ORIGINAL RESEARCH

Prevalence of malnutrition and associated risk factors among patients admitted to the intensive care unit of a tertiary university teaching hospital in Kigali, Rwanda: A cross-sectional study

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Abstract

Background
Malnutrition in critically ill patients is associated with increased risk of infections, prolonged hospitalization, and mortality. This study aimed to determine the prevalence of malnutrition, risk factors for malnutrition, and the association between malnutrition and outcomes among patients admitted to the intensive care unit (ICU) at the University Teaching Hospital of Kigali.

Methods
This was a cross-sectional study of ICU patients at a Rwandan referral hospital. Clinical and demographic features were collected for all patients. Malnutrition was assessed using ASPEN (American Society for Parenteral and Enteral Nutrition) guidelines. Risk factors for malnutrition were determined using multivariate logistic regression with cluster analysis by diagnosis.

Results
Over the study period, we enrolled 147 patients. Malnutrition was identified in 32 patients (22%) upon ICU admission. Multivariate analysis revealed the following factors as associated with malnutrition: trauma (adjusted odds ratio [aOR], 8.48; 95% confidence interval [CI], 2.30-31.21; *P*=0.001), obstetric or gynaecologic diagnosis (aOR, 7.96; 95% CI, 1.72-36.94; *P*=0.008), acute abdomen (aOR, 7.85; 95% CI, 1.76; 35.08; *P*=0.007), *other diagnoses* (aOR, 12.74; 95% CI, 3.99-40.62; *P*<0.001), age >65 years (aOR, 3.18; 95% CI, 2.39-4.23; *P*<0.001), and female gender (aOR, 2.62; 95% CI, 1.09-6.34; *P*=0.032). The presence of malnutrition at the time of ICU admission was not associated with increased odds of mortality or ICU length of stay.

Conclusions
Malnutrition is common among patients admitted to the ICU at the University Teaching Hospital of Kigali. Underlying diagnoses and patient demographics can identify patients at high risk of malnutrition who should be targeted for early and aggressive nutritional support.

Keywords: malnutrition, critical illness, intensive care unit, Rwanda

Introduction

The prevalence of malnutrition among patients managed in intensive care units (ICUs) has been reported to be as high as 50% in many parts of the world and up to 64% in sub-Saharan Africa.[1],[2] Malnutrition is associated with increased risk of infections, prolonged hospitalization, and death.[3] Different malnutrition screening and diagnostic tools have been used for ICU patients, often using history of recent intake, weight changes, gastrointestinal symptoms, and clinical findings to assess malnutrition.[4]-[8] The Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition (ASPEN) define malnutrition as having 2 or more of the following: insufficient energy intake, weight loss, loss of muscle mass, loss of subcutaneous

Table 1. Characteristics of intensive care unit patients at admission

Variable	n (%)
Age (n=143)	
<65 years	131 (92)
≥65 years	12 (8)
Sex	
Male	79 (54)
Female	68 (46)
Province	
North	5 (4)
South	14 (12)
East	19 (16)
West	7 (6)
Kigali	73 (61)
Other	1 (1)
Comorbidities	
Hypertension	13 (9)
Diabetes mellitus	7 (5)
Heart disease	6 (4)
Gastritis	3 (2)
HIV	3 (2)
Chronic kidney disease	2 (1)
Tuberculosis	1 (1)
None	97 (66)
Symptom duration (n=129)	
<5 days	72 (56)
≥5 days	57 (44)
Clinical signs	
Fever[a]	38 (26)
Tachycardia[b]	102 (69)
Tachypnoea[c]	49 (33)
Hypotension[d]	6 (4)
Hypoxia[e]	12 (8)
Diagnosis	
Trauma	46 (31)
Neurosurgical	27 (18)
Acute abdomen	22 (15)
Obstetric or gynaecologic	19 (13)
Other	33 (22)
Operation	
Yes	98 (67)
No	48 (33)
ASA physical status	
Low (class 1, 2)	58 (69)
High (3, 4)	26 (31)

