

**Kent, Surrey and Sussex (KSS)
Academic Health Sciences Network (AHSN)**

**GUIDANCE ON PRACTICAL
ACUTE NON INVASIVE VENTILATION (NIV) SESSION
May 2016**

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BTS summary diagram for providing acute NIV

TRAINEE GUIDE

1. Who do I treat with NIV?

Discuss:

- *Definitions of type 1 and type 2 respiratory failure*
- *Compensated and uncompensated type 2 respiratory failure*
- *Target oxygen saturations for both conditions*
- *Differentiate between the need for continuous positive airways pressure (CPAP) or NIV*
- *Likely underlying causes for type 2 respiratory failure*
 - *COPD, OHS/OSA, chest wall disease, neuromuscular disease and heart failure*
- *Contraindications for use of NIV*
- *Issues of consent and patient capacity*

2. What is the escalation plan and where should the patient be managed?

Discuss:

- *Importance of the escalation plan being decided early*
- *Rationale for escalation and de-escalation of treatment*
- *Discuss suitable locations for patients with type 2 respiratory failure*

3. Where do I find the machines and what kit do I need?

Advise:

- *Where your machines are located in the hospital*
- *What other consumables are needed for the machine e.g. tubing, filters etc*
- *Discuss suitable locations for patients with type 2 respiratory failure*

4. How do I choose and fit a mask?

Discuss

- *Mask types available in the trust and advantages and limitations*
- *Local guidance for prevention of pressure areas*

Demonstrate:

- *How to size, fit, adjust and remove the mask*

5. How do I set up and look after the circuit?

Demonstrate:

- *How and where to attach the filter, tubing, exhalation port, mask*
- *How to entrain oxygen (if needed) and how to administer nebulisers*

Discuss

- *Importance of anti-asphyxiation valve in circuit*
- *How often filters and tubing need to be replaced and how to dispose of them*

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6. How do I set up the machine?

Discuss:

- *Initial settings: mode (CPAP or NIV), pressures, inspiratory time, rise time, back up rate*
- *Setting alarm parameters (especially apnoea and disconnect alarms)*
- *Reference to local trust guidelines*

Demonstrate:

- *Location and use of on/off switch, how to connect power supply and check battery*
- *How to establish the settings and alarms*

7. What monitoring will the patient need and how often? What should I record and where?

Advise:

- *Direct patient observations i.e. comfort, agitation, dehydration, mask fit, respiratory rate, chest wall movement, use of accessory muscles, abdominal distension, patient ventilator synchrony, pressure areas*
- *Indirect observations i.e. heart rate, blood pressure, oxygen saturations, temperature, fluid balance, arterial blood gases*
- *Machine observations i.e. pressures set and achieved, tidal volumes set and achieved, respiratory rate – spontaneous and timed, amount of leak*
- *Accurate record keeping – refer to local trust documentation*

8. How do I get started and troubleshoot?

Advise:

- *Who to call if advice is needed e.g. respiratory or critical care nurse, physiotherapist or respiratory specialist and how to access local trust guidelines*

Discuss:

- *How to increment pressures i.e. how quickly, by how much, 'IPAP' vs. 'EPAP'*
- *Common issues*
 - *Immediate: hypoxaemia, hypotension, leak, poor synchrony, agitation, non compliance*
 - *Subsequent: worsening or no improvement in blood gases*
 - *Ventilator alarms and what they mean*
 - *Procedure for reporting ventilator faults, defects and failure*
 - *Procedure for reporting adverse incidents and near misses*

9. When do I stop NIV? What do I do with the machine?

Discuss:

- *'Success' and weaning i.e. once patient has responded well*
- *'Failure' and escalation to intubation or de-escalation i.e. if patient is not improving*
- *Supportive or end of life care*
- *Returning the machine and procedure for cleaning and decontamination*

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TRAINER COMPETENCY DOCUMENT

1. Who do I treat with NIV?

<i>Discuss:</i>	Competent:	Trainee	Trainer
		Yes/No	Yes/No
• <i>Definitions of type 1 and type 2 respiratory failure</i>			
• <i>Compensated and uncompensated type 2 respiratory failure</i>			
• <i>Target oxygen saturations for both conditions</i>			
• <i>Differentiate between the need for CPAP or NIV</i>			
• <i>Likely underlying causes for type 2 respiratory failure</i> <ul style="list-style-type: none"> ○ <i>COPD, OHS/OSA, chest wall disease, neuromuscular disease and heart failure</i> 			
• <i>Contraindications for use of NIV</i>			
• <i>Issues of consent and patient capacity</i>			

2. What is the escalation plan?

<i>Discuss:</i>	Competent:	Trainee	Trainer
		Yes/No	Yes/No
• <i>Importance of the escalation plan being decided early</i>			
• <i>Rationale for escalation and de-escalation of treatment</i>			

3. Where do I find the machines, what kit do I need?

<i>Discuss:</i>	Competent:	Trainee	Trainer
		Yes/No	Yes/No
• <i>Where your machines are located in the hospital</i>			
• <i>What other consumables are needed for the machine e.g. tubing, filters etc</i>			
• <i>Discuss suitable locations for patients with type 2 respiratory failure</i>			

