Interactive CardioVascular and Thoracic Surgery 20 (2015) 107–113
doi:10.1093/icvts/ivu324 Advance Access publication 25 September 2014

Is low serum albumin associated with postoperative complications in patients undergoing oesophagectomy for oesophageal malignancies?

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Received 27 May 2014; received in revised form 26 August 2014; accepted 4 September 2014

Abstract

A best evidence topic was written according to a structured protocol. The question addressed was: in patients undergoing oesophagectomy for oesophageal malignancy, is low serum albumin associated with postoperative complications? Altogether, 87 papers were found using the reported search, of which 16 demonstrated the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes and results of these papers are tabulated. This paper includes 2 level 2 papers, 12 level 3 papers and 2 level 4 papers. All the papers compared either all or some of the following postoperative complications: mortality, morbidity, anastomotic leak, respiratory and non-respiratory complications, and length of hospital stay. Eleven of the 16 papers found an association between low serum albumin and postoperative complications. Of these, one study showed that low serum albumin combined with low fibrinogen levels (FA score) was predictive of postoperative recurrence of oesophageal cancer. Another study showed that when combined with white cell count and C-reactive protein (CRP, NUn score), serum albumin had a high diagnostic accuracy for major complications after postoperative day 3. The largest study compared the in-hospital mortality in 7227 patients who underwent oesophageal surgery for malignancy. The percentage of in-hospital mortality was associated with low serum albumin (<15.0 vs >35.0 g/l, 21.0 vs 11.3%, P <0.001). Five of the 16 papers found no significant association between low serum albumin and postoperative complications. Of these papers, one showed that low serum albumin was not an independent risk factor, while four others found no association between low serum albumin with respiratory complications, anastomotic leak and postoperative mortality. Instead, these studies found other factors responsible for postoperative complications such as: CRP, smoking, disease duration, malnutrition and low T-cell levels. Taken together, while low serum albumin is associated with postoperative complications, opinion regarding the prognostic value of low serum albumin and nutritional support remains conflicted. Because of the confounding factors encountered in these studies, the clinician should consider the finding of low serum albumin in patients, together with disease and surgical factors to provide optimal care for these patients.

Keywords: Oesophageal cancer • Oesophagectomy • Serum albumin • Perioperative care • Postoperative complications

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This is fully described in the *ICVTS* [1].

THREE-PART QUESTION

In patients undergoing [oesophagectomy] for oesophageal cancer, is [low serum albumin] associated with [postoperative complications].

CLINICAL SCENARIO

You are running a preoperative assessment clinic and see a middle-aged male with T1N0M0 oesophageal cancer. His routine investigations were unremarkable except for a low serum albumin (<4.0 g/dl). You have recently read reports that low serum albumin may lead to postoperative complications. To provide optimal perioperative management, you turn to the literature and review the best evidence available.

SEARCH STRATEGY

Medline 1980 to July 2014 using OVID interface [exp albumins/ OR albumin.mp] AND [esophagectomy.mp OR exp Esophagectomy OR oesophagectomy.mp] AND [esophageal cancer.mp OR exp esophageal neoplasms OR oesophageal cancer.mp] AND [exp Post-operative Complications/ OR postoperative complications.mp OR complications.mp].

SEARCH OUTCOME

Eighty-seven papers were found using the reported search. From these, 16 were identified to have provided the best evidence to answer the question. These are presented in Table 1.

