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Original article

Anthropometric malnutrition and mortality in surgical patients in an intensive care unit

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ABSTRACT

Introduction: Malnutrition in surgical intensive care patients is a poorly studied risk factor. With the aim of identifying the association of anthropometric nutritional status with mortality in surgical patients admitted to intensive care, an analytical cross-sectional study was conducted on 58 critically ill surgical patients between 2019 and 2020. Nutritional status was classified using a pragmatic composite of grouped and isolated anthropometric

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measurements. Association with mortality was analyzed using χ^2, crude prevalence ratio, odds ratio, area under the receiver operating characteristic curve, and attributable fraction. The result was a prevalence of malnourished patients of 48.3 %. Malnourished patients had a mortality rate of 67.9 % (crude prevalence ratio: 10.19). The grouped anthropometric measurements showed good discrimination, sensitivity and specificity. Agreement between anthropometric measurement methods was adequate. From the study results, it is concluded that anthropometric undernutrition was associated with mortality in this patient group, with a high attributable clinical impact. Grouped anthropometric measurements are a valid and reproducible biomarker at the patient's bedside.

Keywords: Malnutrition; Anthropometry; Mortality; Intensive Care Units; Surgical Procedures, Operative.

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Introduction

Hospital malnutrition represents a significant challenge in surgical intensive care units (SICUs). This condition, characterized by deficits in energy and protein intake, is associated with hypercatabolism, systemic inflammation, and immune compromise, and exacerbates postoperative morbidity and mortality. International studies estimate prevalences between 30 and 60% in critically ill patients, with impacts on prolonged mechanical ventilation, nosocomial infections, and high healthcare costs. (1,2)

In Cuba, studies have highlighted similar prevalences (between 52 and 76%) in ICUs, with outcomes including high mortality, nosocomial infections, or prolonged mechanical ventilation and hospital stay. (3, 4)

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Biochemical markers such as hypoalbuminemia, lymphopenia, and hypocholesterolemia reflect not only nutritional deficiencies but also acute inflammation and metabolic stress in critically ill surgical patients. These indicators predict up to a 3- to 5-fold increased risk of complications, including sepsis and multiple organ failure. (5) In Cuba, tertiary-level studies correlated severe hypoalbuminemia with ICU mortality of 40 to 60% in postoperative patients. (6)

Periodic assessments and monitoring at the Celia Sánchez Manduley Hospital identified the need for further in-depth nutritional evaluation of critically ill post-surgical patients, as well as contributing factors such as length of hospital stay, associated infections, and reasons for hospital admission, among others, that could influence poor outcomes and prognosis in these patients. The objective of this research was to identify the association between anthropometric nutritional status and mortality in surgical patients admitted to the intensive care unit at the Celia Sánchez Manduley Hospital.

Methods

An observational, analytical, cross-sectional study with a prospective data collection component was conducted on patients who met the inclusion criteria. The study population consisted of 58 individuals with severe or critical surgical illness, defined as any postoperative patient with severe hydroelectrolytic disorders, sepsis, hemodynamic disorders (mean arterial pressure less than 65 mmHg or systolic pressure less than 90 mmHg, heart rate greater than 120 bpm) and/or the need for ventilatory monitoring or mechanical ventilation, who met the following inclusión criteria:

- ✓ Seriously ill or critically ill post-surgical patients admitted to the Intensive Care Unit for more than 24 hours
- ✓ Patients in whom the anthropometric assessments required by the study could be performed.

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Exclusion criteria:

- ✓ Age < 18 years
- ✓ Burn patients, neurosurgical patients, or major trauma patients
- ✓ ICU stay < 24 hours
- ✓ Technical impossibility to perform anthropometric measurements (massive edema, amputations, etc.)

A pragmatic composite criterion was used based on three anthropometric measurements (upper arm circumference, calf circumference, and skinfold thickness). These measurements have been previously used in Cuban and foreign studies in resource-limited contexts. (3, 7, 8) This criterion does not replace validated tools such as mNUTRIC (9) or SGA, (10) but it is feasible at the bedside in thissetting.

Cases were classified as malnourished when they met two or more of the measured anthropometric parameters (grouped). (3)

Reference for malnutrition according to:

Arm circumference (AC): men < 23 cm and women < 22 cm (measured in supine position with measuring tape)

Leg or calf circumference (CP): < 31 cm (measured in supine position with measuring tape)

Skinfold thickness (SFT): men < 12.5 mm and women < 16.5 mm (Measured with calipers, three measurements were taken and the average value was calculated)

Period and place: Intensive Care Unit of the Celia Sánchez Manduley Clinical-Surgical Teaching Hospital of Manzanillo, Granma, during the months of September 2019 to December 2020.

