Acute NIV on the ward: Case studies and trouble shooting.

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Non-Invasive Ventilation

Indications for NIV

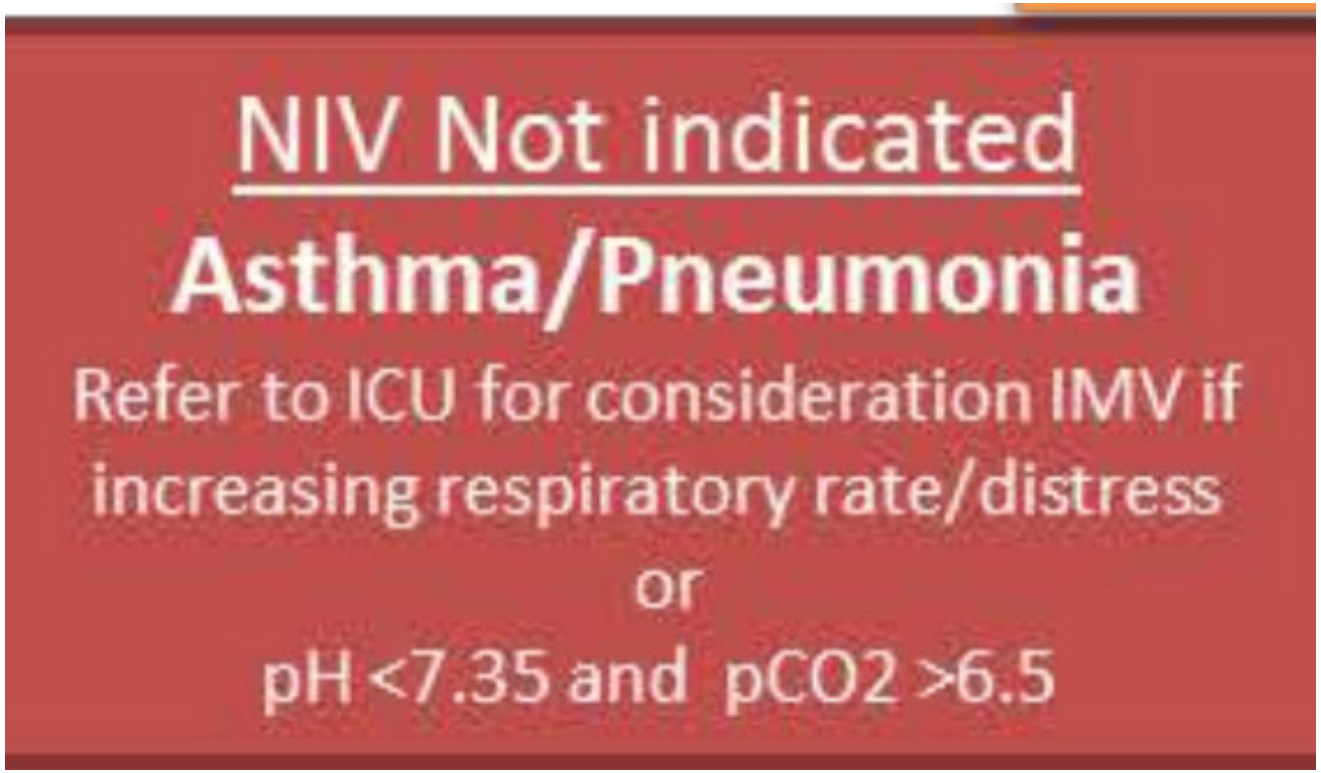
- Acute hypercapnic respiratory failure (respiratory acidaemia):
  - pH < 7.35
  - $PaCO_2$ > 6.5 kPa
- ECOPD
- NMD
  - Even if RR >20 and VC <1L and normal $PaCO_2$ with respiratory illness
- OHS +/- OSA
- Chest wall deformity

Contraindications to NIV

- Absolute
  - Facial deformity or burns
  - Fixed upper airway obstruction
  - Undrained pneumothorax

- Relative
  - pH <7.15 (or pH <7.25 with an additional adverse feature)
  - Factors affecting compliance of wearing the face mask
  - Unprotected airway / GCS <8
  - Copious respiratory secretions

What about asthma or pneumonia?



