



*COLLEGE OF MEDICINE AND HEALTH SCIENCES*

**INTENSIVE CARE UNIT (ICU) OUTCOMES IN RWANDA AND THE  
U.S.: CLINICAL COURSE, MORBIDITY AND MORTALITY**

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## DECLARATION

I, Dr Gerard Nkundimana, to the best of my knowledge hereby declare and certify that the work presented in this dissertation entitled “**INTENSIVE CARE UNIT (ICU) OUTCOMES IN RWANDA AND THE U.S.: CLINICAL COURSE, MORBIDITY AND MORTALITY.**” is entirely my own and original work and it has never been presented or submitted in whole or in part to any other university.

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## **DEDICATION**

*To my Mother Godelive Mukandamage*

*To my Father Protais Ndutiye*

*This work is dedicated with great pleasure*

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## LIST OF ACRONYMS AND ABBREVIATIONS

<b>APACHE:</b>	Acute Physiology and Chronic Health Evaluation
<b>ARDS:</b>	Acute Respiratory Distress Syndrome
<b>BIDMC:</b>	Beth Israel Deaconess Medical Center
<b>CHUB:</b>	University Teaching Hospital of Butare
<b>CHUK:</b>	University Teaching Hospital of Kigali
<b>EPIC-II:</b>	Extended Prevalence on Infection in Intensive Care
<b>GNI:</b>	Gross National Income
<b>HIV:</b>	Human Immunodeficiency Virus
<b>ICON:</b>	Intensive Care Over Nations
<b>ICUs:</b>	Intensive Care Units
<b>IRB:</b>	Institutional Review Board
<b>LUNGSAFE:</b>	Large Observational study to Understand the Global Impact of Severe Acute Respiratory Failure
<b>MPM<sub>0</sub>-III:</b>	Mortality Probability Model-III
<b>PI:</b>	Project Impact
<b>R-MPM:</b>	Rwanda Mortality Probability Model
<b>UR:</b>	University of Rwanda
<b>US:</b>	United States of America

## ABSTRACT

**Background:** Little epidemiologic data has been published regarding critical illness presentations, management strategies, and outcomes in low-income countries. Global efforts to provide international perspective on critical illness have had an admittedly poor representation from the developing world. The few studies that have been published from these countries demonstrate different pathology and poor outcomes compared to higher income settings.

**Methods:** Demographic and clinical data were prospectively collected on all adult patients admitted in the intensive care units of national referral hospitals of both Kigali and Butare University Teaching Hospitals from August 19, 2013 and October 6, 2014. ICU admission patterns, treatment and outcomes data were compared to Project IMPACT (PI) data from October 1, 2000 to March 21, 2009. PI patient data were fit to Rwanda Mortality Probability Model (R-MPM) to assess generalizability.

**Results:** Of 504 Rwandan ICU admissions, 422 patients met inclusion criteria. Of 399,205 Project IMPACT (PI) ICU admissions, 384,724 were included in the study. Rwandan data included 2 ICUs from 2 hospitals whereas PI included 186 ICUs from 125 hospitals. Rwandan hospitals were smaller, with fewer ICU beds (5.5 per hospital vs 15) compared to PI hospitals. Rwandan ICU population was younger, with median age 34 years compared with 63 years in PI patients.

The most common reason for ICU admission in Rwanda was respiratory failure (72.8% of admissions). Within 24 hours of ICU admission, 79.9% Rwandan patients required mechanical ventilation and 18.7% had a Glasgow Coma score (GCS) between 3 and 5. In PI patients, only 30.2% were mechanically ventilated, and only 1.8% had a GCS between 3 and 5. Forty one per cent (41.9%) of Rwandan patients were diagnosed with sepsis. Twelve per cent (12.8%) of Rwandan ICU admissions developed acute respiratory distress syndrome (ARDS).

ICU mortality in Rwanda was 43.8% compared with 8.7% in PI population. PI admission hospital mortality probability (MPM<sub>0-III</sub>) score was 7.8 (IQR 3.2-16.6) compared to 9.4 (IQR 3.8-23.0) for the Rwandan ICU population.

**Conclusion:** Compared to Project IMPACT, patients admitted to Rwandan ICUs were younger, required more mechanical ventilation, and experienced a higher mortality rate. The findings in this study characterize the ICU patient population in one particular low-income country and suggest a

need to prioritize resource utilization to syndromes and interventions most associated with higher mortality. Specific to Rwanda, more ICU beds and more ventilators are needed in Rwandan University Teaching Hospitals to alter the course of morbidity and mortality.

# CHAPTER I

## INTRODUCTION

### I.1 Background of the study

Despite the significant burden of critical illness, few studies have been published defining its prevalence, intensive care management strategies, and intensive care unit (ICU) outcomes in low-income countries.(1)(2) Recent international studies that attempted to characterize global burden of common ICU pathology had an admittedly poor representation from developing countries: only 12% of ICUs in the Large Observational Study to Understand the Global Impact of Severe Acute Respiratory Failure (LUNG SAFE) trial included lower-middle income countries, and 1% of data in the Intensive Care Over Nations (ICON) study originated from Africa.(3)(4) In addition, representation in the Extended Prevalence on Infection in Intensive Care (EPIC-II) cohort was much lower from Latin American and Africa compared to North America.(5)

The few studies that have focused on low income countries have shown some alarming trends. The ICON data demonstrated a stepwise increase in the adjusted risk of in-hospital death with decreasing Gross National Income (GNI).(4) Kwizera et al found a statistically significant increase in mortality from HIV infection in ICU patients from Uganda compared to higher income countries.(6) Data from EPIC-II exhibited higher rates of infection reported in countries that had a lower proportion of GDP devoted to health care.(2)

While it is generally known that critical illness in the developing world is characterized by higher rates of acute trauma (7) and different culprits of bacterial infection (2), existing deficits in healthcare delivery in these countries likely impede accurate description of disease severity and mortality. As Adhikari et al delineated, patients may fail to reach a facility for any treatment or inclusion in reported incidences (8), and accurate reporting of intensive care epidemiology is typically dependent on multiple, well-integrated health care resources, which are notably lacking in the developing world.(2)(9) These factors may help explain why mortality predictor scores developed on patient cohorts from higher income countries, such as the Mortality Probability Model version III (MPM<sub>0</sub>-III), have proved less reliable in low-income populations. The development of simpler mortality predictors such as the Rwanda Mortality Probability Model (R-

MPM) is just one of many research efforts that may be required to measure care in low-income countries.(10)

With the burden of critical illness in the developing world expected to increase with urbanization, an aging population, emerging epidemics, and increased access to health care facilities(1)(8), the need to define epidemiology and treatment strategies of ICU patients in low-income countries is imperative for development of best practice guidelines. The aim of this study is to characterize ICU admissions, management, and outcomes in two university hospitals in Rwanda during a 13-month period and compare these data to Project IMPACT, a large prospective database that quantifies practice patterns and outcomes of ICU patients mostly located in the United States and Australia (11).