4. How do I choose and fit a mask?

<i>Discuss:</i>	Competent:	Trainee	Trainer
		Yes/No	Yes/No
• <i>Mask types available in the trust and advantages and limitations</i>			
• <i>Local guidance for prevention of pressure areas</i>			
<i>Demonstrate:</i>			
• <i>How to size, fit, adjust and remove the mask</i>			

5. How do I set up the circuit?

<i>Demonstrate:</i>	Competent:	Trainee	Trainer
		Yes/No	Yes/No
• <i>How and where to attach the filter, tubing, exhalation port, mask</i>			
• <i>How to entrain oxygen (if needed) and how to administer nebulisers</i>			
<i>Discuss</i>			
• <i>Importance of anti-asphyxiation valve in circuit</i>			
• <i>How often filters and tubing need to be replaced and how to dispose of them</i>			

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6. How do I set up the machine?

	Competent:	Trainee	Trainer
		Yes/No	Yes/No
<i>Discuss:</i>			
<ul style="list-style-type: none"> Initial settings: mode (CPAP or NIV), pressures, inspiratory time, rise time, back up rate 			
<ul style="list-style-type: none"> Alarms 			
<ul style="list-style-type: none"> Reference to local trust guidelines 			
<i>Demonstrate:</i>			
<ul style="list-style-type: none"> Location and use of on/off switch, how to connect to power supply and check battery 			
<ul style="list-style-type: none"> How to establish the settings and alarms 			

7. What monitoring will the patient need and how often? What should I record and where?

	Competent:	Trainee	Trainer
		Yes/No	Yes/No
<i>Advise:</i>			
<ul style="list-style-type: none"> Direct patient observations i.e. comfort, agitation, dehydration, mask fit, respiratory rate, chest wall movement, use of accessory muscles, abdominal distension, patient ventilator synchrony, pressure areas 			
<ul style="list-style-type: none"> Indirect patient observations i.e. heart rate, blood pressure, temperature, oxygen saturations, fluid balance, arterial blood gases 			
<ul style="list-style-type: none"> Machine observations i.e. pressures set and achieved, tidal volumes set and achieved, respiratory rate – spontaneous and timed, amount of leak 			
<ul style="list-style-type: none"> Accurate record keeping – refer to local trust documentation 			

8. How do I get started and troubleshoot?

	Competent:	Trainee	Trainer
		Yes/No	Yes/No
<i>Advise:</i>			
<ul style="list-style-type: none"> Who to call if advice is needed e.g. respiratory or critical care nurse, physiotherapist or respiratory specialist and how to access local trust guidelines 			
<i>Discuss:</i>			
<ul style="list-style-type: none"> How to increment pressures i.e. how quickly, by how much, IPAP vs. EPAP 			
<ul style="list-style-type: none"> Common issues <ul style="list-style-type: none"> Immediate: hypoxaemia, hypotension, leak, poor synchrony, agitation Subsequent: worsening or no improvement in blood gases 			
<ul style="list-style-type: none"> Ventilator alarms and what they mean 			
<ul style="list-style-type: none"> Procedure for reporting ventilator faults, defects and failure 			
<ul style="list-style-type: none"> Procedure for reporting adverse incidents and near misses 			

9. When do I stop NIV? What do I do with the machine?

	Competent:	Trainee	Trainer
		Yes/No	Yes/No
<i>Discuss:</i>			
<ul style="list-style-type: none"> 'Success' and weaning i.e. once the patient has responded well 			
<ul style="list-style-type: none"> 'Failure' and escalation to intubation or de-escalation i.e. if patient is not improving 			
<ul style="list-style-type: none"> Supportive or end of life care 			
<ul style="list-style-type: none"> Returning the machine and procedure for cleaning and decontamination 			

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Practical case – acute NIV sign off

Real patient or simulation session

Declaration of Competency

ASSESSOR:

I certify that this candidate is/is not competent in acute NIV set-up (please delete).

Name: _____ Signature: _____

Department: _____ Date: _____

CANDIDATE:

I am/am not competent in acute NIV set-up (please delete).

Name: _____ Signature: _____

Department: _____ Date: _____

If candidate is not yet competent complete the development plan.

Development plan

CANDIDATE:

My learning needs are:

How will I meet my learning needs:

Date to be achieved:

Name: _____ Signature: _____

Department: _____ Date: _____

ASSESSOR:

Name: _____ Signature: _____

Department: _____ Date: _____

Once the learning plan completed, undertake a further competency assessment.

