Department of Pharmacy[1], Gifu Municipal Hospital; Laboratory of Clinical Pharmacy[2], Gifu Pharmaceutical University; Department of Cardiovascular Surgery[3], Gifu Municipal Hospital, Gifu, Japan

# Nutritional factors affecting length of hospital stay in patients undergoing cardiovascular surgery

M. Yasuda[1,*], T. Tachi[1,2], M. Fukuta[1], M. Kato[2], K. Saito[2], A. Yoshida[2], K. Nagaya[1], E. Setta[1], T. Osawa[1], M. Umeda[1], E. Murakami[3], K. Azuma[3], H. Teramachi[2], C. Goto[1]

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**Corresponding author: Masahiro Yasuda, Department of Pharmacy, Gifu Municipal Hospital, 7-1, Kashima-cho, Gifu-shi, Gifu 500-8513, Japan*
*m.yasuda@gmhosp.gifu.gifu.jp*

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Cardiovascular surgery is a highly invasive intervention that is often performed in elderly patients at risks of complications because of malnutrition and reduced immunity. This study investigated nutritional factors that affected length of hospital stay in patients undergoing cardiovascular surgery. Among 68 patients who underwent surgery at the Department of Cardiovascular Surgery of Gifu Municipal Hospital between April 2013 and March 2015, 55 with complete data were included in the analysis. Data on serum albumin (ALB), transferrin (Tf), pre-albumin (PA) and retinol binding protein (RBP) levels were collected. The median length of hospital stay was 29 days (stays of ≥30 days were considered long-term hospitalization). Multivariate analysis (multiple logistic regression) included age (≥ 65 years), sex (female), and ALB (≤ 3.0 g/dL), Tf (≤ 150.0 mg/dL), PA (≤ 10.0 mg/dL) and RBP (≤ 1.5 mg/dL) levels. ALB [odds ratio (OR) 10.37, 95% CI (confidence interval): 1.185–90.80, $P = 0.035$] and Tf [OR 4.743, 95% CI: 1.375–16.36, $P = 0.014$] were significantly associated with length of hospital stay. Nutritional management of patients and careful monitoring of ALB and Tf levels can shorten length of hospital stay in patients undergoing cardiovascular surgery.

## 1. Introduction

Previous reports have shown that malnutrition can prolong length of hospital stay in various patient groups, including young burn patients (Amavizca et al. 2016; Kyle et al. 2004; Marinella and Markert 1998; Pontiroli et al. 2007). Cardiovascular surgery is a highly invasive procedure that is often performed in elderly patients who are at risks of complications because of malnutrition. Such complications are likely to prolong the length of hospital stay; however, to the best of our knowledge, no data regarding this are published. Therefore, the present study investigated the association between nutritional factors and length of hospital stay (in terms of the number of days of hospitalization) in patients undergoing cardiovascular surgery.

## 2. Investigations and results

### *2.1. Patient background*

Table 1 summarizes the characteristics of the 55 patients included in the study. The mean age of the patients was 69.6 years; 29 were men and 26 were women.

**Table 1: Demographic characteristics of the patients**

| | | n | Mean ± SD |
|---|---|---|---|
| Total patients | | 55 | |
| Sex (male/female) | | 29/26 | |
| Age (years) | | | 69.6 ± 10.1 |
| | | | Median (IQR) |
| Hospitalization days (days) | | | 29 (22-52) |
| Stay days in an intensive care unit (days) | | | 3 (2-7) |
| | | | Mean ± SD |
| Laboratory test value | Protein (g/dL) | | 5.70 ± 0.69 |
| | Total cholesterol (mg/dL) | | 156.30 ± 34.10 |
| | Albumin (g/dL) | | 2.74 ± 0.34 |
| | Transferrin (mg/dL) | | 153.30 ± 35.10 |
| | Pre-albumin (mg/dL) | | 9.98 ± 2.44 |
| | Retinol binding protein (mg/dL) | | 1.68 ± 0.67 |

SD, standard deviation; IQR, Interquartile range

### 2.2. *Length of hospital stay*

#### 2.2.1. *Nutritional evaluation*

Overall, 11 of the 55 patients (20.0%) had serum albumin (ALB) levels of ≤3.0 g/dL; 24 (43.6%) had transferrin (Tf) levels of ≤150.0 mg/dL; 27 (49.1%) had pre-albumin (PA) levels of ≤10.0 mg/dL and 34 (61.8%) had retinol binding protein (RBP) levels of ≤1.5 mg/dL (Table 2).

