Short Communication

The adductor pollicis muscle: a poor predictor of clinical outcome in ICU patients

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No nutrition assessment tools specifically tailored for intensive care unit (ICU) patients have been developed and validated in Singapore. Studies conducted in Brazilian populations suggest that the thickness of the adductor pollicis muscle (TAPM) may be used to assess nutritional status and predict mortality of critically ill patients. The aim of this study was to determine if TAPM can be used as a predictive indicator of mortality in Singapore ICU patients. TAPM values were obtained using skinfold calipers in 229 patients admitted to the medical ICU. TAPM measured in both hands showed no significant correlation with either the primary outcome (28-day mortality) or secondary outcomes (hospital outcome and hospital length of stay). This study demonstrated that TAPM does not predict 28-day mortality and hospital outcome, and is not correlated to length of stay in Singapore ICU patients. More studies are necessary to validate the use of TAPM as an anthropometric indicator of ICU outcome in other regions of the world.

Key Words: adductor pollicis, anthropometry, nutritional status, intensive care, clinical outcome

INTRODUCTION

Shakir and Waterlow were early pioneers who used anthropometry (mid-upper arm circumference (MUAC), weight and height) as proxy indicators to predict morbidity and mortality in children.[1,2] Since their seminal work, anthropometry has become a powerful and simple assessment tool in community nutrition. Today, anthropometry is also increasingly used within hospital settings. One of the challenges in nutrition assessment within hospital settings is the need for a simple yet relatively non-invasive method that has high sensitivity while preserving specificity.

The prevalence and incidence of malnutrition that include significant weight loss, depletion of lean body mass and vitamins and minerals can occur in 15% to 50% of hospitalized patients.[3] A reduction in body weight is an inevitable consequence of food restriction and increased metabolic demand. However, the association between weight loss and energy restriction is not a simple one as the proportion of fat and muscle loss may differ between subjects. Recent years have witnessed a range of techniques to assess nutritional status of hospitalized patients. These include methods such as Nutrition Risk Screening (NRS)-2002, Mini-Nutritional Assessment (MNA) and bio-electrical impedance analysis (BIA).[4] The accuracy and reliability of anthropometric measurements can be significantly influenced by equipment, technical competence, subject compliance and the reference standards used. These methods have had varying degrees of success in predicting metabolic outcomes in hospitalized patients.[4]

To the best of our knowledge, no nutrition assessment tools specifically tailored for intensive care unit (ICU) patients have been developed and validated in Singapore. Recently, Caporossi et al suggested that the thickness of the adductor pollicis muscle (TAPM) may be used to assess nutritional status and predict mortality of critically ill patients.[5] Moreover, it has been used in a number of studies in the Brazilian population but has yet to be validated in Asian or other countries.[5-7] TAPM can be used to estimate the loss of muscle and is correlated with other anthropometrics, such as MUAC, biochemical, and inflammatory parameters.[5] Furthermore, TAPM is relatively non-invasive, repeatable and can be used as a bedside measure. Moreover, the first interosseous space of the

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hand being flat and almost void of fat tissue, TAPM can hence be easily measured.[8] An adequate muscle mass is a valid indicator of good nutritional status and favorable prognosis for critically ill patients. TAPM can be an indicator for the changes in muscle composition of the whole body, and used to detect early changes in nutritional status.[9] The objective of this study was to determine if TAPM can be used as a predictive indicator of mortality in Singapore ICU patients.

METHODS

This was a cross-sectional, prospective study performed in the medical ICU of a tertiary academic medical centre in Singapore, between March 2013 and May 2014. Patients were measured within the first 24 hours of admission, by trained personnel from Monday to Saturday. We excluded patients who had pitting edema and patients with splints, casts or other circumstances that would make accurate TAPM measurement not possible; patients who stayed in ICU for less than 24 hours and patients who were diagnosed with drug overdose. This study complied with the provision of the Declaration of Helsinki and was reviewed and approved by the National Healthcare Group (NHG) Domain Specific Review Board (DSRB) (reference number 2014/00209) and the requirement of consent was waived. Patient identity and confidentiality was protected by anonymizing the data following the collection and during analysis. The record of the anonymization was kept with the principal investigator (PI) and protected with secure password. All hardcopies of the data file were protected under lock and key in PI's cabinet. This was done in line with the policy of the DSRB.

