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Original Article

# The impact of malnutritional status on survival in elderly hemodialysis patients

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**Abstract**

*Background*: The number of geriatric patients with end-stage renal disease undergoing maintenance hemodialysis has increased in Taiwan. However, protein-energy wasting is prevalent and associated with poor outcome in this patient population. It is generally well-known that geriatric nutritional risk index (GNRI) is a good survival predictor in general elderly patients. However, the association of GNRI with mortality in geriatric end-stage renal disease patients remains unclear. The present study aimed to assess the predictive ability of GNRI for overall mortality in elderly hemodialysis patients.

*Methods*: GNRI was measured in a cohort of 104 hemodialysis patients aged ≥65 years. Thereafter, these patients were followed for a median period of 38.5 months. For all cases, all-cause mortality was the primary endpoint.

*Results*: Patients with baseline GNRI <92 had significantly lower body weight, body mass index, serum albumin, and hemoglobin level, but were administered a higher erythropoietin dose as compared to those with GNRI ≥92. Basal GNRI independently correlated with erythropoietin resistance index ($\beta = -1.97$, $p < 0.001$) and serum high-sensitivity C-reactive protein ($\beta = -0.71$, $p = 0.021$). By the conclusion of the study, 45 patients had died. High GNRI was associated with the lower risk of mortality after adjustment for other potential confounders [hazard ratio = 0.41; 95% confidence interval (CI) = 0.22−0.90; $p = 0.005$].

*Conclusion*: GNRI is a significant predictor for mortality in elderly hemodialysis patients, and may be adopted to improve assessment of the malnutrition−inflammation status.



*Keywords:* elderly; geriatric nutritional risk index; hemodialysis; mortality

## 1. Introduction

Similar to many other developed countries, the population in Taiwan is rapidly aging. This demographic change will have a major impact on the rise in prevalence of chronic illnesses. Aging is associated with several other risk factors, including hypertension, diabetes mellitus, obesity, and cardiovascular disease, and may contribute to the development and progression of chronic kidney disease.[1,2] Yang and Hwang[3] revealed that the elderly constituted the major proportion of patients with end-stage renal disease (ESRD) in Taiwan. Moreover, protein-energy wasting (PEW), a state of loss of body protein mass and energy fuels, is prevalent and associated with increased mortality in elderly ESRD patients.[4,5] Routine nutritional evaluation is strongly recommended for timely identification, prevention, and treatment of malnutrition in all elderly dialysis patients. Because PEW consists of many causes and clinical manifestations, a gold standard method is currently not available for diagnosis of this entity.[6]

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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The geriatric nutritional risk index (GNRI), which is calculated from height, body weight, and serum albumin, was initially proposed to predict nutrition-related complications in hospitalized elderly patients.[7] Due to its simplicity, GNRI is widely applied in various clinical settings.[8,9] Recently, the GNRI was reportedly used to successfully assess the nutritional status and predict long-term outcome in ESRD patients.[10,11] However, the validity of GNRI is examined mainly in adult dialysis patients. Whether the GNRI could predict mortality in geriatric ESRD patients remains unclear. Therefore, we performed a single-center, prospective cohort study to investigate the predictive value of the GNRI for overall mortality among elderly hemodialysis (HD) patients.

## 2. Methods

### 2.1. Ethics statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the Changhua Christian Hospital, Changhua County, Taiwan (CCHIRB-140904). Informed consent was obtained in written form from all participants before enrollment.

### 2.2. Study design

The study recruited a cohort of patients receiving HD therapy at a single dialysis unit from July 1, 2008 to December 31, 2008. Initially, 119 patients older than 65 years and ongoing dialysis for ≥6 months were screened. The following patients were excluded from the study: (1) those with inadequate dialysis defined as Kt/V urea <1.2 ($n = 2$); (2) those on dialysis for <12 h/wk ($n = 3$); and (3) patients with clinical conditions of infectious disease ($n = 1$), malignancy ($n = 5$), or hepatobiliary disease ($n = 4$). Finally, 104 clinically stable patients (54 men and 50 women; mean age 72 years) were enrolled and followed up until December 31, 2013.

