I don’t know” or “I’m not sure” or “No I don’t think so....

4. Increase the flow to 4L/min and wait for 1 minute

5. If flow is a real issue you will notice that their respiratory rate slows quickly

6. And they will tell you they can “feel” the oxygen
So remember: when assessing oxygen

What is your supply?

What device is best for your patient?

What are their “demands”? (i.e. is their inspiratory flow fast?)

Always measure respiratory rate

Consider flow as well as FiO2

Aim for pO2 of 8kPa or 60mmHg
What is normal and what is dangerous?
Normal Range for Oxygen saturation

Normal range for healthy young adults is approximately 96-98%  
(Crapo AJRCCM, 1999;160:1525)

SLIGHT FALL WITH ADVANCING AGE
A study of 871 subjects showed that age > 60 was associated with minor SpO2 reduction of 0.4%  

An audit in Salford and Southend showed mean SpO2 of 96.7% with SD 1.9 in 320 stable hospital patients aged >70  
O’Driscoll R et al Thorax 2008; 63(suppl VII): A126
What is the minimum arterial oxygen level recommended in acute illness

**Target oxygen Saturation**

Critical care consensus guidelines  
*Minimum 90%*

Surviving sepsis campaign  
*Aim at 88-95%*

But these patients have intensive levels of nursing & monitoring

This guideline recommends a minimum of 94% for most patients – combines what is near normal and what is safe
Exposure to high concentrations of oxygen may be harmful

- Absorption Atelectasis even at FIO$_2$ 30-50%
- Intrapulmonary shunting
- Post-operative hypoxaemia (on return to room air)
- Risk to COPD patients
- Coronary vasoconstriction
- Increased Systemic Vascular Resistance
- Reduced Cardiac Index
- Possible reperfusion injury post MI
- Hyperoxaemia was associated with INCREASED mortality in survivors of cardiac arrest
- Oxygen therapy INCREASED mortality in non-hypoxic patients with mild-moderate stroke

This guideline recommends an upper limit of 98% for most patients. Combination of what is normal and safe

*Downs JB. Respiratory Care 2003; 48: 611-20*
*Kaneda T et al Jpn Circ J 2001; 213-8*
*Frobert O et al. Cardiovasc Ultrasound 2004; 2: 22*
*Haque WA et al. J Am Coll Cardiol 1996; 2: 353-7*
*Thomaon aj ET AL. BMJ 2002; 1406-7*
Some patients are at risk of CO2 retention and acidosis if given high dose oxygen

• **Chronic hypoxic lung disease**
  – *COPD*
  – *Severe Chronic Asthma*
  – *Bronchiectasis / CF*

• **Chest wall disease**
  – *Kyphoscoliosis*
  – *Thoracoplasty*

• **Neuromuscular disease**

• **Obesity hypoventilation**
What is a safe upper limit of oxygen target range in acute COPD?

- 47% of 982 patients with exacerbation of COPD were hypercapnic on arrival in hospital
- 20% had Respiratory Acidosis (pH < 7.35)
- 5% had pH < 7.25 (and were likely to need ICU care)
- Most hypercapnic patients with pO$_2$ > 10 kPa were acidotic (equivalent to oxygen saturation of above ~ 92%) i.e. They had been given too much oxygen

**RECOMMENDED UPPER LIMITS**
Keep PaO$_2$ below 10 kPa and keep SpO$_2$ ≤ 92% in acute COPD

*Plant et al Thorax 2000; 55:550*
Recommended target saturations

The target ranges are a consensus agreement by the guidelines group and the endorsing colleges and societies.

Rationale for the target saturations is combination of what is normal and what is safe.

Most patients 94 - 98%

Risk of hypercapnic respiratory failure 88 – 92%*

*Or patient specific saturation on 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 nebulisers (with nasal oxygen a 2 l/min).
If compressed air not available, limit oxygen-driven nebulisers to 6 minutes.
Where Is It?
What device and flow rate should you use in each situation?
Standard Oxygen Therapy 1960s-2008

Acute Patients

Stable Patients
Oxygen therapy 2008 onwards

Critical illness

Most patients

Selected COPD patients
Many patients need high-dose oxygen to normalize saturation

- Severe Pneumonia
- Severe LVF
- Major Trauma
- Sepsis and Shock
- Major atelectasis
- Pulmonary Embolism
- Lung Fibrosis
- Etc etc etc
Then you will prescribe oxygen correctly!!!