- Asthma
  - If hypercapnic = near fatal asthma
- Pneumonia
  - Perhaps…
  - If it's complicating another condition known to be responsive to NIV.

Criteria for considering Intubation

- Progressive/persistent respiratory acidaemia
- Unable to maintain SpO_2
- GCS <8
- Agitation limiting adherence
- Life-threatening arrhythmia/haemodynamic instability
- Cardiorespiratory arrest
- Contraindications to NIV

NIV Set-Up

- Equipment:
  - Ventilator, filter, circuit, mask
  - Oxygen supply (SpO_2 88-92%)
  - Nebuliser T-piece
- Settings:
  - Spontaneous/timed (S/T)
  - IPAP, EPAP, Back up rate, I-time
- Good practice:
  - NIV as much as possible in first 24 hours
  - Wean over 48 to 72 hours
  - Escalation and cardiopulmonary resuscitation decisions prior to starting acute ventilation

Monitoring on NIV

- SpO_2, RR, HR, BP
  - Hourly until stable and pH normal
- Temp
  - 4 hourly
- ABG's
  - 1 to 2 hours, and 4 to 6 hours
- Consultant review
  - Within 14 hours
- Nursing/AHP staffing
  - 1:2 in the acute phase (generally first 24-48hrs)

Case Study 1

- 71 female
- SOB, chest pain, wheeze and cough
- Arrived in ED at 21:08
- PMH COPD, rescue pack amoxicillin and prednisolone
- Ex-smoker, lives with sister, can get washed and dressed
- Triage P2 at 21:21
- Medical assessment 22:00
- Diagnosis IECOPD

Arterial blood gases

	23:31
pH	7.34
$PaCO_2$	8.1
PaO_2	8.0
HCO_3-	32.9
BE	7.1
SaO_2	88%
FiO_2	0.28

Arterial blood gases

	23:31	02:32
pH	7.34	7.29
$PaCO_2$	8.1	9.3
PaO_2	8.0	8.5
HCO_3-	32.9	33.2
BE	7.1	6.6
SaO_2	88%	91%
FiO_2	0.28	0.28

Arterial blood gases

	23:31	02:32	04:42
pH	7.34	7.29	7.23
$PaCO_2$	8.1	9.3	10.4
PaO_2	8.0	8.5	7.9
HCO_3-	32.9	33.2	32.7
BE	7.1	6.6	5.1
SaO_2	88%	91%	86%
FiO_2	0.28	0.28	0.28

NIV commenced at 04:45.

Trouble shooting

- Failure to recognise need for NIV
- Door to mask time 7 hours 37 minutes

This wall chart should **always** be used in conjunction with the full NIV guideline. Decompensated type 2 respiratory failure is a medical emergency. NIV dramatically improves survival. Delayed NIV initiation is associated with increased mortality. NIV 'buys time': DO NOT neglect standard medical therapy.

Acute Non-Invasive Ventilation Guideline Wall Chart

Time from arrival in A+E — 60 mins — 120 mins — >120m Door to Mask = breach

pH<7.25 & $PaCO_2$>6.5
OR pH<7.35, $PaCO_2$>6.5 & rapid deterioration

→ **Clinically exclude pneumothorax then initiate NIV immediately (contact physio)**

Arrange urgent CXR

Controlled oxygen target SpO_2 88-92%

Optimise medical therapy

Consider early critical care review

→

pH 7.25-7.34 & $PaCO_2$ >6.5

→ Arrange urgent CXR

Controlled Oxygen target SpO_2 88-92%

Optimise medical therapy

Contact physio

→ Repeat ABG at 60 mins:

If pH <7.35 and $PaCO_2$ >6.5

Initiate NIV even if improving trend

→ **All patients should be established on NIV by 120 mins.** (Breaches subject to root cause analysis)

Repeat ABG at 1 and 4 hours in all

SpO_2, RR, HR, BP temp hourly for at least 4 hours or until clinically stable and pH normal

Continue medical therapy

If failing to improve REASSESS: a) NIV synchrony, settings and circuit; b) clinical diagnosis and management. Consider critical care review.

