

# Ultrasound Assessment of Quadriceps Muscle Layer Thickness as a Predictor of Outcome in Critically ill Patients

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## Abstract

**Aim:** Muscle weakness in critically ill patients is associated with complications, but its accurate quantification at the bedside remains challenging. Our aim was to assess whether loss of quadriceps muscle layer thickness (QMLT) predicts mortality, and to examine its correlation with duration of mechanical ventilation and other severity indices.

**Materials and Methods:** A total of 100 intensive care unit (ICU) patients were prospectively assessed with QMLT measurements on the dominant side on days 1, 3, and 7 of the ICU stay, or on the day of discharge, whichever occurred earlier.

**Results:** Percentage decline in QMLT on days 3 and 7 (or discharge) was a significant predictor of mortality [for day 3: hazard ratio (HR): 1.06, 95% confidence interval (CI): 1.03-1.1,  $p=0.001$ ; for day 7 or discharge: HR: 1.05, 95% CI: 1.02-1.07,  $p=0.0002$ ]. The decline in QMLT correlated well with mortality ( $p=0.50$ ,  $p<0.001$  at day 3, and  $p=0.77$ ,  $p<0.001$  at day 7 or on the day of discharge). A decline in QMLT correlated with duration of mechanical ventilation on day 7 ( $p=0.46$ ,  $p<0.001$ ) and with mNUTRIC score on day 3 and on day 7 of ICU stay or on the day of discharge ( $p=0.36$ ,  $p<0.001$  at day 3;  $p=0.44$ ,  $p<0.001$  at day 7 or on the day of discharge). The decline in QMLT did not correlate with the duration of ICU stay. A  $>25.97\%$  decline in QMLT on day 7 of ICU stay was associated with a high area under the curve (AUC) (AUC 0.96;  $p<0.0001$ ).

**Conclusion:** Continuous monitoring of QMLT decline by ultrasound independently predicts mortality.

**Keywords:** ICU patients, ICU outcome, quadriceps muscle, ultrasound

## Introduction

Muscle weakness in critically ill patients is linked to a wide range of health challenges (1,2). The causes are multifactorial and include deranged glycaemia, inflammatory stress responses, immobilization, nutrient deficiencies, and various medications—all of which contribute to intensive care unit (ICU)-associated muscle weakness (1,3). Early identification of muscle weakness in critically ill patients is essential (4). Muscle wasting can progress at a rate of up to 2% per day, with the greatest losses observed in patients with multiorgan dysfunction syndrome during the first 10 days of illness (3,5). Such muscle loss can delay recovery and is associated with longer hospital stays, higher mortality, and increased healthcare costs (6).

Accurate bedside quantification of muscle wasting remains a challenge (7,8). Conventional anthropometric measurements are often unreliable in the ICU, while advanced imaging techniques such as computed tomography are impractical for routine use (7,9,10). Ultrasonography (USG) has therefore emerged as a valuable bedside tool—non-invasive, cost-effective, and widely accessible (4,10-13).

Loss of quadriceps muscle-layer thickness (QMLT) has been shown to correlate with in-hospital survival, duration of mechanical ventilation, and other indicators of severity in the ICU (3,7,14). However, data on this topic remain limited in Asian populations (15). Therefore, we designed this study to assess QMLT, measured by USG, as a predictor of mortality in critically ill patients. The secondary objectives were to examine the relationships between



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QMLT and the duration of mechanical ventilation, the length of ICU stay, and the modified Nutrition Risk in the Critically Ill (mNUTRIC) score among patients admitted to our ICU.