Continued

Table 1. Continued

[a]Axillary temperature >38.5 °C, [b]heart rate >90 beats per min, [c]respiratory rate >22 cycles per minute, [d]systolic blood pressure <90 mmHg, [e]oxygen saturation <90%

ASA, American Society of Anesthesiologists

fat, localized or generalized fluid accumulation, or decreased functional status.[9]

There are many risk factors associated with malnutrition in ICU patients. Sociodemographic factors, such as advanced age, poverty, and dementia, can contribute to malnutrition.[10] Malnutrition can also be associated with chronic diseases, such as pulmonary disease, alcohol abuse disorder, and cancer, or inflammatory conditions, such as burns, sepsis, or postoperative inflammation. Increased metabolic demands from surgical conditions or the systemic inflammatory response syndrome increase the body's nutrient needs and are a major contributor to losses of lean body mass and malnutrition.

Malnutrition is associated with an increased risk of complications, such as acute respiratory distress syndrome, infections, renal failure, pressure sores, impaired wound healing, prolonged ICU length of stay, and death, with consequent increased total cost of hospitalization.[11],[12] Early identification of patients at high risk of malnutrition is essential to minimize these complications.[12]

To date, most data on malnutrition in critically ill patients come from high-resource settings. Little is known about the prevalence of malnutrition or risk factors for malnutrition among ICU patients in low-income countries such as Rwanda. This study aimed to determine the prevalence of malnutrition and associated risk factors upon ICU admission, as well as the association between malnutrition and clinical outcomes, at a tertiary referral hospital in Kigali, Rwanda.

Methods

This was a prospective, observational study of all ICU patients admitted to a tertiary referral hospital in Kigali, Rwanda, from January through June 2017.

Rwanda, with a population of 12 million, has 4 hospitals with ICU beds, a nationwide ICU capacity of 27 ICU beds, and 41 high-dependency unit beds. The University Teaching Hospital of Kigali (Centre Hospitalier Universitaire de Kigali, CHUK) is a 560-bed teaching and referral hospital in Kigali. The CHUK ICU has 7 beds and 4 high-dependency unit beds. Most patients admitted to the ICU are surgical patients.[13] In 2013, the most common indications for ICU admission in Rwanda were respiratory failure (73%), altered mental status (32%), and shock (25%), with an overall in-hospital mortality rate of 49%.[14]

Table 2. Nutritional characteristics of patients admitted to the intensive care unit

Characteristic	n (%)
Energy intake	
≤25% food intake in the past week	34 (23)
Weight loss	22 (15)
Symptoms ≥10 days	
Abdominal pain	9 (6)
Vomiting	9 (6)
Anorexia	2 (1)
Obstipation	1 (1)
Diarrhoea	0
Dysphagia, odynophagia	0
Physical signs	
Loss of muscle mass	24 (16)
Loss of subcutaneous fat	20 (14)
Ankle oedema	17 (11)
Sacral oedema	4 (3)
Ascites	8 (5)
Malnutrition	32 (22)

All patients admitted to the CHUK ICU during the study period were enrolled and followed through their ICU stay. Collected information included demographics, vital signs at the time of admission, height, weight, history of weight loss, symptoms, admitting diagnosis, and laboratory investigations at the time of admission. Data regarding the following details were captured during the course of hospitalization for each patient: American Society of Anesthesiologists score (if applicable), operation performed, orogastric or nasogastric tube placement, duration of nil per os, initiation of enteral feeding, and provision of parenteral nutrition. Study outcomes included ICU mortality, complications, and ICU length of stay.

Fever, tachycardia, tachypnoea, hypotension, and hypoxia were defined by the following parameters: axillary temperature >38.5 °C, heart rate >90 beats per minute, respiratory rate >22 breaths per minute, systolic blood pressure <90 mmHg, and oxygen saturation <90%, respectively.

Diagnoses were categorized as trauma, neurosurgical conditions, acute abdomen, obstetric or gynaecologic conditions, and *other diagnoses*. All patients with injuries or trauma, including isolated head injuries, were included in the trauma category. Neurosurgical conditions were defined as nontraumatic neurosurgical diagnoses, such as stroke or brain tumours. The acute abdomen category included any intraabdominal infections, peritonitis, or intestinal obstruction. *Other diagnoses* included cancers, soft-tissue infections, respiratory disorders, malaria, heart failure, renal failure, tetanus, and burns.