## **I.2 Justification of the study**

Little is known about the epidemiology and outcomes of ICU patients outside the developed world. Studies to clarify the burden of critical illness in resource-constrained settings are needed to improve quality of care for ICU patients. The present study adds to the very limited epidemiologic data on ICU patients in Sub-Saharan Africa. To our knowledge this is the first epidemiology study on ICU patients' outcomes in Rwandan public teaching hospitals in comparison to developed world ICU epidemiology. We firmly believe the study results will contribute to better ICU utilization and improved outcomes in Rwanda.

## **I.3 Hypothesis**

Outcomes and clinical characteristics of Rwandan patients admitted in ICUs of two referral hospitals are different from ICU patients in the United States of America.

### **I.3.1 Research questions**

- i.** What are the clinical characteristics of Rwandan ICU patients compared to those in Project IMPACT data in the United States?
  
- ii.** What are the management strategies of patients in Rwandan ICUs compared to those in Project IMPACT data in the United States?

- iii. What are the outcomes of patients in Rwandan ICUs compared to those in Project IMPACT data in the United States?
- iv. What are the incidence and outcomes of both sepsis and acute respiratory distress syndromes in Rwandan public hospital intensive care units?

## **I.4 Objectives**

### **I.4.1 Main objective**

To characterize ICU admissions, management, and outcomes in two university hospitals in Rwanda during a 13-month period and compare these data to Project IMPACT (PI).

### **I.4.1 Specific objectives**

- i. Describe the clinical characteristics, management and outcomes of patients in the intensive care units of both Kigali and Butare University Teaching Hospitals and compare these data with Project IMPACT (PI) in the United States.
- ii. Describe the incidence and outcomes of ICU patients with sepsis syndromes and acute respiratory distress syndrome (ARDS) at CHUK and CHUB.

## CHAPTER II

### METHODOLOGY

#### II.1 Study design and setting

This is a prospective descriptive study conducted in two Rwandan public hospitals. Rwandan ICU patient data were collected at the University Teaching Hospitals of Kigali and Butare. Both are affiliated with the University of Rwanda. All admissions were prospectively followed over 13 months, from August 2013 to October 2014. Demographic and outcomes data were then compared to U.S. patients in the Project IMPACT (PI) database and applied to a standardized mortality prediction model (MPM<sub>0</sub>-III).

#### II.2 Study populations

The Rwandan cohort consisted of 422 patients admitted to the two public hospital ICUs from August 19, 2013 to October 6, 2014 (10). Six of the ICU beds were located in Kigali, and five were located in Butare. Data collection included demographic and admission information, MPM<sub>0</sub>-III predictive variables, laboratory values, diagnoses, interventions and significant outcomes at discharge. MPM<sub>0</sub>-III uses 16 variables to predict ICU mortality in the critically ill population as whole and these include age, coma or stupor with GCS of 3 or 4, heart rate  $\geq 150$  beats/min, systolic blood pressure  $\leq 90$  mmHg, chronic renal insufficiency, cirrhosis, metastatic cancer, acute renal failure, cardiac arrhythmia, cerebral vascular accident, gastrointestinal bleeding, intracranial mass effect, cardiopulmonary resuscitation before ICU admission, mechanical ventilation employed within the first hour of admission, medical or unscheduled surgical admission, full code status.

Project IMPACT is database developed by the Society of Critical Care Medicine to allow practitioners to compare patient treatment strategies and outcomes. PI encompasses patient characteristics from more than one hundred ICUs in five different countries (Australia, Brazil, Canada, Puerto Rico, and the United States).(11) For our study, the PI cohort consisted of 384,724 adult patients hospitalized in ICUs between October 1, 2000 and March 21, 2009 in the states. Collected data included demographics, clinical presentation and comorbidities, interventions, and in-hospital mortality.

### **II.2.1 Inclusion criteria**

All ICU patients aged above 15 years admitted to Kigali and Butare University Teaching Hospitals from August 19, 2013 to October 6, 2014, as well ICU patients aged above 15 years in the Project IMPACT database from October 1, 2000 to March 21, 2009 were included in this study.

### **II.2.2 Exclusion criteria**

All ICU patients aged 15 years and below were excluded from the analysis given lack of interest in pediatric population. In Rwanda, pediatric age ranges from 0-15 years.

### **II.3 Data Collection**

The following data were collected from the study populations who met study inclusion criteria:

- i. Hospital and demographic data:** age, patient gender, hospital name and admission date.
- ii. Patient characteristics at hospital admission:** insurance status, type of hospital admission, patient origin.
- iii. Patients' characteristics at ICU admission:** reason for ICU admission, patient's origin prior to ICU admission, characteristics within one hour of ICU admission, chronic conditions, full code status, and HIV status, CPR within 24 hours prior to ICU admission, critical illness syndromes such as acute respiratory distress syndrome, sepsis, severe sepsis and septic shock.
- iv. Vital signs, Laboratory and imaging:** temperature, respiratory rate, blood pressure, heart rate, PEEP, FiO<sub>2</sub>, PaO<sub>2</sub>, Glasgow Coma Scale (GCS), CXR, chest CT scan, echocardiogram, HIV, complete blood count, serum creatinine, serum urea, serum potassium, blood cultures, urine output.
- v. ICU interventions:** mechanical ventilation, duration on ventilator, type of used vasopressor or inotropic medication, use of blood transfusion, renal replacement therapy
- vi. Hospital and ICU outcome:** ICU and in-hospital mortality, hospital and ICU length of stay, MPM<sub>0</sub>-III score.

### **II.4 Outcome**

The primary outcome of our study was the survival status and length of stay in both ICU and the hospital. The key co-variable was the Mortality Probability Model 0-III (MPM<sub>0</sub>-III) score in both Rwandan and U.S. populations.

## **II.5 Data comparison and statistical analysis**

Project IMPACT and Rwandan R-MPM data were compared directly. The number and percentage were provided for all categorical variables, and the median and interquartile range (IQR) were calculated for continuous variables. Chi square and Kruskal-Wallis tests were used to generate statistical comparison. P-values were calculated for all comparison variables with statistical significance set at  $p < 0.05$ . Stata version 14 for Windows was used for statistical analysis (STATA Corp. College Station, Texas).

## **II.6 Ethical consideration**

The Institutional Review Boards (IRB) of both the University of Rwanda (UR) and Beth Israel Deaconess Medical Center (BIDMC) approved the original study in Rwanda. Need for consent for the original study was waived given minimal risk to patients. For the present study, patient consent was not necessary given the comparison of published, de-identified data. The Project IMPACT data use agreement was signed.

## CHAPTER III

### RESULTS

During the study period there were 504 Rwandan ICU admissions with 422 patients meeting study inclusion criteria. Of 399,205 PI ICU admissions, 384,724 were included in the study. Rwandan data included 2 ICUs from 2 hospitals (both urban) whereas PI included 186 ICUs from 125 hospitals (48.8% urban, 35.2% suburban, and 13.6% rural). Rwandan hospitals were smaller, averaging 368 total adult beds with 5.5 ICU beds per hospital compared to PI averaging 425 adult hospital beds with 15 ICU beds.