Remember that oxygen is a drug and therefore needs to be written up!!!

PRN vs REGULAR

MASK vs NASAL SPECS

FLOW L/MIN
# In-Patient Medication Administration Record

**Developed in collaboration with the All Wales Chief Pharmacists Committee**

**Drug Allergies & Sensitivities**

<table>
<thead>
<tr>
<th>Drug / Allergen</th>
<th>Description of Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This section must usually be completed prior to administration of any medicine. Refer to local policies for further guidance.

**Date of Admission**: [ ]
**Hospital**: [ ]
**Ward**: [ ]
**Consultant**: [ ]

**Details of Supplementary Charts**

- **Anticoagulant**
- **Patient Controlled Analgesia (PCA)**
- **Supplementary Infusion Chart**
- **Insulin**
- **Syringe Driver**
- **Other (please specify)**

## Venous Thromboembolism Risk Assessment

- **Does the patient need thromboprophylaxis?** [Y/N]
- **Signature**
- **Date**

(N.B. Reassess risk of bleeding and venous thromboembolism within 24 hours if clinical situation changes)

## Prescriptions for Once Only and Pre-Anaesthetic Medication

<table>
<thead>
<tr>
<th>Date</th>
<th>Medicine (Approved Name)</th>
<th>Dose</th>
<th>Route</th>
<th>Time to Be Given</th>
<th>Prescribers Signature</th>
<th>Pharmacy</th>
<th>Date</th>
<th>Time Given</th>
<th>Given By</th>
<th>Checked By</th>
</tr>
</thead>
</table>

## Medicines Management

**Medication History Obtained From:**

- Patient
- GP
- MDS
- Other

**Compliance Issues**:

<table>
<thead>
<tr>
<th>Initials</th>
<th>Date</th>
</tr>
</thead>
</table>

**Medicines Reconciled**

<table>
<thead>
<tr>
<th>Initials</th>
<th>Date</th>
</tr>
</thead>
</table>

**Community Pharmacy Details**

**Discharge Prescription Written**

<table>
<thead>
<tr>
<th>Initials</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDICINE (Approved Name)</td>
<td>SPECIAL INSTRUCTIONS</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>OXYGEN</td>
<td>Sign in box to indicate that specified target saturations have been checked and achieved. Adjust flow rate and/or delivery device as necessary. Refer to Local Policy for further details.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circle Saturation target</th>
<th>MORNING</th>
<th>MIDDAY</th>
<th>EVENING</th>
<th>BEDTIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-92%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>94-96%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Device?  Flow?  Changes?
Now

Did you get those questions right?
Try and answer the following questions

The percentage of Oxygen that comes out of the end of nasal cannulae at a flow of 2L per minute is...

A  24%
B  28%
C  35%
D  40%
E  60%
F  80%
G  100%

Remember- this is the oxygen supply!
The percentage of Oxygen that comes out of the end of nasal cannulae at a flow of 6L per minute is…

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>24%</td>
<td>[ ]</td>
</tr>
<tr>
<td>B</td>
<td>28%</td>
<td>[ ]</td>
</tr>
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<tr>
<td>D</td>
<td>40%</td>
<td>[ ]</td>
</tr>
<tr>
<td>E</td>
<td>60%</td>
<td>[ ]</td>
</tr>
<tr>
<td>F</td>
<td>80%</td>
<td>[ ]</td>
</tr>
<tr>
<td>G</td>
<td>100%</td>
<td>[✓]</td>
</tr>
</tbody>
</table>

It doesn’t matter what the flow is the percentage will stay the same from 100% supply!
When starting someone on 24% oxygen the minimum flow required to deliver this FiO2 is

A  1 L/min  
B  1.5 L/min  
C  2.0 L/min  
D  2.5 L/min  
E  3 L/min  

It’s written on the mask
If the flow through a 24% venturi mask is increased from 2L/min to 4L/min the % oxygen delivered....... 

A stays at 24%  
B decreases to 21%  
C increases to 28%  
D increases to 35%  
E increases to 40%  
F increases to 60%

One answer only is correct!