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Case Study 1	
Name:	Simon Pegg
Age:	83
Weight:	76kg
Height:	1.86m
RELEVANT HISTORY	
History of presenting complaint:	Found collapsed at home by wife. Recent productive cough.
Past medical history:	Mild Dementia, hypertension, COPD – exercise tolerance 100 yards when well
Social history:	60 pack year smoking history, now stopped Patient functions independently at home but has memory issues.
Medications:	Aspirin, bendroflumethiazide, Fostair 200/12 BD, Ventolin Inhaler prn,
Clinical examination:	Drowsy, GCS 12/15. Febrile at 37.8 ^o c. Pulse 98 regular, BP 141/83, JVP not elevated, heart sounds normal, no peripheral oedema. Respiratory rate 30, oxygen saturations 89% on 35% oxygen. Hyperexpansion of the chest with some quiet wheeze.
ABG:	On 35% oxygen: pH 7.27 PCO ₂ 9.2 KPa PO ₂ 7.7 KPa HCO ₃ ⁻ 25.4 Mmol/L
QUESTION: <i>What does this ABG show and why?</i>	<i>Decompensated respiratory acidosis</i>
Medical Plan:	<ul style="list-style-type: none"> • Blood tests: FBC, U&E, CRP • CXR • Oxygen to maintain SpO₂ 88-92% • Medication: <ul style="list-style-type: none"> ○ Antibiotics (as per Trust policy), nebulisers, prednisolone • NIV
QUESTION: <i>What is your escalation plan?</i>	<i>Discuss how this decision might be made</i>
QUESTION: <i>What patient monitoring is required?</i>	<i>Direct: as per training document Indirect: heart rate, respiratory rate, SaO₂, (Continuous); BP, temperature, fluid balance (hourly), arterial blood gases at one hour (consider arterial line).</i>
QUESTION: <i>What NIV settings would you initially recommend? (mode, FiO₂, pressures etc)</i>	<ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 35% • IPAP 12cmH₂O, EPAP 4cmH₂O • Ti 0.8, Back up rate 16 • Rise time 1
QUESTION: <i>What TV's would you aim to achieve?</i>	<i>Aim tidal volume 600-650mls (8ml/kg)</i>
QUESTION: <i>How will you increment the pressures?</i>	<i>Increase IPAP by 2cmH₂O increments, over 30 minutes</i>
QUESTION: <i>What machine monitoring is required?</i>	<ul style="list-style-type: none"> • Pressures set and achieved • Tidal volumes achieved • Respiratory rate - spontaneous and timed • Amount of leak
QUESTION: <i>Where will the patient be managed?</i>	<i>A level 2 facility for example an acute respiratory unit or a high dependency unit</i>

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<i>UPDATE: Progress within first hour</i>	
<p>General findings:</p> <p>Patients Vital Signs:</p> <p>NIV settings:</p> <p>Arterial blood gas:</p>	<p>Patient is agitated. Nurses are having difficulty keeping the NIV mask.</p> <p>T 37.5, HR 126, BP 165/90, SpO₂ 88%, RR 36</p> <ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 35% • IPAP 18 cmH₂O, EPAP 4 cmH₂O • Ti 0.8, back up rate 16 • Rise time 1 • Tidal volumes: 400 - 425ml <p>pH 7.26 pCO₂ 9.5 KPa pO₂ 7.0 KPa HCO₃⁻ 26.1 Mmol/L</p>
<p>QUESTION:</p> <p><i>What do I do next?</i></p>	<ul style="list-style-type: none"> • <i>One to one patient care</i> • <i>Review mask to check fit and comfort</i> • <i>Increase IPAP to achieve TVs of 600-650mls</i> • <i>Ensure critical care team involved</i> • <i>Low dose sedation according to local protocols e.g. morphine</i>
<i>UPDATE: Progress within next 2 hours</i>	
<p>General findings:</p> <p>Patient's vital signs:</p> <p>NIV settings:</p>	<p>Less agitated, tolerating mask better</p> <p>T 37.0, HR 88, BP 142/72, SpO₂ 92%, RR 22</p> <ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 28% • IPAP 22 cmH₂O, EPAP 4 cmH₂O • Ti 0.8, back up rate 16 • Rise time 1 • Tidal volumes: 550 ml
<p>Repeat ABG taken after 2 hours on NIV:</p>	<p>pH 7.32 pCO₂ 8.2 KPa pO₂ 8.1 KPa HCO₃⁻ 28 Mmol/L</p>
<p>QUESTION:</p> <p>Do you want to change anything?</p>	<p><i>Tidal volumes still a little low so the IPAP could be increased</i></p>
<i>UPDATE: Progress within 4 hours</i>	
<p>General findings:</p> <p>NIV settings:</p> <p>Arterial blood gases:</p>	<p>Patient continues to be calm on the NIV, looking much more settled.</p> <ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 35% • IPAP 26 cmH₂O, EPAP 4 cmH₂O • Ti 0.8, back up rate 16 • Rise time 1 • Achieving tidal volumes 610mls <p>pH 7.35 pCO₂ 7.5 KPa pO₂ 8 KPa HCO₃⁻ 30 Mmol/L</p>
<p>QUESTION:</p> <p>What would you do now?</p>	<ul style="list-style-type: none"> • <i>Continue to manage patient agitation as needed</i> • <i>Continue on NIV until arterial blood gas acidosis completely resolved</i>

