ACUTE NON INVASIVE VENTILATION: WHAT ARE THE CURRENT INDICATIONS?

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INTRODUCTION

Non invasive ventilation (NIV) has been shown to be an effective treatment for ventilatory failure, particularly resulting from acute exacerbations of COPD, but also hypoxaemic respiratory failure, community-acquired pneumonia, cardiogenic pulmonary oedema and following solid organ transplants in a number of randomised controlled trials (RCTs). There have also been two RCTs of NIV in weaning. Non invasive ventilation has been used in a variety of different settings, with different ventilator modes and interfaces and in differing degrees of severity.

NIV IN ACUTE EXACERBATIONS OF COPD

The earliest RCTs[1, 2] were largely performed in the intensive care unit (ICU) and the most striking finding was a reduction in the need for intubation and mechanical ventilation, which in the largest study translated into improved survival, and a reduced complication rate and length of stay in both the ICU and hospital.[1] Brochard *et al.*[1] showed that NIV for patients with severe exacerbations of COPD (n=85, mean pH 7·27) in the ICU reduced the intubation and mortality rates compared to conventional medical therapy. Non invasive ventilation also improved pH, PaO_2, respiratory rate and encephalopathy score at one hour and was associated with a shorter hospital stay (23 days vs 35 days, p=0·005) and a lower complication rate (16% vs 48%, p=0·001). Most of the excess mortality and complications, particularly pneumonia, were attributed to endotracheal intubation (ETI). These data suggest that NIV may be superior to invasive mechanical ventilation (IMV), but this was a highly selected group with the majority (70%) of potentially eligible patients excluded from the study, primarily because they were deemed to require immediate intubation. In a smaller study (n=31) in two US ICUs, Kramer *et al*.[2] showed a marked reduction in intubation rate, particularly in the sub-group with COPD. However, mortality, hospital stay and charges were unaffected. Those enrolled had a severe exacerbation, as evidenced by a mean pH of 7·28.

In a further ICU study from Turkey,[3] Celikel showed a more rapid improvement in various physiological parameters, but there was no difference in intubation rate or survival. However, some patients randomised to standard therapy subsequently received NIV and there was a significant reduction in treatment failure rate, defined as the need for ventilatory support; at the time of failure all patients had a decrement in pH. Martin *et al.*[4] in a prospective RCT comparing NIV with usual medical care in 61 patients, including 23 with COPD, showed (in common with other studies) that there was a significant reduction in intubation rate (6·4 vs 21·3 intubations per 100 ICU days, p=0·002). However, there was no difference in mortality (2·4 vs 4·3 deaths per 100 ICU days, p=0·21). Although the intubation rate was lower in the COPD sub-group (5·3 vs 15·6 intubations per 100 ICU days, p=0·12), this did not reach statistical significance; this may simply reflect the small sample size. Three patients in the NIV group and one in the control group required ETI to maximise the safety of other procedures (e.g. bronchoscopy) and two patients in the NIV group required ETI because of haemodynamic compromise related to massive gastrointestinal bleeding. All other patients required ETI because of progressive ventilatory failure. In summary, only four of the intubations in the NIV group were as a result of an inability to control respiratory failure compared with 16 in the control group.

However, these studies were performed in units committed to the non invasive approach and with particular expertise, and this factor more than location may have been important in determining the outcome. Furthermore, there are still questions which have to be raised about the general applicability of these results into everyday clinical practice; results achieved in enthusiastic units as part of a clinical trial may not be achievable in other units lacking the same skill levels or commitment to making NIV work. What these studies do show is that successful NIV is possible and that the prevention of ETI is advantageous. A reduction in the incidence of nosocomial infection is a consistent and important advantage of NIV compared with IMV.[5,6] In intubated patients there is a one per cent risk per day of developing nosocomial pneumonia.[7] This complication of invasive ventilation is associated with a longer ICU stay, increased costs and a worse outcome.[8] The reduction in nosocomial infections is probably the most important advantage of avoiding ETI using NIV.