It is the flow to the patient that is increased NOT the percent oxygen
Basis of the BTS guideline
Prescribing by target oxygen saturation

Keep it normal/near-normal for all patients except pre-defined groups who are at risk from hypercapnic respiratory failure
What is normal and what is dangerous?
Normal Range for Oxygen saturation

Normal range for healthy young adults is approximately 96-98%  
(Crapo AJRCCM, 1999;160:1525)

SLIGHT FALL WITH ADVANCING AGE
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An audit in Salford and Southend showed mean SpO2 of 96.7% with SD 1.9 in 320 stable hospital patients aged >70  
O’Driscoll R et al Thorax 2008; 63(suppl VII): A126
Why is oxygen used?
Aims of emergency oxygen therapy

- To correct or prevent potentially harmful hypoxaemia

- To alleviate breathlessness (only if hypoxaemic)

*Oxygen has no effect on breathlessness if the oxygen saturation is normal*
Fallacies regarding Oxygen Therapy

“Routine administration of supplemental oxygen is useful, harmless and clinically indicated”

- Little increase in oxygen-carrying capacity
- Renders pulse oximetry worthless as a measure of ventilation
- May prevent early diagnosis & specific treatment of hypoventilation

This guideline only recommends supplemental oxygen when SpO2 is below the target range or in critical illness or CO Poisoning
Oxygen therapy is only one element of resuscitation of a critically ill patient

The oxygen carrying power of blood may be increased by

• Safeguarding the airway
• Enhancing circulating volume
• Correcting severe anaemia
• Enhancing cardiac output
• Avoiding/Reversing Respiratory Depressants
• Increasing Fraction of Inspired Oxygen ($FIO_2$)

• Establish the reason for Hypoxia and treat the underlying cause (e.g. Bronchospasm, LVF etc)

• Patient may need, CPAP or NIV or Invasive ventilation
Defining safe lower and upper limits of oxygen saturation
What is the minimum arterial oxygen level recommended in acute illness

**Target oxygen Saturation**

Critical care consensus guidelines  
*Minimum 90%*

Surviving sepsis campaign  
*Aim at 88-95%*

But these patients have intensive levels of nursing & monitoring

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This guideline recommends an upper limit of 98% for most patients.
Combination of what is normal and safe

Some patients are at risk of CO2 retention and acidosis if given high dose oxygen

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- 20% had Respiratory Acidosis (pH < 7.35)
- 5% had pH < 7.25 (and were likely to need ICU care)
- Most hypercapnic patients with pO$_2$ > 10 kPa were acidotic (equivalent to oxygen saturation of above ~ 92%) i.e. They had been given too much oxygen

**RECOMMENDED UPPER LIMITS**

Keep PaO$_2$ below 10 kPa and keep SpO$_2$ ≤ 92% in acute COPD

*Plant et al Thorax 2000; 55:550*
Recommended target saturations

The target ranges are a consensus agreement by the guidelines group and the endorsing colleges and societies.

Rationale for the target saturations is combination of what is normal and what is safe.

Most patients 94 - 98%

Risk of hypercapnic respiratory failure 88 – 92%*

* Or patient specific saturation on Alert Card
Safeguarding patients at risk of type 2 respiratory failure

- Lower target saturation range for these patients (88-92%)
- Education of patients and health care workers
- Use of controlled oxygen via Venturi masks
- Use of oxygen alert cards
- Issue of personal Venturi masks to high-risk patients
Name: _______________________________

I am at risk of type II respiratory failure with a raised CO₂ level.

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

Use compressed air to drive nebulisers (with nasal oxygen a 2 l/min).
If compressed air not available, limit oxygen-driven nebulisers to 6 minutes.
Oxygen Alert Cards and Venturi masks can avoid hypercapnic respiratory failure associated with high flow oxygen masks

- Oxygen alert card (and a Venturi mask) given to patients admitted with hypercapnic acidosis with a $\text{PO}_2 > 10\text{kPa}$.
- Patients instructed to show these to ambulance and A&E staff.

After introduction of alert cards
- Use of Venturi mask: 63% in Ambulance
  94% in A&E

Oxygen use in palliative care

• Most breathlessness in cancer patients is caused by specific issues such as airflow obstruction, infections or pleural effusions and the main issue is to treat the cause

• Oxygen has been shown to relieve dyspnoea in hypoxic cancer patients

• Morphine and Midazolam may also relieve breathlessness
Oxygen Flow Meter

The centre of the ball indicates the correct flow rate.