Anthropometry

The measurement of TAPM was performed on both hands with the patients lying in bed using the technique described by Gonzalez et al 2010.[9] Briefly, the index finger and thumb was extended, and the TAPM was measured at the vertex of the imaginary triangle thus formed, using a Holtain caliper (Holtain Limited, UK). In addition, the MUAC of the right arm was measured using standardized measurements at the mid-point between the tip of the arcomion and olecranon process using a flexible measuring tape (SECA measuring tape).[10] The average of two measurements was recorded for both TAPM and MUAC measurements. Height and weight in the ICU were measured by measuring tape and hoist respectively. Lastly, the body mass index (BMI, kg/m^2) was calculated.

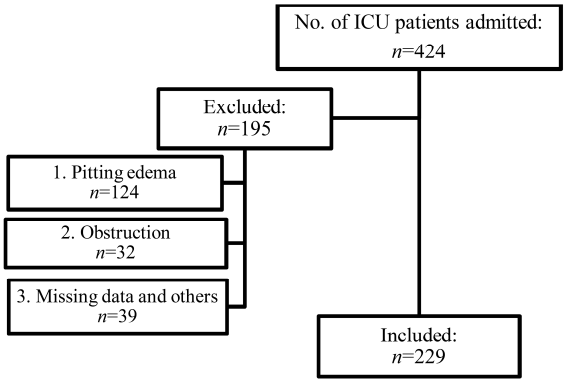

Figure 1. Details of patient inclusion. *n*: number; Missing data and others: ICU stay less than 24 hours (*n*=23); drug overdose (*n*=5); and missing data (*n*=11)

Outcome

The primary outcome was 28-day mortality of the ICU patients. The secondary outcomes were hospital outcome and length of stay (LOS) of the ICU patients. ANOVA was used to compare the TAPM and 28-day mortality of ICU patients. Linear regression was performed to assess the association between LOS and TAPM. Pearson correlation was used to assess the correlation of TAPM with BMI and MUAC. Data were analyzed with R, version 2.15.3 (R Foundation for Statistical Computing, Vienna, Austria). Statistically significant difference was accepted at $p<0.05$.

RESULTS

Out of the 424 patients admitted to the medical ICU from March 2013 to May 2014, 229 patients were evaluated (Figure 1). The 195 patients excluded were due to pitting edema (*n*=124); obstruction of the adductor pollicis muscle area (*n*=32); ICU stay less than 24 hours (*n*=23); drug overdose (*n*=5); and missing data (*n*=11). In our study sample, there were nearly twice the number of males than females (males=63%, females=37%). The percentages of the different races included in this study has a similar proportion to that present in the Singapore population (Chinese=54%, Malay=20%, Indian=13%, Others=13%).

Results from the 229 patients measured are tabulated in Table 1. There were significant differences ($p<0.05$) between genders for height, weight and TAPM for both the right and left hands (Table 1).

TAPM measured in both hands showed no significant correlation with either the primary outcome (28-day mortality) or secondary outcomes (hospital outcome and LOS)

Table 1. General and anthropometric characteristics (mean±SD) of the patients

Variables	All (*n*=229)	Male (*n*=145)	Female (*n*=84)
Age (years)	59.4±16.0	57.9±15.3	61.9±16.7
Height (cm)	164±9.5	168±8.2*	157±8.1*
Weight (kg)	63.1±17.0	65.1±15.5*	59.6±18.9*
BMI (kg/m^2)	23.5±6.2	23.2±5.3	24.1±7.7
Right hand TAPM (mm)	20.4±6.0	21.2±5.6*	19.0±6.3*
Left hand TAPM (mm)	19.9±6.1	20.6±5.6*	18.8±6.6*
MUAC (cm)	27.2±4.9	27.0±4.5	27.4±5.6

*$p<0.05$ ANOVA test between genders.

SD: standard deviation; *n*: number; BMI: body mass index; TAPM: thickness of the adductor pollicis muscle; MUAC: mid-upper arm circumference.

