Nosocomial Infection of Malnourished Patients in an
Intensive Care Unit

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Malnutrition is one of the most important factors for the
development of nosocomial infection (NI). We performed a
study of the correlation between abnormal nutritional factors
and NI risk by investigating the patients who stayed longer
than 3 days in the intensive care unit (ICU) of our university
hospital. The patients were classified into three groups based
on serum albumin levels and total lymphocyte counts (TLC).
The criteria of Group I (well nourished group) were serum
albumin level of 3.5 g/dl or higher and TLC of 1,400/mm3 or
higher. The criteria of Group III (severely malnourished group)
were serum albumin of less than 2.8 g/dl and TLC of less than
1,000/mm3. The other patients were classified as Group II
(moderately malnourished group). The occurrences of NI were
monitored during the study period and the APACHE III Score
was calculated. The probability of first NI infection in Group
III was 2.4 times higher than that in Groups I & II. The
mortality rate of 20.5% was more significantly correlated with
APACHE III Score than nutritional status. Nineteen (53%) of
the total 36 NI patients were infected within 10 days after ICU
admission and they all belonged to Group III. When we
compared the gap period between infections, the time to first
infection was significant.

Key Words: Malnutrition, nosocomial infection

INTRODUCTION

Nosocomial infection (NI), defined as a major
contributor to hospital associated morbidity and
mortality,2 is any infection acquired in hospital
that was not present or incubating prior to hospi-
talization.2 The synergistic interaction of poor
nutrition and superimposed infection increases
the morbidity and mortality of hospitalized patients.
Yet the importance of nutrition is still largely
devaluated in hospital practice.3 In 1974, Blackburn
reported the prevalence of hospital malnutrition.4

Now it is generally accepted that malnutrition
is one of the most important risk factors for the
development of NI. NI is a major contributor to
hospital associated morbidity and mortality rates,
especially in critically ill patients in the intensive
care unit (ICU).5 However, limited information was
available about the correlation between malnutri-
tion and NI in critically ill patients in ICU.

Thus, we designed the present study to investi-
gate the incidence of malnutrition in a popula-
tion of critical ill patients using simple diagnostic
criteria and to determine whether malnutrition is
correlated with poor outcome, defined as inci-
dence of NI, longer hospital day and increased
mortality.

MATERIALS AND METHODS

All patients admitted to general ICU of our
university hospital in a recent 6 months period
were included in this prospective study. Patients
were excluded from the study if their ICU stay
was shorter than 72 hours. Thereafter we also
monitored the occurrence of NI for 3 months.

General information on age, sex and hospital
stay was recorded for all the patients, and
laboratory data on serum albumin, total lympho-
cyte count (TLC), and hematocrit were collected at the time of admission. The APACHE (Acute Physiology, Age, Chronic Health Evaluation) III Score, known to predict hospital mortality risk for critically ill adult patients, was calculated. Serum albumin and TLC were selected for assessment of the degree of nutritional depletion. The patients were classified into one of three groups based on the levels of serum albumin and TLC. The criteria of Group I (well nourished group) were serum albumin level of 3.5 g/dl or higher and TLC of 1,400/mm³ or higher. The criteria of Group III (severely malnourished group) were serum albumin of less than 2.8 g/dl and TLC of less than 1,000/mm³. The others were classified as Group II (moderately malnourished group).

We used the NI data reported by the infection control surveillance system at our institution. The system included individual case study of patients reported to the infection control practitioner, as well as review of microbiological data and patients with positive cultures.

In this study, all the data were summarized by mean and standard deviation values for continuous variables and by frequency and percentage values for discrete variables. In order to understand the patients' infectious status, we counted the number of infections and compared the distribution of infection frequency among the three groups using Chi-squared test. The mean values of age, hospital stays and APACHE III score among the three groups were compared using Kruskal-Wallis test. We calculated Kaplan-Meier estimates of first infection time and survival time, and compared the distribution of these two variables among the three groups using log-rank test. As we observed recurrent infections in many patients, we applied the multivariate survival analysis proposed by Wei et al. and Prentice at al to compare differences in infection occurrence and gap period between the three groups. SAS V6.12 was used to analyze all the data.

RESULTS

One hundred and sixty one patients (102 male, 59 female) were selected. The patients with serum albumin level 3.5 g/dl or higher were 50 patients (31%), those with 2.8 g/dl or lower were 72 patients (45%). The patients with TLC 1,400 /mm³ or higher were 93 patients (58%), those with 1,000/ mm³ or lower were 37 patients (23%) (Table 1).