Comparatively, the Rwandan ICU population was younger (median age 34 years (IQR 25-48)) with 49.5% male. PI patients had median age 63 (IQR 49-75) and were 55.4% male. The vast majority of both Rwandan patients and PI patients had medical insurance, 91.7% vs 91% respectively.

The majority (46.5%) of ICU admissions in Rwanda were unscheduled surgical admissions compared to 12.1% in PI. PI admissions were mostly medical (65.3%). Seventy nine per cent (79.4%) of admissions in Rwanda were transfers from outside acute care facilities. Table 2

Prior to arrival in the ICU, 35.6% of Rwandan patients were in the operating theatre and 16.6% in the emergency room. PI patients were mostly arriving from the emergency room (36.8%) and fourteen per cent (14.8%) from the operating theatre. Most common reasons for ICU admission in Rwanda included respiratory failure (72.8%), altered mental status (32.5%), and postoperative recovery (23.5%). A smaller percentage of PI patients had respiratory failure (24.6%), and even fewer required post-operative recovery (4.8%).

In Rwanda, hypotension/shock was associated with higher mortality (34.8% in non-survivors compared to 14.4% in survivors,  $p < 0.001$ ). This trend continued with sepsis (24.5% in non-survivors compared to 8.8% in survivors,  $p < 0.001$ ) and altered mental status (40.2% of non-survivors compared to 25.5% in survivors,  $p = 0.001$ ). In Project IMPACT respiratory failure (38.5% in non-survivors compared to 22.4% in survivors,  $p < 0.001$ ) and sepsis (16.4% in non-survivors compared to 5.8% in survivors,  $p < 0.001$ ) were associated with higher mortality.

In Rwanda within one hour of ICU admission, the majority of patients (79.9%) required mechanical ventilation, and 21.6% experienced acute renal failure. Eighteen per cent (18.7%) had a Glasgow Coma score (GCS) between 3 and 5. PI patient presentations were less severe, with only 30.2% requiring mechanical ventilation in the first hour, 6.4% experiencing acute renal failure, and only 1.8% possessing a GCS between 3 and 5. In both patient populations, GCS 3-5, heart rate  $\geq$  150 beats per minute, systolic blood pressure  $\leq$  90 mmHg, need for mechanical ventilation, acute renal failure, cardiac dysrhythmias, and gastrointestinal bleeding were associated with higher mortality.

Rwandan patients lacked the comorbidities that PI patients possessed: 3.8% of PI patients had metastatic carcinoma (vs 1.2% of Rwandan patients), 2.7% with cirrhosis (vs 1.0% of Rwandan patients), and 4.3% with chronic renal insufficiency (vs 2.6% of Rwandan patients). However, 4.7% of Rwandan patients were HIV positive (compared to 0.5% of PI patients), and this was associated with a higher mortality (6.9% in non-survivors vs 2.3% in survivors,  $p = 0.02$ ).

Forty one per cent (41.9%) of Rwandan patients in the two teaching hospitals were diagnosed with sepsis within 24 hours of ICU admission, 33.2% with severe sepsis, and 20.9% with septic shock. Each of these diagnoses were associated with a higher mortality ( $p < 0.001$ , respectively). Twelve per cent (12.8%) of Rwandan ICU admissions developed acute respiratory distress syndrome (ARDS), and this was associated with a higher mortality (17.2% in non-survivors vs 8.3% in survivors,  $p = 0.01$ ).

Eighty five per cent (85.3%) of Rwandan ICU patients required mechanical ventilation with median duration of 3 days compared to 38.7% of PI patients with median of 1 day. Mechanically ventilated Rwandan patients experienced a mortality of 96.1 % ( $P < 0.001$ ). Thirty seven per cent (37.5%) of Rwandan patients required blood product transfusion vs 18.6% of PI patients. Vasopressor or inotropic drugs were used in 41.4% of Rwandan patients compared to 22.9% of PI patients. Seven per cent (7.4%) of Rwandan patients underwent renal replacement therapy compared to 5.7% of PI patients.

ICU mortality in the Rwandan public teaching university hospitals was 43.8% with in hospital mortality of 48.6%. The median hospital length of stay of 13 days (IQR 6-28) with ICU length of stay of 5 days (IQR 6-28). The PI population experienced lower mortality at 8.7% in the ICU with in hospital mortality of 13.9%. ICU and hospital length of stays were 2 days (IQR 1-4) and 7 days

(IQR 4-14), respectively. PI admission hospital mortality probability (MPMo-III) score was 7.8 (IQR 3.2-16.6) compared to a score of 9.4 (IQR 3.8-23.0) for the Rwandan ICU population.

## CHAPTER IV

### DISCUSSION

Compared to Project IMPACT patients, individuals admitted to two Rwandan ICUs were younger, required more mechanical ventilation and vasopressors, experienced more acute renal failure, and had worse Glasgow Coma Scores. Patients in Rwandan ICUs were typically transferred from an outside acute care facility. Most admissions were unscheduled surgical admissions, whereas admissions in Project IMPACT were mostly medical. Rwandan ICU mortality was 43.8% compared to Project IMPACT at 8.7%.

ICU epidemiology and outcomes would be different in different settings depending on the availability of resources as well as clinical practice guidelines and or protocols in place to guide admitting priorities. Rwandan ICU patients in both Butare and Kigali university teaching hospitals were sicker, had significant mortality ( $P < 0.001$ ). Observed more transfers for Rwanda (79.4%) are largely due to Rwanda organized structure of referral system from lower facility to tertiary level. The impressive insurance coverage (91.7%) might be explained by both improved health care system and economic gains for Rwanda over the last 23 years after genocide against Tutsi.

Most Rwandan patients were unscheduled surgical admissions compared to medical, 72.8% had respiratory failure as one of the main reasons for admission, 79.9% required mechanical ventilation within hour of admission, 41.9% had sepsis within 24 hours and 12.8% had ARDS during admission; These study findings speak to the scarcity of ICU beds in both teaching hospitals and probably admission of sicker patients due to late presentation.

Tomlinson et al describe 234 patients in an ICU in Malawi, Kamuzu Central Hospital, a 600-bed hospital with a median age of 26.5 years (IQR4-88), the majority of whom were surgical admissions (82%). ICU mortality was 43.8%, exactly the same compared to Rwandan ICU mortality. Although the majority of their patients required mechanical ventilation (88.4%) and blood transfusions (61.4%), these interventions were not associated with increased mortality.(12) This differs from our findings in Rwanda, where mechanical ventilation was associated with higher mortality (96.1%,  $p < 0.001$ ).

Kwizera et al describe 40 patients with median age 38.5 years in an ICU setting in Uganda who required renal replacement therapy for acute kidney injury mostly associated with sepsis and malaria. In these patients, mechanical ventilation, septic shock, and need for vasopressor were associated with higher mortality (30-day mortality of 52.5%). In their study, 90.5% of mechanically-ventilated patients were non-survivors(13); these findings are comparable to the ventilated Rwandan population.

