Protein-Energy Undernutrition Among Elderly Hospitalized Patients

A Prospective Study

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Context Numerous studies have identified strong correlations between the severity of nutritional deficits and an increased risk of subsequent morbid events among the hospitalized elderly, but whether inadequate nutrient intake during hospitalization contributes to such nutritional deficits or the risk of adverse outcomes is not known.

Objectives To identify the distribution of average daily nutrient intake among the nonterminally ill hospitalized elderly, ascertain what factors contribute to persistently low intakes, and determine whether the adequacy of nutrient intake correlates with the risk of mortality.

Design Prospective cohort study conducted from 1994 to 1997.

Setting University-affiliated Department of Veterans Affairs hospital.

Patients A total of 497 patients 65 years or older (mean [SD] age, 74 [6] years; 97% male; 86% white) with a length of stay of 4 days or more.

Main Outcome Measures Daily in-hospital nutrient intake, in-hospital mortality, and 90-day mortality.

Results A total of 102 patients (21%) had an average daily in-hospital nutrient intake of less than 50% of their calculated maintenance energy requirements. Admission illness severity, average length of stay, and admission albumin and prealbumin levels for this low nutrient group did not differ significantly from those of the remaining patients. However, the low nutrient group had lower mean (SD) discharge serum total cholesterol (154 [44] mg/dL [4 {1.1} mmol/L] vs 173 [42] mg/dL [4.5 {1.1} mmol/L]; $P = .001$), albumin (29.1 [6.7] vs 33.2 [6.1] g/L, $P = .001$), and prealbumin (162 [69] vs 205 [68] mg/L; $P = .001$) concentrations and a higher rate of in-hospital mortality (relative risk, 8.0; 95% confidence interval, 2.8-22.6) and 90-day mortality (relative risk, 2.9; 95% confidence interval, 1.4-6.1). Contributing to the problem of inadequate nutrient intake, patients were frequently ordered to have nothing by mouth and were not fed by another route. Neither canned supplements nor nutritional support were used effectively.

Conclusions Throughout their hospitalization, many elderly patients were maintained on nutrient intakes far less than their estimated maintenance energy requirements, which may contribute to an increased risk of mortality. Given the difficulties reversing established nutritional deficits in the elderly, greater efforts should be made to prevent the development of such deficits during hospitalization.

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Up to 60% of elderly hospitalized patients are protein-energy undernourished on admission or develop serious nutritional deficits prior to discharge.[1,2] Within this population, such nutritional deficits are associated with an increased risk of subsequent morbid events.[3] Despite these facts, protein-energy undernutrition is often not diagnosed, and the older patient's risk for further nutritional deterioration during hospitalization is usually not recognized.[4-6] Several reports suggest that hospitalized elderly patients are often allowed to subsist for days on very low nutrient intakes,[7-13] and even when their nutritional problems are recognized, adequate nutrition support is rarely provided.[5,7,8] Thus, many elderly patients receive less than optimal nutritional care while hospitalized. Whether inadequate nutrient intake during hospitalization is an important contributor to the development of nutrient deficits within this population is not known. However, since the risk of complications and death increases in direct proportion to the severity of the elderly patient's nutritional deficits,[14] the adequacy of the nutritional care routinely provided to elderly hospitalized patients is an important issue.

To determine the significance of poor nutrient intake among elderly patients in an acute care hospital setting, we conducted a prospective study in a university-affiliated Veterans Affairs hospital. The specific objectives were to identify the distribution of average daily nutrient intake among the hospitalized elderly, to determine the characteristics of patients receiving and not receiving adequate nutrient intake, to determine nonpatient factors related to persistently low nutrient intakes, and to determine whether adequacy of in-hospital nutrient intake correlated with the risk of mortality. We also determined how frequently various types of nutritional support were provided and how effectively they were used.

