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The Use of Biochemical Parameters as Nutritional Screening Tools in Surgical Patients

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Abstract

Nutritional status influences surgical outcome and complication rates. The National Institute of Clinical Excellence, (NICE) recommends screening patients on admission; yet traditional nutritional screening tools are underutilised. This retrospective case-control study investigates the association between biochemical factors and adverse outcomes in orthopaedic patients to ascertain whether they could provide more suitable alternatives to traditional screening tools. 66 patients with fractured neck of femur were investigated. Adverse outcomes including Length of Stay, (LOS), and deaths were recorded. Total Lymphocyte Counts, (TLC), Serum Albumin Levels and Haemoglobin levels, were recorded pre-operatively, (pre-op) and post-operatively, (post-op). Adverse outcomes in those with normal and abnormal biochemical values were compared using Chi Squared and T Testing. Linear associations were tested for using Pearson rank correlation. Automated Nutrition Scores Beta, (ANSB) were calculated and their relationship to adverse outcomes investigated. Protein energy malnutrition was common on admission. However, only 2 patients were nutritionally screened during admission. Those patients with abnormal pre-op TLC had an increased LOS in hospital. Those with abnormal albumin and/or TLC had increased mortality rates. Abnormal albumin levels were associated with a significant 3 fold increase in mortality, ($p = 0.009$) and post-operative TLC were found to be negatively correlated with LOS, ($r = –0.3$, $p = 0.038$). ANSB were also found to correlate with increased adverse outcomes although this was not significant. This study demonstrates that nutritional status is poorly assessed on admission in orthopaedic patients and consequently that provision of nutritional supplements is suboptimal. This study also demonstrates a highly significant relationship between abnormal albumin and adverse outcomes and identifies a new correlation between post-operative TLC and LOS. This study confirms that individual biochemical parameters and biochemical scores can be used to identify orthopaedic patients at particular risk of adverse post-op outcomes. These biochemical screening methods may be a more efficient and reliable way of stratifying malnutrition associated risk on admission.

Keywords: Nutrition, MUST, Mortality, Lymphocyte Count, Albumin, ANS Beta

1. Introduction

Malnutrition in elderly patients has long been recognised as a predictor of poor clinical outcome. Poor nutritional status has been identified as a causative factor in sustaining fractures [1]. Protein-energy malnutrition has also been associated with increased post-op complications including delayed wound healing, infections, decubitus ulcers and increased mortality [2,3]. Conversely improved nutrition has been shown to protect against geriatric trauma [4].

There is a large body of evidence emphasising the importance of recognising poor nutritional status in hospitalised patients early and addressing it appropriately. NICE guidelines recommend screening for poor nutritional status on admission facilitating appropriate provision of nutritional supplementation throughout the admission. The gold standard of nutritional assessment is the Subjective global assessment, (SGA) tool which is both involved and, open to interpretation based inconsistencies. It is infrequently taught during medical education and less frequently used on hospital wards. More simple screening tools are available for use on admission and are frequently included in admission clerking pro-

formas. One such tool being the Malnutrition Universal Screening Tool, (MUST) which highlights those at risk of malnutrition associated complications. Despite recommendations and tools being in place, assessments and screening tools remain notoriously underutilised and provision of supplementation is generally poor [5]. The cause for such poor compliance with such tools is unclear, but the involved nature of the validated assessment tools and the need to frequently involve other healthcare professionals to screen and assess patients and to provide supplementation is partly to blame.

Simple biochemical markers including albumin levels and TLC have long been regarded as markers which can reflect the risk of malnutrition related complications and provide simple means of screening for those at risk [2,3, 6-10]. However, use of these markers as indicators of nutritional status is controversial. There is debate as to whether abnormal biochemical factors are reflective of poor nutritional status or whether they simply reflect the physiological severity of illness. Most acute illnesses increase the physiological demand on the body and therefore increase the nutritional requirement of the patient. Biochemical factors and nutritional status are therefore intricately related. Complex biochemical assessment tools have been validated and used pre-op to allocate appropriate nutritional support to at risk patients and have been shown to reduce post-op mortality [11]. Simple biochemical assessment tools have also been validated against the SGA tool and have been shown to identify those at risk of malnutrition related complications [12]. Biochemical factors can therefore reflect malnutrition associated risk. Whether their role is as a surrogate or as a direct marker of nutritional status remains unclear. Few validated biochemical systems of nutritional screening are encouraged in clinical practice and as a consequence, these important factors are overlooked in spite of evidence to the contrary. In light of such poor compliance with traditional screening tools biochemical markers could provide a simple and effective alternative which may allow us to identify those at risk of malnutrition related complications earlier in their clinical course.