Patients were assessed for malnutrition according to ASPEN guidelines[12] at the time of ICU admission. Patients were classified as having malnutrition according to ASPEN criteria if they had ≥2 of the following: insufficient energy intake, weight loss, loss of muscle mass, loss of subcutaneous fat, localized or generalized fluid accumulation, or diminished functional status. Insufficient energy intake was defined as receiving nil per os or no energy intake for at least 5 days. Weight loss at the time of admission was defined as weight loss ≥3 kg in the past 6 months. As there were no hospital bed scales, weight measurements were taken for the few patients who were physically able to stand on a scale. Otherwise, we relied on the patient's or caretaker's report of weight and weight loss. Localized or generalized fluid accumulation was defined as intraperitoneal (ascites), ankle, or sacral oedema with a rating of ≥1+. Diminished functional status was measured by handgrip strength using an electronic handgrip strength meter (DrillPro). Handgrip was reported as weak, normal, strong, or not assess-

Table 3. ASPEN criteria assessment of patients with malnutrition admitted to the intensive care unit

Variable	No malnutrition (n=115) n (%)	Malnutrition (n=32) n (%)	*P* value
Age (n=142)			
<65 years	106 (96)	24 (77)	0.007
≥65 years	5 (5)	7 (23)	
Sex			
Male	66 (57)	13 (41)	0.092
Female	49 (43)	19 (59)	
Residence			
Kigali	59 (63)	14 (54)	0.374
Outside Kigali	34 (37)	12 (46)	

Continued

able according to the device manufacturer's recommendations. As many patients were intubated or sedated, handgrip strength was predominantly recorded as not assessable. Therefore, in the analysis, handgrip strength was removed from the malnutrition assessment.

Table 3. **Continued**

Variable	No malnutrition (n=115) n (%)	Malnutrition (n=32) n (%)	*P* value
Comorbidities			
Diabetes mellitus	5 (4)	2 (6)	0.655
Hypertension	9 (8)	4 (13)	0.410
HIV	1 (1)	0	0.597
Tuberculosis	1 (1)	2 (6)	0.057
Other	0	1 (3)	0.057
Symptom duration (n=128)			0.003
<5 days	64 (63)	8 (31)	
≥5 days	38 (37)	18 (69)	
Clinical signs			
Fever[a]	30 (26)	8 (25)	0.901
Tachycardia[b]	78 (68)	24 (75)	0.436
Tachypnoea[c]	40 (35)	9 (28)	0.480
Hypotension[d]	5 (4)	1 (3)	0.757
Hypoxia[e]	9 (8)	3 (9)	0.777
Diagnosis			
Trauma	39 (34)	7 (22)	0.194
Neurosurgical	24 (21)	3 (9)	0.137
Acute abdomen	14 (12)	8 (25)	0.072
Obstetric or gynaecologic	15 (13)	4 (13)	0.935
Other	23 (20)	10 (31)	0.177
Operation (n=146)			0.291
Yes	79 (69)	19 (59)	
No	35 (31)	13 (41)	
ASA physical status (n=84)			0.173
Low (class 1, 2)	43 (65)	14 (82)	
High (3, 4)	23 (35)	3 (18)	

[a]Axillary temperature >38.5 °C, [b]heart rate >90 beats per min, [c]respiratory rate >22 cycles per minute, [d]systolic blood pressure <90 mmHg, [e]oxygen saturation <90%

ASA, American Society of Anesthesiologists; ASPEN, American Society for Parenteral and Enteral Nutrition

Data were entered into a REDCap (Research Electronic Data Capture; Vanderbilt University, Nashville, TN, USA) database and analysed using Stata 13.0 (StataCorp, College Station, TX, USA).[15] Categorical variables are reported as frequencies and percentages. Continuous variables are reported as medians and interquartile ranges (IQRs). Univariate analysis was performed using the chi-square test, the Fisher exact, or the Wilcoxon rank-sum test.

