

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 for Health and Care Excellence process manual for the development of quality standards.

Results 6 quality statements have been developed, each describing a standard of care for the provision of acute non-invasive ventilation in the UK, together with measurable markers of good practice.

Conclusion BTS Quality Standards for acute non-invasive ventilation in adults form a key part of the range of supporting materials that the Society produces to assist in the dissemination and implementation of guideline's recommendations.

INTRODUCTION

The British Thoracic Society (BTS) has been at the forefront of the production of guidelines for best clinical practice in respiratory medicine since the Society was established over 30 years ago. The Society was awarded National Institute for Health and Clinical Excellence (NICE) Accreditation for its guideline production process in November 2011, and the Society's Guideline Production Manual¹ setting out the detailed methodology and policy to produce guidelines is reviewed annually by the BTS Standards of Care Committee (SOCC).

A statement on quality standards based on each BTS Guideline is a key part of the range of supporting materials that the Society produces to assist in the dissemination and implementation of a Guideline's recommendations.

A quality standard is a set of specific, concise statements that:

- ▶ 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 Guide² were used as a model for the development of BTS Quality Standards.

The rationale for these quality standards is drawn from evidence and recommendations summarised in the BTS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure³ and is informed by the 2017 National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report on non-invasive ventilation (NIV), 'Inspiring Change'.⁴

The purpose of the Quality Standards document is to provide commissioners, healthcare professionals, planners and patients with a guide to standards of care that should be met for provision of acute NIV in the UK, together with measurable markers of good practice.

BTS Quality Standards are intended for:

- ▶ **Service providers:** to be able to quickly and easily examine the clinical performance of their organisation and assess the standards of care they provide;
- ▶ **Health care professionals:** to allow decisions to be made about care based on the latest evidence and best practice;
- ▶ **Commissioners:** so that they can be confident that the services they are purchasing are high quality and cost effective;
- ▶ **People who receive acute NIV:** to enable understanding of what services they should expect from their healthcare provider.

METHOD OF WORKING

A Quality Standards Working Group was convened in February 2017 and met in May 2017, with the following membership given in table 1.



For numbered affiliations see end of article.

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Table 1 BTS Quality Standards Working Group members

Name	Location/organisation
Dr Mike Davies, Chair	Consultant Respiratory Physician Cambridge
Dr Martin Allen	Consultant Respiratory Physician, Stoke Representing Royal College of Physicians, London
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Dr Stephen Bourke	Consultant Respiratory Physician Northumbria
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Members of the Quality Standards Group submitted Declaration of Interest forms in line with the BTS Policy, and copies of forms are available on request from BTS Head Office.

The draft document was considered in detail by the BTS Standards of Care Committee and the BTS Quality Improvement Committee initially in June 2017.

The document was made available on the BTS website for public consultation for the period from 1 August to 13 September 2017.

Following further revision, the document was submitted for approval to the BTS Standards of Care Committee in December 2017.

The Quality Standards document will be reviewed in 2023 or following the publication of a revised Guideline, whichever is the sooner.

Each Quality Standard includes the following:

- ▶ **A Quality Statement**, which describes a key marker of high-quality, cost-effective care for this condition.
- ▶ **Quality Measures**, which aim to improve the structure, process and outcomes of healthcare.

The quality measures are not intended to be new sets of targets or mandatory indicators for performance

management that need to be collected. The quality measures are specified in the form of a numerator and a denominator, which define a proportion or ratio (numerator/denominator). It is assumed that the numerator is a subset of the denominator population. The suggested numerator and denominator are provided to allow healthcare professionals and service providers to examine their clinical performance in relation to each quality standard. It is recognised that no national quality indicators will be available for this condition, and institutions will need to agree locally what information is required for the denominator to be used in each case, and what the expected level of achievement should be, given local circumstances. A brief description about the quality standard in relation to each audience is given.

The main source references for these quality standards are:

BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016).³

National Confidential Enquiry into Patient Outcome and Death. Inspiring Change. London: NCEPOD; 2017.⁴

There is no specific order of priority associated with the list of quality statements.

LIST OF QUALITY STATEMENTS

- 1: Acute non-invasive ventilation (NIV) should be offered to all patients who meet evidence-based criteria. Hospitals must ensure there is adequate capacity to provide NIV to all eligible patients.
- 2: All staff who prescribe, initiate or make changes to acute NIV treatment should have evidence of training and maintenance of competencies appropriate for their role.
- 3: Acute NIV should only be carried out in specified clinical areas designated for the delivery of acute NIV.
- 4: Patients who meet evidence-based criteria for acute NIV should start NIV within 60 min of the blood gas result associated with the clinical decision to provide NIV and within 120 min of hospital arrival for patients who present acutely.
- 5: All patients should have a documented escalation plan before starting treatment with acute NIV. Clinical progress should be reviewed by a healthcare professional with appropriate training and competence within 4 hours and by a consultant with training and competence in acute NIV within 14 hours of starting acute NIV.
- 6: All patients treated with acute NIV should have blood gas analysis performed within 2 hours of starting acute NIV; failure of these blood gas measurements to improve should trigger specialist healthcare professional review within 30 min.