Indications: **PRIOR TO Specialist Approval:**

pH <7.35 and $PaCO_2$ >6.5 due to:

- Exacerbation of COPD
- Obesity hypoventilation syndrome (OHS)
- Chest wall deformity
- Neuromuscular disease
- Left ventricular failure (CPAP first line)

Indications: **ONLY with Specialist Approval:**

pH <7.35 and $PaCO_2$ >6.5 due to other conditions including:

- CF / bronchiectasis
- Immunocompromised patient
- Chronic asthma (airways remodeling)

Compensated Hypercapnia (pH ≥7.35) with / due to:

- Progressive fatigue / drowsiness
- Neuromuscular disease
- Chest wall deformity

Absolute Contra-indications:

- Facial deformity preventing mask seal
- Facial Burns
- Fixed upper airway obstruction
- Undrained pneumothorax *(urgent chest drain)*

NB low GCS presumed due to hypercapnia: NIV if otherwise appropriate and improving within 2 hours. Consider critical care review.

Consider Intubation:

- Clinical deterioration despite optimisation of NIV, including:
  - Progressive respiratory acidaemia (pH <7.25 and falling, rising $PaCO_2$)
  - Persistent severe acidaemia (especially pH <7.15)
  - PaO_2 < 6 kPa despite FiO_2 100% on NIV
  - GCS < 8
  - Marked agitation limiting adherence
- Life-threatening arrhythmia or haemodynamic instability
- Cardio-respiratory arrest / Peri-arrest
- Contra-indication to NIV

This wall chart should **always** be used in conjunction with the full NIV guideline. Decompensated type 2 respiratory failure is a medical emergency. NIV dramatically improves survival. Delayed NIV initiation is associated with increased mortality. NIV 'buys time': DO NOT neglect standard medical therapy.

Acute Non-Invasive Ventilation Guideline Wall Chart

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Arrange urg

Contra

O

pH 7.25-7.34 & $PaCO_2$ >6.5

gent CXR

d Oxygen target 92%

medical ther

Physio

ABG at 60 min

aCO_2

All patients should be established on NIV by 120 mins. (Breaches subject to root cause analysis)

peat ABG at 1 and 4 hours in all

R, HR, BP temp hourly for at least 4

until clinically stable and pH normal

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prove REASSESS: a) NIV

tings and circuit; b) clinical

management. Consider critical

"They only a le bit a aemic"

Indications: **PRIOR TO Specialist Approval:**

pH <7.35 and $PaCO_2$ >6.5 due to:

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- GCS < 8
- Marked agitation limiting adherence

- Life-threatening arrhythmia or haemodynamic instability
- Cardio-respiratory arrest / Peri-arrest
- Contra-indication to NIV