Using multivariate logistic regression analysis, we evaluated risk factors for malnutrition upon hospital admission. Recognizing that certain diagnoses could manifest with specific signs and symptoms delineating malnutrition, we decided to incorporate all diagnoses into our multivariate logistic regression model. Furthermore, factors that yielded *P* values <0.1 in the univariate analysis were introduced into the multivariate regression model. This model was subjected to cluster analysis based on the diagnosis. Factors that yielded *P* values <0.05 in the multivariate analysis were deemed statistically significant. To ascertain the model's fit, we performed a Hosmer–Lemeshow goodness-of-fit test.

The study received ethical approval from the University of Rwanda College of Medicine and Health Sciences Institutional Review Board (No. 211/CMHS IRB/2017), the University Teaching Hospital of Kigali Ethics Committee, and the University of Minnesota Institutional Review Board (STUDY00000723). Before enrolling in the study, patients or their caregivers provided written informed consent.

Results

Patient characteristics at ICU admission

Over 6 months, we enrolled 151 patients from the ICU in the study. However, we excluded 4 patients from our analysis due to incomplete data concerning mortality or nutritional status, leaving us with 147 patients for the final analysis.

Table 1 details the characteristics of the patients admitted to the ICU. The median age was 34 years (IQR, 26-49). Surgical diagnoses predominated, with the most common being trauma (n=46, 31%), nontraumatic neurosur-

Table 4. Multivariate analysis of factors associated with malnutrition at hospital admission with cluster analysis by diagnosis among patients admitted to the intensive care unit

Variable	Odds ratio	95% confidence interval	*P* value
Age <65 years	Reference	–	–
Age ≥65 years	3.18	2.39-4.23	<0.001
Male sex	Reference	–	–
Female sex	2.62	1.09-6.34	0.032
No tuberculosis	Reference	–	–
Tuberculosis	3.29	0.001-11479	0.775
Symptom duration ≤5 days	Reference	–	–
Symptom duration >5 days	3.42	0.72-16.44	0.123
Neurosurgical diagnosis	Reference	–	–
Trauma	8.48	2.30-31.21	0.001
Acute abdomen	7.85	1.76-35.08	0.007
Obstetric or gynaecologic diagnosis	7.96	1.72-36.94	0.008
Other diagnosis	12.74	3.99-40.62	<0.001

gical conditions (n=27, 18%), acute abdomen (n=22, 15%), and obstetric or gynaecological diseases (n=19, 13%). The majority of the patients (n=98, 67%) underwent surgery, had a nasogastric tube in place (n=102, 69%), and 42% (n=62) had enteral intake within 24 hours of ICU admission. Only a small proportion (n=6, 4%) received total parenteral nutrition.

Risk factors for malnutrition at ICU admission

Upon ICU admission, 32 patients (22%) were malnourished (Table 2). The univariate analysis indicated that patients with malnutrition were typically older (median age 47 years vs 32 years, P=0.002) and had a longer symptom duration (symptom duration greater than 5 days: 69% vs 37%, P=0.003) (Table 3). We observed no significant difference in vital signs on admission based on malnutrition status.

Our multivariate analysis, with cluster analysis by diagnosis, identified several factors associated with malnutrition at ICU admission. These included trauma (adjusted odds ratio [aOR], 8.48; 95% confidence interval [CI], 2.30-31.21; P=0.001), an obstetric or gynaecologic diagnosis (aOR, 7.96; 95% CI, 1.72-36.94; P=0.008), acute abdomen (aOR, 7.85; 95% CI, 1.76-35.08; P=0.007), other diagnosis (aOR, 12.74; 95% CI, 3.99-40.62; P<0.001), age over 65 years (aOR, 3.18; 95% CI, 2.39-4.23; P<0.001), and female sex (aOR, 2.62; 95% CI, 1.09-6.34; P=0.032) (Table 4). The Hosmer–Lemeshow goodness-of-fit test indicated a good fit for our model (P=0.906).

