The Changing Comorbidity Burden and its Association with Outcomes in Acute NIV: A Charlson Comorbidity Index-Based Analysis

Aylin Ozsancak Ugurlu[1], Alastair Watson[2,3], Barea Tanveer[1], Syed Abid[1], Giselle Pereira[1], Rahul Mukherjee[1,*]

ABSTRACT

Acute non-invasive ventilation (NIV) is a lifesaving treatment for acute hypercapnic respiratory failure, particularly during exacerbations of chronic obstructive pulmonary disease (COPD), and is also an established therapy that improves outcomes in acute cardiogenic pulmonary oedema. Decisions regarding NIV initiation are complex and require careful consideration of patient-specific factors. With an aging population, with increasing multimorbidity, understanding the evolving acute NIV patient characteristics is critical to optimize NIV delivery.

We audited all adult acute NIV patients at a tertiary centre, pre-COVID (April 2019–March 2020) and post-COVID (April 2023–March 2024) and performed a retrospective observational cohort analysis. We compared the Charlson Comorbidity Index (CCI) scores and outcomes using Chi-squared or Mann-Whitney U.

Three hundred and twelve patients received acute NIV, 171 pre-COVID and 141 post-COVID. Post-COVID patients had higher comorbidity burden vs pre-COVID (median CCI 5 vs 4, p=0.002), and ward-based NIV ceiling of care frequency (83% vs 66%, p=0.009). Across the entire cohort, higher CCI score associated with increased NIV failure (p=0.007) and in-hospital mortality (p<0.001).

Our demonstration of increasing multimorbidity in a real-world cohort, and the association of multimorbidity with NIV failure, provides insights to guide optimization strategies for acute NIV services. Further understanding the evolving patient characteristics and their impact on outcome is essential to determine how best to incorporate comorbidity assessment into clinical decision making for improved NIV delivery.

KEYWORDS

non-invasive ventilation; COPD; exacerbations; comorbidity; Charlson Comorbidity Index

AUTHOR AFFILIATIONS

[1] Department of Respiratory Medicine, Birmingham Heartlands Hospital, Bordesley Green East, Birmingham, B9 5SS, United Kingdom
[2] School of Clinical Medicine, University of Cambridge, Cambridge, United Kingdom
[3] Cambridge University Hospitals NHS Foundation Trust, United Kingdom
* Corresponding author: Department of Respiratory Medicine, Birmingham Heartlands Hospital (part of University Hospitals Birmingham), Birmingham, B9 5SS; r.mukherjee@nhs.net

Received: 8 May 2026
Accepted: 9 June 2026
Published online: 11 August 2026

Acta Medica (Hradec Králové) 2026; 69(2): 72–74
https://doi.org/10.14712/18059694.2026.21

BRIEF COMMUNICATION

Acute non-invasive ventilation (NIV) is a lifesaving treatment for acute hypercapnic respiratory failure, particularly during exacerbations of chronic obstructive pulmonary disease (COPD) (1) and is also an established therapy that improves outcomes in acute cardiogenic pulmonary oedema (2). Decisions regarding NIV initiation are complex and require careful consideration of patient-specific factors, including expected treatment tolerance, benefit and overall prognosis (3). With an aging population with increasing multimorbidity, understanding the evolving characteristics of patients receiving acute NIV, and their impact on clinical trajectory, is essential to optimize delivery, guide service development and improve patient outcomes.

Since the coronavirus disease 2019 (COVID-19) pandemic, acute NIV services have undergone marked changes (3, 4). However, the impact of evolving comorbidity burden on outcomes remains poorly understood. We aimed to characterise the comorbidity burden among patients requiring acute non-invasive ventilation before and after the COVID-19 pandemic and assess its association with clinical outcomes. By doing this we sought to provide real-world data to better understand the evolving cohort of patients receiving acute NIV in the United Kingdom, with the aim of informing the future organisation and development of acute NIV services.

We audited all adult patients treated with acute NIV at a tertiary centre during two periods – pre-COVID (April 2019–March 2020) and post-COVID (April 2023–March 2024). We performed a retrospective observational cohort analysis of existing data. This data had previously been collected as part of a clinical audit which had been registered within our National Health Service Institution's Clinical Audit Registration and Management System (CARMS; registration number CARMS-19085). Demographic, clinical, and outcome data for each group were assessed and the Charlson Comorbidity Index (CCI) was calculated (5). The CCI is an established clinical scoring system for comorbidity which has been shown to be inversely proportional to the estimated 10-year survival and has utility in classifying prognostic comorbidity in longitudinal studies. This score is calculated based on a patient's age and the presence of the following comorbidities: prior myocardial infarction, congestive heart failure, peripheral vascular disease, prior cerebrovascular accident or transient ischaemic attack, dementia, chronic pulmonary disease, connective tissue disease, peptic ulcer disease, liver disease, diabetes mellitus, hemiplegia, moderate to severe chronic kidney disease, solid tumour, leukaemia, lymphoma and acquired immunodeficiency syndrome (AIDS) (5). We compared the Charlson Comorbidity Index (CCI) scores and clinical outcomes using non-parametric tests, Chi-squared or Mann-Whitney U. NIV failure was defined as either NIV being withdrawn, or the requirement for intubation, due to clinical deterioration on NIV.

