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COMMENTARY

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The impact of COVID-19 on acute non-invasive ventilation services: A case for change

Acute non-invasive ventilation (NIV) is a life-saving treatment, particularly in hypercapnic chronic obstructive pulmonary disease (COPD) exacerbations.[1] COVID-19 has placed an unparalleled burden on delivery of healthcare services and led to excess deaths. However, the effect on acute NIV service delay is still to be full determined. It is essential we now evaluate the true impact of COVID-19 on NIV services and generate insights to deliver prospective, multicentre studies to improve care despite the continuing pandemic.

In the UK, the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report showed that there was a delay in initiating NIV in 27% of patients and recommended that the emergency department (ED) is probably the best place to start acute NIV.[2] This enables the focus on starting standard medical therapy, including oxygen delivered to a target saturation of 88%–92%, as these measures alone result in 20% of patients presenting to ED with acidosis correcting their pH within the first hour.[3] Early NIV therapy improves physiological outcomes, reduces intubation rates and shortens hospital stay, this is reflected by NIV service quality metrics and national improvement objectives.[4] The 'door-to-mask' time (hospital arrival to NIV commencement) has been widely used to measure the quality of acute NIV services. However, this is a broad metric with various determinants impacting it, the new 2018 British Thoracic Society (BTS) quality standard within this has since been established which uses the 'decision to mask time' and indicates that patients should be started on NIV treatment within 60 min of their decision-making arterial blood gas.[4]

We therefore audited data for all recipients of acute NIV at our local Heartlands Hospital ED before and after the pandemic start, 1 April–1 October 2019 and 2020, respectively. We used the new BTS quality standard and measured the decision to mask time (Table 1). Despite 45.8% fewer patients receiving NIV, in concordance with recent reports of fewer COPD exacerbation presentations,[5] we saw an increased median (interquartile range) decision to mask time, from 61 min (43–77) to 132 min (65–179), in 2020 ($p < 0.0001$) (Table 1). Following this delay in NIV set up, we saw increased deaths (4 [4.8%] vs. 8 [17.8%], $p = 0.014$) associated with lower blood gas pH levels (7.34 [7.30–7.37] vs. 7.62 [6.53–9.17], $p = 0.019$) and higher partial pressure of carbon dioxide (pCO_2) levels (8.59 [7.79–10.37] vs. 7.62 [6.53–9.17], $p < 0.001$) in 2019 versus 2020 (Table 1). This delay likely reflects stringent infection control measures around aerosol-generating procedures (AGPs) and recommendations for side rooms with 10–12 air-changes per hour for AGPs, resulting in patients no longer being set up on acute NIV until an appropriate side room became available.[6] Various hospitals have found new ways to overcome the limitation of suitable rooms for NIV set ups by converting small rooms or wards using dehumidifier exhausts to increase the number of air-changes per hour.[6] However, given the global impact of COVID-19 on hospitals, broad restructuring and improvement of patient flow through hospitals may be required. This has already been mooted by respiratory leaders, bringing the concept of respiratory support units to the fore,[7] but these may not be the only solution.

Emerging information technology systems with ED blood gas dashboards flagging acute hypercapnic respiratory acidosis to the relevant (respiratory/critical care) team will be a welcome quality improvement. However, alongside continual local Quality Improvement (QI) projects, prospective multicentre studies are needed that incorporate interventions and provide high-quality evidence about their potential for improvement of NIV service quality. These should be designed with the most suitable outcomes based on the relevant standards and performance metrics, for example using the decision-to-mask time quality metric, as used above, as opposed to door-to-mask time which is confounded by whole system delays including wait times in ambulances outside of hospitals.[4]

Studies are needed that evaluate new promising automated oxygen administration systems. The potential of automated oxygen titration systems has been shown in a retrospective study where they saw a decrease in time patients spent with hypoxaemia and an increase in time with target oxygen saturations.[8] This study also demonstrated the potential of these systems to lower time patients spent with hyperoxia, which is known to increase mortality in COPD.[9] The benefit of these systems now needs to be demonstrated in larger prospective multicentre studies longitudinally with the incorporation of various outcomes such as reversal of mild acidosis, pre-empting the need for acute NIV; prevention of escalation to critical care; and reduction in the length of hospital stay, especially in patients with COPD exacerbations.