Wunsch et al compared medical ICU admissions to the United States and the United Kingdom by creating a dataset consisting of 172,785 admissions notable for similar age distribution. In addition to longer hospital stay prior to ICU admission, UK patients experienced increased mechanical ventilation within 24 hours of ICU admission, 68% compared to 27.4 % in the United States. UK patients had higher mortality (38%) compared to US (15.9%).(14) This is likely similar to Rwanda in that comparatively, the United States has far more ICU beds and likely different ICU admission criteria with lower proportion of critically ill patients on admission.

In Tanzania, Sawe et al carried out a retrospective study to analyze disease patterns and clinical outcomes of 5,627 patients admitted to the intensive care units of four tertiary referral hospitals from 2009-2011. Trauma and infections were the leading diagnoses, and these patients had an overall ICU mortality of 41.4%, an almost identical figure to our young population.(15)

Paary et al, in their study including 410 participants on clinical profile and outcome of patients with severe sepsis treated in intensive care unit in India, reported an incidence of severe sepsis of 30.6% with a mortality rate of 51.6%. Sixty three per cent (63%) required mechanical ventilation and 25.5% required vasopressor support. Similarly, severe sepsis was associated with higher mortality in Rwanda; mechanical ventilation requirements were comparable.(16)

Several studies from the developed world have emphasized the lack of data on general epidemiology of critical illness in low incomes countries. What is published is typically restricted to syndromes such as the acute respiratory distress syndrome or sepsis, leaving us unable to appreciate the true burden of critical illness. It is generally assumed that ICU patients in low income countries are different than those in high income countries due to difference in the setting, but few papers exist clearly delineating how they are different. Our study is among the few to add to the existing literature.

## **LOCAL RELEVANCE OF THE STUDY AND RECOMMENDATIONS**

The study results pointed out higher surgical ICU admissions in Rwanda with increased mechanical ventilation, suggesting a need to prioritize resources addressing the scarcity of ventilator machines in public teaching hospitals. The high mortality among ventilated patients may in part reflect a poor understanding of ventilator use. Learning and adhering to ventilator protocols may help.

Improved blood banking and safe blood transfusion protocols with skilled personnel for the rational use of inotropic/vasopressor drugs seem to be among the most pressing needs in Rwanda. In PI data, there is a higher proportion of medical admissions vs surgical patients; more studies are needed to understand why critically ill medical patients do not always reach ICU in low-income countries such as Rwanda.

Recent tremendous Rwandan health gains include significant reduction in maternal and child mortality, increased health insurance coverage, decline in malaria and HIV incidence(17); in our present study, 4.7% tested positive for HIV, half were on treatment, and there was an associated mortality.

## **STUDY LIMITATIONS**

Limitations of our study include the small sample size of the Rwanda ICU population. Only 504 patients were admitted, likely due to a scarcity of ICU beds and existence of relatively few public tertiary hospitals located in Kigali and Butare. Consequently, ICU beds are occupied by only the sickest of patients, especially those requiring mechanical ventilation. This leads to a failure of capturing many critically ill patients who never make it to the intensive care unit.

Staffing of the Rwanda ICU is different compared to the United States. Rwandan intensivists are typically anesthesiologists who may not be comfortable with medical complexities. Surgeons do follow their patients into the ICU in Rwanda. In the United States many intensivists are medically subspecialized and would theoretically have more comfort with medically complex patients. This may have affected patient outcomes in each cohort.

## **CONCLUSION**

In conclusion, compared to Project IMPACT patients, individuals admitted to two Rwandan ICUs were younger and more clinically unstable in their initial presentation. Rwandan patients required more mechanical ventilation and vasopressors. Accordingly, our study demonstrates a higher mortality in the Rwandan ICU patient population, 43.8% compared to Project IMPACT at 8.7%.

The findings in this study characterize the ICU patient population in one particular low-income country and suggest a need to prioritize resource utilization to syndromes and interventions most associated with higher mortality. Specific to Rwanda, more ICU beds and more ventilators are needed in Rwandan University Teaching Hospitals to alter the course of morbidity and mortality.

This new data adds more to the existing body of knowledge for the care of critically ill patients in the developing world. ICU utilization patterns in similar African countries might help change admitting practices for better outcomes. Overall, little is published regarding epidemiology in low-income country ICUs, and more studies should be supported.

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**Table 1. Hospitals and ICU characteristics**

<b>Characteristics</b>	<b>Rwanda ICUs</b>	<b>Project Impact*</b>
<b>Data collection time period</b>	August 19, 2013 – October 6, 2014	October 1, 2000 – March 21, 2009
<b>Total number of patients</b>	504	389,205
<b>Total number of adults (&gt; 15 years old)</b>	422	384,724
<b>Number of hospitals</b>	2	125
Urban, n (%)	2 (100.0)	61 (48.8)
Suburban, n (%)	0 (0.0)	44 (35.2)
Rural, n (%)	0 (0.0)	17 (13.6)
<b>Number of adult hospital beds per hospital</b>	368 (313-424 )	425 (319-596)
<b>Number of ICUs, n</b>	2	186
<b>ICU type</b>		
Combined/multiple specialties, n (%)	2 (100.0)	95 (51.1)
Medical/coronary care, n (%)	0 (0.0)	39 (21.0)
Surgical/trauma/burn, n (%)	0 (0.0)	43 (23.1)
Cardiothoracic surgery, n (%)	0 (0.0)	3 (1.6)
Neurologic, n (%)	0 (0.0)	2 (1.1)
<b>Number of ICU beds per hospital</b>	6(6-9)	15 (11-20)
<b>Total ICU beds</b>	11	3283

\* Data missing for —age: 3301 patients; hospital location: 3 hospitals; ICU type: 4 ICUs;

Number of ICU beds per ICU and total number of ICU beds in all included ICUs: 6 ICUs