Quality statement 1	Acute non-invasive ventilation (NIV) should be offered to all patients who meet evidence-based criteria. Hospitals must ensure there is adequate capacity to provide NIV to all eligible patients.
Rationale:	<p>Acute NIV reduces mortality by 50% and shortens hospital length of stay when used to treat COPD exacerbations complicated by acute hypercapnic respiratory failure (AHRF).^{5,6} Non-randomised studies also show that NIV benefits patients with AHRF in association with obesity hypoventilation, chest wall disorders and neuromuscular disease. However, national audit data confirm suboptimal uptake; in the 2014 COPD audit, 34% of patients with persistent or new respiratory acidemia on serial blood gases did not receive NIV.⁷ NCEPOD also reported that 40% of hospitals had insufficient capacity to meet the demand for acute NIV.⁴</p> <p>A clinical decision to start acute NIV should be based on diagnostic criteria as described above, patient wishes and other factors. These include an assessment of stable state performance status and degree of frailty, such as needing assistance washing and dressing. Other clinical indices that may influence outcome, for example, late development of AHRF following optimal inpatient treatment, should also be considered. Poor performance status alone is not an exclusion criterion for acute NIV and therapeutic nihilism should be avoided; for a similar patient population, the CAOS study showed that 80% of clinician estimates of outcome were unduly pessimistic.^{8,9} Accurate information that takes all of the above into account should be provided to patients to enable an informed discussion of treatment options.</p> <p>Failure to provide acute NIV when it is indicated is an omission of care that places the patient at risk of moderate or serious harm. Measures should be in place via routine clinical governance to review all cases of morbidity and mortality associated with NIV, including investigation as a Serious Incident if omission of care is believed to have caused unexpected or avoidable death.</p>
Quality measure:	<p>Structure:</p> <p>Acute hospitals and trusts should ensure:</p> <ul style="list-style-type: none"> ▶ Patients who meet evidence-based criteria are offered acute NIV. ▶ There should be sufficient ventilators and bed capacity in designated areas to provide acute NIV when required. ▶ At all times, there should be sufficient trained staff on-site with appropriate expertise to decide whether to initiate acute NIV following an objective review and discussion with the patient. ▶ There should be an available on-call consultant with expertise in the use of acute NIV to discuss and review the patient if necessary when clinical decisions are uncertain (eg, use of acute NIV for non-evidence-based indications). ▶ There is a robust governance structure to investigate acts or omissions in care. <p>Process:</p> <ul style="list-style-type: none"> ▶ Measure 1 quantifies patients with COPD alone on the basis that they represent the most frequent indication for NIV and are easier to define as a single patient population. To show variation in practice that may reflect undue nihilism, the denominator includes patients in whom NIV was judged futile or who decline NIV following discussion with clinicians. ▶ Measure 2 quantifies all patients not treated with NIV who, on review (eg, morbidity and mortality review), should have been treated with NIV. <p>Numerator 1: number of patients with COPD exacerbation and an indication for acute NIV who are treated with acute NIV.</p> <p>Denominator 1: total number of patients with COPD exacerbation and a clinical indication for NIV.*</p> <p>*Including all patients who meet evidence-based criteria but do not start acute NIV due to patient wishes or a clinical decision that NIV would be futile.</p>

Numerator 2: number of patients NOT treated with acute NIV who, on review,** should have been treated with acute NIV.

Denominator 2: total number of patients treated with acute NIV.

**Recommendation to sample AHRF blood gas data over a set period (eg, 4 weeks) and undertake MDT review within an NIV morbidity and mortality process.

What the quality statement means for each audience:

Service providers:

- ▶ Should ensure there are adequate systems, staffing and capacity in place to provide acute NIV to all eligible patients
- ▶ Should ensure that there is a robust and responsive clinical governance process to investigate acts or omissions in care.

Healthcare professionals:

- ▶ Should ensure that patients with a clinical need for NIV are reviewed by a specialist healthcare professional with the necessary NIV competence to make the decision to start acute NIV.

Commissioners:

- ▶ Should ensure that they commission services with sufficient capacity and resources to provide acute NIV to all patients with a clinical indication for its use.

People who receive acute NIV:

- ▶ Access to acute NIV should not be restricted due to either nihilism or lack of infrastructure.
- ▶ Should receive a fully informed discussion around treatment options with a specialist healthcare professional with the necessary NIV competence to make such decisions.