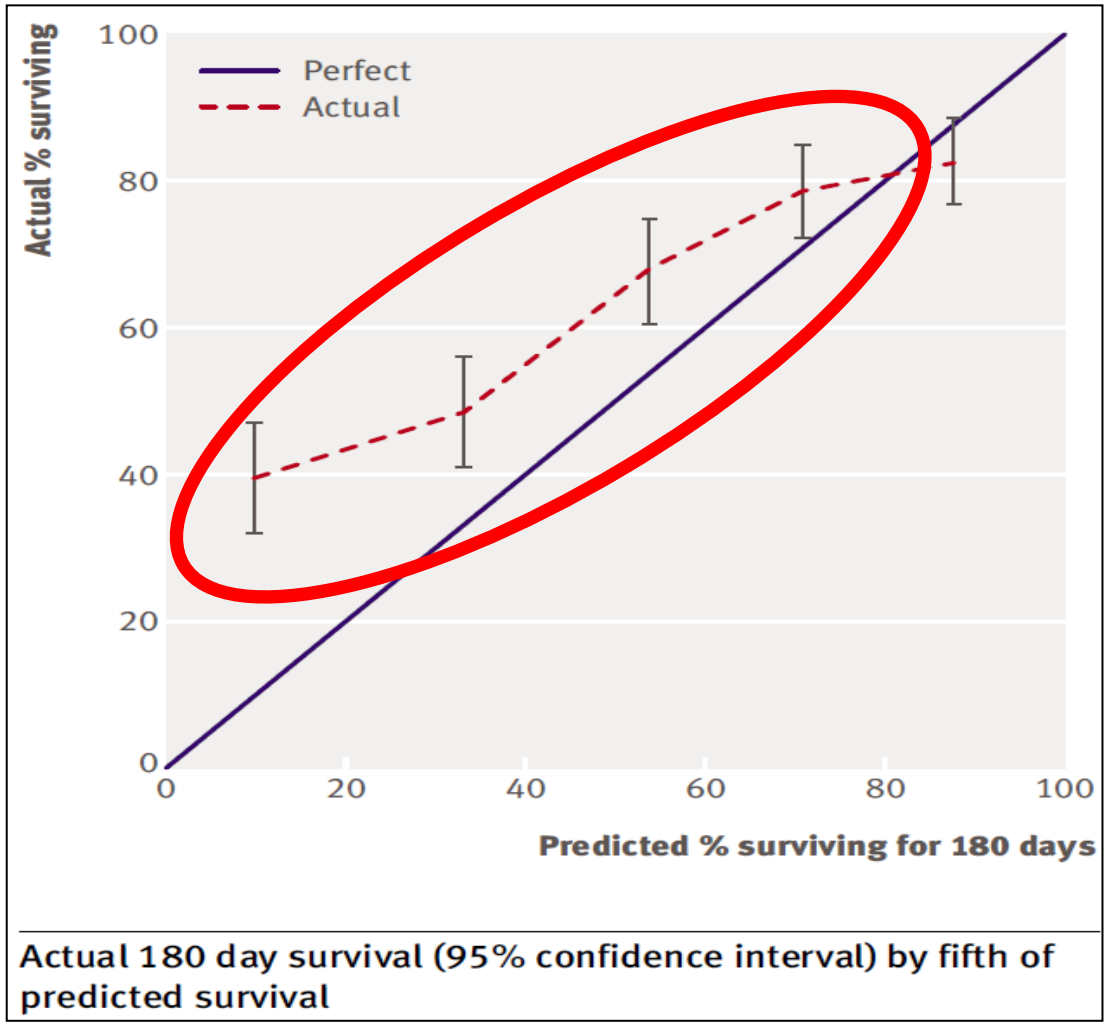
Problems with recognising the need for NIV

- Under recognition is probably the single biggest barrier to improvement

- Poor quality services
  - NCEPOD report - only 27.5% of patients have ‘good quality’ NIV

- Variation between institutions and clinicians
  - Institution attended the strongest predictor of whether NIV is received
  - Of the indices used by clinicians to decide NIV treatment only one associated with inpatient survival

Prognostic pessimism



Actual 180 day survival (95% confidence interval) by fifth of predicted survival

- Patients do better than we think they might
- Anything above the blue line is overly pessimistic on the clinician predicted outcome
- 4 fold difference in the lowest group!
  - Predicted survival 10%
  - Actual survival 40%

Clinical tools / prognostic scores

NIVO score	Points
Consolidation	1
GCS <15	1
AF	1
pH <7.25	1
Time to Acidaemia >12 hours	2
eMRCD 5a	2
eMRCD5b	3 /9

- Can help challenge pessimism and objectify outcomes.

Risk Group (NIVO scores)	N=	Inpatient mortality	
		N=	%
Low Risk 0-2	279	14	5.0%
Medium Risk 3-4	268	45	16.8%
High Risk 5-6	151	63	41.7%
Very High Risk 7-9	35	25	71.4%

NIVO illustration

Patient 1

- 82 seen in ED, drowsy.
- Pneumonia.
- COPD, Diabetes, CVA.
- Struggles round the block walking dog.
- pH 7.14, CO_2 9.1

Patient 2

- 58 seen on respiratory ward day 2.
- Uses mobility scooter out of house, otherwise independent.
- COPD, AF on Rivaroxaban.
- Nil else of note.
- pH 7.31, CO_2 9.1

NIVO Illustration

Patient 1

- 82 seen in ED, drowsy.
- Pneumonia.
- COPD, Diabetes, CVA.
- Struggles round the block walking dog.
- pH 7.14, CO_2 9.1
- NIVO SCORE = 3

Patient 2

- 58 seen on respiratory ward day 2.
- Uses mobility scooter out of house, otherwise independent.
- COPD, AF on Rivaroxaban.
- Nil else of note.
- pH 7.31, CO_2 9.1
- NIVO SCORE = 5