#ICUs: Intensive Care Units

(%) : calculated percentage

**Table 2. Patient characteristics at hospital admission**

	Rwanda ICUs*				Project Impact†			
	Full Cohort	Survivors	Non-survivors	P Value	Full Cohort	Survivors	Non-survivors	P Value
	<i>N</i> = 422	<i>N</i> = 216	<i>N</i> = 204		<i>N</i> = 384,724	<i>N</i> = 331,046	<i>N</i> = 53,310	
<b>Male, n (%)</b>	209 (49.5)	107(49.5)	101 (49.5)	1.00	213,225 (55.4)	184,498 (55.7)	28,518 (53.5)	<0.001
<b>Patient's age in years, median (IQR)</b>	34 (25- 48)	35 (26-50)	34 (25-46)	0.22	63 (49-75)	62 (48-74)	71 (57-80)	<0.001
16-64 years	385 (91.2)	201 (93.1)	182 (89.2)	0.17	203,926 (53.0)	183,737 (55.5)	19,982 (37.5)	<0.001
≥65 years	37 (8.8)	15 (6.9)	22 (10.8 )		180,798 (47.0)	137,309 (44.5)	33,328 (62.5)	
<b>Patient's insurance status, n (%)</b>								
Yes	387 (91.7)	199 (92.1)	186 (91.2)	0.50	349,978 (91.0)	300,068 (90.6)	49,581 (93.0)	<0.001
No	28(6.6)	15 (6.9)	13 (6.4)		31,041 (8.1)	27,742 (8.4)	3,269 (6.1)	
Unknown	7 (1.7)	2 (0.9)	5 (2.5)		3,705 (1.0)	3,236 (1.0)	460 (0.9)	
<b>Type of hospital admission, n (%)</b>								
Medical	162 (38.4)	78 (36.1)	82 (40.2)	0.01	251,257 (65.3)	208,570 (63.0)	42,407 (79.6)	<0.001
Unscheduled surgical	196 (46.5)	94 (43.5)	102 (50.0)		46,492 (12.1)	40,090 (12.1)	6,364 (11.9)	
Scheduled surgical	64 (15.2)	44 (20.4)	20 (9.8)		86,962 (22.6)	82,377 (24.9)	4,538 (8.5)	
<b>Patient arrived from, n (%)</b>								
Home	32 (7.6)	24 (11.1)	8 (3.9)	0.04	109,992 (28.6)	96,259 (29.1)	13,672 (25.7)	<0.001
Transferred from outside acute care facility	335 (79.4)	163 (75.5)	170 (83.3)		16,871 (4.4)	13,575 (4.1)	3,284 (6.2)	
Unknown	5 (1.2)	2 (0.9)	3(1.5)		247,870 (64.4)	213,721 (64.6)	33,860 (63.5)	
Other	7 (1.7)	5 (2.3)	2 (1.0)		1,572 (0.4)	1,365 (0.4)	206 (0.4)	

‡ P-values: statistical significance set at P<0.05

\*Two patients are missing survival data but are included in the full cohort.

† Missing data for—hospital survival: 368; male gender: 3221; type of hospital admission: 13

**Table 3. Patient's characteristics at ICU admission**

	Rwanda ICUs				Project Impact <sup>†</sup>			
	Full Cohort*	Survivors	Non-survivors	P Value	Full Cohort	Survivors	Non-survivors	P Value
	N = 422	N = 216	N = 204		N = 384,724	N = 331,046	N = 53,310	
<b>Where was the patient prior to ICU admission</b> n (%)								
Emergency room	70 (16.6)	34 (15.7)	35 (17.2)	0.16	141,659 (36.8)	123,108 (37.2)	18,412 (34.5)	<0.001
Operating theatre	150 (35.6)	87 (40.3)	63 (30.9)		56,904 (14.8)	52,264 (15.8)	4,612 (8.7)	
Post-operative recovery room	61 (14.5)	26 (12.0)	35 (17.2)		56,057 (14.6)	52,663 (15.9)	3,351 (6.3)	
Obstetrics recovery room	21 (5.0)	7 (3.2)	14 (6.9)		n/a	n/a	n/a	
Medical ward	55 (13.0)	25 (11.6)	30 (14.7)		n/a	n/a	n/a	
Surgical ward	5 (1.2)	3 (1.4)	2 (1.0)		n/a	n/a	n/a	
Obstetrics and gynecology ward	48 (11.4)	25 (11.6)	22 (10.8)		36,566 (9.5)	27,192 (8.2)	9,325 (17.5)	
Transfer from another hospital	7 (1.7)	6 (2.8)	1 (0.5)		28,750 (7.5)	23,856 (7.2)	4,861 (9.1)	
Other	5 (1.2)	3 (1.4)	2 (1.0)		64,788 (16.8)	51,963 (15.7)	12,749 (23.9)	
<b>Reason for ICU admission</b> n (%)								
Respiratory failure / intubation	307 (72.8)	149 (69.0)	157 (77.0)	0.07	94,714 (24.6)	74,077 (22.4)	20,527 (38.5)	<0.001
Hypotension /shock	102 (24.2)	31 (14.4)	71 (34.8)	< 0.001	6,328 (1.6)	4,552 (1.4)	1,771 (3.3)	<0.001
Sepsis	69 (16.4)	19 (8.8)	50 (24.5)	< 0.001	27,886 (7.3)	19,094 (5.8)	8,757 (16.4)	<0.001
Hemorrhage	33 (7.8)	19 (8.8)	14 (6.9)	0.46	23,226 (6.0)	20,437 (6.2)	2,762 (5.2)	<0.001
Altered mental status	137 (32.5)	55 (25.5)	82 (40.2)	0.001	n/a	n/a	n/a	
Acute renal failure	45 (10.7)	22 (10.2)	23 (11.3)	0.72	10,554 (2.7)	9,438 (2.9)	1,104 (2.1)	<0.001
Trauma	32 (7.6)	17 (7.9)	15 (7.4)	0.84	26,353 (6.9)	23,288 (7.0)	3,047 (5.7)	<0.001
Seizure	29 (6.9)	14 (6.5)	14 (6.9)	0.88	4,645 (1.2)	4,304 (1.3)	332 (0.6)	<0.001
Postoperative recovery	99(23.5)	56 (25.9)	43 (21.1)	0.24	18,583 (4.8)	17,996 (5.4)	570 (1.1)	<0.001
Other	36 (8.5)	20 (9.3)	15 (7.4)	0.48	195,791 (50.9)	179,550 (54.2)	16,087 (30.2)	<0.001
<b>Characteristics within one hour of ICU admission</b> n (%)								
Glasgow coma score 3-5	79 (18.7)	18 (8.3)	60 (29.4)	< 0.001	18,479 (1.8)	6,031 (1.8)	12439 (23.3)	<0.001
Heart rate $\geq$ 150 beats per min	25 (5.9)	3 (1.4)	22 (10.8)	< 0.001	8,706 (2.3)	5,784 (1.8)	2,911 (5.5)	<0.001
Systolic blood pressure $\leq$ 90mmHg	67 (15.9)	22 (10.2)	45 (22.1)	0.001	69,963 (18.2)	48,539 (14.7)	21,375 (40.1)	<0.001
Mechanical ventilation	337 (79.9)	150 (69.4)	185 (90.7)	< 0.001	116,201 (30.2)	90,299 (27.3)	25,832 (48.5)	<0.001
Acute renal failure	91 (21.6)	37 (17.1)	53 (26.0)	0.001	24,493 (6.4)	14,444 (4.4)	10,026 (18.1)	<0.001