Each patient's age (completed years), sex, biochemical indicators were recorded (mild hypoalbuminemia (L): 28-34.9 g/L, moderate (M): 21-27.9 g/L and severe (G): 20.9 g/L or less; hypocholesterolemia L: 1.9-2.2 mm/L, M: 1.5-1.8 mm/L and G: <1.5 mm/L;

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lymphocytopenia L: 1999 and 1200 lymphocytes/mm3, M: 1199 and 800 lymphocytes/mm3 and G: <800 lymphocytes/mm3), presence of comorbidity (according to the Charlson Comorbidity Index [3]), presence of hospital-acquired infections, surgical location (abdominal/extra-abdominal), type of surgery (urgent/elective), presence of reintervention, presence of mechanical ventilation, and discharge status (alive / deceased).

For data collection, a form was created for each of the selected patients who were admitted during the time the investigation lasted.

The information was obtained directly from the unit's admission records, from each patient's medical records, from autopsy protocols, and from the nutritional examination performed by the researchers at different times during the study.

Statistical analysis

The statistical analysis of the primary data was processed using computerized techniques on an ASUZ laptop and through the SPSS statistical program version 21(IBM Corp., Armonk, NY) and R 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria). Categorical variables were expressed as absolute and relative frequencies (%). The association between nutritional status and clinical variables was initially assessed using Pearson's χ^2 test or Fisher's exact test when any expected frequency was< 0.05.

The crude prevalence ratio (PR) was calculated and as a complementary analysis the odds ratio (OR) was estimated by binary logistic regression, recognizing that the OR may over estimate the association when the outcome is frequent.

The discriminatory power of pooled anthropometric measures to predict mortality was assessed using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the receiver operating characteristic (ROC) curve with a 95% confidence interval.

The agreement between anthropometric methods (grouped vs isolated) was measured using Cohen's Kappa index.

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The attributable risk (AR), attributable fraction in exposed individuals (AF), and population attributable fraction (PAF) were estimated to quantify the clinical impact of malnutrition.

All confidence intervals were reported at 95% and a p-value < 0.05 was considered statistically significant.

For this study, the ethics committee of the Celia Sánchez Manduley Hospital was informed of the purpose of this research, and permission was granted to access individual medical records without disclosing the patients' names or any other identifying information. Therefore, no special bioethical considerations were necessary. Approval was also obtained from the institutional scientific council and from those patients who consented to participate in the research.

Results

Table 1 shows the anthropometric variables that assessed the nutritional status of the 58 surgical patients in the study period; these represented 21.6% of the total patients treated in the ICU.

The combined measurements of at least two grouped anthropometric indicators showed that 28 patients presented with energy-nutritional malnutrition, representing a prevalence of 48.3% in the surgical population studied. Isolated measurement of body fat suggested some type of malnutrition in 46.5% of the series, while isolated measurement of body composition and waist circumference showed malnutrition rates of 44.8% and 43.2%, respectively.

Table 1. Nutritional status according to anthropometric indicators in surgical patients.

Indicators anthropometric	Nutritional Status (n= 58)			
	Malnourished		Nourished	
	No.	%	No.	%
Grouped anthropometric measurements	28	48.3	30	51.7

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Measures anthropometric isolated	Arm circumference	27	46.5	31	53.5
	Leg circumference	25	43.2	33	56.8
	Skin fold thickness	26	44.8	32	55.2

Source: Medical record

Table 2 shows the results of the analysis of sociodemographic and laboratory variables. Malnourished individuals were older (85.6% ≥ 60 years vs. 76.7%; $p = 0.031$) and had more comorbidities (96.4% vs. 80%; $p = 0.054$). From a biochemical standpoint, hypoalbuminemia affected 100% of malnourished individuals (35.8% mild, 32.1% moderate-severe) vs. 6.7% of well-nourished individuals ($p < 0.001$); lymphopenia and hypocholesterolemia were present in 100% ($p < 0.001$).

Table 2. Nutritional status according to sociodemographic, laboratory, surgical and life support variables.

Variables	Categories	Malnourished (n = 28)		Nourished (n = 30)		Total (n = 58)		p-value
		No.	%	No.	%	No.	%	
Sociodemographic								
Age (years)	≥ 30	4	14.4	2	6.6	6	10.2	0.031
	30-60	12	42.8	5	16.7	17	29.4	
	> 60	12	42.8	23	76.7	35	60.3	
Sex	Male	17	60.7	18	60	35	60.3	0.956
	Female	11	39.3	12	40	23	39.7	
Comorbidity	Present	27	96.4	24	80	51	87.9	0.054

Source: Medical record

Table 3 shows the results of the analysis of surgical and life support variables. No differences were observed in surgical location (100% abdominal), type (100% urgent), reoperations, or infections. From a clinical perspective, 32.1% of malnourished patients required mechanical ventilation ($p = 0.000$). Mortality was 69.7% in malnourished patients vs. 6.7% in the non-malnourished group.RP: 10.19;95% CI: 2.66 – 39.03; $p = 0.000$).The

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pooled anthropometric measurements showed good discriminatory power to identify patients with a higher risk of mortality (ACOR: 0.83; 95% CI: 0.72 – 0.94; p = 0.000).