This diagram illustrates the correct setting of the flow meter to deliver a flow of 2 litres per minute.
What device and flow rate should you use in each situation?
Standard Oxygen Therapy 1960s-2008

Acute Patients

Stable Patients
Oxygen therapy 2008 onwards

Critical illness

Most patients

Selected COPD patients
Many patients need high-dose oxygen to normalize saturation

- Severe Pneumonia
- Severe LVF
- Major Trauma
- Sepsis and Shock
- Major atelectasis
- Pulmonary Embolism
- Lung Fibrosis
- Etc etc etc
BTS Recommendations

- Critical Illness Requiring High Levels of Oxygen Supplementation
- Serious Illness Requiring Moderate Levels of Oxygen if the Patient is Hypoxaemic
- COPD and Other Conditions Requiring Controlled or low-dose Oxygen Therapy
- Conditions for which patients should be monitored closely but oxygen therapy is not required unless the patient is hypoxaemic

Prescribe to target
Prior to Blood Gas Analysis

Is the patient critically ill*?

Yes – treat with reservoir or bag-valve mask

No

Is the patient at risk of hypercapnic respiratory failure?

Yes – aim for SpO₂ 88-92% or level on alert card pending ABG

No – is SpO₂ < 85%?

No – aim for SpO₂ 94-98%

Yes – aim for SpO₂ 88-92% or level on alert card pending ABG

Start with 24 or 28% Venturi mask

Start with nasal cannulae (2-6 l/min) or face mask (5-10 l/min)

*Critical illness is defined as cardiopulmonary arrest, shock, major trauma & head injury, near-drowning, anaphylaxis, major pulmonary haemorrhage and carbon monoxide poisoning.
Titrating Oxygen up and down.

This table below shows APPROXIMATE conversion values.

Venturi 24% (blue) 2-4l/min  OR  Nasal specs 1L

Venturi 28% (white) 4-6 l/min  OR  Nasal specs 2L

Venturi 35% (yellow) 8-10l/min  OR  Nasal spec 4L

Venturi 40% (red)10-12l/min  OR  Simple face mask 5-6L/min

Venturi 60% (green) 15l/min  OR  Simple face mask 7-10L/min

Reservoir mask at 15L oxygen flow

seek medical advice

If reservoir mask required

seek senior medical Input immediately
So..........................

If her diagnosis is COPD?

Target saturations? 88-92%

Device?
Type 1 Respiratory Failure is.....

A  Low pO2/Low pCO2
B  Normal pO2/Low pCO2
C  Low pH/Low pO2
D  Low pO2/normal pCO2
E  Low pO2 /High pCO2
F  Low pH/High pCO2

One answer only is correct!
Type 2 Respiratory Failure is.....

A  Low pO2/Low pCO2
B  Normal pO2/Low pCO2
C  Low pH/Low pO2
D  Low pO2/normal pCO2
E  Low pO2 /High pCO2
F  normal pH/High pCO2

One answer only is correct!
The most important measurement on a blood gas to determine whether a patient needs NIV is…….

A  pO2
B  pCO2
C  pH
D  HCO3
E  O2 sats
F  Base Excess

One answer only is correct!
Which of the following are most likely to be present in type 2 respiratory failure:

A  metabolic acidosis
B  respiratory alkalosis
C  hypokalaemic acidosis
D  respiratory alkalosis
E  respiratory acidosis
F  hypochloraemic alkalosis

One answer only is correct!
Respiratory Failure

A failure of gas exchange

**Type 1**
- Hypoxia
- Normal CO2

**Type 2**
- Hypoxia
- Raised CO2
Respiratory Failure: Why?

**Alveolar Hypoventilation**

Usually Type 2 Respiratory Failure

*LNB in COPD there is also loss of lung elasticity*
Respiratory Failure: Why?

**Diffusion Deficit**

Pulmonary oedema (usually type 1)

A pathological process
Affecting exchange at alveoli

Pulmonary Fibrosis (starts off as type 1)
Respiratory Failure: Why?

**Shunt**

when venous blood mixes with arterial blood either by bypassing the lungs completely (extra-pulmonary shunt) or by passing through the lungs without adequate oxygenation (intra-pulmonary shunt).

Extra-pulmonary usually involves congenital heart disease so you won’t see it in adults.