The use of NIV brings new opportunities in the management of patients with ventilatory failure, particularly with regard to location and the timing of intervention. With NIV, paralysis and sedation are not needed and ventilation outside the ICU is an option; given the considerable pressure on ICU beds, the high costs, and that for some patients admission to ICU is a distressing experience,[9] this is an attractive option. It also means that ventilatory support can be instituted at an earlier

stage in the natural history of the condition before ventilation would normally be considered necessary. A number of studies has suggested that NIV is less likely to be successful in the more severely affected patients.[1, 10, 11]

Nine prospective RCTs of NIV took place outside the ICU either on general wards[12–18] or in the Accident and Emergency (A&E) department.[13, 14] Non invasive ventilation was instituted at a higher pH than that in the ICU studies and most failed to show any significant advantage to NIV when analysed on an intention to treat basis. However, in one study[12] when those unable to tolerate NIV were excluded a significant survival benefit was seen (9/30 vs 1/26, p=0·014).

A large multicentre RCT of NIV in acute exacerbations of COPD (n=236) on general respiratory wards in 13 centres has recently been reported.[17] Non invasive ventilation was applied, by the usual ward staff – most of whom had had little or no previous experience of NIV – using a bilevel device in spontaneous mode, according to a simple protocol. Patients were randomised to conventional treatment or the same treatment with the additon of NIV if they had a respiratory rate > 23 breaths per minute, PaCO2 >6 kPa and a pH between 7·25 and 7·35, on arrival on the ward after allowing time for treatment initiated in the A&E department to work. 'Treatment failure', a surrogate for the need for intubation, defined by *a priori* criteria, was reduced from 27% to 15% by NIV (P <0·05). In-hospital mortality was also reduced from 20% to 10% (P <0·05). This study suggests that, with adequate staff training, NIV can be applied with benefit outside the ICU by the usual ward staff, and that the early introduction of NIV on a general ward results in a better outcome than providing no ventilatory support for acidotic patients outside the ICU. It confirms that early intervention is also advantageous. The results in the more severely affected patients (pH <7·30 after initial management) were not as good as those seen in the ICU studies, suggesting that this simple approach is not appropriate in these patients and that they are best managed in a higher dependency setting with a more sophisticated ventilator individually adjusted to their requirements. This study does however confirm that early intervention is advantageous.

If NIV started when the patient arrived on the ward is effective, is there any role for earlier intervention when the patient first presents to hospital? Two studies have addressed the usefulness of NIV initiated in the A&E department;[13, 14] both failed to show any advantage to NIV over conventional therapy. Barbe *et al.*[13] initiated NIV in the A&E department in patients presenting with an acute exacerbation of COPD and continued it on a general ward. In this small study (n=24) no intubations were required and no deaths occurred in either group; arterial blood gas tensions improved equally in both the NIV group and in the controls. However, the mean pH at entry in each group was 7·33 and at this level of acidosis significant mortality is not expected; in other words, it was unlikely that such a small study would show an improved outcome when recovery would be expected anyway.[19] In a one year period prevalence study[20] of patients with acute exacerbations of COPD, of the 983 patients admitted through the A&E departments in Leeds 20% were acidotic on arrival in the departments, and of these 20% had completely corrected their pH by the time of arrival on the ward. There was a weak relationship between the PaO_2 on arrival at hospital and the presence of acidosis, suggesting that, in at least some patients, respiratory acidosis had been precipitated by high flow oxygen therapy administered in the ambulance on the way to hospital. Time in the A&E department is better spent initiating medical treatment and optimising oxygen therapy.

