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Comparison of Various Nutritional Screening Methods in Patients Undergoing Abdominal Surgery

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Abstract

Objective: **To compare the following nutritional screening methods - the serum albumin and serum prealbumin levels, the Short Form Mini Nutritional Assessment (MNA-SF), the Nutrition Risk Classification (NRC), the Malnutrition Screening Tool (MST), the Nutrition Risk Score (NRS) and the Subjective Global Assessment (SGA) in the prediction of postoperative infectious and wound complications.**

Patients and Methods: **Nutritional assessment was performed on 103 patients undergoing major abdominal surgery between November and December 2002. All patients were followed postoperatively for 30 days or till the occurrence of postoperative complications. The ability of the "at-risk" of malnutrition classification to predict postoperative complications was measured by the area under the receiver operating characteristic (ROC) curve for each method and compared.**

Results and Conclusions: **All nutritional screening methods were capable of predicting postoperative complications reasonably well (ROC area between 0.65 and 0.8) but the best predictor was the NRC (ROC area = 0.78).**

Many biochemical nutritional markers, nutritional risk indices and nutritional screening tools have been developed to measure the nutritional status of patients.[1-9] In the surgical setting the single most popular measure of nutritional status is the serum albumin level. This is because serum albumin level measurement is widely available, easily obtainable, not costly, and is one of the most important predictors of postoperative morbidity and mortality.[1-3] An alternative to the measurement of serum albumin level is the measurement of serum prealbumin level, theoretically a better measure of acute change in nutritional status than the serum albumin level[1] and sometimes used as a "gold standard" in the development of some nutritional screening tools,[6] but it is more expensive to obtain. However, this measure, along with other proposed biochemical measures of nutritional status such as the serum transferrin level, have not been shown to be superior to the serum albumin level as markers of nutritional status.[1] Nutritional risk indices, such as the Prognostic Nutritional Index (PNI), are based on several anthro-pometric and immunological measures which are difficult to obtain or not routinely available, such as triceps skin fold measurements and delayed skin hypersensitivity reaction.[10] Nutritional screening tools are viable alternatives to biochemical

measurements, since they require the use of assessment questions which may be quite easy to apply. Among the more recent and well-validated nutritional screening tools, the Short Form Mini Nutritional Assessment (MNA-SF),[5] the Nutrition Risk Classification (NRC),[6] the Malnutrition Screening Tool (MST),[7] and the Nutrition Risk Score (NRS)[8] are possible candidates. However, the only nutritional assessment tool shown to have predictive validity in terms of postoperative compli-cations and mortality is the Subjective Global Assessment (SGA) methodology,[11] also used as a "gold standard" in some nutritional studies, but it is a rather complicated tool to use.[7] The aim of this study was to validate and compare the following nutritional markers and screening tools - serum albumin, serum prealbumin, SGA, MST, MNA-SF, NRS and NRC - in terms of their ability to predict postoperative infectious and wound complications on a sample of patients undergoing a variety of abdominal operations.

Patients and Methods

In the one month period from November 2002 to December 2002, one hundred and three Thai adult patients (over 15 years of age) undergoing various major abdominal surgical procedures in a tertiary care hospital were prospectively enrolled into the study. Patients were excluded if admitted for organ transplantation (either as a donor or as a recipient), if preoperative admission was too short to obtain a complete preoperative nutritional assessment, or if reliable preoperative nutritional assessment could not be obtained (e.g. in comatose or confused patients). All patients participating in the study signed an informed consent sheet prior to the nutritional evaluation. The study protocol was approved by the hospital's institutional review board. The nutritional assessment included the serum albumin level, the serum prealbumin level, and a questionnaire consisting of items abstracted from the following nutritional assessment tools: the NRC, the MNA-SF, the MST, the NRS, and the SGA. A research nurse collected all the relevant data. Outcomes of the study included various infectious and wound complications listed in Table 1, occurring within 30 days after operation. All these complications were defined according to the Centers for Disease Control and Prevention (CDC), US Department of Health and Human Services.[12] All patients were followed-up until 30 days after the primary operation, till the first follow-up visit after hospital discharge, or until hospital death.

All infectious and wound complications were pooled together as postoperative complications and used as the primary outcome in subsequent analysis. Each nutritional assessment tool was used to classify patients as "at risk" or "not at risk" of malnutrition, according to criteria set in the original publications.[5-8,11] For the MNA-SF, scores of 10 or below ("at risk" and "malnourished" categories) were considered "at risk" and 11 or above as "not at risk". For the NRS, scores of 4 or above ("needs monitoring" and "high risk" categories) were considered "at risk" and below 4 as "not at risk". For the SGA, the "moderately malnourished" and "severely malnourished" categories were considered "at risk" and the "well nourished" category was considered "not at risk". For the NRC, the MNA-SF, the MNS, the NRS and the SGA, the odds ratio was used as a measure of the association between the classification of "at risk" of malnutrition and postoperative complications. The measures of association for serum albumin and serum prealbumin levels were the odds ratio per gm/dL and per mg/dL decrease, respectively. The odds ratios were estimated using the maximum likelihood method.[13] The discriminatory ability of each tool or biochemical marker was measured by the c-index [i.e. the area under the receiver operating characteristic (ROC) curve].[3] Pairwise agreement between nutritional assessment tools and markers was measured using the kappa statistic. The ROC areas were compared using the method of DeLong, DeLong and Clarke-Pearson.[14]

Two-sided p-values of 0.05 or less were considered statistically significant. STATA version 7 was used for all statistical analyses.

