



## SHORT REPORT

## Respiratory failure requiring mechanical ventilation in critically ill adults in Ghana: A prospective observational study



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## ABSTRACT

**Introduction:** Respiratory failure is commonly seen in African emergency centres and intensive care units, but little is known about the need for intubation and mechanical ventilation.

**Methods:** From April to October 2017, we recorded the number of patients intubated and ventilated in the emergency centre and intensive care unit at Komfo Anokye Teaching Hospital in Kumasi, Ghana on a daily basis. We assessed patients for presence of acute respiratory distress syndrome (ARDS) using the Kigali Modification of the Berlin ARDS criteria. ARDS patients were re-assessed daily.

**Results:** During the study period, 102 patients were intubated, of which 82 were assessed by the study team. The remaining 20 patients died before they could be assessed. Two (2.4%) patients were identified as having ARDS, and both died. Neither was treated with prone positioning or chemical paralysis. It is possible that many of the patients who died before an assessment suffered from ARDS, considering its associated high mortality, and thus the true incidence of ARDS may have been higher.

**Conclusion:** Respiratory failure requiring intubation and mechanical ventilation is common in patients presenting to the emergency centre or intensive care unit at an academic tertiary care centre in Ghana. The true incidence of ARDS was likely underestimated by our study.

## African relevance

- Respiratory failure is a common problem encountered in African emergency care.
- Little is known about the incidence and outcomes of severe respiratory failure requiring intubation.
- Data on acute respiratory distress syndrome in this setting are equally lacking.
- In this study, about 10% of critically ill patients were intubated and almost 20% died.

## Introduction

With African nations now facing the double burden of communicable and non-communicable diseases, critical illness is common in emergency centres (EC) and intensive care units (ICU). As patients often present to local health centres first, before ultimately arriving at a referral centre, presentation in extremis is common. The Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana is a major regional referral centre. Critical illness and respiratory failure are common presentations [1]. Little is known about the incidence of severe respiratory failure in low- and middle-income countries (LMIC), but mortality is high [2].

In this study, we assessed the incidence of respiratory failure

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requiring mechanical ventilation in critically ill patients presenting to the EC and ICU at KATH. We also assessed the presence and outcomes of acute respiratory distress syndrome (ARDS).

## Methods

This was a prospective observational study of critically ill patients who required intubation and mechanical ventilation in the EC or ICU at KATH.

KATH is the second largest hospital in Ghana. With 1200 beds, it is a major regional referral centre, in addition to serving Kumasi's population of 2.1 million. KATH is home to West Africa's only emergency medicine residency training programme. From April 24 to October 23, 2016, we screened patient in the EC and the 8-bed ICU daily for intubated patients.

Study investigators, all emergency physicians or anaesthesiologists/intensivists at KATH, visited the EC and ICU daily to assess for any intubated patients. In addition, we inquired with the physicians and nursing staff on duty about any patients who had been intubated since the last in-person screening, but who died before being evaluated. We also reviewed the units' patient logs for patients who expired after intubation and before evaluation. Lastly, a smart phone messaging app group was used to notify the investigators of newly intubated patients.

For each patient, we reviewed the hand-written medical record, chest X-ray, if available, and ventilator settings. We then measured the oxyhaemoglobin saturation (SpO<sub>2</sub>) and reviewed any chest X-ray taken within six hours before or after intubation for bilateral infiltrates. If no X-ray was available, we performed a lung ultrasound to assess for bilateral lung opacities [3]. All investigators had training and experience in lung ultrasound. If bilateral lung opacities were present, we estimated the ratio of partial pressure of oxygen in arterial blood (PaO<sub>2</sub>) and fraction of inspired oxygen (FiO<sub>2</sub>) based on SpO<sub>2</sub> and FiO<sub>2</sub> values, following the approach shown in the Kigali Modification of the Berlin Definition of ARDS and using the non-linear imputed data derived and validated by Brown et al. [2,4]. Patients identified to have ARDS were followed upon death or discharge from the EC or ICU, and note was made whether prone positioning or chemical paralysis was employed as treatment for ARDS. Note was also made of the number of intubated patients who died before an assessment. All data were entered into an online password-protected Excel (Microsoft, Redmond, WA, USA) database. No identifiable patient information was recorded.

As this was an exploratory study, no a priori power calculation for study size was performed. Descriptive statistics were used to characterise the study population.

The study was reviewed and approved by the Committee on Human Research, Publications and Ethics of the Kwame Nkrumah University of Science and Technology, School of Medical Sciences.