Table 2. Association of TAPM and MUAC with clinical outcomes (*n*=229)

Variables	Deceased	Alive	*p* value
A. 28-day mortality analyzed using ANOVA (mean±SD)			
n	46	183	
Right hand TAPM (mm)	20.0±5.3	20.5±6.1	0.62
Left hand TAPM (mm)	19.7±5.0	20.0±6.3	0.77
MUAC (cm)	26.0±4.3	27.5±5.0	0.07
B. Hospital outcome analyzed using ANOVA (mean±SD)			
n	50	179	
Right hand TAPM (mm)	20.0±5.3	20.4±6.2	0.65
Left hand TAPM (mm)	19.7±5.0	19.9±6.4	0.80
MUAC (cm)	26.4±4.3	27.4±5.1	0.20
C. Length of stay (LOS) in the hospital analyzed using linear regression			
	Slope	R	
Right hand TAPM (mm)	-0.044	-0.033	0.61
Left hand TAPM (mm)	-0.014	-0.010	0.88
MUAC (cm)	0.005	0.000	0.99

TAPM: thickness of the adductor pollicis muscle; MUAC: mid-upper arm circumference; SD: standard deviation.

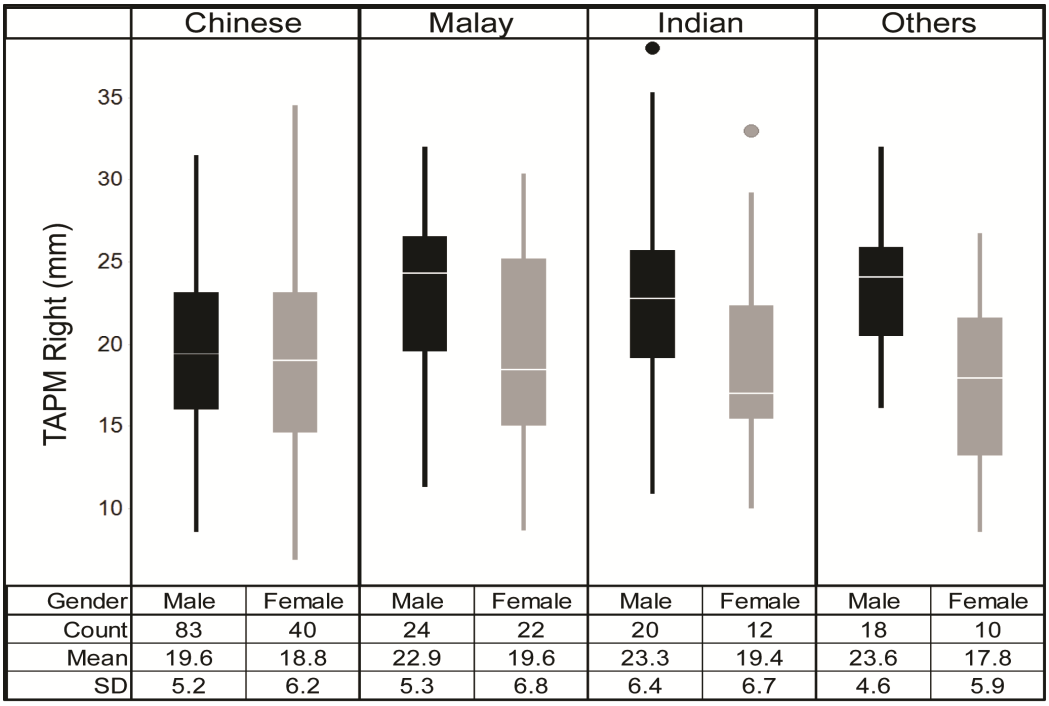

Figure 2. Boxplot illustration of TAPM (mm) of right hand in ICU patients segregated by ethnic groups. TAPM: thickness of the adductor pollicis muscle; SD: standard deviation; • -dots above the columns represent outliers

(Table 2). Near-significant difference (*p*=0.07) for MUAC can be seen with 28-day mortality. The right hand TAPM values of the different ethnic groups are shown in Figure 2.

DISCUSSION

To date, all information on TAPM has been from Brazilian populations, both in hospital patients,[5-7] or the general population.[9] In the Brazilian population, TAPM was noted to be a valuable tool to predict mortality in critically ill patients.[5] However, our study in Singapore did not find any significant difference of TAPM in predicting mortality in ICU patients. Similar to our study, the Brazilian study which predicted mortality in critically ill patients did not demonstrate significant correlation between TAPM and LOS.[5]

In this study conducted in the Singapore ICU (*n*=229), patients had higher values both in the deceased (right hand TAPM: 19.9±5.3 mm) and alive (right hand TAPM: 20.4±6.2 mm) compared to the values recorded in the ICU patients in Brazil (*n*=246). In Brazil, much lower values were seen in both the deceased (right hand TAPM: 11.4±4.1 mm) and alive (right hand TAPM: 14.5±4.2 mm).[5] Intuitively, one would expect the Brazilian population, with a larger frame size to have higher TAPM values compared to the Singapore Asian population, with a generally smaller frame size. However, when compared to the study conducted by Mauricio et al, 2013,[6] in Brazilian patients who were candidates for elective major surgery of the gastrointestinal tract; those who were classified under moderate malnutrition (TAPM: 22.5±6.5 mm) and severe malnutrition (TAPM: 20.0±5.1 mm),[6] had relatively closer TAPM values to the study conducted in Singapore.