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METHODS

Patient Accrual

From January 1994 to February 1997, all patients 65 years or older admitted to a general medical or surgical ward of the John L. McClellan VA Hospital in Little Rock, Ark, were screened within 12 hours of admission to determine eligibility, based on current and past medical records. Patients with metastatic cancer and those receiving palliative care for other terminal conditions were excluded since such patients may be expected to receive less aggressive nutritional interventions. Remaining patients were assigned a random number, and, to maintain an enrollment rate of 3 to 4 patients per week, only those with a number below a preestablished cutoff were asked to enter the study. Of the 722 patients selected, 31 declined to participate. The remaining 691 participants received oral and written explanations of the nature of the study and the possible risk involved prior to signing an informed consent in accordance with the ethical standards of the US Department of Veterans Affairs and the Human Research Advisory Committee of the University of Arkansas for Medical Sciences. Because of the questionable clinical relevance of short periods of low nutrient intake, patients with a length of stay of fewer than 4 days were dropped from the analysis, leaving a final study sample of 497 patients.

In-hospital Evaluation

An initial assessment, completed within 48 hours of admission, included: (1) a concise social, nutritional, and functional status history obtained by a standardized series of questionnaires administered to each patient or the primary caregiver; (2) a complete list of all primary and secondary diagnoses recorded in the current hospital chart and old medical records; (3) a complete clinical and laboratory nutritional assessment; (4) a neuropsychological evaluation, including the Mini-Mental State Examination[15] and the Geriatric Depression Scale[16]; (5) a detailed evaluation of functional status using a modified version of the Patient Classification for Long-Term Care instrument,[17] the Katz Index of Activities of Daily Living scale,[18] and the Philadelphia Geriatric Center Instrumental Activities of Daily Living Scale[19]; and (6) an array of additional illness severity measures, including number of medications prescribed within the first 24 hours after admission, number of active and unstable medical problems, hematocrit, white blood cell count, blood urea nitrogen levels, total Acute Physiology and Chronic Health Evaluation score,[20] calculated diagnosis related group length of stay, and the Charlson Weighted Index of Comorbidity.[21]

The nutritional assessment included anthropometric measurements, determination of serum secretory protein concentrations (albumin, prealbumin, and transferrin), total cholesterol levels, and total lymphocyte count. Prior hospital and clinic records were reviewed to document previous weights. Only weights obtained while the patient appeared to be euvolemic were recorded. All participants were reweighed and had their serum secretory protein concentrations, total cholesterol levels, and total lymphocyte counts measured every 7 days. A second comprehensive assessment was completed for each patient at discharge. The variables obtained at all assessments were chosen based on their ease of measurement and the results of previous studies that demonstrated their utility in predicting morbid outcomes in populations of elderly hospitalized patients.[22-25]

Complete energy intake counts were obtained for the first 3 days after admission, and every other day until hospital discharge, using a standardized protocol that included direct patient observation and record of volitional intake and enteral and parenteral alimentation.[26] Patients who experienced significant (>25%) day-to-day variations in the amount of food consumed and those who were receiving enteral or parenteral alimentation had their nutrient intakes monitored daily. Patients who received enteral or parenteral alimentation were also monitored for the development of nutritional support-related complications.

Any study patient with a nutrient intake of less than 50% of calculated requirements for a given meal was assessed more closely at subsequent meals until the intake stabilized at 75% of requirements for at least 2 days. The purpose of this more in-depth assessment was to determine possible factors contributing to the patient's poor nutrient intake. As part of the assessment, the patient was observed during each meal, the patient and the staff were queried at the end of the meal, and the medical record was reviewed. A record was made as to whether the patient (1) had chewing difficulties due to poor dentition; (2) refused to eat because of dislike of, or lack of appetite for, the food provided; (3) had problems swallowing, as indicated by choking, coughing, or other evidence of aspiration with eating; (4) complained of nausea; (5) was ordered to have nothing by mouth; (6) had been placed on a low-energy (eg, clear liquid) diet; (7) was confused or comatose; or (8) was not provided adequate feeding assistance. The need for feeding assistance was determined by the research staff based on patient observation and staff interviews using the meal portion of the functional assessment instrument. The amount of time spent feeding the patient and who provided the feeding assistance were also recorded.

Outcomes Assessment

All subjects were tracked for at least 90 days after admission. After hospital discharge, subjects were tracked by telephone and the VA Hospital computer system. When necessary (and as arranged prior to each patient's discharge), next of kin, caregivers, or neighbors were contacted to confirm the subject's health status. Dates of all deaths were recorded. No subject was lost to follow-up.