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Case Study 2	
Name:	Sandip Patel
Age:	78yrs
Weight:	80kg
Height:	1.60m
RELEVANT HISTORY:	
History of presenting complaint:	Shortness of breath, fever and cough for 3 days
Past medical history:	COPD, previous admission for Type 2 respiratory failure which required NIV, hypertension
Medications:	Relvar ellipta and Salbutamol
Clinical examination:	Thin gentleman, fever 37.8 ^o c. Pulse 100 bpm, BP 110/64, heart sounds normal, no oedema. Respiratory rate of 26, oxygen saturations of 92% on 40% oxygen, quiet chest, no crackles
ABG:	On 40% oxygen: pH 7.24 pCO ₂ 8.9 KPa pO ₂ 8.0 KPa HCO ₃ ⁻ 22.5 Mmol/L
QUESTION: What does this ABG show?	Decompensated respiratory acidosis
QUESTION: What else would you want to know to help determine his escalation status?	The patient's wishes. The limitations his COPD puts on his day to day living, particularly walking.
Medical plan:	<ul style="list-style-type: none"> • Target oxygen saturations 88-92% • Blood tests • Chest radiograph: hyperexpanded, no pneumonia • Nebulisers, steroids and antibiotics • Non-invasive ventilation on high dependency • Full escalation of care
UPDATE: Progress within 2 hours on NIV	
General observations:	Respiratory pattern 'very laboured'
Vital signs:	Temp 36.1, HR 116, BP 98/50, SpO2 88%, RR 34
NIV settings:	<ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 40% • IPAP 16 cmH₂O, EPAP of 4cmH₂O • Back up rate 14, Ti 1.0s • Rise time 3
ABG:	On 40% oxygen pH 7.25 pCO ₂ 9.0 KPa pO ₂ 9.4 KPa HCO ₃ ⁻ 24.2 Mmol/L
QUESTION: What worries you about the patient and their vital signs?	High respiratory rate and laboured breathing
QUESTION: What does this ABG show?	Ongoing respiratory acidosis

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QUESTION: What else might you want to know?	Direct patient observations Machine observations
QUESTION: Why might the patient not be improving?	Inadequate pressures Poor patient ventilator synchrony
UPDATE:	
Clinical observation: NIV observations:	Not all of the patient's breaths are triggering a ventilator breath, chest wall hardly moving, the patient is using his accessory muscles <i>Pressures set 16/4. Pressures achieved 16/4</i> Tidal volumes achieved: 210 mls Respiratory rate: spontaneous 34, machine 17 Leak 70L/min
QUESTION: What is your clinical impression?	Inadequate pressures generating low tidal volumes Patient not triggering machine
QUESTION: What should happen next?	<ul style="list-style-type: none"> • Check interface for adequate fit • Make breathing trigger more sensitive • Reset rise time to 1 (COPD patients have high drive and prefer a high rise time) • Gradually increase IPAP as required to achieve therapeutic volumes (8ml/kg)
UPDATE: Progress within a further 2 hours	
General observations: Vital signs: NIV settings: ABG:	Patient looks much more comfortable Temp 36.3, HR 90, BP 94/60, SpO2 92%, RR 20 Pressure support - Spontaneous/Timed mode On 28% oxygen IPAP 28 cmH ₂ O, EPAP of 4 cmH ₂ O Back up rate 14, Ti 1.0s Rise time 1 On 28% oxygen pH 7.38 pCO ₂ 7.0 KPa pO ₂ 8.2 KPa HCO ₃ ⁻ 28.1 Mmol/L
QUESTION: Do you want to make any further changes?	No, patient doing much better Might consider weaning with periods off NIV

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Case Study 3	
Name:	Cynthia Pyke
Age:	55
Weight:	60kg
Height:	1.58m
RELEVANT HISTORY	
History of presenting complaint:	Found collapsed at home by relatives, unwell, drowsy breathless. Recent cough. Background of increasing difficulty with eating and communicating.
Past medical history:	Learning difficulties, congenital kyphoscoliosis
Social history:	Lives with family, carers twice a day, mobilises with stick when well but has struggled with this recently.
Medications:	Nil
Clinical examination:	Slightly drowsy, GCS 14/15. Febrile at 38.5 ^o c. Marked kyphoscoliosis. Pulse 130 irregular, BP 100/58, JVP +3cm, heart sounds loud P2, swelling of the ankles. Respiratory rate 32, oxygen saturations 91%. Coarse breath sounds bilaterally with some basal crepitations.
ABG:	On 35% oxygen: pH 7.16 PCO ₂ 14.3 KPa PO ₂ 8.3 KPa HCO ₃ ⁻ 28.9 Mmol/L
ECG:	Fast atrial fibrillation, dominant R wave
Chest radiograph:	Marked chest wall deformity, increased shadowing bilaterally suggestive of pulmonary oedema
Bloods:	Raised WCC and CRP, renal function normal
QUESTION: What does the blood gas show?	<i>Severe respiratory acidosis with evidence of chronic renal compensation</i>
QUESTION: What is the cause of her respiratory failure?	<i>Chest wall disease and heart failure</i>
QUESTION: What would her escalation status be?	<i>Her deterioration in recent months maybe due to insidious respiratory failure from her chest wall disease leading to cardiac compromise. These are potentially reversible conditions and she would be a candidate for long-term domiciliary NIV. She has minimal co-morbidities. Being for full escalation of care would not be unreasonable, however a trial of NIV may be successful inspite of the severity of the acidosis.</i>
QUESTION: What would be your next steps?	<i>Treat for fluid overload and fast atrial fibrillation</i> <ul style="list-style-type: none"> • <i>Frusemide</i> • <i>Digoxin</i> • <i>Anticoagulate if no contra-indications</i> <i>Cover for infection</i> <i>Maintain SpO₂ 88-92%</i> <i>Commence non invasive ventilation</i>
QUESTION: Where would you manage her?	<i>A level 2 area e.g., acute respiratory care unit, high dependency</i>

