



A review of the role of non-invasive ventilation in critical care responses to COVID-19 in low- and middle-income countries: lessons learnt from Baghdad

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In 2021, the burden of the coronavirus disease 2019 (COVID-19) pandemic became especially severe in low- and middle-income countries (LMICs). With high numbers of patients requiring advanced respiratory support and invasive mechanical ventilation (IMV), many ICUs were overwhelmed. This problem is particularly pronounced in LMICs, where the availability of intensive care beds may be limited. Non-invasive ventilation (NIV) has been increasingly used in COVID-19, as both a bridge to intubation as well as a definitive treatment. Use of NIV may be a feasible management strategy in settings where performing IMV is not possible on a large scale due to resource constraints. During 2020–2021, Médecins Sans Frontières helped manage a COVID-19 ICU in Baghdad, Iraq. The predominant mode of treatment was NIV. Due to a shortage of intensive care ventilators, NIV was delivered in the majority of cases by home continuous positive airway pressure machines. In total, 709 patients were admitted to the ICU during the study period with an overall mortality of 61.1%. In addition to the ventilation strategy, patients must be treated holistically, with a comprehensive package of critical care. We aim to highlight the role of NIV in this setting and summarise our experiences to assist future critical care projects during the pandemic.

Keywords: COVID-19, CPAP, humanitarian, LMIC, non-invasive ventilation

Introduction

Coronavirus disease 2019 (COVID-19) has affected almost every healthcare system globally. By June 2021, the majority of COVID-19-related deaths occurred in low- and middle-income countries (LMICs).¹ Many of these patients required invasive mechanical ventilation (IMV), a costly mode of treatment necessitating specialist medical teams and a high nurse:patient ratio. Early intubation of the critical COVID-19 patient has been discussed since the onset of the pandemic; however, it remains a contentious issue.^{2,3} Due to its lower resource utility, continuous positive airway pressure (CPAP) and non-invasive ventilation (NIV) became increasingly used as a bridge to intubation as well as a definitive treatment.⁴ NIV may represent a more conceivable treatment option in LMIC settings, where the ability to facilitate IMV is often limited.⁵ Preliminary data from the Recovery-RS trial further supports this role, demonstrating the superiority of CPAP in managing COVID-19 over conventional oxygen therapy.⁶ We report the experience of the Médecins Sans Frontières (MSF) in managing a COVID-19 ICU in Baghdad in collaboration with the Iraq Department of Health (DoH), using home CPAP machines to deliver advanced respiratory care.

Project background

In June 2020, Iraq experienced its first wave of the COVID-19 pandemic. Following a relative decline in cases in November, a second surge of cases ensued during February–June 2021, with both waves cumulatively accounting for 16 860 deaths.⁷ During the first wave, a lack of ICU beds, as well as equipment to manage the surge of critical patients and a novel disease, culminated in a high mortality rate among intubated patients. As such, the maximum ventilatory support for Iraqi COVID-19 patients was restricted to NIV. Throughout the project, we observed many patients presenting extremely late in the course of their illness, with the majority having received oxygen and other medical therapies prior to hospital admission.

Interventions

Prior to the onset of the second wave, the collaboration moved into a 55-bed COVID-19 ward designed to deliver NIV. All rooms contained central monitoring and a piped oxygen supply. We used a closed unit model, with junior doctors being supervised

either by DoH or international specialists with COVID-19 experience. Patients were admitted directly from the emergency room following a radiological diagnosis of COVID-19 or positive PCR. Patients were admitted to the unit if they required CPAP, NIV or other critical care interventions, including vasopressors. Patients with a simple oxygen requirement of >8 L per min and who were anticipated to deteriorate, were also eligible for admission to the ward.