Table 1: Best evidence papers

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Matsuda *et al.* (2014), J Clin Oncol, Japan [2] Retrospective single-centre cohort study (level 3)	215 patients who underwent transthoracic oesophagectomy	Postoperative disease-free survival (DFS)	*Univariate:* low serum albumin (<4.0 g/dl) and fibrinogen (<350 mg/dl) associated with lower DFS *Multivariate:* low serum and fibrinogen levels predict postoperative DFS	Fibrinogen and albumin scores able to predict postoperative occurrence in oesophageal cancer patients
Yoshida *et al.* (2013), Surg Today, Japan [3] Retrospective single-centre cohort study (level 3)	299 patients undergoing elective subtotal oesophagectomy *Group 1:* patients with respiratory complications, *n* = 53 *Group 2:* patients without respiratory complications, *n* = 246	Respiratory complications	Serum albumin <4.0 g/dl group 1: group 2 = 25 : 129, *P* = 0.486	No significant association was identified between low serum albumin preoperatively and incidence of postoperative pulmonary complications
Noble *et al.* (2012), J Gastrointest Surg, UK [4] Retrospective single-centre review (level 3)	258 patients undergoing undergoing oesophagogastric resection for high-grade dysplasia	Major complications (Clavin–Dindo III–V) Anastomotic leak	Lower serum albumin in the major complication group from postoperative day 3 (*P* <0.008) and postoperative day 7 (*P* <0.0001) Serum albumin significantly low on multivariate analysis (*P* = 0.008)	This study examined the combined use of blood-borne markers including C-reactive protein (CRP), white cell count and albumin levels to develop a novel 'NUn' score to guide perioperative management and improve outcomes
Poziomyck *et al.* (2012), Nutr Cancer, Brazil [5] Prospective single-centre cohort study (level 3)	74 patients undergoing foregut surgery for malignancy AJCC 2010 stage II or III: oesophagectomy (*n* = 19), gastrectomy (*n* = 43) and Whipple (*n* = 12) *Group 1:* patients who had postoperative complications and died, *n* = 50 *Group 2:* Patients who had postoperative complications and did not die, *n* = 24	Mortality Length of hospital stay	A statistical significance was found for albumin levels (3.9 vs 3.5 g/dl, *P* <0.04) between patients who had postoperative complications and who lived or died, while other markers (haemoglobin, haematocrit and total lymphocyte count) did not Length of hospital stay was inversely correlated with serum albumin (*r* = 0.277, *P* = 0.017)	While malnutrition is a risk for adverse outcomes, new comparative studies are needed for nutritional assessment to elucidate an approach that better demonstrates nutritional risk of patients
Shiozaki *et al.* (2012), Oncol Lett, Japan [6] Retrospective single-centre cohort study (level 3)	96 patients undergoing oesophagectomy (76 thoracotomy and 20 thoracoscopic surgery) *Group 1:* Presence of postoperative respiratory complications (*n* = 20) *Group 2:* Absence of postoperative complications (*n* = 76)	Postoperative respiratory complications: pneumonia and acute respiratory distress syndrome (ARDS)	The patients with and without postoperative complications did not differ significantly with respect to preoperative serum albumin levels Preoperative serum levels were not effective predictors of postoperative respiratory complications (multiple logistic regression analysis)	Forced expired volume in 1 second (FEV1.0%) serum CRP and smoking history were reliable predictors of the risk of respiratory complications following oesophageal resection compared with serum albumin levels
Khan *et al.* (2010), Saudi J Gastroenterol, Pakistan [7] Retrospective single-centre	284 patients undergoing subtotal oesophagectomy for malignant disease *Group 1:* patients who had undergone subtotal oesophagectomy and were	Mortality at 12 months	Preoperative serum albumin levels in Group 1 were higher compared with Group 2 (3.35 ± 0.49 vs 2.99 ± 0.51, *P* <0.05)	Preoperative low serum albumin levels have a strong predictive relation to mortality on patients who undergo oesophagectomy for oesophageal cancer