## Results

During the six-month study period, 10,050 patients were seen in the EC, of which 1111 were triaged as being critically ill. Forty-eight patients were admitted to the ICU during the study period. One-hundred and two patients (8.8%) of these 1159 patients were intubated. Out of these, 82 (80.4%) patients were assessed by the study team, the remaining 20 (19.6%) patients died before an assessment could be performed. Of the 82 patients assessed, two (2.4%) met criteria for ARDS. One patient developed post-operative ARDS after evacuation of a subdural empyema and had a paO<sub>2</sub>/FiO<sub>2</sub> ratio of 89. His initial tidal volume had been set at 6.9 ml/kg of predicted body weight (PBW). He died after eleven days of mechanical ventilation. The other patient presented with pneumonia and had an initial paO<sub>2</sub>/FiO<sub>2</sub> ratio of 64. Her initial tidal volume had been set at 8.7 ml/kg PBW. She died after four days of mechanical ventilation. No prone positioning or chemical paralysis was used in either patient.

## Discussion

In this study, intubation and mechanical ventilation was performed in about 9% of critically ill patients. While only 2.4% of intubated patients met criteria for ARDS, we do not know about the presence of ARDS in patients who died soon after intubation and prior to assessment by the study team. Given the high mortality of ARDS even in high-resource settings, it is conceivable that many of these patients would have been diagnosed with ARDS [5].

Traditionally, the Berlin Definition of ARDS is being used to diagnose ARDS. However, given its reliance on chest radiography and arterial blood gases, its use is impractical in the resource-limited LMIC environment. The Kigali Modification used in this study is a more practical approach in this setting, because it allows the use of lung ultrasound to substitute for chest X-rays, and the use of SpO<sub>2</sub> to estimate the PaO<sub>2</sub>/FiO<sub>2</sub> ratio. Lung ultrasound has been identified as an excellent diagnostic tool for the evaluation of patients with potential ARDS, though its higher specificity for lung pathology than chest X-ray likely leads to some degree of over-diagnosis of ARDS [3,6]. The imputation table used for PaO<sub>2</sub>/FiO<sub>2</sub> estimation was recently validated [7]. Among the two patients with proven ARDS in our study, none of the three interventions known to reduce or likely reduce mortality in ARDS, which include an initial tidal volume of 6 ml/kg PBW, prone positioning and early administration of a neuromuscular blocking agent, were used [8–10].

Our study is not without limitations. Because KATH is a tertiary referral centre, we cannot speak to the incidence and outcomes of severe respiratory failure seen at district hospital and health centres. We also did not include patients on non-invasive ventilation (NIV), which in our experience is at times used as a last resort even in patients traditionally not considered candidates for NIV when no ventilator is available. Because ventilators are a scarce resource in LMICs and at KATH, with multiple ventilators becoming unusable towards the end of the study period, it is likely that more patients would have been intubated and mechanically ventilated had the appropriate resources been available. The lack of resources often forces a triage decision about which patients are more likely to survive after the initiation of mechanical ventilation; these patients will subsequently be prioritised for intubation. Nonetheless, this accurately reflects the realities of emergency and critical care in a resource-limited environment.

Additionally, it is possible that some patients were intubated purely for airway protection, rather than 'primary' respiratory failure (insufficient oxygenation and/or gas exchange). However, given the scarcity of ventilators at KATH, intubations for airway protection are unusual, as the few ventilators available are typically reserved for those presenting with primary respiratory failure. Seasonal fluctuation in respiratory failure presentation is possible, which may have caused us to miss patterns for patients presenting outside of the study period. However, Ghana has a year-round tropical climate, and the study period from April to October did include parts of Ghana's two rainy seasons.

Data on the incidence, epidemiology and outcomes of critical illness, including respiratory failure, in LMIC are scarce. Our study demonstrates that intubation and mechanical ventilation occurred in about 9% of critically ill patients at KATH. Our study also highlights the successful interdisciplinary cooperation between the EC and ICU, leading to a better understanding of critical illness in the LMIC setting. The collaboration between the departments will continue, with new studies currently being planned.

Respiratory failure requiring intubation and mechanical ventilation is common in patients presenting to the EC or ICU at an academic tertiary care centre in Ghana. The true incidence of ARDS was likely underestimated by our study.

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### Conflicts of interest

The authors have no conflicts of interest to declare.

### Dissemination of results

Results from this study were shared with staff members in the EC and ICU at KATH. They will also be presented at a local conference.

### Authors' contributions

TKB conceived the original idea. AA, MOA, TKB, and AAK developed the study protocol. TKB and MJT trained all other authors in the study procedures. AA, MOA, OO, SK, MSF, and COKO collected the data. AA, MOA, and TKB drafted the manuscript. OO, SK, MSF, COKO, and AAK revised it. All authors approved the final version.

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