The relative inexperience of the junior doctors in the ICU necessitated a heavy emphasis on training. Travel restrictions created additional problems locating international specialists to support MSF activity, placing further pressure on our staff to absorb new concepts quickly. Application of clinical protocols surrounding proning, vital sign monitoring and ventilator weaning helped to mitigate this to some extent. Strict protocols for commencing and managing NIV were introduced, with the emphasis placed on starting NIV early in patients with respiratory distress and a high oxygen requirement. Safe management of the NIV patient can be applied more promptly than the intubated patient when introduced alongside comprehensive treatment strategies in a critical care environment. The latter cohort of patients require a greater knowledge of airway management, drugs facilitating mechanical ventilation and they have distinct nursing care needs. NIV patients, however, also present several unique challenges. Many of our patients required NIV for prolonged periods and, due to hypoxia, were unable to tolerate significant breaks from wearing the NIV mask. Unlike intubated and sedated patients, this creates huge psychological implications for compliance with treatment and motivation. NIV patients frequently become distressed, necessitating a close level of monitoring and sometimes low-dose sedation, treatments that can only be delivered safely in a critical care setting. We elected to allow two family members to accompany the patient inside the hospital. In most cases, these relatives had been caring for the patient at home prior to hospital admission. These relatives were able to fill crucial gaps in basic care needs caused by our overstretched nursing teams and provided a vital psychological boost to the patient. The role of patients' relatives in assisting with COVID-19 care is debatable and needs to be balanced against infection control risk, cultural and housing factors, as well as the capacity of nursing teams available. In our project they enabled us to deliver care to a far greater number of patients. However, considerable concern has been expressed in the ability of NIV to enhance viral dissemination and this represents a genuine risk to staff and caregivers.⁸ Adequate supply and provision of personal protective equipment, minimising device leaks alongside conventional hygiene measures, formed an important part of our infection prevention and control policy in reducing this risk.

NIV was delivered using home CPAP machines or non-invasive ventilators designed to manage chronic respiratory conditions. Oxygen was entrained directly into the vented mask and, as such, did not utilise more oxygen than the use of a non-re-breather mask (NRM). Use of these machines provided an effective solution to a lack of intensive care ventilators. Ventilation principles are akin to those of the intensive care ventilator; however, home CPAP machines are technically less complicated and were less difficult for our junior staff to adopt. Furthermore, their cost-effectiveness enabled us to deliver NIV to a much larger number of patients. When intolerance to NIV occurred (due to patient refusal or agitation), individuals were managed on an NRM alone.

Greater emphasis was placed on mobility, prone positioning and physiotherapy through introduction of a dedicated COVID-19 physio team. Posters and visual aids placed in rooms served to encourage patients to mobilise and self-prone. Particular focus was placed on optimising nutrition with nutritional supplementation and nasogastric tube insertion. Ensuring adequate nutrition can be problematic in the conscious NIV patient, who is often too breathless to eat adequately. This can lead to malnutrition and subsequent respiratory muscle weakness.

During the peak of the second wave, the average oxygen consumption per patient was 20 L/min in the unit. Maintaining a safe and consistent oxygen supply system is therefore a crucial part of any humanitarian COVID-19 response. Emphasising the importance of oxygen-preserving tasks, including protocols for oxygen titration and minimising leaks from NIV masks, played a key role in managing the high oxygen demand.

Intensive care represents a small proportion of the patient's disease course. Because of the significant demand to admit critical patients to the ICU, patients were discharged from the unit when they required low levels of simple oxygen therapy (<5 L) and had no further NIV requirement. This could either be to a medical ward or directly home with oxygen and ongoing follow-up, depending on ward bed availability and patient preference. Recognising that patients frequently deteriorate, even late in the course of the illness, we implemented a telephone follow-up service during the second wave to monitor each patient's progress after discharge. This is a useful tool for ensuring that the discharge process is safe and maximises the number of critical patients in the ICU.

Patient outcomes

From 26 September 2020 to 19 June 2021, 709 patients were admitted to the centre. The age of the patients ranged from 11 to 93 (mean 59.9) y, of whom 566 patients were managed with NIV. All patients were initially commenced on CPAP upon admission to the unit, with NIV used to manage respiratory muscle fatigue and worsening respiratory failure in deteriorating patients. The average duration of CPAP/NIV therapy was 13 (1–73) d (Figure 1).

Excluding patients currently undergoing treatment or with unknown outcomes, the overall mortality rate was 61.1%. Despite the relatively high frequency of admissions and case severity (as indicated by NIV requirements) in the latter phase of the project, the mortality rate remained consistent. This may reflect the gradual uplift in care quality and confidence utilising NIV among medical staff throughout the project's maturation.