National data sources: Stone RA, Holzhauser-Barrie J, Lowe D, *et al.* Who cares matters. National Chronic Obstructive Pulmonary Disease (COPD) Audit Programme: Clinical audit of COPD exacerbations admitted to acute units in England and Wales 2014. London: RCP; 2015.⁷

Source references: BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016).³
National Confidential Enquiry into Patient Outcome and Death. Inspiring Change. London: NCEPOD; 2017.⁴
Lightowler JV *et al.* Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. *BMJ.* 2003;326 (7382):185.⁵
Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet.* 2000; 3;355 (9219):1931–5.⁶
Wildman MJ, Sanderson C, Groves J, *et al.* Implications of prognostic pessimism in patients with chronic obstructive pulmonary disease (COPD) or asthma admitted to intensive care in the UK within the COPD and asthma outcome study (CAOS): multicentre observational cohort study. *BMJ;* 2007;335.1132.⁸
Wildman MJ, Sanderson CF, Groves J, *et al.* Survival and quality of life for patients with COPD or asthma admitted to intensive care in a UK multicentre cohort: the COPD and Asthma Outcome Study (CAOS). *Thorax* 2009;64:128–32.⁹

Quality statement 2 **All staff who prescribe, initiate or make changes to acute NIV treatment should have evidence of training and maintenance of competencies appropriate for their role.**

Rationale: Acute NIV is an effective treatment provided it is delivered correctly. Key to this is training staff to ensure they have both the knowledge and the practical skills commensurate with their role. NCEPOD's study⁴ highlighted important deficiencies in the training of staff involved in NIV services. It found that 45% of hospitals permitted staff without competency to directly supervise the care of patients receiving NIV. Effective acute NIV treatment can be delivered by a range of specialist healthcare professionals (eg, nurse, physiotherapist and doctor) provided that they are competent to deliver the aspect of treatment they are responsible for. For example:

- ▶ Staff responsible for the clinical decision to start acute NIV must demonstrate evidence of training and ongoing competence in the theory and practice of acute NIV.
- ▶ Staff responsible for the practical application of acute NIV (including starting and adjusting treatment) should demonstrate current competence in the practical application of NIV.
- ▶ Consultants responsible for the care and escalation decisions of patients treated with acute NIV should be able to demonstrate competence in all aspects of acute NIV care. This includes starting and maintaining treatment as well as practical and theoretical knowledge.

This quality statement links to recommendation 8 of the NCEPOD 'Inspiring Change' report.⁴

Quality measure:	<p>Structure: Evidence that the practical delivery of NIV is only by staff who are competent to do so, and those individuals with clinical responsibility demonstrate competence in NIV clinical decision making.</p> <p>Process: Proportion of staff delivering acute NIV with evidence of training and competencies together with evidence of annual updates.</p> <p>Numerator 1: number of healthcare professionals with direct responsibility to initiate and make changes to acute NIV treatment who have evidence of competence in the practical use of acute NIV.</p> <p>Denominator 1: total number of healthcare professionals with direct responsibility to initiate and make changes to acute NIV treatment.</p> <p>Numerator 2: number of healthcare professionals with responsibility for the clinical decision to start acute NIV who have evidence of competence in the theory and practice of acute NIV treatment.</p> <p>Denominator 2: total number of healthcare professionals with responsibility for the clinical decision to start acute NIV.</p>
What the quality statement means for each audience:	<p>Service providers:</p> <ul style="list-style-type: none"> ▶ Should ensure that all staff delivering NIV are competent to do so with evidence of initial training and annual updates. This should be provided via a mandatory rolling competency assessment commensurate with the role undertaken. ▶ Should ensure that training and competency assessments are standardised for all areas in which acute NIV is delivered, recognising that NIV services typically span multiple clinical divisions. ▶ Should ensure the Clinical Lead for the acute NIV service is supported in mandating training across all designated areas of the hospital where acute NIV may be delivered. <p>Healthcare professionals:</p> <ul style="list-style-type: none"> ▶ Who are involved in any aspect of delivering acute NIV should have evidence of training in the theory and practice of NIV, commensurate of their role. <p>Commissioners:</p> <ul style="list-style-type: none"> ▶ Should ensure that any service commissioned to provide acute NIV has staff who are trained, competent and receive annual knowledge updates. <p>People who receive acute NIV:</p> <ul style="list-style-type: none"> ▶ Should have this delivered by trained and competent staff, commensurate with their role in the service.
Relevant existing indicators:	BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016). ³
National data sources:	National Confidential Enquiry into Patient Outcome and Death. Inspiring Change. London: NCEPOD; 2017. ⁴
Source references:	BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016). ³
Other information:	Table 2 – NIV service staff training checklist.

Quality statement 3	Acute NIV should only be carried out in specified clinical areas designated for the delivery of acute NIV.
Rationale:	<p>Acute NIV is delivered as a ward-based service for most patients treated in the UK. National audit data confirm that patients treated with acute NIV should be considered at high risk of death; national averages for in hospital mortality exceed 30%. Use of acute NIV in non-specialised areas is associated with poorer outcomes.¹⁰</p> <p>Levels of trained staff, patient monitoring and near-patient point of care testing must be sufficient to manage such patients effectively. Accepting that there are differences in hospital size and provision, defining appropriate areas for acute NIV is the function of a local operational policy. Nevertheless, there are key infrastructure requirements for acute NIV treatment that apply regardless of area. These are provided in table 3.</p> <p>Areas should be specified according to their capacity to provide effective NIV care, not the name of the area. Suitable areas may include emergency departments (EDs), acute medical units, respiratory wards, high dependency units and critical care. As stated in quality statement 1, capacity for acute NIV should match expected demand. As stated in quality statement 1, NCEPOD's study showed insufficient capacity for acute NIV in 40% of hospitals who provide an NIV service. This indicates a need for additional resource for some hospitals to meet the needs of this high-risk patient population with AHRF. The severity of AHRF and evidence of other organ dysfunction should influence the choice of care environment and staffing requirement.</p> <p>This quality statement links to recommendations 6 and 7 of the NCEPOD 'Inspiring Change' report.</p>