Historically albumin has been the most common biochemical marker used to assess nutritional status and it is well known to reflect protein energy malnutrition. Albumin levels have been shown to be predictive of LOS, in-hospital mortality, and recovery of basic activities of daily living following hip fracture [4,7]. However albumin has a prolonged half-life, (20 days) and serum levels can be significantly affected by concurrent inflammatory processes including those caused by surgical intervention. This has to some extent precluded serum albumin levels from being used to monitor in-patient nutritional status. Pre-admission values however, which have not been distorted by hospitalization and operative intervention retain their predictive value.

TLCs are also known to reflect protein energy malnutrition and surgical outcome. Koval demonstrated that TLC on admission is predictive for one-year mortality after hip fracture [4]. Other studies have implicated Pre-operative lymphopenia as a significant risk factor for the development of post-operative sepsis and mortality [6,9]. Therefore TLCs can also act as independent nutritional markers in hospitalized patients.

Both these biochemical factors have been used independently to assess risk of adverse outcomes but evidence suggests combining such variables creates increasingly valuable predictors of adverse outcomes [8]. With this in mind several groups have devised composite scores with demonstrable predictive value. Koval investigated both serum albumin levels and TLC in surgical patients and succinctly demonstrated a lower likelihood of poor outcome in those with normal variables than those with one abnormal variable. He identified the highest risk group were those with two abnormal variables [3]. These results were supported by similar findings by Syeminodis *et al.* [13]. Brugler went further combining several biochemical parameters with clinical parameters to create a six parameter scoring system, known as the automated nutrition score. The variables included poor oral intake, occurrence of a wound, malnutrition related admission, serum albumin levels, haemoglobin and TLC. Specific cut off values were established which were shown to reflect increased risk of adverse outcomes. Brugler confirmed that the screening tool they created was able to identify those at risk of malnutrition related complications as previously identified by the SGA. Brugler also validated an abridged score using only the biochemical parameters, named the ANSB score. This system was able to assess patient's level of risk based on admission bloods alone. Identifying at risk patients in this manner had the potential to increase the efficiency of nutritional intervention [12]. Further evidence supporting this method of assessment was set out by Smith who demonstrated that those scoring 2 and above were at increased risk of developing significant complications [14].

With a growing body of evidence to support the use of nutritional assessments in surgical patients and the apparent ineffectiveness of established assessment and screening tools it could be beneficial to remind ourselves of the predictive value of simple biochemical tests. This study aims to assess the current use of traditional nutritional assessments in orthopaedic practice and to investigate the relationship between biochemical parameters and adverse patient outcomes in order to ascertain

whether these simple measures could be used as more effective alternative screening tools.

2. Methods

One hundred and thirty seven patients, admitted to a trauma centre over a three month period following fractured neck of femur, were assessed retrospectively at 6 months post-opp. Data was collected from individual patient records, theatre records, hospital pathology databases and patient admission databases. Biochemical markers including TLC, Albumin and haemoglobin levels were recorded from the admission blood sample and the first blood test post procedure.

Those without a fully documented length of stay were excluded. Patients not operated on within 48 hours of admission were also excluded to prevent in hospital malnutrition confounding results. Data sets were excluded if any pre-op parameter investigated was not recorded, or recorded from blood samples taken at different times. They were also excluded if post-op parameters were not recorded, or recorded from samples taken at different times. The normal values for albumin and TLC were taken from Queens Hospital Biochemical Database and are were 1.5-4 $x10^9$/L for TLC and 35-50 g/L for Albumin.

After exclusion of data, complete data sets from 66 patients remained. Notes of the 66 patients were analysed for MUST assessments and for provision of nutritional supplements. Notes were used to establish the adverse outcomes, LOS and deaths. The measured parameters and adverse outcomes were processed and analysed using SPSS 17.

Pearson rank correlation was used to assess linear relationships between age and biochemical parameters and LOS at the 0.05 significance level. The relationship between abnormal lymphocyte counts and albumin levels and adverse outcomes including mortality and LOS were then assessed using chi-squared and t-testing at the 0.05 significance level. ANSB scores were then separately calculated using the criteria set out by Brugler *et al.* [12]. These scores were then compared against adverse outcomes both independently and grouped within score categories as set out by Smith *et al.* [14].