Table 3. Nutritional status according to surgical variables and life support.

Variables	Categories	Malnourished (n = 28)		Nourished (n = 30)		Total (n = 58)		p-value
		No.	%	No.	%	No.	%	
Surgical								
Surgical location	Abdominal	28	100	28	93.4	56	96.6	0.351
	Extra-abdominal	-	-	2	6.6	2	3.4	
Type of surgery	Urgent	28	100	29	96.7	57	98.3	0.333
	Elective	-	-	1	3.3	1	1.7	
Reintervention		28	100	29	96.7	57	98.3	0.331
Hospital-acquired infections		28	100	28	93.3	56	96.6	0.166
Life support								
Artificial mechanical ventilation		9	32.1	-	-	9	15.6	0.000
State at discharge	Deceased	19	69.7	2	6.7	21	36.2	0.000
	Alive	9	32.1	28	93.3	37	63.8	
Prevalence ratio (PR): 10.19;95% CI: 2.66 – 39.03; p = 0.000 Odds Ratio (OR):29.6; 95% CI: 5.9 – 148.5; p = 0.000 ACOR: 0.83; 95% CI: 0.72 – 0.94; p = 0.000								

Source: Medical record

The pooled anthropometric measurements correctly identified 90.5% of the deceased and ruled out malnutrition in 75.7% of the survivors. The negative predictive value (NPV) of 93.3% suggests that a patient classified as well-nourished has a high probability of survival. (Table 4) Theoretically, 90.1% of deaths in malnourished individuals were attributable to this factor, and 63.8% of all deaths could be prevented by correcting malnutrition.

Table 4. Diagnostic value of mortality according to anthropometric nutritional status and clinical impact.

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Metrics	Worth	95% CI
Sensitivity	90.5	69.6 – 98.8
Specificity	75.7	58.8 – 88.1
Positive predictive value	67.9	48.4 – 83.0
Negative predictive value	93.3	77.9 – 99.2
Attributable risk: 61.2% Attributable fraction in exposed individuals: 90.1% Population attributable fraction: 63.8%		

Source: Medical record

The pooled method showed excellent reproducibility with the isolated criteria (average Kappa: 0.86), and validates its use in the ICU (Table 5).

Table 5. Agreement between anthropometric methods for classifying malnutrition.

Comparison	Cohen's Kappa	95% CI
Grouped vs arm circumference	0.93	0.84 – 1.00
Grouped vs leg circumference	0.79	0.64 – 0.94
Clustered vs. skin fold	0.86	0.74 – 0.98
Average	0.86	-

Source: Medical record

Discussion

The prevalence of malnutrition of 48.3% in the present series coincides with the report of a systematic review of more than 200,000 hospitalized patients in which they estimate values of 5-50%, with peaks of more than 50% in prolonged abdominal post-surgical patients. (11)

The association with advanced age coincides with other results such as the large Chinese study by Liu et al., (12) in which there was a positive correlation between frailty and malnutrition with older adults (r= 0.464; p= 0.000), attributable to sarcopenia and the presence of comorbidities.

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The unique biochemical alterations in malnourished individuals underscore a severe inflammatory-nutritional phenotype. Critically ill patients present with a state of inflammation linked to the severity of their illness, leading to increased caloric and protein consumption, associated with greater intolerance to nutritional therapy and, consequently, malnutrition. In turn, malnutrition leads to greater morbidity and a greater state of inflammation, creating a vicious cycle that can result in multiple organ dysfunction. (13)

Biochemical variables are affected by metabolic changes that modify synthesis and degradation processes in critically ill patients. Nevertheless, they are useful in the initial assessment and monitoring of patients during their stay in the ICU. (13)

Prealbumin and retinol-binding protein have short half-lives, 2 days and 12 hours respectively, and are highly sensitive to acute changes. They provide information on new events of metabolic stress and the anabolic phase and are therefore useful for monitoring. Albumin and transferrin have longer half-lives, 20 and 10 days respectively, are less sensitive to acute changes, and are therefore useful for initial assessment but not for monitoring. Albumin also has prognostic value for reasons other than purely nutritional ones in critically ill patients. (13)