Wood *et al.*[14] randomised 27 patients with acute respiratory distress, due to a variety of different conditions, to conventional treatment or NIV in the A&E department. Intubation rates were similar (7 /16 vs 5/11) but there was a non-significant trend towards increased mortality in those given NIV (4/16 vs 0/11, p=0·123). The authors attributed the excess mortality to delay in intubation, as conventional patients requiring invasive ventilation were intubated after a mean of 4·8 hrs compared to 26 hrs in those on NIV (p=0·055). The need for rapid access to facilities for intubation and mechanical ventilation is an important message from this study. Further potential problems relating to the provision of NIV in the A&E department include the wide heterogeneity of disorders treated there; staff need to be skilled in the management of disorders of many different organ systems and it may not be possible to train them adequately in NIV given the many other demands placed upon them.

THE ROLE OF NIV WHEN INTUBATION IS CONSIDERED APPROPRIATE FROM THE OUTSET OR AFTER A FAILED TRIAL OF NIV

All the studies have excluded patients who required immediate ETI and IMV and inevitably a proportion of patients will require intubation after a failed trial of NIV. The role of NIV has been evaluated in weaning[21, 22] and for the treatment of post extubation respiratory failure[23] and, although further studies are needed, these do suggest that it is useful in selected patients.

DETERMINANTS OF SUCCESS WITH NIV IN COPD

Acidosis is an indicator of the severity of decompensation in acute on chronic ventilatory failure and it has been shown to predict death in a number of studies of acute exacerbations of COPD.[12, 19, 24, 25] It is therefore a logical starting point for identifying patients who might benefit from NIV. In a retrospective review aimed at identifying patients with COPD who could have been successfully treated with NIV, Ambrosino *et al.*[10] found that patients failing NIV were significantly more acidaemic at baseline

compared with those successfully treated. Although using discriminant analysis a number of variables had a predictive value of >0·80 for successful NIV, when tested together using logistic regression analysis, only baseline pH remained as a significant predictor for successful NIV, with a sensitivity of 97% and specificity of 71%. Similarly, Brochard *et al*.,[1] using *a priori* criteria for the need for intubation, found that success was less likely the lower the starting pH. In contrast, a number of studies have failed to show any relationship between baseline arterial blood gas tensions and the response to NIV.[26–31]

Once NIV has been started progress with treatment may indicate the likely outcome. Not surprisingly the ability of the patients to tolerate NIV is a factor. Benhamou *et al*.[27] found that 'tolerance' of NIV was the only factor of prognostic value. Ambrosino *et al*.[10] also found that better compliance was associated with a greater likelihood of success with NIV and, in their prospective case series of 12 patients with hypercapnic acute respiratory failure (ARF), Soo Hoo *et al*.[28] noted that successfully treated patients were able to tolerate NIV for longer than the patients who could not be successfully treated. Larger volumes of air leak were noted in patients who failed with NIV;[28] these patients also tended to be edentulous and to breathe through pursed lips.

A number of studies have shown that the change in arterial blood gas tensions, particularly pH, after a short period of NIV predicts a successful outcome.[1, 10, 12, 26, 28–30] Patients who have been intubated and are likely to fail a weaning attempt adopt a pattern of rapid shallow breathing when disconnected from the ventilator,[32] indicating that they are breathing against an unsustainable load. A reduction in respiratory rate with NIV has been variably shown in a number of studies, with larger falls generally being associated with a successful outcome from NIV,[1, 28, 29] though this is not always seen.[31]