TABLE 1 Patient demographics, clinical characteristics and outcomes

Metric	2019	2020	*p* value
Diagnosis, *N* (%)			
Total	83	45	
COPD	53 (63.9)	33 (73)	0.276[a]
Obesity/hypoventilation	19 (22.9)	9 (20.0)	0.706[a]
Neuromuscular	5 (6.0)	3 (6.7)	0.886[a]
Cardiogenic pulmonary oedema	2 (2.4)	0 (0.0)	0.294[a]
Chest wall deformity	1 (1.2)	0 (0.0)	0.460[a]
Other	3 (3.6)	0 (0.0)	0.197[a]
Age, median (IQR)	67.4 (59.0–76.1)	71.0 (63.1–74.7)	0.514
Sex (M/F), *n* (%)	55/28 (66.3/33.7)	26/19 (57.8/42.2)	0.223
Prior clinical frailty score	5 (4–6)	5 (4–6)	0.617
Chest x-ray consolidation (Y/N)	23/60	11/34	0.382
HR prior to NIV commencement	105 (92–116)	97 (88–110)	0.175
RR prior to NIV commencement	23 (20–28)	22 (20–25)	0.845
Decision to mask time (min)	61 (43–77)	132 (65–179)	<0.0001
Proportion meeting the BTS decision to mask time standard (<60 min) (%)	48.7	23.7	<0.0001
First ABG in T2RF results, median (IQR)			
pH	7.27 (7.23–7.32)	7.27 (7.23–7.31)	0.441
pCO_2	9.37 (8.08–11.29)	10.03 (9.05–11.59)	0.057
pO_2	8.08 (6.31–10.93)	8.49 (6.26–10.65)	0.940
HCO_3	27.05 (23.53–29.34)	27.1 (24.60–29.70)	0.443
Second (decisive) ABG results, median (IQR)			
pH	7.27 (7.23–7.30)	7.27 (7.23–7.30)	0.816
pCO_2	9.61 (8.40–11.23)	9.85 (9.01–11.72)	0.345
pO_2	8.4 (7.10–9.94)	8.10 (7.11–9.25)	0.203
HCO_3	26.1 (23.43–29.35)	26.8 (24.10–29.90)	0.276
First ABG results post NIV commencement, median (IQR)			
pH	7.34 (7.30–7.37)	7.31 (7.27–7.35)	**0.019**
pCO_2	7.62 (6.53–9.17)	8.59 (7.79–10.37)	**<0.001**
pO_2	8.08 (7.33–9.27)	8.63 (7.50–9.61)	0.283
HCO_3	26.2 (23.7–29.2)	27.0 (24.40–30.50)	0.105
Discharge ABG, median (IQR)			
pH	7.39 (7.36–7.43)	7.37 (7.34–7.42)	0.131
pCO_2	7.08 (6.20–7.89)	8.41 (7.35–9.15)	**<0.001**
pO_2	8.20 (7.35–8.98)	8.14 (7.10–8.84)	0.772
HCO_3	28.65 (26.28–31.75)	30.3 (25.60–31.90)	0.664
Maximum IPAP, median (IQR)	20 (18–24)	20 (15–24)	0.126
Maximum EPAP, median (IQR)	5 (4–6)	5 (3–6)	0.167
Time on NIV (days), median (IQR)	3 (1–5)	3 (0–7)	0.960
Length of stay (days), median (IQR)	7 (4–18)	6 (4–12)	0.101
Critical care set up, *N* (%)	9 (10.8)	1 (1.9)	**0.023**[a]
Final outcome, *N* (%)			
Discharged without NIV	48 (57.8)	15 (33.3)	**0.008**[a]
Domiciliary NIV	6 (7.2)	7 (15.6)	0.136

(Continues)

TABLE 1 (Continued)

Metric	2019	2020	*p* value
NIV failure/withdrawn	25 (30.1)	15 (33.3)	0.708
Death	4 (4.8)	8 (17.8)	**0.014**[a]

Note: Unless otherwise stated, data are expressed as median (IQR) and statistical analysis was performed using Mann–Whitney *U* test. . Time from decisive ABG to NIV set up (decision to mask time). Values were treated as significant if $p < 0.05$ and are in bold. Data from two 6-month time periods, 1 April–1 October 2019 (2019); 1 April–1 October 2020 (2020).

Abbreviations: ABG, arterial blood gas; BTS, British Thoracic Society; COPD, chronic obstructive pulmonary disease; EPAP, expiratory positive airway pressure; HR, heart rate; IPAP, inspiratory positive airway pressure; IQR, interquartile range; NIV, non-invasive ventilation; pCO_2, partial pressure of carbon dioxide; pO_2, partial pressure of oxygen; RR, respiratory rate; T2RF, type 2 respiratory failure.

[a]Chi-square test was performed.

A study from Australia showed no difference in outcomes when NIV was delivered in the intensive care unit, high-dependency unit or a ward.[10] However, in the ward model, more patients received NIV, which was also more cost effective. Increasing the number of negative pressure rooms to directly admit patients requiring acute NIV set ups to the wards would be the most obvious way forward and further studies are needed to assess the efficacy of portable partitions (e.g., Room Divider 360 Portable Partitions and Polycarbonate Covid Cubicles) in the continued utilization of ward bays where NIV recipients could be cohorted.

In summary, COVID-19 poses an unprecedented challenge to health care and calls for innovative approaches to manage the surge in demand for specific services. However, on a positive note, emerging data indicate that there is a significant decrease in the total rate of nosocomial infection during the COVID-19 pandemic, most likely due to stringent implementation of infection control protocols.[11] Multicentre prospective studies on the mode of NIV service delivery during the pandemic therefore need to focus on the incorporation of the infection control protocols, which has a potential to be a welcome improvement for vulnerable respiratory patients receiving NIV.

KEYWORDS

clinical respiratory medicine, clinical trials, COPD, COVID-19, critical care medicine, ventilation

CONFLICT OF INTEREST

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Alastair Watson PhD[1,2,3]
Hannah Barnard BSc[1]
Pearlene Antoine-Pitterson MSc MCSP[4]
Bethany Jones MSc MCSP[4]
Alice M. Turner MRCP PhD[1,4]
Rahul Mukherjee FRCP (London) FRCP (Edin.) FCCP[1,4]

[1]*College of Medical and Dental Sciences, University of Birmingham, Birmingham, UK*
[2]*Faculty of Medicine, University of Southampton, Southampton, UK*
[3]*NIHR Southampton Biomedical Research Centre, University Hospital Southampton, Southampton, UK*
[4]*Department of Respiratory Medicine, Birmingham Heartlands Hospital (Part of University Hospitals Birmingham), Birmingham, UK*

ORCID

Alastair Watson https://orcid.org/0000-0002-6735-2567
Alice M. Turner https://orcid.org/0000-0002-5947-3254
Rahul Mukherjee https://orcid.org/0000-0003-4466-0660

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