Continued

Table 1: (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
cohort study (level 3)	alive on completion of 12 months (n = 185) *Group 2:* patients who had undergone subtotal oesophagectomy and died by the completion of 12 months (n = 99)			
Marin *et al.* (2010), Arq Gastroenterol, Brazil [8] Retrospective single-centre cohort study (level 3)	100 patients undergoing oesophagectomy for malignant disease *Group 1:* major surgery (oesphagectomy with gastroplasty by transhiatal or transthoracic route, n = 25) *Group 2:* minor/palliative surgery (gastrostomy or jejunostomy, n = 75)	Postoperative complications: pleuropulmonary of infectious/non-infectious origins, cardiovascular, surgical site infection, sepsis, anastomosis dehiscence, stenosis and tumour recurrence	Lower frequency of hypoalbuminaemia (>3.5 g/dl) was associated with lower weight loss and less postoperative complications (P = 0.041) Surgical mortality in minor surgery patients was higher in the presence of hypoalbuminaemia, with postoperative survival more than 30 days significantly higher in patients with serum albumin >3.5 g/dl (P = 0.041)	Authors conclude that disease severity (e.g. advanced stage) causes a worse nutritional state, which complicates surgery and is associated with mortality, and thus recommended early diagnosis and nutritional treatment to support surgical action
Park *et al.* (2009), Crit Care, UK [9] Retrospective multicentre review (level 4)	7227 patients who were admitted to 181 critical care units following elective oesophageal surgery for malignancy	In-hospital mortality	Multiple logistic regression showed that percentage of in-hospital mortality was associated with low serum albumin (<15.0 vs >35.0 g/l, 21.0 vs 11.3%, P <0.001) Preoperative albumin levels did not predict postoperative levels or increased risk of death	Postoperative serum albumin was confirmed as an additional prognostic factor regarding the risk of death. More work is needed to determine how this may improve clinical management
Ryan *et al.* (2007), J Gastrointest Surg, USA [10] Retrospective single-centre review (level 4)	200 patients undergoing oesophagectomy (thoracotomy with three- or two-stage exploration) and two-field lymphadenectomy for malignant disease	Morbidity and mortality	Patients with albumin <20 g/l were more likely to develop complications than those with albumin >20 g/l (54 vs 28%, respectively, P <0.011) Patients with albumin <20 g/l had higher rates of ARDS (22 vs 5%, P <0.001), respiratory failure (27 vs 8%, P <0.01), and were more likely to die in the hospital (27 vs 6%, P <0.001) than those with albumin >20 g/l Multivariate logistic regression analysis showed that day 1 albumin level was independently related to postoperative complications [odds ratio (OR) = 0.85; 95% confidence interval (CI) 0.85–0.77; P <0.001]	Authors suggest that albumin less than 20 g/l on the first postoperative day may identify a cohort postoperatively that should continue to be monitored in the high dependency unit (HDU) or the intensive care unit (ICU)
Tomimaru *et al.* (2006), J Surg Oncol, Japan [11] Retrospective single-centre	762 patients who underwent oesophagectomy (right thoracotomy and three- or two-field lymph node dissection)	Morbidity and mortality	The serum albumin and lymphocyte count in the salvage group were significantly lower than those in the neoadjuvant group	Because salvage oesophagectomy is performed on immunocompromised hosts, it therefore important to accurately assess the preoperative T factor, in

Continued

Table 1: (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
cohort study (level 3)	*Group 1:* salvage oesophagectomy after definitive chemoradiation (*n* = 24) *Group 2:* oesophagectomy after neoadjuvant chemoradiation (*n* = 26)		Univariate analysis performed for age (<60/<60), clinical T (T1–2/T3–4), reason for salvage surgery, curability, preoperative serum albumin (<4.0 /<4.0 g/dl) and lymphocyte did not identify preoperative serum albumin as an independent prognostic factor The lower preoperative serum albumin level in the salvage group may be due to a more malnourished and immunosuppressed condition than those in the neoadjuvant group	addition to serum albumin levels, when deciding on the indication for salvage surgery
Kudsk *et al.* (2003), J Parenter Enteral Nutr, USA [12] Retrospective multicentre cohort study (level 3)	706 patients undergoing elective surgery on the oesophagus (*n* = 59), stomach (*n* = 40) and pancreas (*n* = 221)	Incidence of complications: pneumonia, fasciitis, anastomosis or wound dehiscence, intra-abdominal abscess, renal or respiratory failure, decubitus ulcer formation or death	With albumin <3.75 g/dl (Groups 1–5), oesophageal surgery resulted in significantly more complications than stomach (*P* = 0.04) or colon (*P* = 0.005) Complications increased significantly as albumin levels dropped (Group 1 vs Group 2–7, *P* <0.02; 1–2 vs 3–7, 1–3 vs 4–7, 1–4 vs 5–7, 1–5 vs 6–7, all *P* <0.0001), 1–6 vs 7, *P* = 0.035)	Both preoperative serum albumin and operative site affect the complication rate, which subsequently influenced postoperative stay (POS), ICU stay and nil per oral (NPO) days
		Mortality	Mortality was low (1–5%) with a preoperative albumin >3.25 g/dl, regardless of operative site. Mortality increased up to 20–30% in the two lowest albumin groups	
		Length of postoperative stay (POS)	Complications significantly increased POS in all groups except for the highest and lowest albumin groups (*P* <0.0001)	
		Intensive care unit stay	Mean ICU stay gradually increased with a decreasing preoperative albumin level	
		Nil per oral days	Delay to resumption of diet was prolonged in patients surviving oesophagectomy at all albumin levels <4.25 g/dl	
Nakamura *et al.* (2004), Am J Surg [13], Japan Retrospective single-centre cohort study (level 3)	55 patients undergoing oesophagectomy for oesophageal malignancy *Salvage group:* patients who underwent oesophagectomy after definitive chemoradiation (*n* = 27)	Mortality, morbidity, need for mechanical ventilation, ICU stay, postoperative hospital stay, anastomotic leakage, wound infection, pleural effusion, residual tumours and pathological effect	No differences in overall postoperative survival/ mortality between the salvage and neoadjuvant groups	Low serum albumin level in the salvage group could be related to the long duration of disease