In the absence of *a priori* criteria for endotracheal intubation, it is not surprising that a failure of commonly measured physiological variables to improve prompts an escalation of therapy, which in this case is a switch to invasive ventilation: in other words, it is a self-fulfilling prophecy. However, in a further analysis of the patients in the study of Plant *et al*.[33] in which treatment failure was defined *a priori* acidosis ([H^+] (OR 1·22 per nmol/l 95% CI 1·09–1.37, p <0·01)) and hypercapnia (OR 1·14 per kPa 95% CI 1·14–1·81, p <0·01) at baseline were associated with treatment failure. Improvement in acidosis (OR 0·89 per nmol/l 95% CI 0·82–0·97, p <0·01) and respiratory rate (OR 0·92 per breath/min 95% CI 0·84–0·99, p=0·04) after four hours of therapy were predictive of a successful outcome. These data have been modelled to provide a clinically useful guide to outcome with NIV in COPD (Table 1). As long as one of either the respiratory rate or pH is improving and the other is no worse, NIV is likely to be successful. If one parameter stays the same and the other is worse, the outcome is worse. If both deteriorate failure is likely. Subdividing patients into those with a pH of greater than or less than 7·30 at presentation is also clinically useful. In this study,[17] 8·3 patients needed to be treated with NIV to avoid one patient meeting the criteria for intubation. If the pH was >7·30, 80% of patients in the control group improved. There is therefore an advantage from NIV but if the patient is tolerating it poorly it is reasonable just to monitor the patient since most will get better anyway. However, when the pH was <7·30, 37% of patients in the control group 'failed' and 21% died; without ventilatory support the outcome is therefore much worse and patients should be made aware of the risks of not continuing NIV, even if they do not particularly like it.

Late failure after successful NIV is recognised, with rates reported at 0–20%, and has been associated with a poor outcome. Morretti *et al*.[34] found that 23% of patients

Initial pH	pH at 4 Hrs	RR -8/min	RR -4/min	No change	RR +4/min	RR +8/min
7·30	7·35	0·27	0·38	0·53	0·74	1·03
	7·30	0·51	0·72	1·00	1·40	1·95
	7·25	1·05	1·46	2·04	2·85	3·97
7·25	7·35	0·13	0·19	0·26	0·36	0·51
	7·30	0·25	0·35	0·49	0·68	0·96
	7·25	0·51	0·72	1·00	1·40	1·95

TABLE 1

Predictors of outcome with NIV in COPD after four hours.

Relative risk of success/failure of NIV in COPD after four hours. Comparison of pH and respiratory rate between time of randomisation and after four hours. If pH and respiratory rate at four hours are unchanged the relative risk of failure is 1·00. All other values relate to this with <1 indicating likelihood of success and >1 indicating likelihood of failure. If one stays the same and the other improves, success is likely, if one stays the same and the other becomes worse, failure is more likely. If both get better then NIV is very likely to succeed. If both get worse then failure is likely. RR = respiratory rate. (Reproduced and adapted with permission from the BMJ Publishing Group. *Thorax* 2001; **56:**708–12.)

initially successfully treated with NIV deteriorated after 48 hours. These 'late failures' were assigned to either an increased number of hours of NIV or intubation and mechanical ventilation depending on the patients'/ relatives' wishes. Patients assigned to increased NIV did significantly worse, with a mortality of 92% compared with 53% in those invasively ventilated. At the time of relapse those patients treated with increased NIV were more acidotic than those who were intubated (pH 7·1 vs pH 7·29) and although this difference was not statistically significant it suggests that the patients who were treated with increased NIV were sicker than those who were intubated.[35] There is also the possibility that patients who were not intubated were self-selected as a group with more advanced disease, as they were not offered or declined ETI. Using logistic regression analysis, a low pH, a low activities of daily living score and the presence of associated complications at admission were more likely in patients who failed after ≥48 hours of NIV.

Failure because the patient could not tolerate NIV needs to be distinguished from patients who tolerate NIV but still deteriorate. In the former group, ventilation using an alternative route, e.g. endotracheal tube, may be successful. By contrast, those who fail despite being able to tolerate NIV are likely to have a poor outcome regardless of further ventilatory support. They are likely to be those with more severe lung disease prior to the exacerbation.