**Table 2: Classifications of nutritional indices**

| | Reference value | n | Rate (%) |
|---|---|---|---|
| Albumin (g/dL) | ≤ 3.0 | 11 | 20.0 |
| Transferrin (mg/dL) | ≤ 150.0 | 24 | 43.6 |
| Pre-albumin (mg/dL) | ≤ 10.0 | 27 | 49.1 |
| Retinol binding protein (mg/dL) | ≤ 1.5 | 34 | 61.8 |

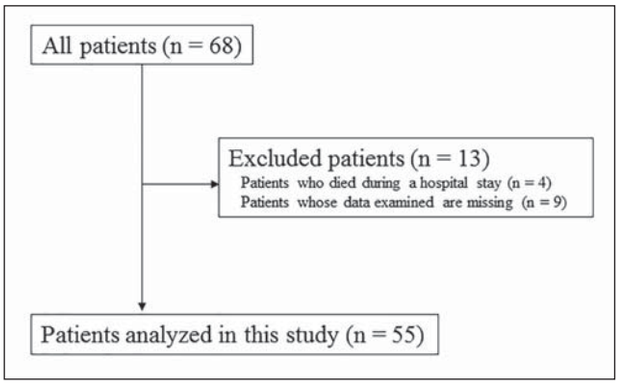


Fig. 1: Flowchart of the study population

#### 2.2.2. *Risk factors causing long-term hospitalization*

Multivariate analysis confirmed that ALB (OR, 10.37; 95% CI: 1.185–90.80, $P = 0.035$) and Tf (OR 4.743; 95% CI: 1.375–16.36, $P = 0.014$) were significantly associated with the length of hospital stay (Figs. 2–5).

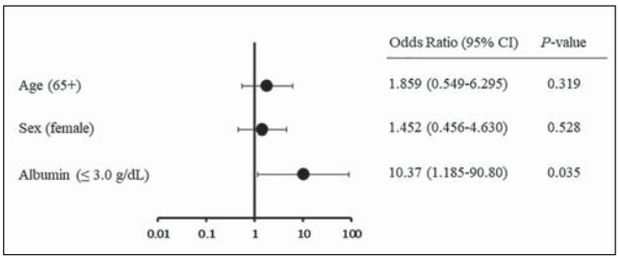


Fig. 2: Multivariate analysis (albumin). 95% CI, 95% confidence interval

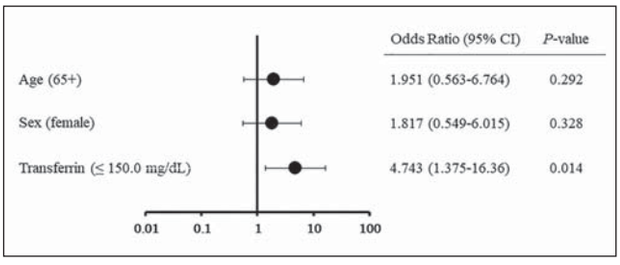


Fig. 3: Multivariate analysis (transferrin) 95% CI, 95% confidence interval

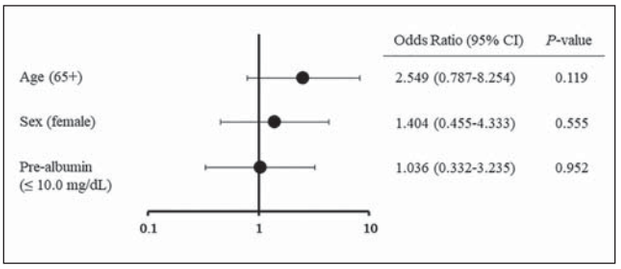


Fig. 4: Multivariate analysis (pre-albumin) 95% CI, 95% confidence interval

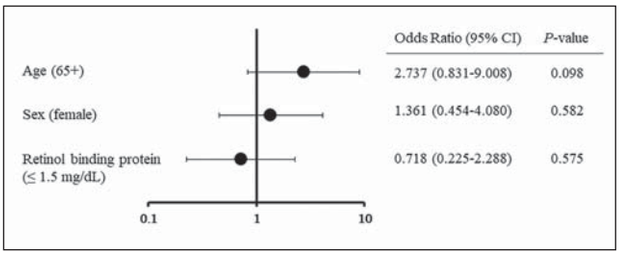


Fig. 5: Multivariate analysis (retinol binding protein) 95% CI, 95% confidence interval