Statistical Analyses

The data were analyzed using SAS Institute software.[27] From the energy intake count data, each patient's average daily nutrient intake from all sources and from each source was calculated. Energy intake counts were expressed as kJ/kg (kcal/kg) of ideal body weight and as a percentage of total daily energy requirements, estimated using the Harris-Benedict equation for basal metabolic rate plus a 25% activity and stress factor.[28] Based on total nutrient intake, patients were stratified into 1 of 2 groups: those who had an average daily nutrient intake of less than 50% of their calculated requirements (the low nutrient group) and all others. We chose a cutoff of 50% because we believe that this represented a clearly deficient nutrient intake, even accounting for the imprecision of our estimates of energy requirements.[29-31]

To determine if patients in 1 group had greater day-to-day fluctuations in their nutrient intake than those in the other group, intrapatient SD in daily volitional nutrient intake was used as a quantitative measure. After determining that the distribution of intrapatient mean (SD) in daily volitional nutrient intake was reasonably symmetrical, a nonpaired *t* test was used to compare the groups with respect to this measure.

Baseline characteristics of patients that correlated with persistently low in-hospital nutrient intakes were identified using nonpaired *t* tests and other univariate statistical procedures. As indicated, variables with skewed distributions were either log-transformed or analyzed using a nonparametric test (Wilcoxon rank sum test). Because many of the admission assessment variables were previously shown to be reliable indicators of disease severity and health status, the analyses incorporating these variables were used to indicate whether patients in the low nutrient group were more severely ill at admission than remaining patients. The nutritional status of the 2 groups was compared at discharge using analysis of covariance controlling for hospital length of stay and admission body mass index (weight in kilograms divided by the square of height in meters); levels of albumin, total cholesterol, and prealbumin, functional status, total Acute Physiology and Chronic Health Evaluation score[20]; calculated diagnosis related group length of stay; and Charlson Weighted Index of Comorbidity.[21] Differences in clinical outcomes were identified using logistic regression analysis also controlling for admission illness severity and nutritional status as indicated. The covariates selected were significantly correlated with the outcomes of interest. The multivariate models were generated using a stepwise procedure. Adjusted relative risks and 95% confidence intervals are reported.

RESULTS

Patient Population

The study population had an average age of 74 (6) years (range, 65-96 years). As shown in TABLE 1, the majority were white and nearly all were men. The most common admitting diagnoses are listed in TABLE 2. The median length of stay for the 497 study participants was 8 days (interquartile range, 5-13 days). The mean (SD) per-patient average daily nutrient intake was (from all sources) 6004 (2297) kJ (1430 [547] kcal) (range, 0-11 632 kJ [0-2770 kcal]) or 75% (31%) (range, 0%-180%) of calculated maintenance requirements (FIGURE). When expressed as a function of ideal body weight, average daily nutrient intake ranged from 0 to 185 kJ/kg (0-44 kcal/kg) of ideal body weight. Only 42 pa-

Table 1. Comparison of the Low Nutrient Intake Group and All Other Subjects With Respect to Admission Characteristics*

Characteristic	Low Nutrient Intake Patients (n = 102)	All Others (n = 395)	*P* Value
Social/demographic			
White	88 (86)	340 (86)	.96
Male	102 (100)	382 (97)	.06
Married	65 (64)	256 (65)	.84
Smoker	36 (35)	135 (34)	.83
History of alcohol abuse	12 (12)	30 (8)	.18
Living in nursing home prior to admission	9 (9)	26 (7)	.43
Self-assessment of health†			
Excellent or good	48 (50)	147 (38)	.02
Fair or poor	48 (50)	245 (63)	
Admission type			
Elective	43 (42)	124 (31)	.04
Urgent or emergent	59 (58)	271 (69)	
Admitted for			
Acute problem	100 (98)	382 (97)	.75
Other	2 (2)	13 (3)	
Admitted to			
Medical service	40 (39)	227 (57)	.001
Surgical service	62 (61)	168 (43)	
Functionally dependent‡	24 (24)	78 (20)	.40
Disease prevalence			
Gastrointestinal disorder§	50 (49)	134 (34)	.007
Cerebrovascular accident	5 (5)	4 (1)	.02
Age, mean (SD), y	73.6 (5.8)	73.8 (5.8)	.75
Body mass index, mean (SD), kg/m^2	26.5 (5.4)	25.2 (5.3)	.04
Total cholesterol, mean (SD), mmol/L [mg/dL]	4.8 (1.2) [186 (48)]	4.7 (1.1) [183 (44)]	
Midarm muscle circumference, mean (SD), mm	270 (3)	262 (4)	.01
Subscapular skinfold thickness, mean (SD), mm	19.5 (9.5)	17.2 (8.2)	.02
Triceps skinfold thickness, mean (SD), mm	14.5 (7.7)	12.9 (6.7)	.05
Albumin, mean (SD), g/L	36.6 (6.2)	36.6 (5.6)	.93
Prealbumin, mean (SD), mg/L	218 (84)	216 (75)	.84