3. Results

Of the 66 patients assessed the average age was 82 years with 17 males and 49 females, (**Table 1**). TLC and albumin levels were assessed pre and post operatively and their relationship with adverse outcomes investigated. Hemoglobin levels were assessed pre operatively for later inclusion in ANSB scoring for which pre-op hemoglobin is a factor along with TLC and albumin. The mean biochemical values observed and their normal reference ranges are noted in **Table 2**. Abnormal pre-op TLC's, (Mean: 1.02) indicate that the majority of patients were nutritionally depleted on admission, (**Table 2**). Only two patients had been nutritionally assessed using the MUST and 2 different patients had nutritional supplements prescribed during their admission.

The adverse outcomes analyzed were mortality and total length of stay. 20 patients had died at time of follow up and the average length of stay was 24 days, (**Table 1**). Pearson rank correlation showed that age was positively correlated with length of stay, (**Figure 1**) and that post-op TLC's were negatively correlated with length of stay, (**Figure 2**) both findings were significant at the 0.05 level. Those with abnormal pre-op albumin results had a 1 day shorter in hospital stay , (**Table 3**) but were found to have a significant 38% increase in mortality , (**Table 4**). Patients with abnormal pre-op TLC's were found to have a 2 day increased LOS, (**Table 3**) and a 21% increase in mortality, (**Table 4**) though these were not found to be statistically significant. Only one patient was found to have an ANSB score of 3 and therefore was not thought to be representative of the score bracket. It can therefore be discounted from individual analysis. With this result omitted increasing ANSB scores were associated with a general increase in mortality and LOS, (**Table 5**). When the ANSB scores were grouped, without omissions, into those scoring between 0 and 1 and those scoring between 2 and 3, the higher scoring group was found to have a prolonged in hospital LOS being admitted 8 days longer than the lower scoring group, (**Table 6**).

Table 1.

Patient Demographics	*Mean*	*Range*
Total Number of Patients	66	
Males	17	
Females	49	
Average Age	82	52-103 , (Years)
Average Length of Stay	23	1-68 , (Days)

Table 2. Mean biochemical values with reference ranges.

Biochemical Measures	*Pre-Op*	*Post-Op*	*Normal Ranges*	
Lymphocytes	1.02*	1.08	1.5-4	$x10^9$/L
Albumin	38.6	30.4	35-50	g/L
Haemoglobin	12.1		12-18	g/dL

*Abnormal pre-op lymphocytes suggests protein energy malnutrition on admission.

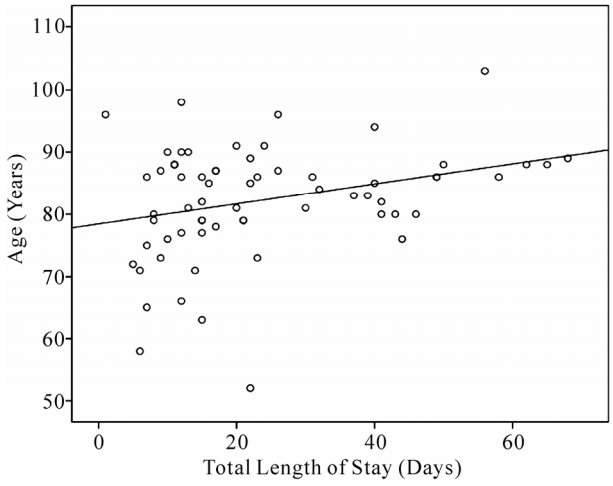

Figure 1. Age against length of stay–demonstrating positive correlation r = 0.298, p = 0.015.

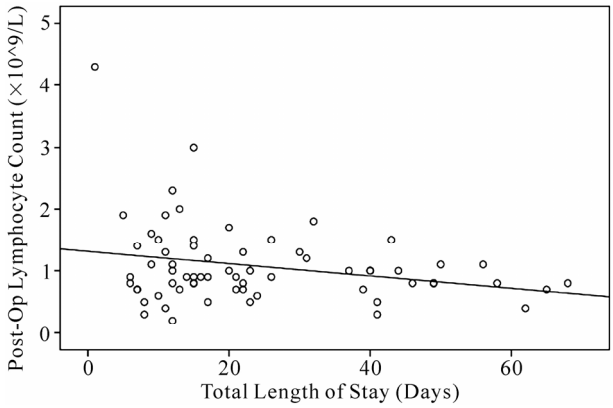

Figure 2. Post-op lymphocyte counts against length of stay–demonstrating negative correlation r = –0.256, p = 0.038.

Table 3. Pre-op biochemical markers related to length of stay.