Results

Characteristics of the patients in the study are presented in Table 2. The average age of the patients in the sample was 58 years, of which 57 per cent were women. Ninety-one percent of patients underwent gastro-intestinal or hepatobiliary-pancreatic surgery, while 52 per cent had cancer. Ninety percent of operations were classified as clean-contaminated. "At risk" nutritional status (malnutrition status or at risk of malnutrition) as identified by the five screening or

Table 1 Post-operative infections, wound complications, and mortality

Events*	Number (%) (N = 103)
Total number of patients with postoperative complications	21 (20)
Surgical site infection types I-II	15 (15)
Surgical site infection type III (intra-abdominal abscess)	1 (1)
Pneumonia	7 (7)
Catheter-related infection	4 (4)
Urinary tract infection	4 (4)
Wound dehiscence	3 (3)
Hospital death	3 (3)

**Each category of infection is defined according to the CDC*

Table 2 Characteristics of patients in the study (N = 103)

Characteristics	Summary		
Age (years): mean (sd) [range]	58.5	(14.4)	[24-88]
Sex (women): number (%)	59	(57)	
Organ system disease			
Hepato-biliary-pancreas: number (%)	50	(48)	
Colorectal: number (%)	28	(27)	
Esophago-gastric: number (%)	16	(16)	
Urological: number (%)	3	(3)	
Miscellaneous: number (%)	6	(6)	
Cancer (yes): number (%)	52	(51)	
Diabetes Mellitus (yes): number (%)	20	(20)	
Preoperative nutritional support (yes): number (%)	13	(13)	
Wound classification			
Clean: number (%)	7	(7)	
Clean-contaminated: number (%)	90	(87)	
Contaminated: number (%)	6	(6)	
ASA class			
I: number (%)	12	(12)	
II: number (%)	57	(55)	
III: number (%)	34	(33)	
Body Mass Index (kg/m^2): mean (sd) [range]	22.4	(4.3)	[12.3-38.8]
Serum albumin (gm/L): mean (sd) [range]	38.7	(5.4)	[24.8-48]
Serum prealbumin (mg/dl): mean (sd) [range]	18.8	(7.3)	[4.7-40.8]
MNA-SF at-risk (yes): number (%)	43	(42)	
NRC at-risk (yes): number (%)	47	(46)	
MST at-risk (yes): number (%)	39	(38)	
NRS at-risk (yes): number (%)	68	(66)	
SGA at-risk (yes): number (%)	41	(40)	

assessment tools varied from 40 per cent (the SGA) to 66 per cent (the NRS). There was 3 per cent perioperative mortality, and 20 per cent had various forms of infectious and wound complications (Table 1).

The relationship between the malnutrition "at-risk" status and postoperative complications as measured by the odds ratio, and the discriminatory ability of each screening tool to predict postoperative complications measured as the c-index are presented in Table 3. The at-risk status according to the NRC was associated with an 18-fold increase in the odds of

Table 3 Odds ratios and c-indices for each nutritional screening tool and method

Screening tool	Odds Ratio (95% CI)	c-index (95% CI)	p-value*
SGA	7.30 (2.41 - 22.11)	0.729 (0.623 - 0.834)	<0.001
NRC	18.32 (3.98 - 84.34)	0.782 (0.699 - 0.864)	<0.001
MNA-SF	4.82 (1.69 - 13.79)	0.686 (0.575 - 0.798)	0.003
MST	4.56 (1.64 - 12.67)	0.681 (0.566 - 0.796)	0.004
NRS	6.40 (1.40 - 29.32)	0.654 (0.570 - 0.737)	0.017
Serum albumin**	5.26 (2.00 - 13.89)	0.759 (0.637 - 0.881)	0.001
Serum prealbumin**	2.77 (1.28 - 5.99)	0.686 (0.559 - 0.813)	0.010

** p-values are for likelihood ratio tests for association between each measure and postoperative complications.*
*** The odds ratios for serum albumin and serum prealbumin are per gm/dL and mg/dL decrease, respectively.*

postoperative complications, and the c-index was the largest (0.782) for the NRC. Serum albumin level performed quite well in this sample, with the second largest c-index (0.759) and a large odds ratio (5-fold increase in odds for every 1 gm/dL decrease). The SGA performed almost as well as the serum albumin level (c-index of 0.729). The serum prealbumin level did not perform as well as the serum albumin. Other nutritional screening tools performed reasonably well, but none were as good as the NRC or the SGA. Nonetheless, the differences between the c-indices were not significant statistically, but only marginally so (p-value = 0.077 for the test for any significant pairwise difference).