## Materials and Methods

This prospective observational study involved 100 patients admitted to the ICU of our institute and was conducted after obtaining this study received approval the Vardhman Mahavir Medical College and Safdarjung Hospital Institutional Ethics Committee (desicion number: IEC/VMMC/SJH/Thesis/06/2022/CC-47, date: 11.07.2022). Toledo et al. (7) reported hazard ratios (HRs) of 2.1 for requiring mechanical ventilation, 3.7 for probability of ICU survival, and 4.5 for probability of hospital survival, based on thigh muscle thickness. Using these values as references, the minimum required sample size to achieve 80% study power at a 5% significance level was calculated as 97.13 patients. To reduce the margin of error, 100 patients were recruited.

All adults aged 18 years and above who were expected to require mechanical ventilation for at least 48 hours were included after obtaining written informed consent. Patients were excluded if they had documented neuromuscular disease (e.g., myopathy, neuropathy), cerebrovascular accident, lower limb amputation or orthopedic surgery, pregnancy, requirement for prone positioning, transfer from another hospital after an ICU stay of more than 48 hours, extubation within 48 hours, or a hospital stay of less than 72 hours due to death or discharge.

During the first 24 hours after ICU admission, demographic, biochemical, and clinical data were collected. Acute Physiology and Chronic Health Evaluation II (APACHE II) scores, Sequential Organ Failure Assessment (SOFA) scores, and mNUTRIC scores were recorded at admission. Quadriceps muscle thickness was measured using a portable B-mode Sonosite M-Turbo (Digi 600 A Pro) ultrasound device with a 6-12 MHz linear array probe. The assessor was trained through 20 supervised scans to ensure standardization. All measurements were taken in a semi-recumbent position (30°-45°), with the knees extended and the toes pointing upward.

A line was drawn between the anterior superior iliac spine and the upper pole of the patella. The point at the junction between the upper two-thirds and the lower one-third of this line was marked, and ultrasound gel was applied. The transducer was held perpendicular to the line, and the depth was adjusted to visualize the femur. Once an optimal image was obtained, it was frozen. QMLT was measured as the distance between the upper surface of the femoral bone and the lower border of the superficial fascia of the rectus femoris, thereby including both the rectus femoris and vastus intermedius muscles. Each

measurement was taken twice on the dominant leg (defined by the hand used for eating), and the average value was recorded. QMLT measurements were obtained on days 1, 3, and 7 of the ICU stay, or earlier if the patient was discharged.

All patients were monitored for biochemical parameters, treatments received, duration of mechanical ventilation, length of ICU stay, total hospital stay, and 28-day mortality. Caloric and protein intakes (calorie/protein debt) from days 1 to 7 were also recorded, using baseline requirements of 25 kcal/kg/day and 1.2 g/kg/day of protein. Intake was documented on days 1, 3, and 7.

## Statistical Analysis

Data entry was performed using Microsoft Excel, and statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS), version 25.0 (IBM, Chicago, USA). Quantitative data with a normal distribution were expressed as mean  $\pm$  SD, whereas non-normally distributed data were expressed as median (interquartile range). Normality was assessed using the Shapiro-Wilk test. Non-normal data were analyzed using the Mann-Whitney U test, and normally distributed data were analyzed using the independent t-test.

ROC curves were used to determine the cut off point, sensitivity, specificity, positive predictive value, and negative predictive value for predicting mortality based on the percentage decrease in QMLT. Kaplan-Meier survival curves with log-rank testing were used to assess overall survival. Univariate and multivariate Cox proportional hazards regression analyses were performed to identify significant risk factors for mortality. Spearman's rank correlation coefficient was used to evaluate the relationships between the percentage change in QMLT and duration of mechanical ventilation (days), ICU stay (days), and mNUTRIC score. A point-biserial correlation was used to assess the association between the percentage change in QMLT and mortality.