Cardiac dysrhythmias	34 (8.1)	13 (6.0)	20 (9.8)	0.04	25,753 (6.7)	18,233 (5.5)	7,491 (14.1)	<0.001
Cerebrovascular accident	8 (1.9)	4 (1.9)	4 (2.0)	0.62	14,837 (3.9)	10,694 (3.2)	4,134 (7.8)	<0.001
Intracranial mass effect	11 (2.6)	5 (2.3)	6 (2.9)	0.98	16,075 (4.2)	10,645 (3.2)	5,419 (10.2)	<0.001
Gastrointestinal bleeding	13 (3.1)	3 (1.4)	10 (4.9)	0.04	17,755 (4.6)	14,910 (4.5)	2,816 (5.3)	<0.001
<b>Chronic conditions</b>								
Metastatic carcinoma	5 (1.2)	2 (0.9)	3 (1.5)	0.63	14,791 (3.8)	10,749 (3.3)	4,028 (7.6)	<0.001
Cirrhosis	4 (1.0)	2 (0.9)	2 (1.0)	0.38	10,485 (2.7)	7,825 (2.4)	2,649 (5.0)	<0.001
Chronic renal insufficiency	11 (2.6)	7 (3.2)	4 (2.0)	0.004	16,455 (4.3)	12,803 (3.9)	3,636 (6.8)	<0.001
<b>Full code status</b>	375 (88.9)	197 (91.2)	176 (86.3)	0.24	365,035 (94.9)	317,799 (96.0)	46,900 (88.0)	<0.001
<b>HIV positive</b>	20 (4.7)	5 (2.3)	14 (6.9)	0.02	2,072 (0.5)	1,530 (0.5)	538 (1.0)	<0.001
<b>CPR within 24 hours prior to ICU admission</b>	29 (6.9)	7 (3.2)	20 (9.8)	0.02	13,477 (3.5)	6,712 (2.0)	6,757 (12.7)	<0.001
<b>Critical illness syndromes</b>								
Sepsis within 24 hours of ICU admission	177 (41.9)	62 (28.7)	114 (55.9)	< 0.001	n/a	n/a	n/a	
Severe sepsis within 24 hours of ICU admission	140 (33.2)	40 (18.5)	99 (48.5)	< 0.001	n/a	n/a	n/a	
Septic shock within 24 hours of ICU admission	88 (20.9)	15 (6.9)	73 (35.8)	< 0.001	n/a	n/a	n/a	
<b>ARDS at any time during ICU admission</b>								
S/F $\leq$ 315, No CHF, BL Opacities by CXR	54 (12.8)	18 (8.3)	35 (17.2)	0.01	n/a	n/a	n/a	

‡ P-values: statistical significance set at P<0.05

\*Two patients are missing survival data but are included in the full cohort.

Sepsis is defined using pre-Sepsis-III definitions: sepsis is suspected infection plus  $\geq$  2/4 SIRS criteria. Severe sepsis is sepsis with a sign of hypoperfusion. Septic shock is sepsis with hypotension (SBP<90 or MAP<60) after adequate fluid resuscitation.

ARDS is defined as p/F ratio<251 (Berlin definition ratio 300, adjusted for altitude), bilateral opacities on chest radiograph, and no congestive heart failure.

n/a: not available

† Missing data for—ICU admission categories: 11; APACHE II diagnostic categories: 2225; Glasgow Coma Score: 55797; full code status: 2466

Reason for ICU admission mapped from (1) APACHE II Diagnostic Categories—respiratory failure/intubation = asthma/allergy, COPD, pulmonary edema (non-cardiogenic), post-respiratory arrest, aspiration, pulmonary embolism, respiratory infection, respiratory neoplasm, congestive heart failure, post-cardiac arrest, post-operative respiratory insufficiency, respiratory system problems; hypotension/shock = hemorrhagic shock/hypovolemia, cardiogenic shock; sepsis = sepsis; hemorrhage = hemorrhagic shock/hypovolemia, gastrointestinal bleeding; acute renal failure = metabolic/renal system problems; trauma = multiple trauma, head trauma; seizure = seizure disorder; other = hypertension, coronary artery disease, dissecting aneurysm, rhythm disturbance, intracranial hemorrhage, drug overdose, diabetic ketoacidosis, chronic cardiovascular disease, peripheral vascular surgery, heart valve surgery, craniotomy for neoplasm, renal surgery for neoplasm, renal transplant, thoracic surgery for neoplasm, craniotomy for intracranial hemorrhage, laminectomy/other spinal cord surgery, gastrointestinal surgery for neoplasm, gastrointestinal perforation/obstruction, neurologic problems, cardiovascular problems, gastrointestinal problems; and (2) designation as admitted to the ICU for “Post Operative Observation” = “All post operative patients that require close monitoring, but do not have a body system dysfunction which would apply to one or the other monitoring categories... A post op patient with no known sequela would be recorded here.”

Characteristics within one hour of ICU admission—Mechanical ventilation = mechanical ventilation in place on ICU admission (not up to 1 hour after admission); Acute renal failure = APACHE II diagnosis of “acute renal failure” = Creatinine  $\geq$  1.5mg/dL within 24 hours of ICU admission and present for  $\leq$  48 hours prior to ICU admission associated with oliguria

Chronic conditions from the APACHE II Chronic Health Conditions—Metastatic carcinoma = “cancer metastasis proven by surgery, by computed tomographic scan, by confirmed pathology report, by obvious clinical assessment or other reliable method within the last 5 years”; Cirrhosis = “Biopsy-Proven Cirrhosis & documented portal hypertension” and/or “Episodes of past upper gastrointestinal bleeding attributed to portal hypertension” and/or “Prior episodes of hepatic failure/encephalopathy/coma”; Chronic renal insufficiency = “Chronic renal compromise or insufficiency noted in the medical history with the most recent creatinine  $>$  2.0 mg/dl”

Full code status reported at time of ICU admission

HIV positive from the APACHE II Chronic Health Conditions = “HIV positive with clinical complications such as pneumocystis carinii pneumonia, Kaposi’s sarcoma, lymphoma, tuberculosis or toxoplasma infection”

**Table 4. ICU interventions**

	Rwanda ICUs*				Project Impact†			
	Full Cohort	Survivors	Non-survivors	P Value	Full Cohort	Survivors	Non-survivors	P Value
	N = 422	N = 216	N = 204		N = 384,724	N = 331,046	N = 53,310	
<b>Mechanical ventilation, n (%)</b>	360 (85.3)	162 (75.0)	196 (96.1)	<0.001	148,896 (38.7)	110,911 (33.5)	37,879 (71.0)	<0.001
Time on ventilator in days, median (IQR)	3 (2-7)	3 (2-8)	3 (2-6)	0.96	1 (1-4)	1 (1-4)	2 (1-6)	<0.001
<b>Blood products transfusion, n (%)</b>	158 (37.5)	72 (33.3)	86 (42.4)	0.06	71,453 (18.6)	55,830 (16.9)	15,581 (29.2)	<0.001
<b>Vasopressor or inotropic medication, n (%)</b>	174 (41.4)	39 (18.1)	134 (66.0)	<0.001	88,120 (22.9)	57,595 (17.4)	30,451 (57.1)	<0.001
<b>Type of vasopressor or inotrope</b>								
Dopamine	121 (28.7)	25 (11.6)	95 (46.6)	<0.001	45,234 (11.8)	28,126 (8.5)	17,060 (32.0)	<0.001
Epinephrine	95 (22.5)	9 (4.2)	85 (41.7)	<0.001	6,317 (1.6)	3,845 (1.2)	2,471 (4.6)	<0.001
Dobutamine	4 (1.0)	1 (0.5)	3 (1.5)	0.36	13,960 (3.6)	9,379 (2.8)	4,570 (8.6)	<0.001
Norepinephrine	1 (0.2)	1 (0.5)	0 (0)	1.00	38,619 (10.0)	20,813 (6.3)	17,780 (33.4)	<0.001
Other	10 (2.4)	8 (3.7)	2 (1.0)	0.11	29,904 (7.8)	18,024 (5.4)	11,867 (22.3)	<0.001
<b>Renal replacement therapy, n (%)</b>	31 (7.4)	19 (8.8)	12 (5.9)	0.25	22,082 (5.7)	15,403 (4.7)	6,661 (12.5)	<0.001

‡ P-values: statistical significance set at P<0.05

\*Two patients are missing survival data but are included in the full cohort.