All patients received HD therapy three times weekly with a standard bicarbonate-buffered dialysate bath utilizing disposable biocompatible dialyzers with a membrane surface area of 1.6–1.7 $m^2$. The mean dialysis duration before study entry was 64 months. No major adjustments were made in terms of dialysis treatments or protocols during this follow-up period. A thorough medical history of all patients was taken at the beginning of study. The presence of cardiovascular disease (CVD) was defined as a medical history, clinical symptoms, or findings of congestive heart failure, arrhythmia, coronary artery, cerebrovascular, and/or peripheral arterial disease. The primary endpoint was all-cause mortality from the time of inclusion.

### 2.3. GNRI

The GNRI is calculated incorporating serum albumin levels, body weight, and height by modifying the nutritional risk index for elderly patients, as reported by Bouillanne et al.[7] The GNRI equation is as follows:

Table 1
Areas under receiver operating characteristic (ROC) curve and cutoff values of geriatric nutritional risk index (GNRI), serum albumin, body mass index (BMI), and body weight with sensitivity and specificity for prediction of mortality.

| Parameters | Area under ROC curve | $p$ | Cutoff value | Sensitivity (%) | Specificity (%) |
|---|---|---|---|---|---|
| GNRI | 0.603 ± 0.056 | 0.040 | <92 | 64.4 | 55.9 |
| Albumin (g/dL) | 0.602 ± 0.054 | 0.073 | <3.85 | 62.2 | 52.5 |
| BMI (kg/$m^2$) | 0.540 ± 0.060 | 0.060 | <23.2 | 61.9 | 40.7 |
| Body weight (kg) | 0.449 ± 0.058 | 0.395 | <59.3 | 51.6 | 45.8 |

$$\text{GNRI} = [14.89 \times \text{albumin (g/dL)}] + [41.7 \times (\text{body weight/ideal body weight})] \quad (1)$$

The ideal body weight was calculated from the height and a body mass index (BMI) of 22 kg/$m^2$ because of its validity and its reported association with the lowest mortality in the Asian population.[12,13] Body weight/ideal body weight was set to 1 when the patient's body weight exceeded the ideal body weight. The cut-off value of GNRI for predicting mortality was derived from creating a receiver operating characteristic (ROC) curve. The area under the ROC curve defined the probability for discriminating risk of mortality. The best cutoff with the highest sensitivity and lowest 1 − specificity for GNRI was 92 (Table 1).

Dietary protein intake was estimated by calculating normalized protein catabolic rate from the urea generation rate by using single-pool urea kinetics.[14] Body weight was determined as *dry weight*, and measured subsequent to each dialysis session. Blood pressure was measured at the beginning of each HD session with a standard sphygmomanometer in the nonaccess arm by dialysis staff while the patient was resting for at least 5 minutes with both feet on the floor. Patient response to erythropoietin treatment was examined using erythropoietin resistance index (ERI), defined as the weekly weight-adjusted erythropoietin dose (U/kg/wk) divided by hemoglobin level (g/dL).

### 2.4. Laboratory measurements

All blood samples were taken from patients who had fasted overnight before the mid-week dialysis session. Serum levels of high-sensitivity C-reactive protein (hs-CRP) were determined by utilizing an immunoturbidimetric assay and rate nephelometry (Beckman Coulter, Galway, Ireland). Serum creatinine, urea, albumin, calcium, phosphate, iron, and total iron-binding capacity levels were measured by using a model 7600 Autoanalyzer (Hitachi Ltd, Tokyo, Japan). Transferrin saturation was determined by calculating the ratio of serum iron and total iron-binding capacity, multiplied by 100. Serum levels of ferritin were measured with a radioimmunoassay kit (Incstar, Stillwater, MN, USA). The dialysis dose was measured by calculating mid-week Kt/V urea, which was computed by use of the Daugirdas equation.[15]