Table 3. Correlations between TAPM and BMI and MUAC

Variable 1	Variable 2	Correlation	*p* value
Right hand TAPM	BMI	0.42	<0.05
Right hand TAPM	MUAC	0.50	<0.05
Left hand TAPM	BMI	0.43	<0.05
Left hand TAPM	MUAC	0.51	<0.05

TAPM: thickness of the adductor pollicis muscle; BMI: body mass index; MUAC: mid-upper arm circumference

It is worth considering reasons for these differences. This study used the Holtain caliper while some studies used the Cescorf caliper,[5] and other studies used the Lange caliper.[6,8,9] Differences in TAPM values were also found in the various Brazilian populations studied; as shown in the study conducted by Gonzalez et al, 2010.[9] They reported higher TAPM values compared to the study by Lameu et al, 2004.[11] In the present study, TAPM was found to be significantly different between races ($p<0.05$; Figure 2) and gender (Table 1). The significant difference in TAPM found between races in the ICU population may be a reason that TAPM does not predict 28-day mortality and hospital outcome in this study. However, when the association of TAPM with clinical outcomes data in Table 2 was corrected for race, the differences were still not significant ($p>0.05$). Similar to other studies,[8,9] this study showed that males have significantly higher TAPM values than the females. It is to be noted that in the Brazilian study which showed TAPM to be a predictor of mortality in ICU,[5] the baseline TAPM was low compared to our study. It is possible that such low TAPM was indicative of poor nutrition on admission to ICU in the Brazilian population studied and therefore correlated better with mortality.

Two key limitations of anthropometric measures are its variability and subjectiveness even when obtained by the most trained practitioners. In this study, variations were minimized by conducting inter- and intra-measurer measurements before the study was carried out. As an anthropometric measurement, TAPM showed significant and moderate correlation with MUAC and BMI (Table 3), and it is simple and fast to measure. However, TAPM has its limitations. Not all the patients can be measured due to the presence of edema and blockage of the TAPM area due to operation, cast or needle insertions. The initial enthusiasm to use TAPM as a simple technique to assess nutritional status in hospitals may need to be interpreted with caution as our results demonstrate that TAPM is not a universally applicable measure. TAPM cut off points that are specific to ethnic groups may also need to be considered.

There are a few limitations to this study. First, nearly half of the ICU patients admitted had to be excluded due to pitting edema and obstruction of the adductor pollicis muscle area. Second, measurements of height and weight are not gold standard for research due to difficulty of measuring height and weight in the ICU setting.

Conclusion

Our study had demonstrated that TAPM did not predict 28-day mortality and hospital outcome, and was not correlated to length of stay in Singapore ICU patients. Additional research needs to be conducted in order to demonstrate the utility and applicability of TAPM as a new nutrition assessment tool to predict health and mortality outcomes in divergent ICU patients. Without this validation, the universal application of TAPM should be used with caution.

AUTHOR DISCLOSURES

The authors declare no conflict of interest. The authors are grateful to the Singapore Institute for Clinical Sciences for facilitating this article.

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內收拇肌：對加護病房病人是一個差的臨床結果預測因子

在新加坡，尚未有針對加護病房病人量身打造的營養評估工具被發展或驗證。巴西族群研究，建議內收拇肌（TAPM）的厚度可用於評估重症疾病病人的營養狀況，及預測死亡風險。本研究目的為評估 TAPM 是否可作為新加坡加護病房病人的死亡預測指標。使用皮脂測量儀，收集 229 名在醫療加護病房的病人其 TAPM。雙手的 TAPM 測量值與主要結果（28 天死亡率），或次要結果（住院結果及住院天數）均未達顯著相關。本研究證實 TAPM 無法預測新加坡加護病房病人的 28 天死亡率及住院結果，與住院天數也無關。需要更多研究，才能驗證 TAPM 是否可在世界的其他區域當作加護病房結果的體位測量指標。

關鍵字：內收拇肌、體位測量、營養狀況、重症照護、臨床結果