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QUESTION: What NIV settings would you start with? (mode, FiO ₂ , pressures etc)	<ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 35% • IPAP 12cmH₂O, EPAP 4cmH₂O • Back up rate 16, Ti 1.2 • Rise time 3
QUESTION What TV's would you aim for?	<i>Aim tidal volume 500mls (8ml/kg)</i>
QUESTION: How would you increment the IPAP?	<i>Increase IPAP by 2cmH₂O increments, titrate up over 10 to 30 minutes</i>
QUESTION: Would you change the EPAP?	<i>She has pulmonary oedema, so an increase in EPAP may help oxygenation</i>
QUESTION: What patient monitoring is required?	<i>Direct: as per training document Indirect: heart rate, respiratory rate, SaO₂, (Continuous); BP (at start of NIV and 15 minute intervals until pressures stable), temperature, fluid balance (hourly), arterial blood gases at one hour (consider arterial line).</i>
QUESTION: What machine monitoring is required?	<ul style="list-style-type: none"> • Pressures set and achieved • Tidal volumes set and achieved • Respiratory rate - spontaneous and timed • Amount of leak
<i>UPDATE: Progress after two hours</i>	
General observations: Patients Vital Signs: NIV settings: Arterial blood gas:	<p>Patient is awake, looking comfortable on NIV. Achieving good chest wall movement.</p> <p>T 37.0, HR 90, BP 110/65, SpO₂ 92%, RR 20</p> <ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 28% O₂ • IPAP 24 cmH₂O, EPAP 8 cmH₂O • Back up rate 16, Ti 1.2 • Rise time 3 • Tidal volumes: 480ml <p>pH 7.34 pCO₂ 9.7KPa pO₂ 8.5 KPa HCO₃⁻ 33.1 Mmol/L</p>
QUESTION: Are you happy with the blood gas?	<i>Yes, her respiratory acidosis has almost resolved</i>
<i>UPDATE: Progress within 3 hours</i>	
General: Repeat ABG taken after 4 hours on NIV:	<p>Continues to do well</p> <p>pH 7.44 pCO₂ 7.3 KPa pO₂ 8.3 KPa HCO₃⁻ 33.8 Mmol/L</p>
QUESTION: What might you do next?	<i>Wean</i>
QUESTION: How would you approach weaning?	<i>Allow short breaks off the NIV initially. If tolerating well and gases remain stable, increase the length of the breaks e.g. aim for 2 hours of NIV in the morning, afternoon and evening. Continue NIV at night. Aim to gradually withdraw the daytime NIV completely.</i>
QUESTION: Should I withdraw the night-time NIV?	<i>In view of the pathophysiology of her respiratory failure (chest wall disease) she is likely to need nocturnal domiciliary NIV.</i>