NIVO

Risk Group (NIVO scores)	N=	Inpatient mortality	
		N=	%
Low Risk 0-2	279	14	5.0%
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Patient

- 82 see … atory ward day 2.
- Pneum … oter out of house, … ndent.
- COPD, …
- Strugg … roxaban. … dog.
- pH 7.1 …
- NIVO SCORE = 3
- NIVO SCORE = 5

Case Study 2

- 71 Female
- SOB and productive cough
- PMH COPD
- Ex-smoker, lives with son, indep mobile
- Covid +ve, triple vaccinated, sinus rhythm, MRCD 4
- TEP Ward based ceiling of care
- Diagnosis ECOPD
- ABG pH 7.30, $PaCO_2$ 9.8, PaO_2 9.5, HCO3- 35.9, BE 9.5, SaO_2 95%

- Obs
  - BP 120/66, HR 68, Temp 35.8, RR 20, and SpO_2 92% on 28% oxygen
- NIV: IPAP 26, EPAP 5, Rate 18, I-time 1.1, FiO_2 25%
- 15 mins on NIV: BP 66/42
- IPAP ↓20, Dr: 500ml NaCl 0.9%

	Pre-NIV	1 hour of NIV
pH	7.30	7.29
$PaCO_2$	9.8	10.1
PaO_2	9.5	8.0
HCO_3-	35.9	35.6
BE	9.5	8.8
SaO_2	95%	90%
NIV / FiO_2	0.28	20/5 + 18 I-time 1.1 FiO_2 0.25 BP 105/71

	Pre-NIV	1 hour of NIV	Changes made
pH	7.30	7.29	IPAP ↑ 26
$PaCO_2$	9.8	10.1	Rate ↑ 20
PaO_2	9.5	8.0	I-time ↓ 1.0
HCO_3-	35.9	35.6	
BE	9.5	8.8	
SaO_2	95%	90%	
NIV / FiO_2	0.28	20/5 + 18 I-time 1.1 FiO_2 0.25 BP 105/71	

	Pre-NIV	1 hour of NIV	Changes made	1 hour later
pH	7.30	7.29	IPAP ↑ 26	7.33
$PaCO_2$	9.8	10.1	Rate ↑ 20	8.8
PaO_2	9.5	8.0	I-time ↓ 1.0	9.4
HCO_3-	35.9	35.6		35.2
BE	9.5	8.8		8.6
SaO_2	95%	90%		96%
NIV / FiO_2	0.28	20/5 + 18 I-time 1.1 FiO_2 0.25 BP 105/71		26/5 + 20 I-time 1.0 FiO_2 0.25

	Pre-NIV	1 hour of NIV	Changes made	1 hour later	Changes made
pH	7.30	7.29	IPAP ↑ 26	7.33	FiO_2 ↓ 0.22
$PaCO_2$	9.8	10.1	Rate ↑ 20	8.8	
PaO_2	9.5	8.0	I-time ↓ 1.0	9.4	
HCO_3-	35.9	35.6		35.2	
BE	9.5	8.8		8.6	
SaO_2	95%	90%		96%	
NIV / FiO_2	0.28	20/5 + 18 I-time 1.1 FiO_2 0.25 BP 105/71		26/5 + 20 I-time 1.0 FiO_2 0.25	

	4 hours later
pH	7.32
$PaCO_2$	9.0
PaO_2	8.1
HCO_3-	35.4
BE	8.9
SaO_2	91%
NIV / FiO_2	26/5 + 20 I-time 1.0 FiO_2 0.22

	4 hours later	Changes made
pH	7.32	IPAP ↑ 30
$PaCO_2$	9.0	
PaO_2	8.1	
HCO_3-	35.4	
BE	8.9	
SaO_2	91%	
NIV / FiO_2	26/5 + 20 I-time 1.0 FiO_2 0.22	

	4 hours later	Changes made	ABG 1 hour later
pH	7.32	IPAP ↑ 30	7.35
$PaCO_2$	9.0		8.3
PaO_2	8.1		8.4
HCO_3-	35.4		34.2
BE	8.9		8.6
SaO_2	91%		92%
NIV / FiO_2	26/5 + 20 I-time 1.0 FiO_2 0.22		30/5 + 20 I-time 1.0 FiO_2 0.22