Continued

Table 1: (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
	Neoadjuvant group: patients who underwent oesophagectomy after neoadjuvant chemoradiation (n = 28)			
Rentz *et al.* (2003), J Thorac Cardiovasc Surg, USA [14] Prospective multicentre cohort study (level 2)	945 patients undergoing oesophagectomy. *Group 1:* transthoracic oesophagectomy (n = 562) *Group 2:* transhiatal oesophagectomy (n = 383)	Serious morbidity: pneumonia, unplanned intubation, respiratory failure, pulmonary oedema, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, wound dehiscence, coma for >24 h, acute renal failure, sepsis, perioperative bleeding >4 units and graft or prosthesis failure	Risk stratification model applied to both groups showed an association between serum albumin <3.5 g/dl with postoperative mortality (β coefficient: 0.56, P = 0.0135) and morbidity (β coefficient: 0.37, P = 0.0102)	Although no differences in postoperative mortality and morbidity were found between either techniques, identifiable risk factors, such as serum albumin levels, that might reduce mortality and morbidity may assist in the selection of the procedure best suited for the patient
Bailey *et al.* (2003), Ann Thorac Surg [15], USA Prospective multicentre outcomes cohort study (level 2)	1777 patients who had undergone oesophagectomy for malignancy (n = 1509) and benign disease (n = 268)	Mortality and morbidity	Lower preoperative albumin level was an independent risk factor for overall morbidity on multivariable analysis (β coefficient = −0.21, SE = 0.09, P = 0.02, OR = 0.81)	Use of preoperative serum albumin levels, in addition to other independent risk factors, can be used to better stratify patients before oesophagectomy
Takagi *et al.* (2001), Nutrition, Japan [16] Retrospective single-centre cohort study (level 3)	103 patients undergoing oesophagectomy for thoracic oesophageal cancer via thoracotomy and three-field lymphadenectomy Patients with complications, n = 27 (6 received preoperative chemoradiation) Patients without complications, n = 76 (2 received preoperative chemoradiation)	Infectious complications: pneumonia, abscess (neck, mediastinum and abdomen), enterocolitis, sepsis and viral infection	At 21 days postoperatively, serum albumin level was significantly higher in patients without postoperative infectious complications compared with those who had (3.55 ± 0.08 vs 3.20 ± 0.14 g/dl, P <0.05)	Although postoperative serum albumin levels may predict infectious complications, to prevent infectious complications, preoperative treatment that may adversely affect the host's immune system, such as heavy chemoradiation, should be avoided
Nishi *et al.* (1988), Ann Surg, Japan [17] Retrospective single-centre cohort study (level 3)	364 patients who underwent oesophagectomy, oesophagogastrectomy and/or partial gastrectomy 62 patients admitted for cholecystectomy were used as controls	Anastomotic leak and respiratory complications	There were significantly lower serum albumin levels in elderly patients (>70 years old) compared with controls An extremely high correlation was seen between serum albumin levels and total lymphocyte count in patients with oesophageal cancer (r = 0.56, P <0.001)	Although serum albumin levels did not correlate with the study outcomes, improvement in the nutritional status of patients with cancer can reduce operative morbidity and mortality rates. The authors suggested that cancer patients required between 40 and 50 kcal/kg/day with simultaneous administration of 150–200 non-protein calories/g nitrogen

RESULTS

Matsuda *et al.* [2] examined the between serum fibrinogen and albumin (FA) score with postoperative disease-free survival. Patients with low serum albumin (<4.0 g/dl) and fibrinogen (<350 mg/dl), and thus a higher FA score, had a higher incidence of cancer recurrence following uni- and multivariate analysis.