Quality measure:	<p>Structure: Evidence of local arrangements to ensure that acute NIV is delivered in clinical areas that are specified in local operational policy.</p> <p>Process: Proportion of adults who receive acute NIV treatment in an appropriate clinical area as defined in a local operational policy. This area should meet the recommendations of the BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory failure in Adults (2016)³ and NCEPOD's 'Inspiring Change' report.⁴</p> <p>Numerator 1: number of patients who start acute NIV treatment in a designated NIV area* of the hospital.</p> <p>Denominator 1: total number of patients treated with acute NIV.</p> <p>Numerator 2: number of patients who receive continuous oximetry monitoring during the first 24 hours of treatment with acute NIV.</p> <p>Denominator 2: total number of patients treated with acute NIV.</p> <p><i>*A hospital's local operational policy must specify appropriate clinical areas for acute NIV. Designated areas must meet all key infrastructure requirements as defined in table 3. Dedicated outreach teams may start acute NIV prior to transfer to a designated area, provided that patients receive the same provision of staffing and monitoring. Transfer to an appropriate area should occur within 4 hours. If these criteria (table 3 and/or transfer) are not met, then the patient should not be included in numerator 1.</i></p>
What the quality statement means for each audience:	<p>Service providers:</p> <ul style="list-style-type: none"> ▶ Should ensure systems are in place for all appropriate patients to be treated with NIV in an appropriate clinical area. This includes specifying clinical and operational pathways to ensure that such areas are identified and provide sufficient ventilators, masks and monitoring equipment to meet the expected demands of the service. ▶ Should ensure that designated acute NIV areas have an appropriate trained staff/patient ratio (as set out in table 3). <p>Healthcare professionals:</p> <ul style="list-style-type: none"> ▶ Should ensure that patients treated with NIV are cared for in an appropriate clinical area. ▶ Senior healthcare professionals should work with operational managers to ensure that their NIV service meets BTS/ICS criteria and NCEPOD recommendations (table 3). <p>Commissioners:</p> <ul style="list-style-type: none"> ▶ Should ensure they commission acute NIV services that can demonstrate clinical pathways and effective delivery of care. <p>People who receive acute NIV:</p> <ul style="list-style-type: none"> ▶ Should only be treated in an appropriate clinical area that is configured to provide safe, effective care.
Relevant existing indicators:	BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016). ³
National data sources:	National Confidential Enquiry into Patient Outcome and Death. Inspiring Change. London: NCEPOD; 2017. ⁴ BTS National NIV audit, 2010–2013. ¹⁰
Source references:	BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016). ³
Other information:	Table 3 – NIV service infrastructure checklist.

Quality statement 4 **Patients who meet evidence-based criteria for acute NIV should start NIV within 60 min of the blood gas result associated with the clinical decision to provide NIV and within 120 min of hospital arrival for patients who present acutely.**

Rationale: Consensus expert opinion is that prompt application of acute NIV substantially reduces the risk of death in appropriately selected patients with AHRF.^{5,6,9} Clinical deterioration due to treatment delay may result in worsening acidemia which, in turn, is associated with a poorer outcome.^{4,10} As such, there should be no delay in starting acute NIV once the decision to treat with NIV is made. The 'defining' blood gas measurement is the result that informs the clinical decision to start acute NIV treatment and is consistent with recommendation 5 of the NCEPOD study.⁴ Prompt and effective clinical management is also essential prior to the decision to start NIV.^{4,10} The National Institute for Health and Clinical Excellence (NICE)¹¹ and NCEPOD¹² highlight the importance of physiological track and trigger systems to triage and assess acutely ill patients. However, NCEPOD show that an early warning score was not recorded for 47% of patients treated with acute NIV.⁴ When used, 56% of patients had a National Early Warning Score of 6 or more, indicating the need for urgent clinical assessment.

When a blood gas shows AHRF, a time-limited trial of standard medical therapy (eg, controlled oxygen and drugs) may be appropriate provided the patient is not in extremis.¹³ BTS guidance on the use of oxygen in the emergency setting states 'if the patient is hypercapnic and acidotic, start NIV with targeted oxygen therapy if respiratory acidosis persists for more than 30 min after initiation of standard medical management'.¹⁴ If the clinical indication for acute NIV remains, then acute NIV should start without delay.