	4 hours later	Changes made	ABG 1 hour later	Changes made
pH	7.32	IPAP ↑ 30	7.35	I-time ↓ 0.75
$PaCO_2$	9.0		8.3	I:E ratio 1:3
PaO_2	8.1		8.4	
HCO_3-	35.4		34.2	
BE	8.9		8.6	
SaO_2	91%		92%	
NIV / FiO_2	26/5 + 20 I-time 1.0 FiO_2 0.22		30/5 + 20 I-time 1.0 FiO_2 0.22	

	4 hours later	Changes made	ABG 1 hour later	Changes made	Repeat ABG
pH	7.32	IPAP ↑ 30	7.35	I-time ↓ 0.75	7.41
$PaCO_2$	9.0		8.3	I:E ratio 1:3	6.8
PaO_2	8.1		8.4		8.0
HCO_3-	35.4		34.2		32.3
BE	8.9		8.6		7.7
SaO_2	91%		92%		92%
NIV / FiO_2	26/5 + 20 I-time 1.0 FiO_2 0.22		30/5 + 20 I-time 1.0 FiO_2 0.22		30/5 + 20 I-time 0.75 FiO_2 0.22

Troubleshooting

COPD settings	
IPAP	Start 15 cmH_2O; aim 20-30 cmH_2O
EPAP	Start 3 cmH_2O
Back up rate	16 to 20
I-time	Set to achieve I:E ratio of 1:2

- Hypotension
- Increased $PaCO_2$
- Target SpO_2 88-92%

Case Study 3

- 76 year old female
- Admitted with dry cough, shortness of breath and confusion
- PMH: COPD, OSA, obesity
- SH: Ex-smoker, lives alone, mobile with stick, indep ADL’s
- Diagnosis: ECOPD, T2RF
- Treatment: Abx, pred, nebs, NIV

	Pre-NIV	NIV settings
pH	7.32	IPAP 26
$PaCO_2$	9.6	EPAP 8
PaO_2	11.7	Rate 18
HCO_3-	37.1	I-time 1.65
BE	11.0	FiO_2 0.28
SaO_2	98%	
NIV / FiO_2	0.35	

	Pre-NIV	NIV settings	1 hour of NIV
pH	7.32	IPAP 26	7.31
$PaCO_2$	9.6	EPAP 8	10.3
PaO_2	11.7	Rate 18	7.4
HCO_3-	37.1	I-time 1.65	38.8
BE	11.0	FiO_2 0.28	11.2
SaO_2	98%		90%
NIV / FiO_2	0.35		26/8 + 18 I-time 1.65 FiO_2 0.65

	Pre-NIV	NIV settings	1 hour of NIV	Changes made
pH	7.32	IPAP 26	7.31	IPAP ↑ 28
$PaCO_2$	9.6	EPAP 8	10.3	
PaO_2	11.7	Rate 18	7.4	
HCO_3-	37.1	I-time 1.65	38.8	
BE	11.0	FiO_2 0.28	11.2	
SaO_2	98%		90%	
NIV / FiO_2	0.35		26/8 + 18 I-time 1.65 FiO_2 0.65	

	Repeat ABG
pH	7.31
$PaCO_2$	10.2
PaO_2	7.6
HCO_3-	37.9
BE	12.6
SaO_2	91%
NIV	28/8 + 18 I-time 1.65 FiO_2 0.28

	Repeat ABG	Changes made
pH	7.31	IPAP ↑ 30
$PaCO_2$	10.2	
PaO_2	7.6	
HCO_3-	37.9	
BE	12.6	
SaO_2	91%	
NIV	28/8 + 18 I-time 1.65 FiO_2 0.28	

	Repeat ABG	Changes made	Repeat ABG
pH	7.31	IPAP ↑ 30	7.33
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NIV	28/8 + 18 I-time 1.65 FiO_2 0.28		30/8 + 18 I-time 1.65 FiO_2 0.28