NIV FOR RESPIRATORY FAILURE IN LUNG DISEASES OTHER THAN COPD

Some of the studies discussed above, while predominantly involving patients with COPD, also included some patients with respiratory failure of other causes. One problem of studies including patients with respiratory failure of different aetiologies is that the outcome varies considerably depending upon the diagnosis. For some conditions the outcome is generally good, whereas in others it is very poor regardless of all intervention, e.g. respiratory failure in patients with haematological malignancy.[36, 37] An apparent advantage to a particular intervention in an RCT may be because of poor matching between groups by diagnosis or because good results in one group of patients implies benefit in all, when sub-group analysis, which may not be statistically valid because of small sample size, would show a very different picture. Antonelli *et al.*,[11] in a prospective RCT of NIV versus ETI and IMV in a group of patients with respiratory failure of various aetiologies, showed a reduction in complication rates in the NIV group but no difference in outcome except in a less severely affected sub-group. In line with the COPD studies this suggests that early intervention and NIV used as a means of avoiding intubation and its complications is most appropriate. The same group went on to perform a prospective RCT of NIV in a group of patients with respiratory failure following solid organ transplantation, though again the respiratory failure had a variety of different causes.[38] Non invasive ventilation was compared with high flow oxygen; there was a reduction in the need for intubation and its attendant complications but no effect on outcome or hospital or ICU length of stay. Confalonieri *et al.*[39] in a further prospective RCT randomised patients with respiratory failure as a consequence of community-acquired pneumonia to standard therapy with high flow oxygen or NIV. There was a significant reduction in the intubation rate but no effect upon survival, length of stay or nursing workload. However, in the sub-group who also had COPD the two-month survival was better in the NIV group.

Respiratory failure requiring intubation in a patient with haematologic malignancy portends a very poor outcome.[36, 37] Hilbert *et al.*[40] randomised 52 immuno-suppressed patients with pulmonary infiltrates, fever, dyspnoea, respiratory rate >30 breaths per minute and a PaO_2/FiO_2 ratio <200 to standard therapy or NIV. Each group of 26 patients included 15 patients with haematological malignancy and neutropenia. Fewer patients in the NIV group required endotracheal intubation (12 vs 20, P=0·03), had serious complications (13 vs 21, P=0·02), died in the ICU (10 vs 18, P=0·03) or died in hospital (13 vs 21, P=0·02). In common with other studies, this suggests that early NIV can prevent intubation and is best introduced early in these patients. The outcome in the patients who were intubated was universally poor such that none survived to hospital discharge and the question of whether invasive ventilation is an exercise in futility, at least in those with haematological malignancy, needs to be considered.[36] The criteria (Table 2) used by Hilbert *et al.*[40] in their study are a useful starting point for considering when NIV should be initiated in these patients.

CONTINUOUS POSITIVE AIRWAY PRESSURE

Continuous positive airway pressure (CPAP) has similar physiological effects, is easier and cheaper to deliver and has been used in a variety of studies.[41,42] An improvement in gas exchange is a consistent finding and in an uncontrolled trial Hilbert *et al.*[43] found that CPAP alone eliminated the need for intubation in 25% of 64 patients

TABLE 2
Indications for starting NIV.

Acute exacerbation of COPD (after initial treatment including controlled oxygen)[17]

- respiratory rate >23 breaths per minute
- PaCO2 >6 kPa
- pH <7·35

Hypoxaemic respiratory failure[40]

- dyspnoea
- respiratory rate >30 breaths per minute
- PaO_2/FiO_2 ratio <200

with neutropenia. However, in the only prospective randomised trial of CPAP vs standard therapy published to date, no improvement in outcome (intubation rate and survival) was demonstrable, though CPAP did result in a more rapid physiological improvement.[44] A higher number of adverse events occurred with CPAP treatment (18 vs 6; P =0·01). A number of patients in the CPAP group had respiratory arrests, suggesting that non invasive CPAP delayed intubation. This is a reminder that some patients will continue to deteriorate to the point at which invasive ventilation becomes mandatory and that if intubation is delayed too long the risk of death may be increased. Current data favours NIV as the non invasive mode of ventilatory support of choice for patients with hypoxaemic respiratory failure.