Concluding remarks

In our project, the use of NIV enabled a higher level of therapy to be delivered to a large cohort of critically ill patients. With implementation of treatment protocols, training and senior supervision, junior medical staff can become accustomed to its use more rapidly than IMV. Furthermore, our policy to allow patients' relatives entry into the ICU helped to reduce the nursing care needs of this, often challenging, group of patients. As such, NIV provides a possible alternative to managing COVID-19 pandemics in settings that are unable to provide IMV on a large scale. Use of home

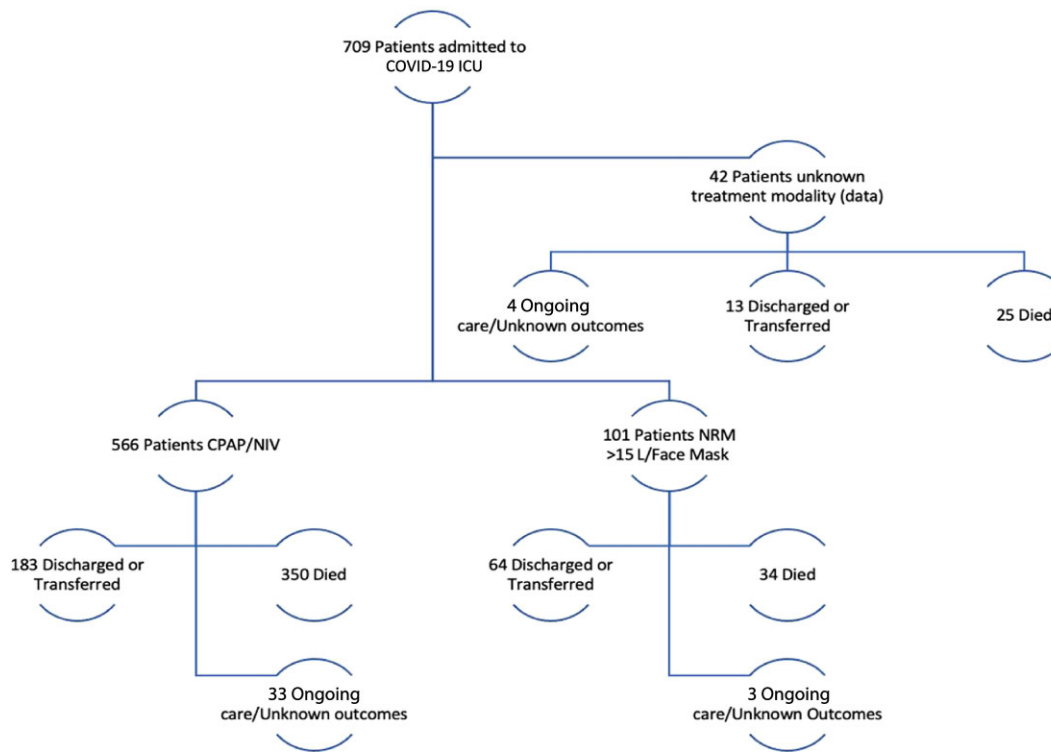


Figure 1. Treatment modalities and outcomes for COVID-19 ICU admissions.

CPAP machines in addition to intensive care ventilators enabled us to deliver a rapid and cost-effective response.

The high mortality rate in the project reflects both the severity and delay in presentation of patients to our centre. The role of intubation in improving this, however, is unclear. Intubation has previously been successfully utilised in other MSF projects.⁹ The multicentred ACCCOS study, however, demonstrated a high in-hospital and intubated mortality rate for critical COVID-19 patients in LMIC settings throughout Africa.¹⁰ The study suggested that critical care units were both under-resourced, as well as being inadequate in number to meet demand. Decisions, therefore, concerning ceilings of therapy as part of a pandemic response are complex and should be taken at a country-specific level. Consideration needs to be given to available medical resources, disease burden, political and cultural factors, as well as emerging evidence on the role of NIV and other treatment modalities, before therapeutic policy can be made. Regardless of the chosen ventilation strategy, this must form part of a comprehensive package of critical care interventions. A holistic approach to patient management is crucial in ensuring that the best possible outcomes are achieved.

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Data availability: Data discussed in this article consisted of routine admission and discharge data collected by MSF as part of the project's internal governance. The data is not publicly available as this may compromise patient anonymity. Anonymised data could be provided upon reasonable request to the corresponding author and to MSF France.

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