## Results

The demographic characteristics of the study population are presented in Table 1. The mean age of participants was  $38.1 \pm 18$  years; 67% were male and 33% were female. The mean body mass index (BMI) was  $22.36 \pm 3.21$  kg/m<sup>2</sup>. A majority of the patients (73%) had no comorbidities. Among the remaining 27%, diabetes mellitus was the most common condition (14%), followed by chronic obstructive pulmonary disease (11%). The median APACHE II, SOFA, and mNUTRIC scores at admission were 14, 7, and 2, respectively. Based on a standard daily requirement of 25 kcal/kg and 1.2 g/kg of protein, the median calorie intake increased from 47.6% on day 1 to 77.4% on day 7; the median protein intake increased from 15.9% on day 1 to 49.2% on day 7. All patients required mechanical ventilation; the median

duration was 5 days, and the mean length of ICU stay was 6 days. The overall mortality in the cohort was 51%.

**Table 1. Demographic data and patient parameters**

Variables	Mean (±SD), median (IQR), n (%)
Age (years)*	38.1 (±18)
<b>Gender#</b>	
Male	67 (67)
Female	33 (33)
Height (cm) #	171.50 (9.56)
Weight (kg) #	66.02 (11.9)
BMI (kg/m <sup>2</sup> ) #	22.36 (3.21)
<b>Comorbidity#</b>	
Diabetes mellitus	14 (14)
COPD	11 (11)
Hypertension	9 (9)
Renal	3 (3)
Cardiac	2 (2)
Absent	73 (73)
APACHE II**	14 (10.2-17)
SOFA score**	7 (4-9)
mNUTRIC score**	2 (1-3)
Serum glucose (mg/dL)*	141.8 (70.4)
Creatinine (mg/dL)*	2.1 (2.8)
Urea (mg/dL)*	75.7 (70)
Sodium (mEq/L)*	138.8 (8.3)
Potassium (mEq/L)*	4.5 (1)
Calcium (mg/dL)*	7.6 (1.1)
Magnesium (mg/dL)*	2.2 (0.5)
Phosphate (mg/dL)*	4.1 (2)
Procalcitonin (ng/mL)*	22 (20.1)
Lactate (mmol/L)*	2.5 (2.3)
Bicarbonate (mmol/L)*	22.7 (6.9)
pH*	7.355 (0.1)
<b>Percentage of expected calorie intake#</b>	
Day 1	47.6 (29.7)
Day 3	74.4 (27.6)
Day 7	77.4 (36.1)
<b>Percentage of expected protein intake#</b>	
Day 1	15.9 (21)
Day 3	44.55 (32.4)
Day 7	49.25 (36.6)
Mechanical ventilation#	100 (100)
Duration of mechanical ventilation (days)**	5 (4-7)
Length of ICU stay (days)**	6 (5-7)
Mortality#	51 (51)

#: Mean (±SD), \*\*: Median (IQR), #: n (%), APACHE II: Acute Physiology and Chronic Health Evaluation 2, SOFA: Sequential Organ Failure Assessment, mNUTRIC: Modified Nutritional Risk in Critically Ill, ICU: Intensive care unit, COPD: Chronic obstructive pulmonary disease, SD: Standard deviation, IQR: Interquartile range

There were no significant differences in age or BMI between survivors and non-survivors. However, non-survivors had significantly higher APACHE II, SOFA, and mNUTRIC scores at admission compared with survivors [APACHE II: confidence interval (CI): 0.63-5.1, p=0.013; SOFA: CI: 1.42-3.81, p<0.0001; mNUTRIC: Z=3.9, p<0.0001]. Median urea and creatinine levels were also significantly higher in non-survivors (Z=3.61, p=0.0003; Z=3.85, p=0.0001, respectively). Non-survivors were more acidotic, with significantly lower mean pH (CI: -0.25 to 5.2; p=0.009). The median duration of mechanical ventilation was significantly lower in survivors (Z=3.29; p=0.001), although the length of ICU stay was comparable between groups.

Median calorie and protein intake on day 1 did not differ significantly between survivors and non-survivors. However, non-survivors demonstrated significantly lower calorie intake (day 3: Z=3.42, p=0.0006; day 7: Z=3.10, p=0.002) and protein intake (day 3: Z=3.12, p = 0.002; day 7: Z=2.81, p=0.005). A significant reduction in QMLT in the dominant leg was observed on ICU days 3 and 7 (Z=4.85, p < 0.0001; Z=7.86, p<0.0001, respectively). These results are summarized in Table 2.