Intra-pulmonary - blood is transported through the lungs without taking part in gas exchange. The commonest causes are alveoli being filled (with pus, oedema, blood or tumour) and atelectasis.

Usually type 1
Respiratory Failure: Why?

**Ventilation-Perfusion Mismatch**

V/Q mismatch is the presence of a degree of shunt and a degree of dead space in the same lung.

It is a component of most causes of respiratory failure and is the commonest cause of hypoxaemia.

A patient with this condition is likely to have areas in the lungs that are better perfused than ventilated and areas that are better ventilated than perfused.

This occurs in normal lungs to some extent. The difference in V/Q mismatch is that the extent to which this occurs is significantly increased.

Types 1 and 2 can be associated with V/Q mismatch

Usually responds to Oxygen
## Conditions causing Respiratory Failure

<table>
<thead>
<tr>
<th>Common</th>
<th>Less Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Exacerbation of COPD</td>
<td>- Valvular heart disease</td>
</tr>
<tr>
<td>- LVF</td>
<td>- Interstitial Lung Disease (e.g. acute interstitial pneumonitis, drug induced pneumonitis, pulmonary fibrosis)</td>
</tr>
<tr>
<td>- Community Acquired Pneumonia/Hospital Acquired Pneumonia</td>
<td></td>
</tr>
<tr>
<td>- Acute asthma</td>
<td>- Extrinsic allergic alveolitis</td>
</tr>
<tr>
<td>- Drug overdose</td>
<td>- Pulmonary haemorrhage</td>
</tr>
<tr>
<td>- ARDS/ALI</td>
<td>- Organising Pneumonia</td>
</tr>
<tr>
<td>- Reduced GCS</td>
<td>- Pneumonia</td>
</tr>
<tr>
<td>- Atelectasis</td>
<td>- Fat emboli</td>
</tr>
<tr>
<td>- Abdominal splinting</td>
<td></td>
</tr>
<tr>
<td>- Pulmonary embolus</td>
<td></td>
</tr>
<tr>
<td>- Pneumothorax</td>
<td></td>
</tr>
</tbody>
</table>
74 yr old man with COPD

ABG on AIR

pH 7.37  **Normal:** but will need watching

pO2 5.6  **Low:** try and find out what it usually is

pCO2 6.7  **High:** but pH is OK so DON’T PANIC

HCO3 42  **High:** so he has been hypoxic for AGES

BE -2  **Normal:** but less than -2 means he’s sick so watch!

In addition to usual COPD treatment, this man needs CONTROLLED oxygen therapy
74 yr old man with COPD

Start 24% oxygen via venturi mask:

2L per minute to start with, but consider increasing flow (NOT the percentage) if respiratory rate >25

Recheck ABG in 1-2 hours

If you don’t know usual pO2 aim for 8kPa

Aim for O2 sats 88-92%
74 yr old man with COPD

Repeat gases an hour later

<table>
<thead>
<tr>
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</tr>
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<td>6.6</td>
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<td>pCO2</td>
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</tr>
<tr>
<td>6.7</td>
<td>8.7</td>
</tr>
<tr>
<td>HCO3</td>
<td>HCO3</td>
</tr>
<tr>
<td>42</td>
<td>32</td>
</tr>
<tr>
<td>BE</td>
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</tr>
<tr>
<td>-2</td>
<td>-3</td>
</tr>
</tbody>
</table>

**Normal:** but will need watching

**Still Low:** you’re aiming for 8

**High:** but pH is OK so DON’T PANIC

**High:** so he has been hypoxic for AGES

**Low:** less than -2 means he’s sick so watch!

In addition to usual COPD treatment, this man needs MORE OXYGEN
74 yr old man with COPD

28% via venturi:

Check the flow!!!

Recheck ABG in 1-2 hours

If you don’t know usual pO2 aim for 8kPa

Aim for O2 sats 88-92%
# 74 yr old man with COPD

Repeat gases an hour later

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<tr>
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<td>-4</td>
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- Low: this triggers NIV
- Still Low: you need 8kPa
- High: but irrelevant really
- Normal: but low for him!
- Low: equals sick!