	Repeat ABG	Changes made	Repeat ABG	Changes made
pH	7.31	IPAP ↑ 30	7.33	EPAP ↑ 10
$PaCO_2$	10.2		9.8	
PaO_2	7.6		7.3	
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pH	7.31	IPAP ↑ 30	7.33	EPAP ↑ 10	7.41
$PaCO_2$	10.2		9.8		7.5
PaO_2	7.6		7.3		7.8
HCO_3-	37.9		38.0		36.5
BE	12.6		12.4		12.0
SaO_2	91%		88%		92%
NIV	28/8 + 18 I-time 1.65 FiO_2 0.28		30/8 + 18 I-time 1.65 FiO_2 0.28		30/10 + 18 I-time 1.65 FiO_2 0.28

Troubleshooting

- Obesity / OSA
- Increased $PaCO_2$
- Prolonged desaturation on NIV

OHS Settings	
IPAP	Aim for 20-30 cmH_2O
EPAP	3 to 8cmH_2O
Back up rate	16 to 20
I-time	Set to achieve I:E ratio of 1:1

NMD settings

NMD settings	
IPAP	Start 10 cmH_2O (range 10-20 cmH_2O)
EPAP	3 cmH_2O
Back up rate	16 to 20
I-time	Set to achieve I:E ratio of 1:1

Troubleshooting Interfaces

Troubleshooting Interfaces

Troubleshooting Interfaces

Troubleshooting Interfaces

Troubleshooting Interfaces

Troubleshooting summary

- Recognise the need for NIV
- Treat underlying medical conditions
- Titrate settings for condition
- Monitor response to NIV
- Increased $PaCO_2$
- Target SpO_2 88-92%
- Range of interfaces
- Airway clearance
- Wean after 24 hours of NIV and ABG’s corrected

Troubleshooting summary

- Recognise the need for NIV
- Treat underlying medical conditions
- Titrate settings for condition
- Monitor response to NIV
- Increased $PaCO_2$
- Target SpO_2 88-92%
- Range of interfaces
- Airway clearance
- Wean after 24 hours of NIV and ABG’s corrected

Failure of ‘NI’ / ‘V'

- *Failure of ‘non-invasive’*
  - Agitation, low GCS, significant claustrophobia/panic
  - Transition to invasive ventilation early can be beneficial
    - (challenge prognostic pessimism)

- *Failure of ‘ventilation’ (despite good quality NIV)*
  - Ensure that efforts are made to optimise ventilation
    - Mask size/fit, leak, adequate pressures, I:E ratio, oxygenation, amount of time using ventilator, medical therapy correct
  - Failure of underlying lung despite best efforts to treat
    - Reality of treating severe lung disease

BMJ Open Respiratory Research

British Thoracic Society Quality Standards for acute non-invasive ventilation in adults

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ABSTRACT

Introduction The purpose of the quality standards document is to provide healthcare professionals, commissioners, service providers and patients with a guide to standards of care that should be met for the provision of acute non-invasive ventilation in adults together with measurable markers of good practice.

Methods Development of British Thoracic Society (BTS) Quality Standards follows the BTS process of quality standard production based on the National Institute

- act as markers of high-quality, cost-effective patient care across a pathway or clinical area, covering treatment or prevention
- are derived from the best available evidence.

NICE Quality Standards and the NICE Quality Standards Process Guide[2] were used as a model for the development of BTS Quality Standards.

The rationale for these quality standards

BMJ Open Respiratory Research

Specialist emergency care and COPD outcomes

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ABSTRACT

Introduction In exacerbation of chronic obstructive pulmonary disease (ECOPD) requiring hospitalisation greater access to respiratory specialists improves outcome, but is not consistently delivered. The UK National Confidential Enquiry into Patient Outcome and Death 2015 enquiry showed over 25% of patients receiving acute non-invasive ventilation (NIV) for ECOPD died in hospital. On 16 June 2015 the Northumbria Specialist Emergency Care Hospital (NSECH) opened, introducing 24/7 specialty consultant on-call, direct admission from the emergency department to specialty wards and 7-day consultant review. A Respiratory Support Unit opened for patients requiring NIV. Before NSECH the NIV service

Key messages

- Does 7-day specialist emergency care improve outcomes in chronic obstructive pulmonary disease exacerbations requiring hospitalisation?
- In both ventilated and non-ventilated patients, this model of care was associated with reduced mortality and length of stay; but a small increase in 90-day readmission rates.
- The potential implications of wider adoption of this model of care to both patients and healthcare providers are substantial.

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