Outcomes

The ICU mortality rate was 33%, and the median length of ICU stay was 6 days (IQR, 3-10) (Table 5). We found no association between mortality (32% vs 34%, P=0.814) or length of ICU stay (6 days vs 6.5 days, P=0.500) and malnutrition. Overall, 88 patients (59%) experienced complications. The most commonly reported complications were infections (n=23, 16%) and bedsores (n=15, 10%). Patients with malnutrition were more likely than those without malnutrition to develop an infectious complication (28% vs 12%, P=0.028).

Discussion

The overall prevalence of malnutrition upon ICU admission was 22%. The multivariate analysis associated malnutrition on ICU admission with factors such as trauma, obstetric or gynaecologic diagnoses, acute abdomen, age over 65 years, and female sex. Most of these diagnoses may be associated with high levels of inflammation, increased ICU stay, inadequate feeding, and poor nutritional status.

To our knowledge, this study is the first to provide objective, quantifiable data on the levels of malnutrition among Rwandan ICU patients. Although this study was conducted at a single institution with 7 ICU beds, this represented 26% of all ICU beds in the country, catering to a catchment area serving half of the Rwandan population (6 million people). While physicians can subjectively identify malnutrition, quantifiable measures are crucial to such assessments. The ability to assess the level of malnutrition during the ICU

Table 5. Outcomes in intensive care unit patients with malnutrition defined according to American Society for Parenteral and Enteral Nutrition criteria

Outcome	Total	No malnutrition	Malnutrition	*P* value
Complications, total	87 (59)	65 (57)	22 (69)	0.213
Infection	23 (16)	14 (21)	9 (28)	0.028
Bedsores	15 (10)	10 (9)	5 (16)	0.252
Unplanned reoperation	5 (5)	5 (6)	0	0.270
Acute kidney injury	3 (2)	3 (3)	0	0.356
Electrolyte abnormalities	3 (2)	3 (3)	0	0.356
Death	48 (33)	37 (32)	11 (34)	0.814
Length of ICU stay, median (IQR) days	6 (3-10)	6 (3-10)	6.5 (3-13)	0.500

Values are n (%) unless otherwise indicated.
ICU, intensive care unit; IQR, interquartile range

course enables providers to determine the efficacy of nutritional supplementation.

Malnutrition prevalence in ICU patients ranges from 30%-100% in other studies.[1],[16]-[19] The diversity in definitions of malnutrition contributes to this wide range of prevalence rates. The lower rate of malnutrition in our study could be attributed to patient demographics and clinical features. Most Rwandan ICU patients are young males admitted with traumatic injuries who were otherwise healthy before the respective injurious events. This is similar to a study of Brazilian trauma ICU patients, wherein the overall rate of malnutrition at the time of ICU admission was 26.8%.[20] The median age in our study sample was relatively young, at 34 years, which aligns with other studies on Rwandan surgical patients.[13],[21]-[23] Conversely, ICU patients in other settings are often older than Rwandan ICU patients.[24],[25] Previous studies have indicated that older patients are at higher risk of malnutrition.[17],[26],[27] This is consistent with our multivariate analysis findings, which showed that age >65 years was associated with 3-times greater odds of malnutrition upon ICU admission.

As evidenced by our multivariate analysis, some underlying diagnoses may place patients at a higher risk of malnutrition.[17],[24] Trauma, acute abdomen, and obstetric or gynaecologic conditions were found to be associated with a higher risk of malnutrition upon ICU admission. Patients with acute abdomen may have had decreased oral intake prior to presentation. Moreover, certain medical illnesses, such as cancer[26] and sepsis,[25] have been associated with malnutrition. Immune status has been shown to play a pivotal role in nutritional status, though the precise mechanisms and pathways involved remain speculative.[25]

On univariate analysis, prolonged symptom duration >5 days was found to be a risk factor for malnutrition; however, this was not statistically significant on multivariate analysis. Prolonged symptom duration may be associated with various factors, including advanced disease, delayed diagnosis, or poor oral intake in the days preceding hospital admission. All of these factors can contribute to malnutrition. Delays in presentation have been identified as a challenge for Rwandan surgical patients.[22],[28],[29] Identifying patients at high risk of malnutrition allows for the early implementation of aggressive nutritional support in these patients.