† All patients for whom a given intervention was not recorded were assumed to have not received that intervention; missing data for—time on ventilator: 69 of the mechanically ventilated patients

Blood products transfusion = packed red cells, platelets, plasma, and/or cryoprecipitate

Vasopressor or inotropic medications defined as dopamine, epinephrine, norepinephrine, phenylephrine, vasopressin, dobutamine, milrinone, and/or amrinone given as a continuous infusion

Renal replacement therapy: dialysis

**Table 5. Hospital and ICU outcomes**

	<b>Rwanda ICU data 2013-2014 *†</b>				<b>Project Impact 2000-2009‡</b>			
	<b>Full Cohort</b>	<b>Survivors</b>	<b>Non-survivors</b>	<b>P Value</b>	<b>Full Cohort</b>	<b>Survivors</b>	<b>Non-survivors</b>	<b>P Value</b>
	<i>N = 422</i>	<i>N = 216</i>	<i>N = 204</i>		<i>N = 384,724</i>	<i>N = 331,046</i>	<i>N = 53,310</i>	
<b>Hospital length of stay in days, median (IQR)</b>	13(6-28)	20(12-41)	7 (4-14)	<0.001	7 (4-14)	7 (4-13)	7 (2-17)	<0.001
<b>ICU length of stay in days, median (IQR)</b>	5(3-9)	5(3-9)	4 (2-8)	0.002	2 (1-4)	2 (1-4)	3 (1-7)	<0.001
<b>ICU mortality, n (%)</b>	184(43.8)	0(0)	184 (90.2)	<0.001	33,321 (8.7)	0 (0.0)	33,321(62.6)	<0.001
<b>Hospital mortality, n (%)</b>	204(48.6)	0(0)	204 (100.0)	<0.001	53,310 (13.9)	0 (0.0)	53,310 (100.0)	<0.001
<b>MPM0-III score (%), median (IQR)</b>	9.4 (3.8-23.0)	5.9 (2.5-14.5)	15.1 (6.0-38.0)	<0.001	7.8 (3.2-16.6)	6.7 (2.9-13.5)	26.2 (13.0-51.4)	<0.001

**‡** P-values: statistical significance set at P<0.05

MPM0-III is the Mortality Probability Model – III; Two patients had missing data for their survival status but are included in the full cohort.

\* Full Cohort N=398, Survivors N = 200, Non-survivors N=198.

† Full Cohort N=375, Survivors N = 191, Non-survivors N=184.

‡ Missing data for—hospital length of stay: 23; ICU length of stay: 291; hospital mortality: 368; ICU mortality: 352; MPM0III score: 90998 (90987 because it didn't apply and 11 purely missing)

## **Appendices**

### **1. Study approval**

Faculty of Medicine  
Faculté de Médecine

Research Ethics Committee  
Comité d'Éthique de la Recherche

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July 13, 2013

**Review Approval Notice N°05 / FoMREC / 2013**

Your research Project: **“Characteristics of critically ill patients in Rwanda’s public referral hospitals”**

This is to inform you that the Faculty of Medicine Ethics Committee has reviewed your above research proposal by expedited review procedure and **approved it**.

Please note that approval of the protocol is valid for 12 months.

You are responsible for fulfilling the following requirement:

Changes or amendments to the protocol must be submitted to the committee for review and approval, prior to activation of the changes.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

**Date of Approval: July 13<sup>rd</sup>, 2013**

**Expiration date: July 12, 2014**

Yours sincerely

**Dr Emmanuel NKERAMIHIGO**

Chair, Faculty of Medicine Research Ethics Committee  
**C.C.**

- Dean, Faculty of Medicine  
- Vice-Dean in Charge of Research/Faculty of Medicine



## 2. Data Collection Form

### Rwanda ICU database 2013-2014 –Data collection form

\* Do not leave answers blank. Missing data will be “999” for number fields and “unknown” for word fields.

#### I. Hospital and demographics

1. Hospital : CHUK  CHUB
2. Location of hospital:  
 Urban  suburban  rural
3. Number of adult hospital beds:
4. Number of ICUs:
5. ICU type:  Combined  specialized : \_\_\_\_\_
6. Number of ICU beds:
7. Patient gender : male  female
8. Patient age (in years): \_\_\_\_\_ (if patient less than 1 year old, record “0”.)
9. Hospital admission date (DD/MM/YY): \_\_\_\_\_
10. Does the patient have insurance?  yes  no  unknown
11. From where did the patient arrive at the hospital?  
 Home  
 Site of accident  
 Referral from health center  
 Referral from district hospital  
 Transfer from private clinic  
 Transfer from another referral hospital  
 Unknown  
 Other: \_\_\_\_\_

#### II. ICU admission

1. ICU admission date (DD/MM/YY) \_\_\_\_\_
2. Where was the patient before he or she was transferred to the ICU?  
 Emergency Room  
 Operating theatre  
 Post-operative recovery room  
 Obstetric recovery room  
 Medical ward  
 Surgical ward  
 Obstetrics and gynecology ward  
 Another hospital (direct transfer from another hospital to the ICU)  
 Other, please specify: \_\_\_\_\_

#### 3. Reason for ICU admission (choose all that apply )

- Respiratory failure / respiratory distress / intubate
- Hypotension / shock
- Sepsis
- Hemorrhage
- Altered mental status
- Acute renal failure
- Trauma
- Seizure
- Pre-eclampsia / eclampsia
- Post-operative recovery
- Other, please specify \_\_\_\_\_

**4. First set of vital signs in ICU (These are the first set of vital signs for the ICU admission.)  
If any are unknown, write "999"**

- 4a. Temperature (°C) \_\_\_\_\_
- 4b. Blood pressure (Systolic, mmHg) \_\_\_\_\_
- 4c. Blood pressure (Diastolic, mmHg) \_\_\_\_\_
- 4d. Heart rate (beats per minute) \_\_\_\_\_
- 4e. Oxygen Saturation (%) \_\_\_\_\_
- 4f. RR (breaths per minute) \_\_\_\_\_