Biochemical Measures	Length of Stay for	
	Normal Values	*Abnormal Values*
Albumin	24.1 +/– 2.44	22.9 +/– 3.72 , (Days)
Lymphocyte Counts	21.9 +/– 5.98	24.1 +/– 2.2 , (Days)

Table 4. Abnormal Biochemical Markers related to Mortality.

Biochemical Measures		Mortality	
		Alive	*Dead*
Albumin	*Normal*	40, (78%)	11, (22%)
	Abnormal	6, (40%)	9*, (60%)
Lymphocyte Counts	*Normal*	7, (.88%)	1, (12%)
	Abnormal	39, (67%)	19, (33%)

*Proportionally higher number of deaths in the abnormal albumin group-significant at the 0.05% level.

Table 5. ANS-B and adverse outcomes.

ANS-Beta Score	Mortality		*Length of Stay*[!]
	Alive	*Dead*[+]	
0	70.6%	29.4%	20.7 +/– 3.9 Days
1	68.9%	31.1%	24.4 +/– 2.5 Days
2	66.7%	33.3%	33.7 +/– 13.1 Days
3*	100%	0%	22 Days

[*]This group had 1 patient within it and can therefore be discounted; [+]Increase in mortality associated with increased score; [!]Increase in Length of Stay associated with increased score.

Table 6. Grouped ANS-beta scores and length of stay.

ANS-Beta Scores	*Length of Stay*
0-1	23.4 +/– 2.1 , (Days)
2-3	30.8 +/– 9.7 , (Days)

4. Discussion

Based on pre-operative TLC's the majority of patients included in the study were protein-energy malnourished on admission. In spite of this the majority of patients were not assessed adequately and they did not receive adequate nutritional support throughout their inpatient stay. Although this study is limited to one hospital, current literature would suggest that this is not an isolated finding [5]. Inadequate utilization of standard nutritional assessment tools is partly responsible for the widespread failure to recognize those at risk of malnutrition related complications. Using tools which are more accessible and less involved could be more appropriate in busy clinical environments. Alternatively such tests could be incorporated into pathology databases, creating an automated assessment tool as originally proposed by Brugler [12].

Albumin is a well investigated parameter and its role reflecting malnutrition associated risk is well documented. This paper demonstrates that abnormal pre-op albumin can be associated with up to a 3 fold increase in mortality. This significant finding makes serum albumin a major prognostic marker at the time of admission identifying those at significant risk of poor outcome post-opp. Whether provision of appropriate nutritional supplementation would reduce this risk is unclear from our data though other evidence suggests that addressing protein energy malnutrition with nutritional supplementation can reduce similar adverse outcomes [15]. This would suggest that pre-op albumin could be used as a surrogate marker of nutritional status to screen those at risk. Interestingly in this study abnormal pre-op albumin levels were associated with decreased LOS. This goes against

previous evidence but could be attributed to the significantly higher mortality observed in the abnormal pre-op albumin group unique to this study.

This study also highlights a significant relationship between TLC's and adverse outcomes. Both LOS and mortality were found to be higher in the abnormal pre-op TLC group which supports existing evidence. The linear relationship between post-op TLC and LOS discovered in this study however is not well documented in current research and appears to be a new finding. This study demonstrates a significant but weak negative correlation between post-op TLC and LOS. Given the small numbers included in this study further investigation with greater numbers would be required to establish whether a stronger relationship exists. Post-op TLC may reflect the physiological shock sustained during the operation and may in this way identify those who are less likely to recover quickly.

ANSB scoring of these patients also correlated with adverse outcomes, both LOS and mortality. Only one patient scored 3 using the ANSB system and therefore figures calculated from this score alone were discounted. After excluding this patient a clear increase in LOS as one increase ANSB group becomes evident as does the increase in mortality. This increase in mortality creates an overall decrease in survival for those scoring higher using the ANSB. When the ANSB scores are grouped into 0-1 and 2-3 as proposed by Smith et al there is a clear increase in LOS in those from the higher scoring bracket [14]. Although the numbers used in this study are insufficient to demonstrate any significant difference using this scoring system the general trend would support using the scoring system to stratify risk in orthopedic patients. Again this would suggest that such biochemical systems do have prognostic value in assessing those at risk of adverse outcomes.