The percentage decline in QMLT was evaluated on days 3 and 7 to determine its predictive value for mortality. ROC curve analysis identified cut-offs of a 14.5% decline on day 3 and a 25.97% decline on day 7 (Table 3, Figure 1). A decline exceeding these thresholds had a specificity of 85.7% and a sensitivity of 62.8% for predicting mortality on day 3. By day 7, sensitivity and specificity increased to 86.3% and 93.9%, respectively. The positive predictive value improved from 82.1% on day 3 to 93.6% on day 7, and the negative predictive value increased from 68.9% to 86.8%. The diagnostic accuracy increased from 72% on day 3 to 90% on day 7. The area under the curve was significantly higher for the day-7 cut off (0.96) compared with the day-3 cut-off (0.75) (p<0.0001).

Cox regression analyses were performed using age, BMI, APACHE II, SOFA, and mNUTRIC scores, along with percentage decline in QMLT, in two models: day 3 (model A) and day 7 (model B) (Table 4). The Percentage decline in QMLT on days 3 and 7 remained the only significant predictor of mortality: HR: 1.06 (95% CI: 1.03-1.10), p=0.001 for day 3; HR: 1.05 (95% CI: 1.02-1.07), p=0.0002 for day 7 This suggests that each percentage decline in QMLT is associated with an approximately 5-6% increase in mortality risk during the ICU stay.

Kaplan-Meier difference in survival curves showed a significant between patients with QMLT declines below versus above the identified thresholds on day 3 and on day 7 or on the day of discharge (log-rank test p=0.001 and p<0.0001, respectively). Patients with smaller declines demonstrated consistently better survival (Figure 2).

**Table 2. Comparison of patient parameters between survivors and non-survivors**

Parameters	Survivors	Non survivors	Z/mean diff (CI)/ $\chi^2$ value	p-value
Age (years)	35.35±17.25	40.57±20.13	5.22 (2.23-12.67)	0.17*
Body mass index (kg/m <sup>2</sup> )	22.47±3.11	22.25±3.33	0.22 (-1.06-1.5)	0.74*
APACHE II score	12.69±4.62	15.55±6.43	2.86 (0.63-5.1)	<b>0.013*</b>
SOFA score	5.57±2.38	8.19±3.51	2.62 (1.42-3.81)	<b>&lt;0.0001*</b>
mNUTRIC score	1 (1-2)	3 (1.5-4)	3.9	<0.0001 <sup>†</sup>
Creatinine (mg %)	0.8 (0.5-1.2)	1.5 (0.85-3.25)	3.85	0.0001 <sup>†</sup>
Urea (mg/dL)	37 (21-57)	71 (35.5-137)	3.61	0.0003 <sup>†</sup>
Procalcitonin (ng/mL)	12.3 (2.5-40.9)	15.7 (3.65-50)	0.36	0.72 <sup>†</sup>
Lactate (mmol/L)	1.4(1-2.6)	1.9 (1.15-3.9)	1.81	0.07 <sup>†</sup>
Bicarbonate (mmol/L)	23.98±7.38	21.5±6.33	2.48 (-0.25-5.2)	0.08*
pH	7.38±0.09	7.33±0.12	0.06 (0.01-0.1)	<b>0.009*</b>
Duration of mechanical ventilation (days)	5 (3-6)	6 (5-7)	3.29	0.001 <sup>†</sup>
Length of ICU stay (days)	6 (5-7)	6 (5-7.5)	0.47	0.64 <sup>†</sup>
% calorie intake day 1	59.21 (16.05-75.32)	43.8 (17.93-66.58)	1.06	0.29 <sup>†</sup>
% calorie intake day 3	84 (72.91-97.05)	67 (49.44-81.922)	3.42	<b>0.0006<sup>†</sup></b>
% calorie intake day 7	95.88 (91.865-113.75)	67.5 (34.77-90)	3.1	<b>0.002<sup>†</sup></b>
% protein intake day 1	0 (0-35.71)	0 (0-33.69)	1	0.32 <sup>†</sup>
% protein intake day 3	60.48 (28.48-75.94)	34 (13.815-52.12)	3.12	<b>0.002<sup>†</sup></b>
% protein intake day 7	81.65 (36.88-87.575)	29.49 (19.9-56.96)	2.81	<b>0.005<sup>†</sup></b>
% decline in QMLT day 3	9.5 (4.808-12.632)	16.73 (11.655-25.516)	4.85	<b>&lt;0.0001<sup>†</sup></b>
% decline in QMLT day 7 or discharge	12.38 (8.466-15.819)	34.45 (28.954-40.017)	7.96	<b>&lt;0.0001<sup>†</sup></b>