**5. Receiving oxygen at time of vital signs?  yes  no  unknown**

If yes

5a. For mechanical ventilation or CPAP, FiO<sub>2</sub>: \_\_\_\_\_%

**6. Labs within first 24 hours in ICU (if a lab was done in the first 24 hours, write "999"):**

Na+ \_\_\_\_\_ K+ \_\_\_\_\_ Cl<sup>-</sup> \_\_\_\_\_

Creatinine \_\_\_\_\_ mg/dl or μmmol/L (circle units) Blood urea \_\_\_\_\_

Hemoglobin \_\_\_\_\_ WBC \_\_\_\_\_ Platelets \_\_\_\_\_

Blood sugar \_\_\_\_\_ mg/dl or mmol/L (circle units) AST \_\_\_\_\_ ALT \_\_\_\_\_

**III. MPMo-III**

1. What type of hospital admission was this?

Medical  unscheduled surgical  scheduled surgical

**At time of ICU admission**

2. Did the patient have cardiopulmonary resuscitation (CPR) within 24 hours *before* ICU admission?

Yes  no  unknown

3. Glasgow coma scale score (circle one):

3 4 5 6 7 8 9 10 11 12 13 14 15      patient sedated      unknown

3a. Intubated at time of Glasgow coma scale?  Yes  no

**On arrival to the ICU, did the patient have any of the following? (If you assumed the patient to have one of these but did not have confirmation via lab or radiologic study, choose “assumed yes”.)**

4. Mechanical ventilation (within 1 hour of arrival)  yes  no  assumed yes  unknown

5. Acute renal failure  yes  no  assumed yes  unknown

6. Cardiac dysrhythmias  yes  no  assumed yes  unknown

7. Cerebrovascular accident  yes  no  assumed yes  unknown

8. Intracranial mass effect  yes  no  assumed yes  unknown

9. Gastrointestinal bleeding  yes  no  assumed yes  unknown

10. Metastatic carcinoma  yes  no  assumed yes  unknown

11. Cirrhosis  yes  no  assumed yes  unknown

12. Chronic renal insufficiency (baseline creatinine >2 mg/dl or >177 µmol/L)

yes  no  assumed yes  unknown

13. “Full code” status  yes  no  assumed yes  unknown

14. HIV positive status  yes  no  assumed yes  unknown

14a. If HIV positive status is “yes”, is the patient on HIV treatment?

Yes  no  unknown

**IV. Sepsis and septic shock (WITHIN FIRST 24 HOURS OF ICU ADMISSION)**

**Did the patient have any of the below in the first 24 hours of admission to the ICU?**

1. Body temperature >38.5 °C or <35.0 °C  yes  no
2. Heart rate >90 beats per minute  yes  no
3. Respiratory rate >20 breaths per minute  yes  no
4. White blood cell count >12,000 mm<sup>3</sup> or <4000 mm<sup>3</sup> or immature forms >10%  yes  no  unknown
5. Suspected or confirmed infection?  yes  no
- 5a. If infection, was there a positive culture?  yes  no

**V. Sepsis and septic shock (continued)**

**6. In the first 24 hours in the ICU, did the patient have any of the following signs of organ hypoperfusion or organ dysfunction?**

- 6a. Areas of mottled skin  yes  no  unknown
- 6b. Capillary refilling time >= 3 s  yes  no  unknown
- 6c. Urinary output <0.5 mL/kg for at least 1 h or renal replacement therapy  yes  no  unknown
- 6d. Lactate >2 mmol/L  yes  no  unknown
- 6e. Abrupt change in mental status or abnormal electroencephalogram  yes  no  unknown
- 6f. Platelet count <100 000/mL or disseminated intravascular coagulation  yes  no  unknown
- 6g. Acute lung injury or acute respiratory distress syndrome  yes  no  unknown
- 6h. Cardiac dysfunction (by echocardiography or clinical exam)  yes  no  unknown
- 6i. Other signs of hypoperfusion or organ dysfunction, please specify: \_\_\_\_\_

***In the first 24 hours in the ICU,***

7. Did the patient have a mean blood pressure <60 mmHg or systolic blood pressure <90 after receiving fluid resuscitation that was thought adequate based on clinical judgment?  yes  no  unknown
8. Did the patient require dopamine, dobutamine, norepinephrine, or adrenaline?  yes  no  unknown

**VI. ARDS (ANY TIME DURING ICU ADMISSION)**

**Did the patient have any of the below *at any time* during ICU admission:**

1. Bilateral opacities on chest xray or CT not fully explained by effusions, lobar/lung collapse, or nodules?

yes       no       unknown

2. At any time during the ICU stay, did the patient have a clinical exam consistent with bilateral opacities (ie, bilateral rales), even if not confirmed by chest xray?  yes     no  unknown

3. Respiratory failure not fully explained by cardiac failure or fluid overload?

yes       no       unknown

3a. Did the patient have an echocardiogram?

yes       no

4. Was the patient receiving any oxygen at any time *or* had an oxygen saturation less than 92% during ICU admission?

yes     no

4a. If yes, what was the lowest recorded oxygen saturation in the ICU? \_\_\_\_\_

(This includes saturations only during active care in the ICU, not the low saturations seen when patients are receiving only palliative care.)

4b. If blood gases are available, what was the lowest recorded pO<sub>2</sub>? \_\_\_\_\_

5. At that lowest oxygen saturation or pO<sub>2</sub>:

5a. O<sub>2</sub> delivery device:

facemask     nasal cannula     non-rebreather     CPAP     endotracheal tube

no device needed       other \_\_\_\_\_

5b. Oxygen flow rate: \_\_\_\_\_ liters / minute    OR    5c. FiO<sub>2</sub> (if on ventilator) \_\_\_\_\_%

5d. If on the ventilator or CPAP, how much PEEP was the patient on? \_\_\_\_\_

6. Did the above characteristics have onset within one week of any of these known clinical insults:

6a. Trauma       yes       no

6b. Burn       yes       no

6c. Severe infection       yes       no

6d. Surgical procedure       yes       no

6e. Myocardial infarction       yes       no

6f. Stroke       yes       no

6g. Other       yes       no

Other, please specify: \_\_\_\_\_

**VII. Interventions (ANY TIME IN HOSPITAL)**

**1. Ventilation**

1a. Did the patient receive mechanical ventilation?  yes  no

2b. Date of ventilation initiation (DD/MM/YY) \_\_\_\_\_

2c. Date of final liberation from ventilation (off ventilator  $\geq$  48 hours) (DD/MM/YY)\_\_\_\_\_

**3. Transfusion**

3a. Did the patient receive any blood products?  yes  no

**4. Vasopressors**

4a. Did the patient receive any vasopressor or inotropic medications during ICU admission?

yes  no

4b. If yes, which one(s)? (check all that apply):

dopamine  epinephrine (adrenaline)  dobutamine  norepinephrine  other, specify \_\_\_\_\_

**5. Renal replacement therapy (hemodialysis or peritoneal dialysis)**

5a. Did the patient receive renal replacement therapy (RRT)?  yes  no

**VIII. Discharge and death**

1. What day was the patient's final discharge *from the ICU*? (DD/MM/YY) \_\_\_\_\_

2. Did the patient die during this hospitalization?  yes  no

3. What day was the patient's death or discharge *from the hospital* (DD/MM/YY) \_\_\_\_\_?