In conclusion this study demonstrates that traditional nutritional screening and provision of nutritional supplementation is inadequate in the majority of patients. Albumin and TLC however can independently, and as part of the ANS Beta score, identify those at risk of adverse outcomes specifically mortality rates. The significant 3 fold increase in mortality associated with abnormal albumin values and the novel inverse correlation noted between post-op lymphocyte counts and length of stay are particularly interesting. Biochemical screening tools are therefore an effective means of assessing nutritional status. Their ease of calculation also makes them less time consuming alternatives to clinical assessment based screening tools. Such biochemical systems could be integrated into pre-admission assessments or into biochemical databases to facilitate automated screening which may improve surgical outcome.

5. References

[1] D. Thiebaud, "Importance of Albumin, 25(OH)-vitamin D and IGFBP-3 As Risk Factors in Elderly Women and Men with Hip Fracture," *Osteoporosis International*, Vol. 7, No. 5, 1997, pp. 457-462.

[2] B. M. Patterson, "Protein Depletion and Metabolic Stress in Elderly Patients Who Have A Fracture of the Hipp," *Journal of Bone and Joint Surgery*, Vol. 74, No. 2, 1992, pp. 251-260.

[3] K. J. Koval, "The Effects of Nutritional Status on Outcome after Hip Fracture," *Journal of Orthopaedic Trauma*, Vol. 13, No. 3, 1999, pp. 164-169. doi:10.1097/00005131-199903000-00003

[4] K. J. Koval, "An AOA Critical Issue: Geriatric Trauma: Young Ideas," *Journal of Bone and Joint Surgery*, Vol. 85, No. 7, 2003, pp. 1380-1388.

[5] S. S. Porben, "The State of the Provision of Nutritional Care to Hospitalized Patients-Results from The Elan-Cuba Study," *Clinical Nutrition*, Vol. 25, No. 6, 2006, pp. 1015-1029. doi:10.1016/j.clnu.2006.04.001

[6] L. J. Grossbard, "Lymphocytopenia in the Surgical Intensive Care Unit Patient," *American Journal of Surgical Pathology*, Vol. 50, No. 4, 1984, pp. 209-212.

[7] M. R. Foster, "A Prospective Assessment of Nutritional Status and Complications in Patients with Fractures of the Hipp," *Journal of Orthopaedic Trauma*, Vol. 4, No. 1, 1990, pp. 49-57. doi:10.1097/00005131-199003000-00009

[8] D. T. Dempsey and J. L. Mullen, "Prognostic Value of Nutritional Indices," *Journal of Parenteral and Enteral Nutrition*, Vol. 11, No. 5, 1987, pp. 109-114. doi:10.1177/014860718701100517

[9] R. T. Lewis and H. Klein, "Risk Factors in Postoperative Sepsis: Significance of Preoperative Lymphocytopenia," *Journal of Surgical Research*, Vol. 26, No. 4, 1979, pp. 365-371. doi:10.1016/0022-4804(79)90021-0

[10] M. Lumbers, "Nutritional Status and Clinical Outcome in Elderly Female Surgical Orthopaedic Patients," *Clinical Nutrition*, Vol. 15, No. 3, 1996, pp. 101-107. doi:10.1016/S0261-5614(96)80033-1

[11] R. C. Smith and R. Hartemink, "Improvement of Nutritional Measures during Preoperative Parenteral Nutrition in Patients Selected by the Prognostic Nutritional Index: A Randomized Controlled Trial," *Journal of Parenteral and Enteral Nutrition*, Vol. 12, No. 6, 1988, pp. 587-591. doi:10.1177/0148607188012006587

[12] L. Brugler, "A Simplified Nutrition Screen for Hospitalized Patients Using Readily Available Laboratory and Patient Information," *Nutrition*, Vol. 21, No. 6, 2005, pp. 650-658. doi:10.1016/j.nut.2004.10.012

[13] P. P. D. Symeonidis and D. Clark, "Assessment of Malnutrition in Hip Fracture Patients: Effects on Surgical Delay, Hospital Stay and Mortality," *Acta Orthopaedica Belgica*, Vol. 72, No. 4, 2006, pp. 420-427.

[14] R. C. Smith, "An Effective Automated Nutrition Screen for Hospitalized Patients," *Nutrition*, Vol. 25, No. 3, 2009,

pp. 309-315. doi:10.1016/j.nut.2008.09.007

[15] P. P. H. Katelaris, G. B. Bennett and R. C. Smith, "Prediction of Postoperative Complications by Clinical and Nutritional Assessment," *Australian and New Zealand Journal of Surgery*, Vol. 56, No. 10, 1986, pp. 743-747. doi:10.1111/j.1445-2197.1986.tb02319.x