In setting a 120 min target from arrival to mask application, this statement intends to establish that recognition and treatment of AHRF are time-critical events for patients admitted acutely, without bypassing the necessity for specialist clinical decision making. It permits adequate time for triage, blood gas sampling, clinical assessment, initial management and planning for acute NIV. Minimum time to assessment and treatment targets are commonplace in EDs and acute medical units. They serve to prioritise interventions most likely to improve outcomes. Patients who develop AHRF at a later stage in their admission should be receiving controlled oxygen and medical therapy already. Late development of AHRF is associated with poorer outcomes, and careful clinical review is recommended. Nevertheless, if there is a clinical decision to start NIV, then it should start without further delay. This statement does not define the blood gas sampling method (arterial vs capillary vs venous). An arterial blood gas is the recommended method for the blood gas measurement that defines the need for NIV. At other times, such as initial triage or monitoring treatment response, other methods may provide advantages such as easier access, improved staff availability and reduced pain.

Quality measure:

Structure:

Evidence of local arrangements to ensure that all patients meeting evidence-based criteria for NIV therapy are treated in a timely fashion, including:

- ▶ Rapid clinical assessment to establish presence of respiratory distress or requirement for supplemental oxygen
- ▶ Performing a blood gas measurement within 1 hour of arrival to hospital in patients with respiratory distress
- ▶ Recognition of qualifying blood gas criteria for treatment with NIV
- ▶ Understanding of evidence-based criteria for starting treatment with NIV
- ▶ Starting NIV within 60 min of the blood gas that identifies the need for NIV treatment.

Process:

Proportion of patients treated with acute NIV who start NIV within 60 min of the first blood gas result that confirms the clinical indication for acute NIV. This includes both acute presentation of AHRF on admission to hospital and late-onset AHRF following admission.

For patients presenting acutely to hospital, the proportion of patients treated with acute NIV who (A) have a blood gas performed within 60 min of hospital arrival and (B) start acute NIV within 120 min of hospital arrival.

Numerator 1: number of patients meeting evidence-based criteria for acute NIV and treated with acute NIV within 60 min of the blood gas result associated with the clinical decision to provide NIV.*

Denominator 1: total number of patients with AHRF who are treated with acute NIV.

*The blood gas measurement defining the decision for acute NIV may be the presenting gas or one obtained after a period of controlled oxygen. Includes patients with AHRF due to COPD, obesity, neuromuscular disease and chest wall disorders. Includes emergency admissions and patients who develop AHRF at a later stage during a hospital admission.

Numerator 2: number of patients meeting evidence-based criteria for acute NIV and treated with acute NIV within 120 min of hospital arrival.**

Denominator 2: total number of patients meeting evidence-based criteria for acute NIV who are treated with acute NIV.

**Excludes patients who develop AHRF at a later stage during a hospital admission. They should be included in numerator and denominator 1 only.

Numerator 3: number of patients meeting evidence-based criteria for acute NIV and treated with acute NIV whose first blood gas measurement is performed within 60 min of hospital arrival.

Denominator 3: total number of patients meeting evidence-based criteria for acute NIV on admission to hospital who are treated with acute NIV.

What the quality statement means for each audience:

Service providers:

- ▶ Should ensure there are operational systems in place to ensure timely, effective triage and treatment with NIV, with accurate and reliable recording of the time of the following events for patients treated with NIV: ED/hospital arrival, point of care blood gas analysis and time of starting treatment with acute NIV. Providers are also required to support audit and data collection, plus mechanisms for feedback and quality improvement.

Healthcare professionals:

- ▶ Should ensure that they are adequately trained in the recognition of AHRF via clinical and blood gas parameters and understand the evidence-based criteria for treatment with NIV.

Commissioners:

- ▶ Should ensure that services are commissioned with sufficient available resources to establish acute NIV services that achieve prompt treatment as specified.

People who receive acute NIV:

- ▶ Their severity of acute illness should be recognised, assessed and treated promptly with an evidence-based intervention.

Source references:

BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016).³

National Confidential Enquiry into Patient Outcome and Death. Inspiring Change. London: NCEPOD; 2017.⁴

Lightowler JV *et al.* Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. *BMJ*. 2003;326 (7382):185.⁵

Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet*. 2000; 3;355 (9219):1931–5.⁶

Wildman MJ, Sanderson CF, Groves J, *et al.* Survival and quality of life for patients with COPD or asthma admitted to intensive care in a UK multicentre cohort: the COPD and Asthma Outcome Study (CAOS). *Thorax* 2009;64:128–32.⁹

National Institute for Health and Clinical Excellence. Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital 2007. (NICE clinical guideline No 50).¹¹

National Confidential Enquiry into Patient Outcome and Death. An acute problem? A report of the national confidential enquiry into patient outcome and death (NCEPOD) London: NCEPOD, 2005.¹²

Roberts CM, Stone RA, Buckingham RJ, Pursey NA, Lowe D. Acidosis, non-invasive ventilation and mortality in hospitalised COPD exacerbations. *Thorax* 2011; 66; 43–48.¹³

O'Driscoll BR, Howard LS, Earis J *et al.* BTS guideline for oxygen use in adults in healthcare and emergency settings. *Thorax*. 2017;72(Suppl 1):ii1-ii90.¹⁴

Quality statement 5

All patients should have a documented escalation plan before starting treatment with acute NIV. Clinical progress should be reviewed by a healthcare professional with appropriate training and competence within 4 hours of starting NIV and by a consultant with training and competence in acute NIV within 14 hours of starting acute NIV.