Yoshida *et al.* [3] compared postoperative complications and found no significant predictive relationship between low preoperative serum albumin (<40 g/l) and postoperative pulmonary complications.

Noble *et al.* [4] examined major complications and anastomotic leak in 258 patients undergoing oesophagogastric resection for high-grade dysplasia. They found a significant association between

low serum albumin and major complications on postoperative days 3 and 7, and anastomotic leak. Furthermore, when albumin was combined with C-reactive protein (CRP) and white cell count (WCC) to create a NUn score, they found that a score >10 was predictive of an anastomotic leak and death on postoperative day 4.

Poziomyck *et al* [5] examined mortality in patients who developed postoperative complications following foregut surgery. Lower serum albumin levels were associated with mortality and longer hospital stay.

Shiozaki *et al.* [6] analysed respiratory complications in patients who underwent oesophagectomy. Serum albumin levels were not significantly different between patients with or without postoperative respiratory complications.

Khan *et al.* [7] compared postoperative 12-month mortality in patients who underwent subtotal oesophagectomy for malignant disease. Patients who were alive after 12 months had higher preoperative serum albumin levels compared with those who did not.

Marin *et al.* [8] reviewed postoperative outcomes in patients who underwent major or minor/palliative oesophageal surgery for malignant disease. Patients with higher serum albumin levels (>3.5 g/dl) had less postoperative complications. In a subset of patients undergoing minor surgery (gastrostomy or jejunostomy), lower serum albumin was associated with mortality and 30-day postoperative survival.

Park *et al.* [9] performed a retrospective multicentre study in 7227 patients who underwent oesophageal surgery for malignancy. They found a positive association between in-hospital mortality and low postoperative serum albumin levels following multiple logistic regression.

Ryan *et al.* [10] examined morbidity and mortality in patients who underwent oesophagectomy for malignant disease. Patients with lower serum albumin (<20 g/l) on the first postoperative day were more likely to develop respiratory failure or acute respiratory distress syndrome (ARDS), or to die in the hospital. Multiple regression modelling showed that postoperative day 1 albumin level was independently related to postoperative complications.

Tomimaru *et al.* [11] compared morbidity and mortality between 762 patients who underwent salvage oesophagectomy with or without prior chemoradiation therapy (CRT). The authors showed that while serum albumin and lymphocyte counts were significantly lower in the salvage group, there was no association between preoperative serum albumin and post-oesophagectomy outcomes.

Kudsk *et al.* [12] performed a study in 706 patients undergoing elective foregut surgery. Patients with lower serum albumin levels had a higher incidence of postoperative complications, mortality, length of intensive care unit stay, postoperative stay and nil per oral days.

Nakamura *et al.* [13] analysed morbidity and mortality in 55 patients undergoing oesophagectomy with or without prior CRT. They found no statistically significant difference in overall mortality between either groups.

Rentz *et al.* [14] examined morbidity in 945 patients who underwent transthoracic and transhiatal oesophagectomy. They found an association between low serum albumin (<35 g/dl) and postoperative mortality and morbidity in both surgical types.

Bailey *et al.* [15] compared mortality and morbidity in a prospective cohort study of 1777 patients who underwent oesophagectomy for malignant and benign disease. They showed that lower preoperative albumin level was an independent risk factor for overall morbidity following multivariate analysis.

Takagi *et al.* [16] examined the presence of infectious complications in 103 patients who underwent oesophagectomy for thoracic oesophageal cancer. They showed that postoperative day 21 serum albumin level was significantly higher in patients without infectious complications compared with those who had infection.

Nishi *et al.* [17] analysed anastomotic leak and respiratory complications in 364 patients who underwent oesophagectomy, oesophagogastrectomy, and/or partial gastrectomy, and found that serum albumin levels were not correlated with study outcomes.