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Case Study 4	
Name:	Terry Marchant
Age:	50
Weight:	180kg
Height:	1.72m
RELEVANT HISTORY	
History of presenting complaint:	Found 'asleep' at home in chair, having not been seen for several days. Neighbour unable to rouse him, looked 'blue'. GP recently started frusemide.
Past medical history:	Type 2 diabetes, hypertension, hypercholesterolaemia, anxiety/depression
Social history:	Lives alone, normally works in an office, not been at work for two weeks.
Medications:	Amlodipine, doxazocin, frusemide, linagliptin, metformin, ramipril, simvastatin.
Clinical examination:	Very drowsy, GCS 13/15. Febrile at 38.0 ^o c. Marked truncal obesity. Pulse 100 regular, BP 160/110, JVP +3cm, heart sounds loud P2, pitting oedema extending up to the sacral area. Respiratory rate 14, oxygen saturations 89% on 60% oxygen (oxygen saturations 65% when ambulance crew arrived). Chest quiet.
ABG:	pH 7.20 PCO ₂ 15 KPa PO ₂ 7.7 KPa HCO ₃ ⁻ 36.3 Mmol/L
Chest radiograph:	Hard to interpret due to body habitus, bibasal collapse
QUESTION: What does the blood gas show?	<i>Partially compensated type 2 respiratory failure</i>
QUESTION: What is the cause?	<i>Obesity and probable concurrent obstructive sleep apnoea</i>
QUESTION: What would his escalation status be?	<i>Full escalation. He is relatively young and all of his co-morbidities are obesity related. He will likely need treatment in the community for OHS/OSA and will need support for weight loss.</i>
QUESTION: What would be your next steps?	<ul style="list-style-type: none"> • <i>Aim SpO₂ 88-92%</i> • <i>Commence NIV</i> • <i>Catheterise</i> • <i>Intravenous frusemide</i> • <i>Antibiotics to cover for a chest infection</i>
QUESTION: Where would you manage him?	<i>A level 2 area e.g. high dependency, acute respiratory care unit</i>
QUESTION: <i>What NIV settings would you start with? (mode, FiO₂, pressures etc)</i>	<ul style="list-style-type: none"> • <i>Pressure support - Spontaneous/Timed mode</i> • <i>FiO₂ 60%</i> • <i>IPAP 12cmH₂O, EPAP 4cmH₂O</i> • <i>Back up rate 14, Ti 1.2</i> • <i>Rise time 3</i>
QUESTION: <i>What TV's would you aim for?</i>	<i>Aim tidal volume 600mls (8ml/kg, lean body weight)</i>
QUESTION: How would you increment the IPAP?	<i>Increase IPAP by 2cmH₂O increments, titrate up over 10 to 30 minutes</i>
QUESTION: What will determine how happy you are with the IPAP setting?	<i>Chest wall moving, respiratory rate falling, reaching tidal volumes</i>

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QUESTION: Would you increase the EPAP?	<i>Yes. He is obese, basal collapse on his chest film, likely OSA when sleeps.</i>
QUESTION: What patient monitoring is required?	<i>Direct: as per training document Indirect: heart rate, respiratory rate, SaO₂, (Continuous); BP (at start of NIV and 15 minute intervals until pressures stable), temperature, fluid balance (hourly), arterial blood gases at one hour (consider arterial line).</i>
QUESTION: What machine monitoring is required?	<ul style="list-style-type: none"> • <i>Pressures set and achieved</i> • <i>Tidal volumes achieved</i> • <i>Respiratory rate - spontaneous and timed</i> • <i>Amount of leak</i>
<i>UPDATE: Progress after two hours</i>	
General observations: Patients Vital Signs: NIV settings: NIV observations: Arterial blood gas:	<p>Patient still drowsy, ventilator going to back up rate. Chest wall movement limited.</p> <p>T 37.0, HR 90, BP 140/90, SpO₂ 92%, RR 24</p> <ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 40% • IPAP 24 cmH₂O, EPAP 8 cmH₂O • Back up rate 14, Ti 1.2 • Rise time 3 <ul style="list-style-type: none"> • <i>Pressures set 24/8. Pressures achieved 24/8</i> • <i>Tidal volumes achieved 450mls</i> • <i>Respiratory rate - spontaneous 0, timed 16</i> • <i>Amount of leak 60L/min</i> <p>pH 7.25 pCO₂ 13.1 KPa pO₂ 8.5 KPa HCO₃⁻ 38 Mmol/L</p>
QUESTION: Are you happy with the gas?	<i>No, still acidotic</i>
QUESTION: What NIV changes will you make?	<i>Increment IPAP, increase back up rate to 16</i>
QUESTION: What is the maximum IPAP you should deliver?	<i>IPAP 30 cmH₂O. Seek specialist respiratory advice.</i>
<i>UPDATE: Progress within next 4 hours</i>	
General: NIV settings: Repeat ABG taken after 4 hours on NIV:	<p>Waking up, starting to breath spontaneously</p> <ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 35% • IPAP 30 cmH₂O, EPAP 8 cmH₂O • Back up rate 16, Ti 1.2 • Rise time 3 <p>pH 7.32 pCO₂ 11.5 KPa pO₂ 8.3 KPa HCO₃⁻ 41 Mmol/L</p>
QUESTION: Are you happy with the blood gas?	<i>Much improved.</i>
QUESTION: What will you do now?	<i>Keep going with the same support until further specialist advice.</i>