Rationale:

There is a high mortality in this patient population, and the initial response to NIV provides key insights into treatment outcome. Failure to demonstrate at least partial physiological improvement after 2 hours of therapy is associated with poorer outcomes¹⁵ and should prompt the need to consider invasive ventilation.^{8,9} Delivering effective care therefore requires clear escalation plans at the onset of treatment with acute NIV. The escalation plan should include appropriateness of invasive ventilation, ceiling of treatment and CPR status.

Careful clinical review is essential for successful patient outcomes. As a minimum, all patients treated with acute NIV should be reviewed by a competent healthcare professional (as defined in quality statement 2) within 4 hours of starting acute NIV. A consultant with expertise in acute NIV should review the patient and initial escalation decision within 14 hours of admission and daily thereafter until NIV treatment stops. Changes to the escalation plan should be made on the basis of review by a clinician with appropriate expertise and include critical care review if required.

This quality statement links to recommendations 9, 10 and 11 of the NCEPOD 'Inspiring Change' report,⁴ and recommendations 2 and 3 of the Clinical Quality Indicators for Acute Medical Units (Society for Acute Medicine, 2011).¹⁶

Quality measure:**Structure:**

Evidence of local arrangements to ensure that all patients treated with acute NIV have:

- ▶ A documented treatment plan that includes decisions around escalation to critical care, appropriateness of invasive ventilation and CPR status before starting acute NIV.
- ▶ Review by a specialist healthcare professional (as defined in quality statement 2) within 4 hours of starting acute NIV.
- ▶ Review by a consultant with expertise in NIV (as defined in quality statement 2) within 14 hours of starting acute NIV; this includes review of the initial escalation and ceiling of treatment decision. Daily review by a consultant with expertise in NIV until treatment with NIV stops.

Process:

Proportion of patients treated with acute NIV who have documented escalation plans and decisions regarding ceiling of treatment prior to starting treatment with acute NIV.

Proportion of patients reviewed by a consultant with expertise in acute NIV within 14 hours of starting treatment with acute NIV.

Numerator 1: number of patients with a documented escalation plan before starting treatment with acute NIV.

Denominator 1: total number of patients treated with acute NIV.

Numerator 2: number of patients reviewed within 4 hours of starting treatment with acute NIV by a healthcare professional who is competent to make clinical decisions regarding acute NIV treatment.

Denominator 2: total number of patients treated with acute NIV.

Numerator 3: number of patients reviewed within 14 hours of starting treatment with acute NIV by a consultant with expertise in NIV.

Denominator 3: total number of patients treated with acute NIV.

What the quality statement means for each audience:

Service providers:

- ▶ Should ensure systems are in place to provide specialist review within 4 hours, expert consultant review within 14 hours and that treatment escalation plans (or similar) are used to document escalation decisions and ceilings of treatment.

Healthcare professionals:

- ▶ Should ensure that only appropriately trained specialists (up to consultant level) make clinical decisions for patients treated with NIV.

Commissioners:

- ▶ Should ensure they commission acute NIV services that can demonstrate clinical pathways and service provision capable of providing effective delivery of care.

People who receive NIV:

- ▶ Should be reviewed in a timely manner by senior clinicians with the necessary expertise to determine appropriate ceilings of care.

Relevant existing indicators:

BTS National NIV audit, 2010–2013.¹⁰

National data sources:

BTS National NIV audit, 2010–2013.¹⁰
National Confidential Enquiry into Patient Outcome and Death. Inspiring Change. London: NCEPOD; 2017.⁴

Source references:

BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016).³
Confalonieri M *et al*, A chart of failure risk for noninvasive ventilation in patients with COPD exacerbation. *Eur Respir J* 2005;25:348–55.¹⁵
Clinical Quality Indicators for Acute Medical Units (AMUs). The Society for Acute Medicine (2011).¹⁶

Quality statement 6

All patients treated with acute NIV should have blood gas analysis performed within 2 hours of starting acute NIV. Failure of these blood gas measurements to improve should trigger specialist healthcare professional review within 30 min.

Rationale:

In addition to continuous monitoring of oxygen saturations and measurement of respiratory rate, blood gas sampling is used to assess the response to acute NIV. Routine analysis 1 hour after starting treatment with NIV is recommended, with additional sampling at 4 hours and in the event of clinical deterioration.³

Studies show that improvements in pH and PaCO₂ values, and a reduction in respiratory rate after 2 hours of NIV are strong predictors of treatment success.¹³ Conversely, failure of physiological improvement is associated with poor outcome and should prompt urgent clinical review by a healthcare professional with the necessary NIV competence to make clinical decisions. In the event of uncertainty, there should be access to a consultant with expertise in acute NIV to aid decision making.

NCEPOD's study⁴ provides evidence of inadequate patient monitoring; case note reviewers found that blood gas sampling was too infrequent for 32% and that overall monitoring could have been improved for 54% of patients treated with NIV. Where sampling took place, the clinical response was often suboptimal; ventilator management was rated as inappropriate for 35% of patients. Clinical review did not take place for 31% of patients who deteriorated after starting acute NIV.