\*: Independent t test, <sup>†</sup>: Mann-Whitney test

QMLT: Quadriceps muscle layer thickness, APACHE II: Acute Physiology and Chronic Health Evaluation 2, SOFA: Sequential Organ Failure Assessment, mNUTRIC: Modified Nutritional Risk in Critically Ill, COPD: Chronic obstructive pulmonary disease, CI: Confidence interval

**Table 3. Sensitivity, specificity, positive predictive value and negative predictive value of percentage decrease in QMLT for predicting mortality**

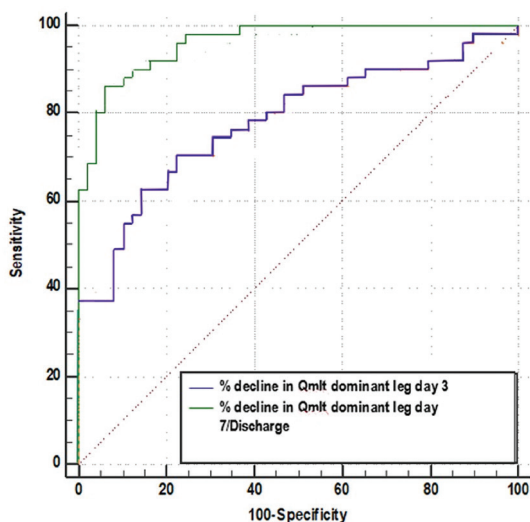
Variables	Percentage decline in QMLT dominant leg day 3	Percentage decline in QMLT dominant leg day 7 or discharge
Area under the ROC curve (AUC)	0.78	0.96
Standard error	0.047	0.016
95% confidence interval	0.69-0.86	0.9-0.99
p-value	<0.0001	<0.0001
Cut off	>14.48	>25.97
Sensitivity	62.8	86.3
Specificity	85.7	93.9
PPV	82.1	93.6
NPV	68.9	86.8
Diagnostic accuracy	72	89

QMLT: Quadriceps muscle layer thickness, PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under the curve

A significant correlation was found between a decline in QMLT and duration of mechanical ventilation on day 7 ( $p=0.46$ ,  $p<0.001$ ), and between a decline in QMLT and mNUTRIC scores on days 3 and 7 ( $p=0.36$ ,  $p<0.001$  and  $p=0.44$ ,  $p < 0.001$ , respectively). A decline in QMLT did not correlate significantly with ICU length of stay (Table 5), suggesting limited reliability for predicting ICU length of stay. The decline in QMLT correlated strongly with mortality ( $p=0.50$ ,  $p<0.001$  on day 3;  $p=0.77$ ,  $p<0.001$  on day 7).