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Case Study 5	
Name:	Betty Flower
Age:	85
Weight:	55 kg
Height:	1.68
RELEVANT HISTORY	
History of presenting complaint:	Increased shortness of breath, wheeze and cough over last few days. Found by carers confused and disorientated, reduced level of consciousness. Brought to A&E by ambulance.
History:	Known COPD on home O ₂ , (2L via concentrator). Known to the community respiratory team. Rheumatoid Arthritis. Reduced functional activity from both the arthritis and COPD (mobilises room to room, rarely gets out of the house).
Medications:	Arthrotec, Aspirin, Carbocysteine, Omeprazole, Phyllocontin, Prednisolone, Salbutamol nebulisers, Seretide 500
Clinical examination:	Frail, elderly lady with marked deformity of the back and hands secondary to rheumatoid. She is confused and drowsy. She is cool peripherally, has dry mucous membranes and a prolonged capillary refill time. Afebrile, respiratory rate of 32, oxygen saturations of 81% on 24% oxygen, pulse 110 bpm, BP 80/45, heart sounds normal, mild swelling of the ankles. Hyperexpansion of the chest, quiet to auscultation. Abdomen soft and non tender.
ABG on admission:	On 40% O ₂ pH 7.10 pCO ₂ 10.6 KPa pO ₂ 6.7 KPa HCO ₃ ⁻ 18.1 Mmol/L
QUESTION: What does this ABG show?	<i>Mixed respiratory and metabolic acidosis</i>
QUESTION: What might the cause of the metabolic acidosis be?	<i>If blood sugar normal, from the clinical picture, probably renal failure.</i>
QUESTION: What is your escalation plan?	<i>Her functional status is poor and so she is unlikely to do well if she is transferred to the intensive care unit. NIV as the ceiling of care would seem suitable.</i>
QUESTION: Who would you wish to discuss this with?	<i>Patient (if able), family members, senior medical team</i>
UPDATE:	
Medical Plan:	<ul style="list-style-type: none"> • Target oxygen saturations 88-92% • Commence NIV • Arrange urgent bloods, check a blood sugar, ECG and a portable chest x-ray • Catheterise, intravenous fluids, fluid balance • Nebulisers: salbutamol 2 hourly, Ipratropium 6 hourly • Load with intravenous hydrocortisone, increase regular prednisolone • Antibiotics
QUESTION: What are your concerns about NIV?	<i>Drowsy, hypotension</i>
QUESTION: What NIV settings will you use? (mode, FiO ₂ , pressures etc)	<ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 40% • IPAP 12cmH₂O, EPAP 4cmH₂O • Back up rate 16, Ti 1.0s • Rise time 1

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QUESTION: How quickly will you increment the IPAP?	<i>Ideally as quickly as possible, but according to tolerance and BP</i>
QUESTION: What TV's would you aim to achieve?	<i>Aim for 8ml/kg, i.e. around 450mls</i>
QUESTION: When will you repeat ABG?	<i>One hour</i>
QUESTION: What patient monitoring is required?	<i>Direct: as per training document Indirect: heart rate, respiratory rate, SaO₂, (continuous); BP (at start of NIV and 15 minute intervals until NIV pressures stable), temperature, fluid balance (hourly), arterial blood gases at one hour</i>
QUESTION: What machine monitoring is required?	<ul style="list-style-type: none"> • <i>Pressures set and achieved</i> • <i>Tidal volumes set and achieved</i> • <i>Respiratory rate - spontaneous and timed</i> • <i>Amount of leak</i>
UPDATE:	
General observations: Vital signs: NIV settings: ABG:	<p>Patient has become slightly agitated, pulling at the mask, saying she doesn't want it despite lots of reassurance. Not synchronising well. Unable to get the ventilator pressures up higher because of blood pressure issues.</p> <p>T 37.0°C, HR 110, BP 85/50, SpO₂ 90%, RR 30</p> <ul style="list-style-type: none"> • Pressure support - Spontaneous/Timed mode • FiO₂ 35% • IPAP 16 cmH₂O, EPAP 4 cmH₂O • Back up rate 16, Ti 0.8s • Rise time 1 <p>pH 7.13 pCO₂ 10.7 KPa pO₂ 7.7 KPa HCO₃⁻ 20.2 Mmol/L</p>
QUESTION: Has the resp. failure improved?	<i>No, mild improvement in the pH but the CO₂ is unchanged.</i>
QUESTION: What are your concerns?	<i>She is not tolerating the treatment well, no improvement in her pCO₂</i>
UPDATE: four hours later	
Developments: Vital signs: ABG:	<p>She continues to pull at the mask. The family feel that she is suffering.</p> <p>T 35.8°C, HR 116, BP 78/45, SpO₂ 90%, RR 34</p> <p>On 35% oxygen pH 7.12 pCO₂ 11 KPa pO₂ 6.7 KPa HCO₃⁻ 20 Mmol/L</p>
QUESTION: What would you do next?	<i>NIV seems futile, consider withdrawing therapy and discuss with family</i>
QUESTION: How would you approach withdrawing therapy and a palliative approach?	<i>Involve the palliative care team if possible. If the patient seems distressed, give her medication to make her feel calmer. Remove the mask and watch further for signs of distress. Remove monitoring and medical equipment as is felt appropriate in collaboration with the family. Continue to support her with medication for distress, agitation, breathlessness and excessive secretions. A syringe driver may be helpful.</i>