CARDIOGENIC PULMONARY OEDEMA

The use of CPAP in patients with acute cardiogenic pulmonary oedema has been studied in three RCTs which compared standard medical treatment plus CPAP and standard medical treatment alone in patients with cardiogenic pulmonary oedema.[45–7] These studies all show a more rapid physiological improvement with CPAP and the pooled results[48] show a risk reduction for intubation of 26% (95% CI 14 – 38%) with CPAP indicating that four patients with pulmonary oedema need to be treated with CPAP to prevent one intubation. They also suggest a trend towards a reduction in hospital mortality, with a risk difference of 6·6% between the two treatment groups; however, the confidence intervals were wide (95% CI – 16% to 3%) and thus do not allow the exclusion of harm with CPAP treatment.

Two prospective RCTs[49, 50] compared NIV with oxygen therapy in addition to standard medical therapy in 40 patients. One[49] showed a reduction in the intubation rate and more rapid resolution of abnormal physiology. Endotracheal intubation was required in five per cent of patients assigned to NIV and in 33% of those treated conventionally (p=0·037). The time to reach an oxygen saturation of 96% or more and a respiratory rate of less than 30 breaths/min was significantly shorter in the NIV group (median 30 [IQR 15–53] vs 105 [50–230] min, p=0·002). However, there was no difference in survival or length of hospital stay. Another study from Israel comparing high dose isosorbide dinitrate with bilevel ventilation found higher rates of intubation, myocardial infarction and death in the NIV group;[50] high dose intravenous nitrates have been shown to improve outcome in patients with acute cardiogenic pulmonary oedema.[51]

Only one study to date has compared bilevel positive airway pressure (BiPAP) and CPAP in the treatment of acute pulmonary oedema.[52] Performed in the A&E department setting, this study of 27 patients showed that BiPAP improved ventilation and vital signs more rapidly than CPAP, but there was no difference in intubation rates, mortality rates or ICU or hospital length of stay. A trend was shown towards an increased myocardial infarction rate in the BiPAP group but it was unclear as to whether this was due to BiPAP ventilation per se, the specific settings used or a higher incidence of chest pain at the outset.

Further larger studies are therefore needed comparing NIV and mask CPAP. It is important that medical therapy, including high dose nitrates, be maximised in all patients. At present CPAP should be the mode of ventilatory support of first choice in patients with acute cardiogenic pulmonary oedema.

CONTRAINDICATIONS TO NIV

The boundaries for the use of NIV continue to expand. However, intubation and conventional ventilation remain the 'gold standard' in the management of many patients with acute respiratory failure. Local protocols need to be developed to avoid inappropriate trials of NIV in patients who require urgent intubation. Non invasive ventilation is not appropriate in well-documented end-stage disease or when several co-morbidities are present. No absolute contraindications occur although a number have been suggested.[10, 28] These include coma or confusion, inability to protect the airway, severe acidosis at presentation, significant co-morbidity, vomiting, obstructed bowel, haemodynamic instability (two studies have shown only small changes in cardiac output when NIV is initiated[53, 54] but haemodynamic collapse comparable to that often seen when patients are intubated is seldom seen), radiological evidence of consolidation, and orofacial abnormalities which interfere with the mask/face interface. In part, these 'contraindications' have been determined by the fact that they were exclusion criteria for the controlled trials. It is therefore more correct to state that NIV is not proven to be effective in these circumstances rather than that it is contraindicated. Whether NIV is contraindicated or not must depend on individual circumstances. For instance, if invasive ventilation is not considered appropriate, but NIV would be acceptable, there is nothing to be lost by a trial of NIV and there are no contraindications in this situation.

NURSING IMPLICATIONS

Non invasive ventilation has been reported by one group to be a time-consuming procedure[55] but as with any new technique there is a learning curve and the same group have subsequently published more encouraging results.[56] A number of studies, on the ICU, have shown that certainly to start with a significant amount of time is required to establish the patient on NIV, but this drops off substantially in subsequent days.[2, 57, 58] It is possible therefore that NIV may have a much greater impact on nursing workload outside the ICU, where nurses have responsibility for a larger number of patients. In the study of Bott *et al.*,[12] there was no observed difference in nursing workload, assessed by asking the senior nurse to rate, on a visual