Twenty-one patients (13%) satisfied the criteria for Group I (well nourished), 108 patients (67%) for Group II (moderately malnourished), and 32 patients (20%) for Group III (severely malnourished).

The most frequent diagnosis in the patients was sepsis, followed by cardiovascular disease, gastrointestinal failure and central nervous system disorder (Table 2).

To clarify the interaction between malnutrition status and NI, we investigated the difference of non-nutritional factors such as age, hospital stay and APACHE III score among the groups (Table 3).

There were a total of 50 cases of NI (36 patients) among the 161 patients (Table 4). The most common types of NI were urinary tract infection (40%), respiratory infection (22%) and bacteremia (14%).

The NI incidence rates were 19.1% (4 of 21 patients) for Group 1, 18.5% (20 of 108 patients) for Group II and 37.5% (12 of 32 patients) for Group III. The differences were, however, not

<table>
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<tr>
<th>Table 1. Frequency Distribution of Serum Albumin Levels and TLC</th>
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<tr>
<td><strong>Serum Albumin (g/dl)</strong></td>
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<tr>
<td><strong>Range</strong></td>
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<tr>
<td>≥ 3.5</td>
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<tr>
<td>2.8-3.5</td>
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<td>&lt; 2.8</td>
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TLC, Total lymphocyte counts.
statistically significant (Fig. 1, \( p=0.072 \)). And Group III showed the highest NI multiple infection rate (Fig. 2).

We combined Group I and II, because the low NI incidence of Group I was not appropriate for log-rank test, and compared them with Group III. The probability of first NI infection in Group III was 2.4 times higher than in Groups I & II within 10 days of ICU admission, and showed significantly different distribution between two groups (\( p=0.029 \), Fig. 3).

On the other hand, the overall mortality rate was 20.5% for the three groups. And showed higher mortality rate of Group III than Groups I & II (\( p=0.001 \), Fig. 4).

We also observed the association between nutritional status and total infection times using multivariate survival analysis (Table 5). The result showed that patients with severe malnutrition had a higher risk ratio in 1st and 2nd infection times (\( p=0.035 \) and \( p=0.075 \), respectively). And the overall probability of total infection was about 2.1 times higher in Group III than in Groups I & II (\( p=0.034 \)). When we compared the gap periods between infections, the time to 1st infection was significant, but the period between 1st and 2nd infection was not significant. The overall risk ratio of gap periods tended to be significant (risk ratio=1.652, \( p=0.077 \)).

**DISCUSSION**

Our data, whilst not new, were startling never-
theless. We found that: a) malnutrition was still highly prevalent in critically ill patients; b) the presence of severe malnutrition had greater impact on NI; but c) malnutrition status on admission did not affect patient mortality.

Our result of 87% of the study population being malnourished appears to be higher than the 40% rate reported by Giner et al. The infection incidence rate was 37.5% in Group III (severely malnourished group); also higher than the 10% reported by Giner et al. This is considered to be due to the difference in the study subjects. The subjects of this study were 161 patients out of 720 ICU patients, and the relatively healthy patients who were admitted to ICU for less than 72 hours were excluded from this study. Thus any comparison of incidence rate between this study and Giner’s is considered inappropriate. The other possible reason is that no uniformly agreed definitions of malnutrition exist. Our malnutrition rate was higher than that reported in the literature, but we consider that the malnutrition criteria in this study were within the generally accepted range for malnutrition criteria. There is no “golden standard” for determining nutritional status because there is no universally accepted clinical definition of malnutrition.

Patient’s body weight is often not measured in critically ill patients. Especially, critically ill patients are often over hydrated to an extent that body weight may be increased by 6 to 12 kg. So,

![Graph showing number of infections among groups](image)

**Fig. 2.** Number of infection among the groups.

<table>
<thead>
<tr>
<th>Table 4. Types of Nosocomial Infection</th>
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<tr>
<td>Nosocomial Infection</td>
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<td>Urinary tract</td>
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<tr>
<td>Respiratory</td>
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<td>Bacteremia</td>
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<td>Skin and soft tissue</td>
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<td>Wound</td>
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<td>Surgical wound</td>
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<td>Nervous system</td>
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<td>Gastrointestinal</td>
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<td>Total</td>
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<th>Table 5. Multivariate Survival Analysis of Infection Times</th>
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<td>Estimate ± SE</td>
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<tr>
<td>Multivariate Infection Times</td>
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<tr>
<td>1st Infection</td>
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<td>2nd Infection</td>
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<td>3rd Infection</td>
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<td>overall</td>
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<td>Gap Times</td>
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*p < 0.05.