A total of 312 patients received acute NIV across both time periods, 171 pre-COVID and 141 post-COVID. Baseline demographics were similar, including median age, 60.2 and 58.2, and percentage female, 68.0% and 70.0%, respectively (Table 1). Patients in the post-COVID cohort had a significantly higher comorbidity burden vs the pre-COVID cohort (median CCI 5 vs 4, p=0.002), and more frequntly had a ward-based NIV ceiling of care (83% vs 66%, p=0.009). Across the entire cohort, a higher CCI score was associated with increased NIV failure risk (p=0.007) and in-hospital mortality (p<0.001). Despite this, overall, NIV success (75.0% vs 72.0%, p=0.521) and in-hospital mortality (22% vs 26%, p=0.408) were similar between cohorts.

This shift towards more complex multimorbid patients receiving acute NIV is clinically relevant, particularly given the association of CCI scores with adverse outcomes. The absence of a corresponding increase in NIV failure rates or mortality during this period may reflect wider hospital factors, including improvements in clinical practice, service organization, and the impact of quality improvement initiatives (3, 6–13). Incorporating comorbidity assessment into early clinical evaluation may enhance risk stratification and escalation planning. Understanding the evolving patient characteristics and their impact on outcome is essential to determine how best to do this, and to facilitate ongoing development and optimisation of acute NIV services.

Tab. 1. Demographics, clinical parameters and outcomes of pre-COVID and post-COVID acute NV cohorts. Showing mean ± standard deviation, or number of patients (percentage of patients). Statistical analysis performed with non-parametric tests, Chi-squared or Mann-Whitney U.

	Total (312)	Pre-Covid (171)	Post-Covid (141)	Significance
Age	68.9±0.7	68.0±11.5	70.0±12.0	0.128
Female, n (%)		103 (60.2)	82 (58.2)	0.710
Ceiling of care Full escalation NIV/HDU Ward based		 45 (26.3) 21 (12.3) 105 (61.4)	 23 (16.3) 2 (1.4) 116 (82.3)	<0.0001
Underlying Diagnosis COPD OHS NMD RLD CPE		 119 (69.6) 38 (22.2) 7 (4.1) 4 (2.3) 3 (1.8)	 95 (67.4) 31 (22) 4 (2.8) 8 (5.7) 3 (2.1)	0.610
CCI Score, median (IQR)	5 (3)	4 (3)	5 (3)	0.002

	Total (312)	Pre-Covid (171)	Post-Covid (141)	Significance
Outcomes				
NIV success		128 (74.9)	101 (71.6)	0.521
In-hospital mortality		38 (22.2)	37 (26.2)	0.408

COPD = Chronic Obstructive Pulmonary Disease; OHS = Obesity Hypoventilation Syndrome; NMD = Neuromuscular Disease; RLD = Restrictive Lung Disease; CPE = Cardiogenic Pulmonary Oedema; CCI = Charlson Comorbidity Index; NIV = Non-Invasive Ventilation; HDU = High Dependency Unit; IQR = Interquartile Range.

REFERENCES

1. Osadnik CR, Tee VS, Carson-Chahhoud KV, et al. Non-invasive ventilation for the management of acute hypercapnic respiratory failure due to exacerbation of chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2017 Jul; 7(7): CD004104.
2. Masip J, Roque M, Sánchez B, et al. Noninvasive ventilation in acute cardiogenic pulmonary edema: systematic review and meta-analysis. JAMA. 2005 Dec; 294(24): 3124–30.
3. Ozsancak Ugurlu A, Watson A, Ellis P, et al. Predicting in-hospital mortality in a real-world population of ward-based non-invasive ventilation in acute COPD exacerbations. Ther Adv Respir Dis. 2026; 20: 17534666261441160.
4. British Thoracic Society. Respiratory Support Audit Report 2023 (Part 2: Organisational Report): Audit period 1 February – 31 March 2023, data collection period 1 February 2023 – 30 June 2023. London: British Thoracic Society; 2024.
5. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987; 40: 373–83.
6. Snell E, Watson A, Alqahtani A, et al. Determinants of in-hospital mortality in Acute Non-invasive Ventilation (NIV): is door-to-mask time a strong predictor? Eur Respir J. 2023 Sep; 62(suppl 67): PA4021.
7. Ozsancak Ugurlu A, Watson A, Ellis P, et al. P234 Predicting in-hospital mortality in a real-world population of ward-based non-invasive ventilation (NIV) in acute exacerbations of COPD. Thorax. 2025; 80: A292–3.
8. Watson A, Barnard H, Antoine-Pitterson P, et al. The impact of COVID-19 on acute non-invasive ventilation services: A case for change. Respirology. 2021; 26: 1106–9.
9. AlHelou A, Watson A, Russell K, et al. Technology-enabled multidisciplinary team in-reach for oral corticosteroid stewardship and optimizing care of suspected airways disease exacerbations. Acute Med. 2022; 21(4): 205–6.
10. Balu A, Watson A, Linhartova L, et al. P14 The role of a Ventilation Multidisciplinary team meeting (VMDT) in optimising critical care resource-use. Thorax. 2021; 76: A74.
11. Watson A, Barnard H, Shanmugarajah A, et al. Response times for acute non-invasive ventilation set-ups. Ulster Med J. 2022 Sep; 91(3): 169–70.
12. Watson A, Mukherjee R, Furniss D, et al. A human factors approach to quality improvement in oxygen prescribing. Clin Med. 2022; 22: 153–9.
13. Balu A, Watson A, Linhartova L, Ellis P, Mukherjee R. COVID-19 highlights the need to optimize critical care resource use: The role of a respiratory-led multidisciplinary team. Respirology. 2021 Aug; 26(8): 727–8.