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Case study 6	
Name:	Agnes Brown
Age:	60yrs
Weight:	76kg
Height:	1.52
RELEVANT HISTORY	
History of presenting complaint:	Patient admitted by ambulance with history of acute onset of severe shortness of breath, associated with chest tightness and pain in the neck and jaw.
Past medical history:	2 x Coronary stents 6 months ago, hypertension, type 2 Diabetes Mellitus.
Social history:	Stopped smoking 6 months ago, 35 year pack history. Lives independently.
Medications:	Aspirin, bisoprolol, clopidogrel, metformin, ramipril, simvastatin, sitagliptin
Vital Signs:	T 36.1, HR 90, BP 98/50, SpO ₂ 92%, RR 38,
Clinical examination:	Looks unwell, sweaty, using accessory muscles of respiration. Low volume pulse, heart sounds quiet, mild ankle swelling, bilateral coarse crackles throughout chest.
ABG:	On 15 litres O ₂ via a non rebreath-mask: pH 7.39 pCO ₂ 4.6 KPa pO ₂ 13.2 KPa HCO ₃ ⁻ 22.7 Mmol/L
QUESTION: What does this ABG show?	<i>Type 1 respiratory failure, marked hypoxaemia</i>
QUESTION: How will you manage the hypoxaemia?	<i>Trial CPAP 5cmH₂O, titrate oxygen, aim O₂ saturations > 94%</i>
QUESTION: What's your escalation plan?	<i>Full escalation of care based on information given</i>
UPDATE:	
Further investigations, results, plan:	<ul style="list-style-type: none"> • FBC, U&E, troponin: mild renal dysfunction, initial troponin normal • ECG: anterior ST depression, CXR: pulmonary oedema • IV diuretics and IV morphine, ACS protocol
QUESTION: What other interventions would you recommend?	<i>Catheterisation to allow accurate fluid balance and for patient comfort Contact outreach team for support. Inform intensive care</i>
QUESTION: What monitoring is required?	<ul style="list-style-type: none"> • <i>Continuous oxygen saturations, pulse rate and ECG</i> • <i>Other vital signs and CPAP observations hourly</i> • <i>Watch for pressure areas from CPAP mask</i>
QUESTION: Where will you manage her?	<i>Level 2 area, e.g. medical high dependency unit</i>
UPDATE: After 2 hours	
Vital signs:	T 36.4 ^o c, HR 102, BP 103/62, SpO ₂ 97%, RR 24,
ABG:	On 60% oxygen pH 7.29 pCO ₂ 7.0 KPa pO ₂ 14.5 KPa HCO ₃ ⁻ 23.1 Mmol/L
QUESTION: What are you worried about and what will you do next?	<i>pCO₂ is rising and the patient has developed a respiratory acidosis, indicating that she is tiring. She is high risk for a respiratory arrest. Call intensive care and on call anaesthetist. Prepare for intubation.</i>

APPENDIX – BTS summary diagram for providing acute NIV

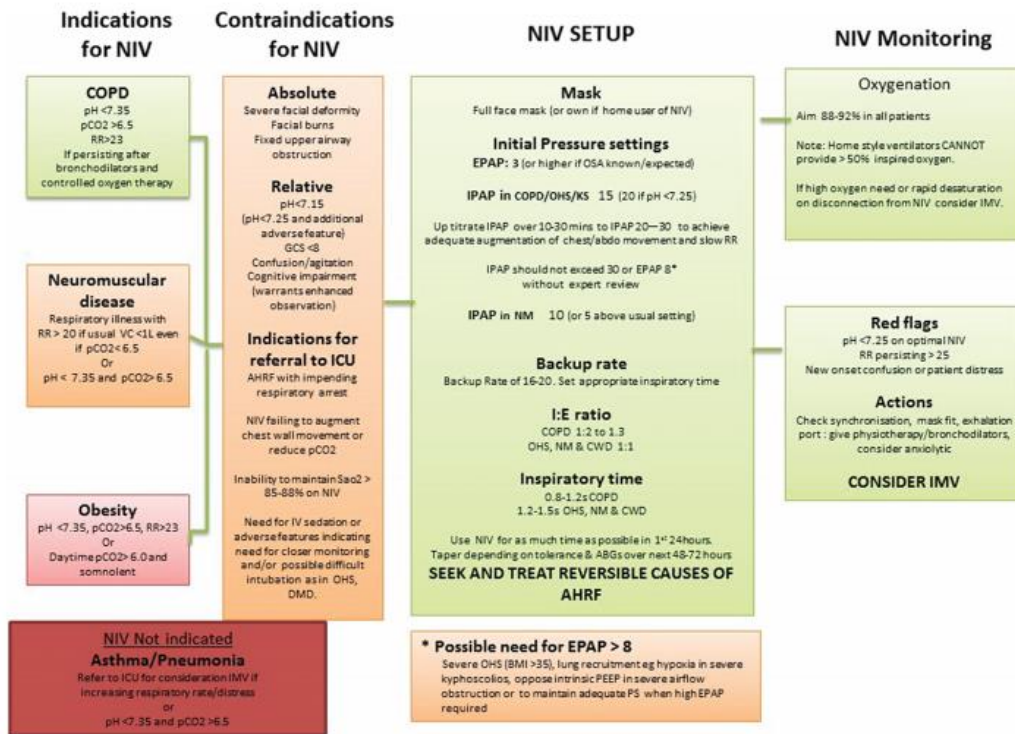


Figure 1 Summary for providing acute non-invasive ventilation.

Davidson AC, et al. *Thorax* 2016;71:ii1-ii35. doi:10.1136/thoraxjnl-2015-208209