SE, Standard error.
body weight is not a reliable indicator of nutritional status in critical ill patients. Thus different anthropometric, biochemical, and immunologic parameters, as well as functional tests and indirect noninvasive techniques such as bioelectric impedance analysis, have been proposed to assess nutritional status. Other clinical surveys have investigated prognostic value by using a combination of biochemical, anthropometric, and immunological tests to increase the sensitivity and specificity of the diagnosis of malnutrition. Unfortunately, many of these indicators are not readily available. An ideal clinical marker of nutritional state should be widely available, easily reproducible, highly specific to nutritional state, and sensitive to its modifications. Unfortunately, no such marker is available.10

Simple and effective criteria for the identification of poor nutritional status are therefore warranted. It has been reported that serum albumin and TLC constitute an useful nutritional index to predict the risk of infection.11

Albumin is considered the first biochemical marker of malnutrition and has long been used in the assessment of hospital patients. Low levels of serum albumin reflect a dynamic balance of
hepatic production, distribution in the plasma space and protein loss from the vascular component. The greatest change in albumin level is due to redistribution between intravascular and extracellular components, as a result of which about 80% of the albumin pool becomes extracellular. Therefore a fall in albumin value is usually a better reflection of the metabolic response and its severity and duration than nutrition status per se.12

Even though serum albumin may not be a good indicator of nutritional status per se in critically ill patients, its predictive value in patient's outcome has been recently emphasized.13 It also has been suggested that a low serum albumin concentration correlates with an increased incidence of medical complications.14

Since lymphocytopenia reflects mainly decreased cell mediated immunity, one would expect only an increase in viral, fungal and intra-cellular bacterial infection, not in pyogenic infection.15 However, few infections of this kind were identified in this study.

Two explanations may be advanced: First, in peripheral blood approximately 65% to 80% of the lymphocytes are T cells and approximately 8% to 15% are B cells.16 Thus phenomena causing changes of T cell count are more likely to be associated with lymphocytopenia. Approximately two thirds of T cells are CD4 positive,16 and these cells are usually affected by lymphocytopenia as the major cause. A risk of opportunistic infections occurs when the CD4 positive cell count falls below 0.2 - 0.3 x 10^3/μ, which would correspond to TLC of approximately 0.4 x 10^3/μ, depending on the degree to which CD8 positive T cells are affected.17 This is a very low level of lymphocytopenia.

Second, since 25% of lymphocytes are B lymphocytes, TLC reflects humoral immunity in part, and therefore lymphocytopenia may indicate a deficiency in this system as well as cell mediated immunity.18 More likely, lymphocytopenia reflects mainly a depressed cell mediated immunity, but this is only part a more widespread deficiency state which includes depressed humoral immunity and impaired phagocytosis. Moreover, the interaction between cellular and humoral immune systems is far greater than previously thought; a decisive factor in derangement of cellular immunity in malnutrition is the failure of formation of humoral agent and the transfer factor by the lymphocytes.19

Whereas the severe malnutrition group showed a higher incidence rate of infection, we couldn't find a difference between the groups in terms of mortality rate. We first thought that although infection was an important contributing factor in determining patient's prognosis, the more important factor is the degree of disease severity. As mentioned above, there was no significant difference in severity score between the groups in our study.

There were no major changes in primary outcomes (mortality and length of hospital stay). Length of stay may also vary with other factors and is usually a weak indicator of outcome. It is generally accepted that early mortality is related to the extent of the disease process, and that late mortality at 6 months may be influenced, at least in part, by nutrition.20

It has been suggested that malnourished patients with less severe degrees of illness appear to be most prone to suffer adverse consequences as a result of their malnutrition.1 In other words, the negative effects of malnutrition on critically ill patients can not be clearly expressed because of the severity of illness.

The main outcome of this study was the result that severely malnourished patients in ICU were more likely to be infected, 2.1 times more in terms of total infection and 2.4 times more in terms of first infection, than moderately malnourished and well nourished patients.

REFERENCES