## Discussion

This study reflects the characteristic demographics of the Asian subcontinent, with all patients in our cohort requiring mechanical ventilation. The high median SOFA scores highlight the severity of illness and explain the elevated mortality rate. This makes our cohort well suited to draw meaningful conclusions regarding QMLT decline as assessed by ultrasound. Although several ultrasound protocols for monitoring muscle mass exist in the literature, we chose to measure quadriceps muscle thickness



**Figure 1.** Receiver operating characteristic curve of percentage decrease in QMLT for predicting mortality

QMLT: Quadriceps muscle layer thickness

without compression rather than assessing cross-sectional area (CSA), owing to its simplicity. Previous research has demonstrated comparable results between measurements taken with and without compression, supporting the reliability of this method (4,5,7,10). However, a standardized ultrasound protocol for QMLT assessment has yet to be established (11).

We found that a 24% decrease in QMLT from baseline—measured on day 7 of the ICU stay or on the day of discharge—is a significant risk factor for mortality. A decline in QMLT was also correlated with higher mNUTRIC scores on days 3 and 7 and with prolonged mechanical ventilation by day 7. The association between QMLT decline and mortality is consistent with findings from other studies, which emphasize that serial decline, rather than single-time-point QMLT values, is more clinically meaningful (7).

Furthermore, patients who exhibited a greater loss of QMLT had a lower probability of survival, as demonstrated by Kaplan-Meier analysis. Cox regression analysis identified QMLT decline as an independent risk factor for mortality. Our findings suggest that each percentage-point decline in QMLT corresponds to a 5-6% increase in mortality risk at both time points evaluated. We analyzed decline in QMLT on days 3 and 7 using separate Cox models to avoid confounding between the two time points. Prior studies employing similar statistical methods have shown comparable trends (7,16-18). To the best of our knowledge, however, no previous study has demonstrated QMLT decline as an independent predictor of mortality using Cox proportional hazards analysis. Studies using CT imaging to assess muscle loss in critically ill patients have similarly reported an association between muscle loss and increased mortality (19).

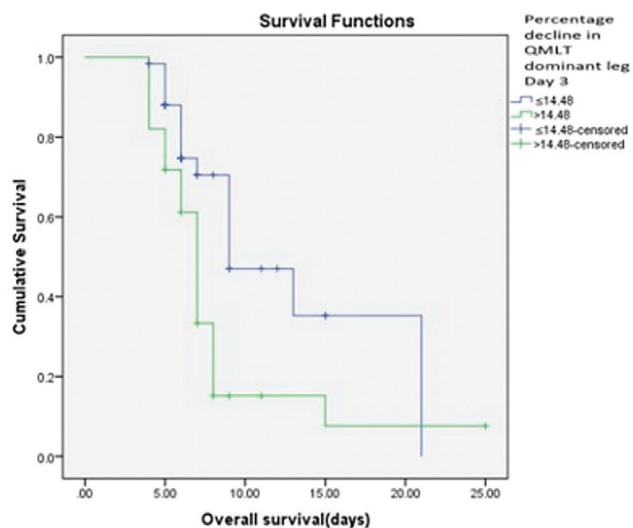
A few studies in the literature, however, report findings that differ from ours (10,20,21). The VALIDUM study, a prospective multicenter trial, concluded that QMLT and CSA assessments were insufficient to identify patients with low muscle mass; patients with a poor prognosis who were unlikely to survive were excluded, and this exclusion may have influenced the results (10). Palakshappa et al. (20) reported a moderate correlation between the decline in rectus femoris CSA and muscle strength, but their study included only 29 predominantly septic patients. A systematic review by Bunnell et al. (21) questioned the utility of neuromuscular ultrasound in assessing critical illness neuromyopathy due to methodological inconsistencies, variable tissue water content, interobserver variability, differences in probe angle, and variation in transducer frequency.