This quality statement aims to quantify the adequacy of the response to the deteriorating patient who is treated with acute NIV. It focuses on the first blood gas sample obtained after starting acute NIV as this is a stronger predictor for treatment failure than routine sampling at a later stage.¹⁴ However, other factors such as change in respiratory rate, heart rate, conscious level or clinical impression should be taken into account; an improving blood gas measurement should not deter a call for urgent clinical review if this is felt to be appropriate.

Quality measure:	<p>Structure: Evidence that all patients treated with acute NIV have a routine blood gas performed within 2 hours of starting NIV. Failure of these blood gas results to improve (pH the same or worse/or PaCO₂ the same or worse) should trigger review by a specialist healthcare professional (as defined in quality statement 2) within 30 min.</p> <p>Process:</p> <ul style="list-style-type: none"> ▶ Proportion of patients who have a blood gas measurement within 2 hours of starting acute NIV. ▶ Proportion of patients whose blood gas reveals a failure to improve and are seen by an appropriately trained specialist healthcare professional within 30 min. <p>Numerator 1: number of patients who have a blood gas measurement within 2 hours of starting acute NIV.</p> <p>Denominator 1: total number of patients treated with acute NIV.</p> <p>Numerator 2: number of occasions when specialist healthcare professional review takes place within 30 min of a blood gas result that fails to improve in comparison with the pre-NIV blood gas measurement.</p> <p>Denominator 2: number of occasions in which there is a blood gas result that fails to improve in comparison with the pre-NIV blood gas measurement.</p>
What the quality statement means for each audience:	<p>Service providers:</p> <ul style="list-style-type: none"> – Should ensure that all sites with an NIV service have a local operational policy that describes: A system that delivers timely blood gas analysis. – Clear pathways to enable prompt upward titration of ventilation pressures and troubleshooting of common ventilator or mask-related issues. – Access to a specialist able to review patients treated with NIV within 30 min if needed. – A method to record the time the specialist is called and attends, and a means to record their assessment and changes in management. <p>Healthcare professionals:</p> <ul style="list-style-type: none"> ▶ Should ensure that the response to NIV is assessed early. Furthermore, the treating clinician should have access to an appropriate specialist colleague in a timely fashion to maximise the chance of delivering optimal care. <p>Commissioners:</p> <ul style="list-style-type: none"> ▶ Should ensure that commissioned services have local policies and standards of care that will facilitate timely identification of patients whose treatment needs to be changed. <p>People who receive NIV:</p> <ul style="list-style-type: none"> ▶ Should be assessed by a qualified healthcare professional within a short period of time if initial treatment is not having the desired effect.
National data sources:	BTS National NIV audit, 2010–2013. ¹⁰ National Confidential Enquiry into Patient Outcome and Death. Inspiring Change. London: NCEPOD; 2017. ⁴
Source references:	BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (2016). ³ Confalonieri M <i>et al</i> , A chart of failure risk for noninvasive ventilation in patients with COPD exacerbation. <i>Eur Respir J</i> 2005;25:348–55. ¹⁵

Table 2 Non-invasive ventilation (NIV) service staff training checklist

#	Specifications	Is it met? Y/N/partially/ planned	Comments	Action required	Timescale	Person responsible
	The purpose of this specification is to improve the quality of care provided to patients receiving acute NIV. Issues in relation to the timeliness, appropriateness, location, level of care and competency of staff treating patients with acute NIV have been highlighted.					
1	Provision of an NIV training programme for staff with responsibility to start or continue NIV.					
2	Training portfolios of nurses/physiotherapists/doctors/physiologists confirm that they have attended such training.					
3	Staffing arrangements such that new/untrained members of staff with any responsibility for the care of patients treated with NIV are directly supervised by a trained member of staff until NIV competence is achieved and documented.					
4	<p>A rolling competency maintenance framework that is appropriate for their continued practice. This will differ according to role with the recommended approach as follows:</p> <p>(1) Healthcare professionals with responsibility to make practical changes to NIV (eg, setting up NIV, adjusting ventilator settings and mask):</p> <ul style="list-style-type: none"> ▶ annual review of competence, ideally observed by the trust lead for training. <p>(2) Healthcare professionals with responsibility for clinical decisions regarding NIV therapy:</p> <ul style="list-style-type: none"> ▶ New staff (eg, rotating ST3+ grade) should receive a review of the theory and evidence base for NIV as part of their induction. ▶ Existing staff (eg, consultant with on-call responsibility for NIV) should review their competence annually via appraisal/mandatory training and should ensure attendance at an acute medical update that includes NIV within each revalidation cycle. 					

Adapted from BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (March 2016) and National Confidential Enquiry into Patient Outcome and Death (July 2017) – Inspiring Change – Acute Non-Invasive Ventilation.