CLINICAL BOTTOM LINE

Taken together, several studies reviewed in this paper suggest an association between low serum albumin and postoperative complications. However, there are conflicting opinions regarding the prognostic value of low serum albumin, and thus, the role of nutritional support to optimize these patients preoperatively. One limitation of this study is the narrow focus on serum albumin and postoperative complications. Several confounding factors were encountered in some of these papers. For example, chyle leak would decrease in the number of circulating T-cells and lower serum albumin levels, thus causing postoperative infections that may be mistakenly attributed to lowered serum albumin levels. Other confounding factors such as preoperative chemoradiotherapy, CRP levels and smoking may contribute to postoperative complications. It is important, in clinical practice, to consider the finding of low serum albumin in the context of the patient as well as, disease and surgical factors to provide optimal care for these patients. In addition, further studies are warranted to determine the role of preoperative nutritional support in this group of patients.

Conflict of interest: none declared.

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eComment. The importance of nutritional assessement and support in patients undergoing oesophagectomy for oesophageal malignancies

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I read with great interest the best evidence topic by Goh *et al.* [1] on the relationship between preoperative serum albumin levels and postoperative complications in patients undergoing oesophageal resection for oesophageal malignancies. This is a sensitive group in which malnutrition is caused not only by the metabolic perturbations from the neoplastic disease, but also from dysphagia and alimentary tract dysfunction, further aggravating the situation. Indeed, it has been demonstrated that up to 32% of oesophageal cancer patients being considered for oesophagectomy present with severe weight loss, underlining the fact that they are prone to malnutrition [2]. Given the well-established association between malnourishment and poor surgical outcomes, it seems reasonable that patients scheduled for major surgery, such as oesophagectomy, should undergo formal nutritional assessment, and if necessary nutritional support. Among the various indices used for the evaluation of the nutritional status, hypoalbuminaemia defined as serum albumin level <3.0 g/dl, has been identified as the most valuable predictor of adverse postoperative outcomes, while to date, the only validated assessment method for surgical patients is the NRS-2002, which is based on weight loss, reduced intake and disease severity [3]. It is important to note that nutritional assessment of the surgical patient is not used to "clear" him for surgery, but rather to optimize surgical outcomes in high-risk groups.

When the oesophagectomy candidate is found to be malnourished, the options to proceed with nutritional support include oral supplements, parenteral nutrition (PN) and enteral tube feeding. The potential benefits of the first option are frequently unattainable due to gastrointestinal intolerance, anorexia and non-compliance, while the major drawbacks to preoperative initiation of PN include glycaemic variability, central line complications and the risk of infection. Nevertheless, PN has been found particularly useful for patients undergoing upper gastrointestinal surgery, given that it can be provided for at least 7 days during the preoperative period [3]. A meta-analysis of various nutritional support methods in patients undergoing gastrointestinal surgery demonstrated that enteral nutrition (EN) is advantageous over PN in terms of infectious complications, anastomotic leaks and duration of hospital stay. Moreover, EN is especially beneficial for patients with malnutrition or malignancy [4]. Feeding jejunostomy tubes (JT) inserted percutaneously, endoscopically or laparoscopically can provide the desired route for EN before oesophagectomy or neoadjuvant therapy, although their routine use has been associated with the development of major complications, including reoperation, bowel ischaemia and even death [5]. However, in the malnourished patient undergoing oesophageal resection apart from preoperative support, JT will also provide the postoperative nutritional bridge to oral intake.

Conflict of interest: none declared.

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eComment. In postoperative oesophagectomy patients, does a change in albumin predict better postoperative outcomes?

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I read with interest the excellent paper from Goh *et al.* [1]. It comprehensively addressed the question of whether serum albumin acts as a predictor of complications in the postoesophagectomy patient. The authors took into account the important fact that low serum albumin may occur secondary to a number of other possible confounding factors. They also briefly address the fact that little is known about the role of preoperative nutritional support in these patients.

This paper leads to a number of further questions that should be asked. Firstly, is there a difference in the predictive value of albumin if it is low in the preoperative setting, but restored using nutritional support to a normal level postoperatively, compared to the patient with a normal preoperative albumin which becomes low in the postoperative setting? Secondly, is there an ideal time and rate at which to improve a patient's albumin level in order to reduce the chances of further complications? Finally, is there a difference in outcomes between patients who have their albumin restored using parenteral nutrition versus those patients who have this done using enteral nutrition?

Conflict of interest: none declared.

Reference

[1] Goh SL, De Silva RP, Dhital K, Gett RM. Is low serum albumin associated with postoperative complications in patients undergoing oesophagectomy for oesophageal malignancies? Interact CardioVasc Thorac Surg 2015;20:107–13.