Albumin and cholesterol levels are the most stable indicators that can be measured in the laboratory. However, due to their very long half-life, it is not possible to quickly determine their synthesis status; their low molecular weight facilitates their rapid passage into the interstitial space, influencing their plasma concentration for reasons other than their synthesis status. Thus, hypoalbuminemia in critically ill patients reflects the passage of albumin into the interstitial space as a consequence of increased capillary permeability, rather than albumin consumption due to malnutrition. (3)

Malnourished patients undergoing airway interventions and mechanical ventilation exhibit higher rates of extreme morbidity and mortality, experiencing greater complications such as pneumonia, sepsis, pressure ulcers, delayed wound healing, increased hospital stays, and greater dependence on nursing care and intensive medical

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treatment. Logically, this also leads to increased hospital costs and a reduced quality of life for survivors. (3)

Koontalay et al., (14) studied the impact of nutritional factors on the duration of mechanical ventilation in criticallyill patients and concluded that monitoring nutritional status, time tostart enteral nutrition, calories and target caloricrequirements are statistically significantly associated with the duration of mechanical ventilation (R: 0.54; R: 0.30, R: 0.40; $p < 0.05$).

The prevalence of malnutrition in critically ill patients ranges from 30% to 55% of patients admitted to the ICU, depending on the criteria used for patient selection and malnutrition diagnosis. Specifically in surgical cases, some reports show lower rates (less than 18.5%). (15, 16)

The critically ill patient presents a state of inflammation linked to the severity of their illness, which leads to a higher caloric-protein consumption, associated with a greater intolerance to nutritional therapy and, therefore, to malnutrition. (13)

The mortality rate reported in this study is high when compared to other studies conducted in the country. However, mortality in this subgroup of patients can exceed 40% according to consulted authors. (4, 17, 18)

In this regard, it is important to note that, although the nutritional status of patients admitted to the ICU can influence mortality as an additional variable, it is not the only factor affecting the outcome, since the presence of other variables such as comorbidities, the occurrence of complications including sepsis, the patient's age, the appearance of tumors, the use of ventilation and length of stay, can also influence mortality. (17)

To calculate nutritional risk, the only instrument specifically designed for critically ill patients is the Nutrition Risk in the Critically Ill (NUTRIC). Compared to other similar instruments, NUTRIC has the following advantages: it is easy to use, practical (requiring data that is normally monitored in the ICU), a validated method, and a tool specifically designed for this population. Furthermore, several studies support the claim that the NUTRIC score (in its NUTRIC 1 and NUTRICm variants) acts as a predictor of death within

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the first 28 days of ICU admission. (19) Finally, Lew et al., (2) in their large meta-analysis linked the presence of malnutrition to a 1.8–2.5-fold increased likelihood of 28-day mortality.

Limitations of the study

The limitations of this research include a small sample size, which limits the statistical power for multivariate analyses and results in wide confidence intervals. The cross-sectional design prevents establishing temporality or causality between anthropometric malnutrition and mortality, and the single nutritional assessment upon admission does not allow for detecting changes during the ICU stay. Furthermore, the heterogeneity of the study population and the lack of adjustment for key confounding variables such as severity scores (APACHE II or SOFA) may have influenced the results.

Prolonged recruitment for a limited number of patients and the single-center study with limited resources restrict the generalizability of the findings. Finally, although justified by accessibility, the use of a caliper instead of a standardized skinfold caliper and the lack of detailed reporting of inter/intra-observer variability represent additional sources of measurementbias.

However, the authors wish to emphasize that the present study provides novel evidence by demonstrating, in a context of limited resources, that a simple composite criterion based on pooled anthropometric measurements has adequate agreement between methods, good discriminatory power for mortality, and bedside reproducibility, even using accessible instruments such as measuring tape and calibrated calipers.

This approach overcomes limitations of previous local studies that focused predominantly on inflammatory biochemical markers or subjective assessments and offers an objective, low-cost and feasible tool in settings where validated scores such as mNUTRIC or SGA are not always applicable due to a lack of data (e.g., IL-6).

From a practical point of view, the findings highlight the value of the population attributable fraction, suggesting that the routine implementation of this anthropometric screening could identify almost half of critically ill surgical patients at risk early on and

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allow prioritization of early nutritional interventions and potentially reduce mortality in more than half of the attributable cases, with direct implications for the optimization of resources and care protocols in intensive care units and in countries with similar characteristics.

Conclusions

Malnutrition, defined by simple anthropometric measurements, affected nearly half of critically ill surgical patients and was associated with higher in-hospital mortality. These findings underscore the need for routine nutritional assessment with readily available indicators and early enteral nutrition protocols to mitigate risks. The pooled anthropometric measurements proved valid and reproducible in a resource-limited setting.

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Conflicts of interest

The authors declare no conflicts of interest.

Authorship contribution

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