Table 3 Non-invasive ventilation (NIV) service infrastructure checklist

#	Specifications	Is it met? Y/N/	Comments	Action required	Timescale	Person responsible
	The purpose of this specification is to improve the quality of care provided to patients receiving acute NIV. Issues in relation to the timeliness, appropriateness, location, level of care and competency of staff treating patients with acute NIV have been highlighted.					
1	<p>Area: acute NIV should only be used in clinical areas equipped with:</p> <ul style="list-style-type: none"> a. Continuous pulse oximetry for all patients. b. Continuous ECG monitoring for all patients with a clinical indication (pulse rate >120bpm, dysrhythmia or possible cardiomyopathy). c. Point of care blood gas analyser within or adjacent to the NIV area. d. An oxygen supply 					
2	<p>Leadership: there should be a clinical lead for the NIV service with time allocated in their job plan, a designated lead nurse and, where appropriate, a designated lead physiotherapist.</p>					
3	<p>Staffing: 1:2 nursing care should be provided for all patients treated with acute NIV until NIV requirements reduce to nocturnal use only. The local operational policy should include a management/escalation plan for critically ill patients who require increased (1:1) nursing care.</p>					
4	<p>Equipment: all ventilators used to deliver acute NIV should be designed for this purpose. There should be sufficient quantity of masks and ventilators to meet the expected demand for NIV.</p>					
5	<p>Service capacity: designated NIV area(s) should have sufficient capacity to meet the demand for acute NIV. If NIV starts in other areas, NIV trained staff should remain with the patient during delivery of NIV; the same monitoring should be provided and transfer to a designated NIV area should occur within 4 hours.</p>					
6	<p>Governance: the NIV service should have:</p> <ul style="list-style-type: none"> a. A locally developed NIV protocol (based on published best practice guides) uniformly applied across all areas. b. A process of regular audit (continuous rolling audit is recommended), including participation in national audits. c. A robust morbidity and mortality process including rapid review of all inpatient deaths of patients treated with (or considered for) acute NIV including a respiratory physician or intensivist. Cases in which an omission in care is likely to have contributed to an avoidable death should be investigated as serious incidents. 					

Adapted from BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults (March 2016) and National Confidential Enquiry into Patient Outcome and Death (July 2017) Inspiring Change – Acute Non-Invasive Ventilation.

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REFERENCES

1. British Thoracic Society. BTS guideline production manual. 2016 <https://www.brit-thoracic.org.uk/guidelines-and-quality-standards/>
2. NICE. Nice quality standards process guide. <https://www.nice.org.uk/media/default/Standards-and-indicators/Quality-standards/Quality-standards-process-guide-April-2014.pdf>
3. Davidson AC, Banham S, Elliott M, et al. BTS/ICS guideline for the ventilatory management of acute hypercapnic respiratory failure in adults. *Thorax* 2016;71(Suppl 2):ii1–35.
4. National Confidential Enquiry into Patient Outcome and Death. *Inspiring Change*. London: NCEPOD, 2017.
5. Lightowler JV, Wedzicha JA, Elliott MW, et al. Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. *BMJ* 2003;326:185.
6. Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *The Lancet* 2000;355:1931–5.
7. Stone RA, Holzhauer-Barrie J, Lowe D, et al. Who cares matters. National Chronic Obstructive Pulmonary Disease (COPD) Audit Programme: Clinical audit of COPD exacerbations admitted to acute units in England and Wales 2014. *London: RCP* 2015.
8. Wildman MJ, Sanderson C, Groves J, et al. Implications of prognostic pessimism in patients with chronic obstructive pulmonary disease (COPD) or asthma admitted to intensive care in the UK within the COPD and asthma outcome study (CAOS): multicentre observational cohort study. *BMJ* 2007;335:1132.
9. Wildman MJ, Sanderson CFB, Groves J, et al. Survival and quality of life for patients with COPD or asthma admitted to intensive care in a UK multicentre cohort: the COPD and Asthma Outcome Study (CAOS). *Thorax* 2009;64:128–32.
10. British Thoracic Society. BTS National NIV audit (2010-2013). <https://www.brit-thoracic.org.uk/document-library/audit-and-quality-improvement/audit-reports/bts-adult-niv-audit-report-2013/>
11. National Institute for Health and Clinical Excellence. *Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital 2007*. (NICE clinical guideline No 50).
12. National Confidential Enquiry into Patient Outcome and Death. *An acute problem? A report of the national confidential enquiry into patient outcome and death (NCEPOD)*. London: NCEPOD, 2005.
13. Roberts CM, Stone RA, Buckingham RJ, et al. Acidosis, non-invasive ventilation and mortality in hospitalised COPD exacerbations. *Thorax* 2011;66:43–8.
14. O'Driscoll BR, Howard LS, Earis J, et al. BTS guideline for oxygen use in adults in healthcare and emergency settings. *Thorax* 2017;72(Suppl 1):ii1–90.
15. Confalonieri M, et al. A chart of failure risk for noninvasive ventilation in patients with COPD exacerbation. *Eur Respir J* 2005;25:348–55.
16. The Society for Acute Medicine. *Clinical Quality Indicators for Acute Medical Units (AMUs)*, 2011.