Studies have found that most ICU patients are underfed during their ICU stay.[30] Nutritional support often starts slowly and never reaches the recommended targets.[30] Under-prescribing is a common challenge.[31] Other difficulties in achieving feeding goals identified by a study conducted in India included obtaining feeds (17.6%) and having feeds held for procedures (16.4%).[18] In our study, most patients had a nasogastric tube, and 42% of patients started enteral feeds within 24 hours of ICU admission. In contrast, a study in Iran found that 28.6% of patients began enteral feeding more than 48 hours after ICU admission.[31] This supports the idea that interventions and treatment can be achieved in a timely manner, especially if at-risk patients can be identified as early as possible. The development of locally appropriate protocols may help optimize nutritional therapy.[32]

While the data comparing enteral versus parenteral nutrition remains inconclusive,[33] resource constraints render enteral nutrition the method of choice in Rwanda. The vast majority of nutritional support in Rwanda is provided enterally. Parenteral nutrition is less commonly used due to limited availability and cost. This study did not capture data on the quantity or quality of enteral nutrition; therefore, we cannot determine its adequacy. Without knowing the nutritional quality and content of the food provided, estimating the necessary quantity of food is challenging. In Rwanda, most food is home-prepared, and commercial preparations are rare. Dieticians provide caretakers with meal preparation recommendations, but it is unclear how consistently these guidelines are followed. Ongoing studies are evaluating the nutritional content of the food consumed by Rwandan patients to develop locally sourced nutrient supplement recommendations.

We observed high rates of mortality and complications. Despite a relatively high mortality rate of 33%, this is lower than previous studies of the Rwandan ICU population.[13],[14] The most common complications included bedsores and infections. Malnutrition was associated with infectious complications in this study, which aligns with findings from other studies. However, contrary to several studies, malnutrition was not associated with ICU mortality or length of stay. This is in contrast to other studies, wherein malnutrition has been associated with increased ICU length of stay and in-hospital mortality.[16]-[19],[24],[26],[34] Malnutrition has also been associated with unplanned hospital readmissions and 90-day mortality,[35] but we did not assess these outcomes in our study. Potential reasons for divergence between our study's findings and those of other studies include varied study populations and the younger demographic of our study cohort.[17],[24],[26] Additionally, we only followed patients during their respective ICU admissions and did not examine in-hospital, 30-day, or 90-day outcomes. The small sample size and lower mortality rate of this study may limit our ability to detect smaller outcome differences between groups.

Limitations

There were several limitations to this study. As patients were in critical condition and generally unable to communicate, data were primarily obtained from caretakers, possibly introducing bias. Each patient was assessed by a trained data collector and followed throughout their respective ICU stays, which helped limit the bias in assessing clinical variables, such as fluid accumulation. However, we only captured data during the ICU admissions and not after ICU or hospital discharge, which limits our outcome data. No perfect standard measurement for malnutrition exists, and every assessment tool has limitations. Although ASPEN has been found to be a valid tool for use in critically ill patients,[17] we did not routinely collect laboratory measurements, such as serum albumin, at our site.[36]

Due to the challenges of obtaining weight data and handgrip strength measurements in the ICU, malnutrition may have been underestimated. Bed weights were not available, so we relied on estimated weights from the patient or caretaker. Furthermore, we could not capture data on handgrip strength for most patients because of their clinical states. However, we do not believe this significantly impacted our results, as other studies have found that handgrip strength correlates poorly with malnutrition.[37],[38]

Conclusions

Malnutrition is a significant issue among patients admitted to an ICU in Rwanda. Patient demographics and underlying diagnoses can be used to identify those at high risk of malnutrition for whom to initiate aggressive nutritional support, potentially decreasing complications. The low incidence of malnutrition in our study relative to others may be attributed to the predominance of young patients with few comorbidities and trauma in our study. Future collaborations with other ICUs in Rwanda and the region are needed to further elucidate the impact of malnutrition on clinical outcomes.

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