analogue scale, the amount of care needed in the conventional and NIV groups. However, this is an insensitive way of measuring nursing needs and in addition some of the potential extra work associated with NIV was performed by supernumerary research staff. In the study of Plant *et al.*,[17] NIV resulted in a modest increase in nursing workload, assessed using an end of bed log, in the first eight hours of the admission, equating to 26 minutes, but no difference was identified thereafter. There are, however, no data on the effect NIV has on the care that other patients on the ward received and it may be at the expense of their care. It is also possible that the outcome with NIV would have been better if the nurses had spent more time with the patients receiving NIV. Non invasive ventilation, in whatever location, is not just a question of purchasing the necessary equipment but also of staff training. Although a considerable amount of input is likely when a unit first starts to provide an NIV service, thereafter, as long as a critical mass of nurses and therapists remain, new staff will gain the necessary skills from their colleagues. In view of the fact that NIV in the more severely ill patient may require as much input as an invasively ventilated patient[57] there should usually be one nurse responsible for no more than three or four patients, though clearly this will be depend upon the care needs of the other patients. In the less severely affected patient NIV can be successful with a lower level of staffing.[17]

NIV IN THE 'REAL' WORLD

One problem with any clinical trial is that patients may have more time devoted to them simply as a consequence of participation in the trial. This may be particularly important with NIV given that it requires time to apply. Although attempts were made in the study of Plant *et al.*[17] to make it generalisable to everyday clinical practice the usual ward staff had access to telephone advice and moral support from the research personnel, who trained the ward staff and supervised data collection, but were not involved in the delivery of NIV or clinical decisions. To establish what happens outside a clinical trial a survey was undertaken among 42 ICUs in France over a three-week period.[59] Patients treated with NIV represented 16% of all patients admitted to the ICU, but 35% of the patients who had not been intubated prior to transfer to the ICU (NIV would not be an option in a patient already intubated elsewhere). Non invasive ventilation was employed in less than 20% of all hypoxic ARF, in half of the patients with hypercapnic respiratory distress and was never used in patients with coma. It was followed by ETI in 40% of cases. The incidence of both nosocomial pneumonia (10% vs 19%, $p = 0{\cdot}03$), and mortality (22% versus 41%, $p < 0{\cdot}001$) was lower in NIV patients than in those with ETI. Success of NIV was associated with a lower risk of pneumonia (OR = 0·06, CI 0·01 to 0·45) and of death (OR = 0·16, CI 0·05 to 0·54). In NIV patients, SAPS II and a poor clinical tolerance predicted secondary ETI. Failure of NIV was associated with a longer length of stay.

CONCLUSION

Non invasive ventilation can be very effective for reversing the severe physiological abnormalities associated with acute on chronic respiratory failure. Indeed it should now be regarded as a new standard of care in the management of acute exacerbations of COPD.[60] An algorithm for the management of the patient presenting to the A&E department with an exacerbation of COPD is presented in Figure 1. Non invasive ventilation may also be useful in selected patients with hypoxaemic respiratory failure, although patient selection and administration of ventilatory support may prove more difficult in this group. Although CPAP has a favourable effect upon abnormal physiology, it had no effect upon outcome in the only RCT in acute lung injury published to date.[44] It has a role in patients with acute cardiogenic pulmonary oedema and available data suggests it is the non invasive mode of choice, though further studies with larger numbers are needed. Invasive mechanical ventilation and NIV should be viewed as complementary, with NIV primarily considered a means of obviating the need for ETI rather than as a direct alternative. Non invasive ventilation should now be available in all hospitals admitting patients with acute respiratory illness.