In addition to usual COPD treatment, this man needs **NIV and Oxygen**
NIV

Non-Invasive Ventilation

Treatment of choice for Type 2 respiratory failure in patients with acute exacerbations of COPD

Also used in patients with neuromuscular disease affecting respiratory system

Can be used by patients in their own homes ("Home NIV!")
In patients with acute COPD..........

Use if: pH <7.35 and pO2 <8kPa after controlled oxygen therapy and other COPD treatments (Nebs/Pred etc)

Check:

No risk of vomiting
No recent (6 weeks) facial surgery
No recent (6 weeks) GI bleed
No recent (6 weeks) pneumothorax

Correct size of mask- face mask only
Machine connected to power source
Mask fits tightly around face

A confused or agitated patient may not tolerate NIV that well
Machine Settings and Terms

IPAP = Inspiratory Positive Airway Pressure

Helps the patient breathe in more “efficiently”

Start usually at 10cmH$_2$O

Usually need to increase to 18-25cmH$_2$O depending on response
Machine Settings and Terms

EPAP = Expiratory Positive Airway Pressure

Protects the small airways from closing when your patient breathes out (like PEEP on a ventilator in ICU)

Usually only need to set at 4cmH₂O and never adjust (unless the patient has a BMI >35)
Back to our patient..................
74 yr old man with COPD

Repeat gases an hour later

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Low: this triggers NIV
Still Low: you need 8kPa
High: but irrelevant really
Normal: but low for him!
Low: equals sick!

In addition to usual COPD treatment, this man needs **NIV and Oxygen**
74 year old man with COPD

Start NIV (10 IPAP / 4 EPAP) and increase IPAP as quickly as tolerated
- oxygen at flow of 4L/Min

Recheck ABG after 60 minutes

<table>
<thead>
<tr>
<th>Pre NIV</th>
<th>60 mins post NIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 7.33</td>
<td>pH 7.35</td>
</tr>
<tr>
<td>pO2 8.23</td>
<td>pO2 8.6</td>
</tr>
<tr>
<td>pCO2 8.50</td>
<td>pCO2 6.92</td>
</tr>
<tr>
<td>HCO3 28</td>
<td>HCO3 34</td>
</tr>
<tr>
<td>BE -4</td>
<td>BE -2</td>
</tr>
</tbody>
</table>

What next.........?
74 year old man with COPD

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DON’T STOP THE NIV just because you are winning

Continue at these settings and aim for sats of 88-92%

It is fine to give people a 10-15min break every couple of hours
So when should I stop the NIV?

Once you’ve started someone on NIV you should aim for at least 24 hours of treatment.

Stop if:

Patient looks better (clinical acumen!)
Patient can talk to you in complete sentences
O2 sats 88-92% on controlled oxygen therapy
Respiratory Rate <25 breaths per minute

If you repeat ABG:  
pH >7.35  
pO2 >8.0
(Don’t worry about the pCO2 if pH is normal!)
So how well did you do......?
Type 1 Respiratory Failure is.....

A  Low pO2/Low pCO2
B  Normal pO2/Low pCO2
C  Low pH/Low pO2
D  Low pO2/normal pCO2
E  Low pO2 /High pCO2
F  Low pH/High pCO2

One answer only is correct!
Type 1 Respiratory Failure is.....

A  Low pO2/Low pCO2
B  Normal pO2/Low pCO2
C  Low pH/Low pO2
D  Low pO2/normal pCO2
E  Low pO2 /High pCO2
F  Low pH/High pCO2

One answer only is correct!
Type 2 Respiratory Failure is.....

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
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<tbody>
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<td>A</td>
<td>Low pO2/Low pCO2</td>
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<tr>
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<tr>
<td>F</td>
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One answer only is correct!
Type 2 Respiratory Failure is.....

A  Low pO2/Low pCO2
B  Normal pO2/Low pCO2
C  Low pH/Low pO2
D  Low pO2/normal pCO2
E  Low pO2 /High pCO2
F  normal pH/High pCO2

One answer only is correct!
The most important measurement on a blood gas to determine whether a patient needs NIV is.......

A  pO2
B  pCO2
C  pH
D  HCO3
E  O2 sats
F  Base Excess

One answer only is correct!
The most important measurement on a blood gas to determine whether a patient needs NIV is........

A  pO2
B  pCO2
C  pH
D  HCO3
E  O2 sats
F  Base Excess

One answer only is correct!