The American Society for Parenteral and Enteral Nutrition recommends screening tools such as the mNUTRIC score for assessing nutritional risk (22). Özdemir et al. (18) argued that mNUTRIC scores may not fully reflect nutritional status because

**Table 4. Univariate and multivariate cox proportional hazard regression for significant risk factors of mortality**

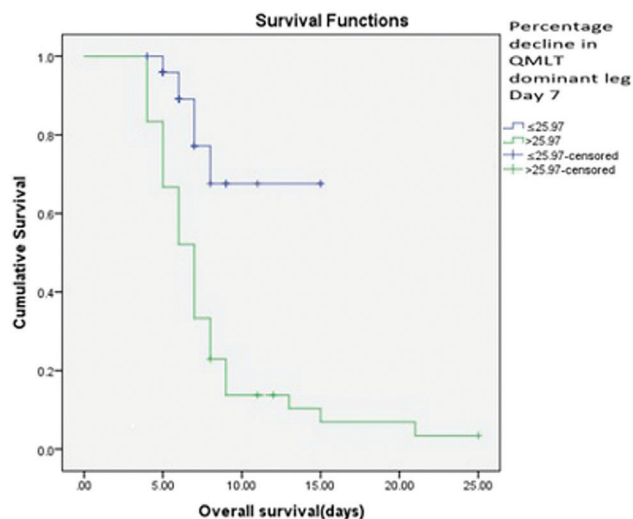
Variables	Univariate hazards ratio (95% CI)	p-value	Multivariate hazards ratio (95% CI)	p-value
Age (years) A, B	1.01 (0.99-1.03)	0.06	...	...
Body mass index (kg/m <sup>2</sup> ) A, B	0.96 (0.87-1.05)	0.38	...	...
APACHE II score A,B	1.04 (0.99-1.09)	0.15	...	...
SOFA score A, B	1.1 (1.01-1.2)	0.03	...	...
mNUTRIC score A, B	1.28 (1.07-1.53)	0.006	...	...
Percentage decline in QMLT dominant leg day 3 A, B	1.07 (1.04-1.11)	<0.0001	1.06 (1.03-1.1)	<b>0.001</b>
Percentage decline in QMLT dominant leg day 7 or discharge A, B	1.051 (1.03-1.07)	<0.0001	1.05 (1.02-1.07)	<b>0.0002</b>

Model A: Age, BMI, APACHE II, SOFA, mNUTRIC, QMLT decline percent day 3 dominant side  
 Model B: Age, BMI, APACHE II, SOFA, mNUTRIC, QMLT decline percent day 7 dominant side  
 QMLT: Quadriceps muscle layer thickness, APACHE II: Acute Physiology and Chronic Health Evaluation 2, SOFA: Sequential Organ Failure Assessment, mNUTRIC: Modified Nutritional Risk in Critically Ill, COPD- Chronic Obstructive Pulmonary Disease, CI: Confidence interval



**Figure 2.1.** Kaplan Meier survival analysis curve to compare overall survival between percentage decline in QMLT in dominant leg on day 3 (log rank test,  $p=0.001$ )

QMLT: Quadriceps muscle layer thickness



**Figure 2.2.** Kaplan Meier survival analysis curve to compare overall survival between percentage decline in QMLT in dominant leg on day 7 or discharge (log rank test,  $p<0.0001$ )

QMLT: Quadriceps muscle layer thickness

they lack anthropometric components. This highlights the need for improved nutritional risk assessment tools for ICU patients. The moderate correlation between QMLT decline and mNUTRIC scores on days 3 and 7 in our study suggests that QMLT may serve as a useful adjunctive tool for nutritional assessment. Previous research indicates that muscle loss is greatest during the first week of mechanical ventilation (5,7). Our study also demonstrated a moderate correlation between QMLT decline and duration of mechanical ventilation, although no correlation was observed with ICU length of stay. These findings support the potential role of QMLT decline as a prognostic marker.