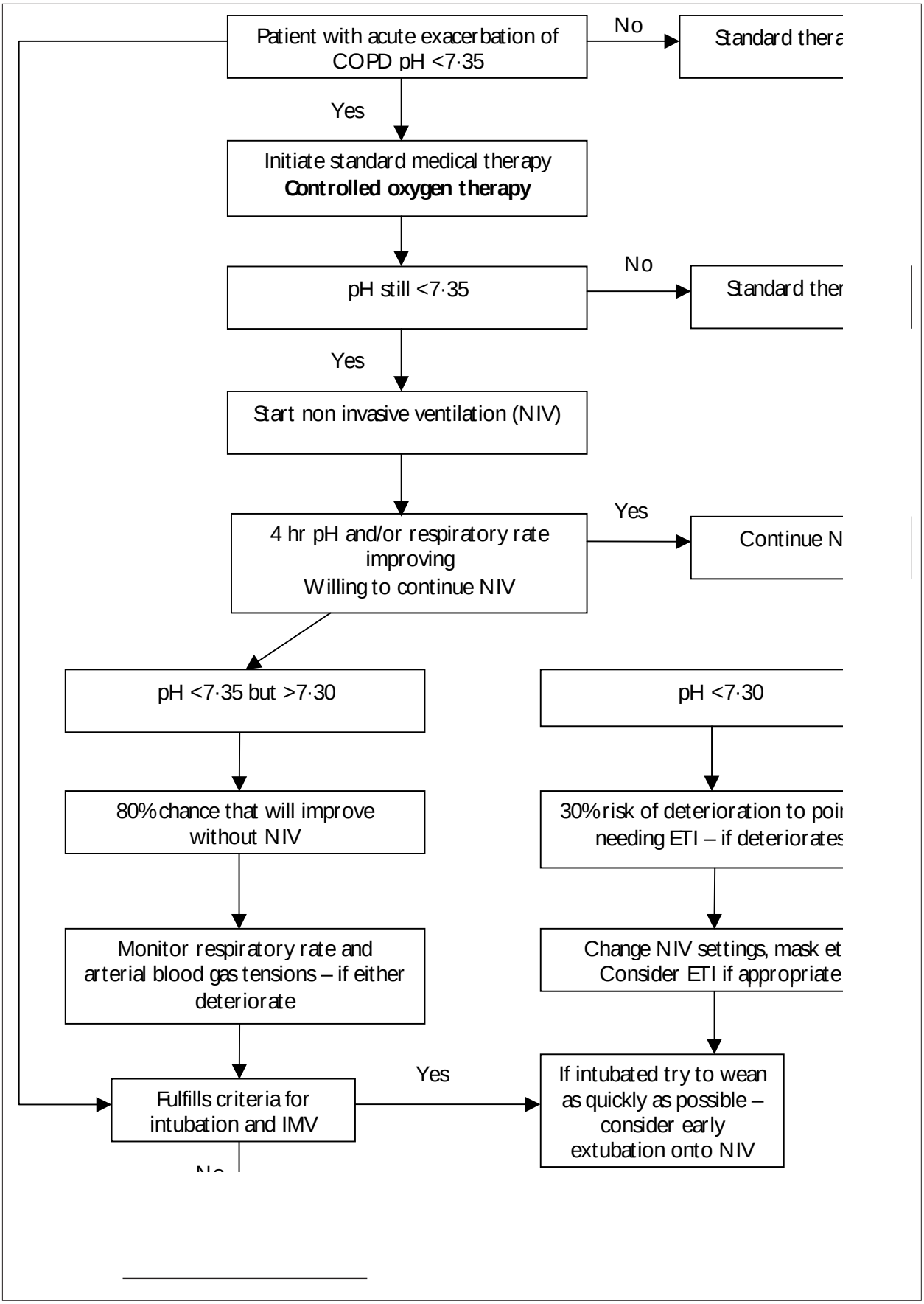

FIGURE 1
Management of a patient with an acute exacerbation of COPD.

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ERRATUM

It has been brought to our attention that the authors of *Type 1 Diabetes and Coeliac Disease* were listed in the incorrect order. The correct citation is as follows:

Soran H, Younis N, Gill G. Type 1Diabetes and Coelaic Disease. *J R Coll Physicians Edinb* 2002; **32:**178–88.

We apologise for any inconvenience or embarrassment this may have caused to the authors.