Don’t get hung up on pCO2

Acidosis and Hypoxia kill you!
Which of the following are most likely to be present in type 2 respiratory failure:

- A  metabolic acidosis
- B  respiratory alkalosis
- C  hypokalaemic acidosis
- D  respiratory alkalosis
- E  respiratory acidosis
- F  hypochloraemic alkalosis

One answer only is correct!
Which of the following are most likely to be present in type 2 respiratory failure

A  metabolic acidosis
B  respiratory alkalosis
C  hypokalaemic acidosis
D  respiratory alkalosis
E  respiratory acidosis
F  hypochloraemic alkalosis

One answer only is correct!

So remember if your blood gases show a low HCO3 then you should think about metabolic not respiratory disease and NIV won’t work!
And what about when your patient wants to take it home with them............
Oxygen

Why do people need oxygen?

When should people be referred for oxygen assessment?

How do you give oxygen?

Special circumstances
Steps in the Development of Cor Pulmonale

Abnormal blood gases

Responsive respiratory centre
- Increased respiration
- Normalisation of blood gases
- Dyspnoea

Unresponsive respiratory centre
- Chronic hypoxia
- Pulmonary hypertension
- Cor pulmonale

Reproduced with permission from Education for Health
Disease progression

Abnormal blood gases (Respiratory failure)

- Renal hypoxia
- Pulmonary capillary constriction
  - Right heart strain
  - Right heart failure
- Peripheral oedema

Reproduced with permission from Education for Health
MRC Long-Term Oxygen Therapy (LTOT) Trial

Mortality in male patients

Mortality in female patients

NOTT and MRC trials
Assessment for LTOT

- Confident clinical diagnosis
  \[ \text{SaO}_2 \leq 92\% \]
- Optimum medical management (treatable causes of hypoxia eliminated)
- Clinical stability – 5 weeks post exacerbation
- Referral to specialist assessment service
BTS Guidelines for Home Oxygen Use in Adults

British Thoracic Society
BTS Home Oxygen Guideline Group
The assessment process

• 2 blood gases 3 weeks apart

• PaO2 < 7.3kPa OR < 8kPa if peripheral oedema, nocturnal hypoxaemia, pulmonary hypertension

• Proceed to full oxygen assessment: 30 mins on oxygen then blood gas

• Aim to get PaO2 > 8kPa without acidosis
LTOT – Follow-Up

After assessment:
– Home visit at 1 month – education, O$_2$ sats and appropriate use (safety)

Thereafter:
– Home visit 6 monthly – sats and education
– Blood Gas yearly
Ambulatory

- Fall in SaO\textsubscript{2} of 4\% to a value of <90\%
- On LTOT and mobile
- Exercise test and response to supplemental O\textsubscript{2}
- Ideally after pulmonary rehabilitation
- Review after 2 months to assess real usage: diary card, interview, O\textsubscript{2} usage
- This can now only be prescribed by the Specialist Service

### Grading

- Grade 1 – LTOT with low activity
- Grade 2 – Mobile LTOT
- Grade 3 – Patients with exercise desaturation but not on LTOT
Size Matters!
Short Burst

Lack of evidence to support use
– Palliative……only if hypoxic!
– whilst awaiting LTOT assessment??  NO
– GP for emergency use?   NO

NO COPD PATIENT SHOULD BE ON SHORT BURST O₂ FOR ANY LENGTH OF TIME WITHOUT FORMAL ASSESSMENT
Difficult questions?....

- What do I do nurse when............
  - I want a weekend away, a holiday, or have been admitted from home to a hospice or care home for a period of respite care
  - the patient has a second (holiday) home, where he stays on a regular basis or where a patient stays with family or friends each weekend
  - a patient is able to attend school or work
It’s Easy!

- Patient contacts the oxygen company themselves!
- Don’t need to cancel if specified dates are given
- Patient’s responsibility to check with holiday destination
- Need at least two weeks notice (more at peak times)
And Further Afield?

- Oxygen supplier will give advice
- Will be a charge usually
- May need a flight assessment
- In flight oxygen costs can vary
- http://www.blf.org.uk/
No Mobile Phones
Explosion at old people's home

"It was a horrific scene on arrival."

"The council has confirmed to us that no gas was used on the premises, but we know that the victim suffered from breathing problems and had some breathing equipment, including an oxygen cylinder in the flat."