There was reasonable pairwise agreement between the at-risk classification according to the NRC, the SGA, the MNA-SF and the MST as measured by the kappa statistic (values from 0.48 to 0.64). The NRS, however, seemed to agree less well with the others (kappa values from 0.34 to 0.48).

Discussion

In the surgical setting the main purpose of assessing preoperative nutritional status is to predict postoperative complications, specifically infectious and wound complications, and to prevent their occurrence. From this view point the serum albumin level is the single most important nutritional measure.[1-3] Other measures of nutritional status and other assessment methods recently proposed may have the potential to complement or even replace serum albumin level in the prediction of postoperative complications. These include other biochemical markers, nutritional assessment or screening tools and anthropometry.[1] In this study, all selected biochemical nutritional markers and nutritional assessment tools were able to predict the occurrence of postoperative infectious and wound complications, but there seemed to be some differences in their accuracy (despite lack of statistical significance).

Several biochemical measures of nutritional status have theoretical advantage over serum albumin in that they reflect acute changes in nutritional intake or increase metabolic activity and thus may be more sensitive in predicting postoperative complications.[1,15] Such biochemical measures include serum prealbumin, serum transferrin and acute phase protein levels.[1,15,16] In particular, serum prealbumin was considered by some as the best marker for nutritional status.[15] A recent study performed on 70 elderly patients (aged over 60 years) found that serum prealbumin was the best predictor of postoperative infectious complications.[15] An earlier study of 218 general surgical patients also found serum prealbumin to be a slightly better predictor of postoperative complications than the serum albumin.[16] In the current study, however, the serum prealbumin level was shown to be inferior to the serum albumin level as a predictor of postoperative complications, a finding in accord with a recent review.[1]

Nutritional assessment or screening tools have been used in the detection and grading of malnutrition states but most of these tools have not been used as predictors of postoperative complications. The SGA, considered to be a "gold standard" of nutritional assessment in some studies,[1,7] was shown to be a better predictor of postoperative morbidity and mortality than the serum albumin level in one study,[11] but this result has not been confirmed elsewhere.[1,2] Of the

other more recent nutritional screening tools studied here only the full version of the MNA-SF (i.e. the MNA) has been used to assess preoperative nutritional status,[4] but none were used to predict postoperative complications. In this study the SGA was a good predictor of postoperative complications, but with a c-index slightly less than that of the serum albumin level. This c-index (0.728) is similar to the c-index of the SGA in the study mentioned previously (i.e. a c-index of 0.73).[11]

The best predictor of postoperative complications among all of the nutritional screening and assessment methods in this study was the NRC. It has been noted that a nutritional assessment based on a reliable history of nutritional intake and utilization, and physical examination (or assessment of ideal body weight) may be more accurate than any single biochemical marker.[2,11] This may be the case for the NRC. A feature of the NRC which could account for its superior predictive ability relative to other screening tools is the inclusion of a diagnostic category item in the questionnaire. This item reflects underlying catabolic illnesses which could adversely influence postoperative recovery or the wound healing process independently of their effect on the nutritional status (e.g., diagnoses such as diabetes mellitus, end-stage renal disease and cancer).[17-19] Other nutritional screening tools were able to predict postoperative complications reasonably well but none as well as the NRC or SGA.

Although anthropometry was not primarily used as a measure of nutritional status in this study, the body mass index (BMI) was also included in the data collection. The BMI has been noted in earlier studies to be an insensitive measure of malnutrition, even more than the serum albumin level, since it does not reflect short-term changes in the nutritional status.[1,3] Also, BMI is a relatively poor predictor of postoperative complications.[1,15,16] Indeed, in this study, the BMI (considered as a continuous variable) had only marginally significant negative association with postoperative complications (t-test p-value of 0.064). Similarly, no significant association was found between the BMI categorized as less than 18.5, between 18.5 and 25, and 25 kg/m^2 or above (categorized according to the World Health Organization[20] taking into account the fact that overweight patients also recovered poorly from surgery) and postoperative complications (chi-square test p-value of 0.103).

The sample size of this study was rather small, and therefore the study may lack statistical power to detect important differences between different groups of patients, e.g. between patients with and without complications. Similarly, the differences in the predictive ability between different measures of nutritional status may not be statistically significant because of the sample size limitation.

The results of this study suggested that although all selected nutritional screening tools or biochemical markers were reasonably valid measures of nutritional status in terms of the ability to predict postoperative complications, none were sufficiently accurate (all c-indices were less than 0.8). To increase the accuracy of the prediction, an evaluation of the nutritional status using a combination of the NRC and serum albumin level, perhaps in the form of a scoring system, is recommended.

Conclusion

A comparison of various biochemical nutritional markers and nutritional screening tools in the prediction of postoperative infectious and wound complications was conducted on a sample of 103 patients undergoing major abdominal surgery. The NRC screening tool appeared to better predict postoperative complications than the serum albumin and serum prealbumin levels. Similarly, the NRC was superior to the SGA, the MNA-SF, the MST and the NRS in terms of the ability to predict the same complications. The NRC and serum albumin level should be used in combination to enable a more accurate prediction of postoperative infectious and wound complications in adult surgical patients.

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