## 3. Discussion

To the best of our knowledge, the present study is the first to report the influence of nutritional status on length of hospital stay in patients undergoing cardiovascular surgery. Two nutritional factors (ALB and Tf) were associated with length of hospital stay. Our results are consistent with those of previous reports stating that low ALB concentrations are associated with prolonged length of hospital stay in patients undergoing surgery, such as cystectomy and arthroplasty (Bhalla et al. 2017; Bohl et al. 2016; Gohil et al. 2014). In a study of 1,088 patients hospitalized for various reasons, multivariate analysis revealed that ALB, but not Tf, PA, glucose or lymphocyte count, was associated with length of hospital stay (Luis et al. 2006). However, comparison between the findings of this previous study and our study is difficult because of differences in the surveyed patient characteristics. Tf is a glycoprotein synthesized in the liver, and it has a half-life of 7 days, which is shorter than the 21-day half-life of ALB, making it a sensitive index of protein nutritional status. Increased Tf levels result in a relatively shorter length of hospital stay in this study population.

A strength of the present study is the evaluation of the impact of nutritional status on length of hospital stay in terms of the number of hospitalization days in a defined patient group, namely elderly patients who were treated with the same type of a highly invasive procedure (cardiovascular surgery).

However, there were several limitations of this study, including a retrospective study in a single facility and no investigation of other factors that affect the outcome such as surgery type, rehabilitation intervention, comorbidities, postoperative complications. Therefore, multicentre prospective surveys investigating other factors would assist in developing nutritional therapy that contributes to shortening the length of hospital stay in elderly patients undergoing invasive cardiovascular surgery.

In conclusion, careful nutritional management of ALB and Tf levels in patients undergoing cardiovascular surgery would shorten the length of hospital stay.

## 4. Experimental

### *4.1. Survey participants*

A total of 68 patients who underwent surgery at the Department of Cardiovascular Surgery of Gifu Municipal Hospital between April 2013 and March 2015 were included, and 4 patients who died during a hospital stay and 9 patients whose data examined were missing were excluded. Finally, 55 of these 68 patients were analyzed in this study (Fig. 1).

### 4.2. Data collection

The following data were retrospectively retrieved from electronic medical records: age, sex, the number of hospitalization days, the number of days in an intensive care unit and total serum protein, total cholesterol, serum albumin (ALB), transferrin (Tf), pre-albumin (PA) and retinol binding protein (RBP) levels. The median length of hospital stay was 29 days; stays of ≥30 days were considered long-term hospitalization.

### 4.3. Statistical analysis

SPSS 18.0 (IBM Corp., Armonk, NY, USA) was used for the statistical analysis. Multivariate analysis (multiple logistic regression) included age (≥ 65 years of age), sex (female), and nutritional indices [ALB (≤ 3.0 g/dL), Tf (≤ 150.0 mg/dL), PA (≤ 10.0 mg/dL) and RBP (≤ 1.5 mg/dL)]. The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each variable. A p value of $<0.05$ was considered statistically significant. To make a statistical strength high in this analysis, we performed the multivariate analysis for each nutritional indices and set three independent valuables in one model.

### 4.4. Ethical considerations

The study was conducted following the ethical guidelines of the Declaration of Helsinki and was approved by the Research Ethics Review Committee of Gifu Municipal Hospital (approval number 151) and the Ethics Review Committee of Gifu Pharmaceutical University (approval date: March 14, 2013), and need for individual patient consent was waived.

Conflict of interest: The authors have no conflicts of interest directly relevant to the content of this article.

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