Non-survivors in our cohort consistently failed to meet the recommended calorie and protein targets from day 2 onward, compared with survivors. Some studies have shown that achieving individualized caloric and protein targets in critically ill patients may reduce mortality by up to 50% (23). However, another study found that this benefit was limited to female patients, likely due to their lower baseline muscle mass (24). Such mixed evidence underscores the need for more robust and objective parameters—such as USG-based QMLT—provided they can be standardized. These may ultimately outperform traditional nutritional targets and risk scores.

Nutritional status plays a crucial role in preserving skeletal muscle mass, and inadequate calorie–protein intake accelerates muscle catabolism in critically ill patients. Studies have shown that ICU patients can lose up to 2% of muscle mass per day during the first week, and undernutrition amplifies this decline. Poor nutritional intake reduces amino acid availability for muscle protein synthesis, leading to a measurable decrease in QMLT. Research demonstrates that greater early muscle loss, including QMLT reduction, is strongly associated with prolonged mechanical ventilation and higher mortality rates. Undernutrition heightens the inflammatory and stress responses, further driving catabolism and worsening muscle wasting.

### Study Limitations

Our study has certain limitations. Sepsis- and trauma-related fluid shifts may have been because intramuscular fluid accumulation could have affected QMLT measurements. Muscle edema can mask true muscle atrophy, resulting in measurements that appear deceptively stable or even elevated. This complicates

Percentage change in QMLT	Duration of mechanical ventilation (days)	Duration of ICU stay (days)	mNUTRIC score	Mortality
Dominant leg day 3	$p^* 0.18, p=0.08$	$p^* -0.04, p 0.8$	$p^* 0.36, p<0.001$	$p^{**} 0.50, p<0.001$
Dominant leg day 7	$p^* 0.46, p<0.001$	$p^* 0.17, p 0.09$	$p^* 0.44, p<0.001$	$p^{**} 0.77, p<0.001$

\*: Spearman's rank correlation, \*\*: Point-biserial correlation, mNUTRIC: Modified Nutritional Risk in Critically Ill, ICU: Intensive care unit, QMLT: Quadriceps muscle layer thickness

the interpretation of our measurements. Second, this single-center observational study may therefore serve primarily as a hypothesis-generating investigation. Additionally, assessing quadriceps dimensions in a single plane may not accurately represent muscle loss throughout the body. This may explain why we observed only a moderate correlation with the duration of mechanical ventilation and no correlation with the ICU length of stay. The quadriceps muscle contains both type I and type II fibers—type II fibers serving as power generators and type I fibers as stabilizers (4). Our measurement technique did not allow differentiation between fiber types, which may also influence the interpretation of muscle loss patterns.

## Conclusion

Continuous monitoring of QMLT by USG shows that loss of muscle mass during ICU stay is an independent predictor of mortality and correlates with mNUTRIC score and increased days of mechanical ventilation by day 7. This tool is applicable at the bedside, noninvasive, and cost-effective. Intensivists should thus prioritize the routine evaluation of QMLT and adjust nutritional support accordingly. These findings underscore the importance of integrating QMLT assessment into clinical practice to improve patient care in intensive care settings.

## Highlights

Continuous monitoring of quadriceps muscle layer thickness using ultrasound is a cost-effective, safe, and valuable tool for intensivists. It can be used to monitor recovery as well as to predict mortality.

## Ethics

**Ethics Committee Approval:** this study received approval the Vardhman Mahavir Medical College and Safdarjung Hospital Institutional Ethics Committee (decision number: IEC/VMMC/SJH/Thesis/06/2022/CC-47, date: 11.07.2022).

**Informed Consent:** All adults aged 18 years and above who were expected to require mechanical ventilation for at least 48 hours were included after obtaining written informed consent.

## Footnotes

### Authorship Contributions

Surgical and Medical Practices: S.M.M., V.T., A.K., Concept: S.A., V.T., Design: S.A., V.T., Data Collection or Processing: S.A., S.M.M., Analysis or Interpretation: S.M.M., A.K., S.K., Literature Search: S.A., V.T., S.K., Writing: S.M.M., A.K., S.K.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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