*Subjects whose average daily energy intake while hospitalized was less than 50% of their calculated maintenance requirements. All data are presented as number (percentage) unless otherwise indicated.
†Nine subjects could not or refused to answer the question asking them to rate their own health during the majority of the last 12 months as being excellent, good, fair, or poor.
‡Completely dependent in 1 or more activities of daily living, based on patient self-assessment of the highest level of physical functioning within the 30 days prior to admission as measured using the Katz Index of Activity of Daily Living Scale.[18]
§Any acute or chronic disease of the bowel, liver, biliary tract, or pancreas as a primary or secondary diagnosis.

tients (8.5%) maintained an average daily nutrient intake greater than 126 kJ/kg (30 kcal/kg) of ideal body weight, the level recommended by Jeejeebhoy[32] for maintenance therapy of hospitalized patients.

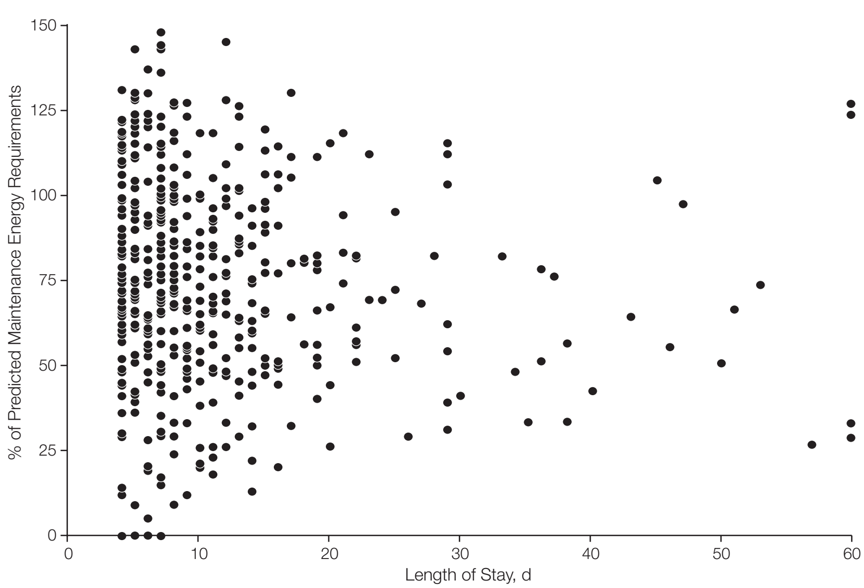
A total of 102 patients (21%) maintained an average daily nutrient intake of less than 50% and were designated the low nutrient group (**Table 3**). The average intrapatient SD daily volitional nutrient intake was greater in the low nutrient group than in the remaining patients (2586 [1170] vs 2183 [1328] kJ/d [615.6 {278.7} vs 519.7 {316.2} kcal/d]; $P = .008$). The length of stay of the low nutrient group did not differ significantly from that of the remaining patients (median [interquartile range], 9 [6-14] vs 8 [5-12] days, respectively; $P = .14$).

Table 2. Most Common Primary Admitting Diagnosis of Study Subjects by Service and Nutrient Intake Group

Disease Types	No. (%) of Subjects With Diagnosis: Low Nutrient Intake* (n = 40)	All Others (n = 227)	*P* Value
Admitted to a Medical Service			
Cardiac arrhythmia	1 (3)	14 (6)	.71
Congestive heart failure	1 (3)	26 (11)	.09
Chronic obstructive lung disease exacerbation	5 (13)	44 (19)	.30
Renal and electrolyte disorders	3 (8)	13 (6)	.72
Gastrointestinal disorder	8 (20)	20 (9)	.05
Pneumonia	9 (23)	36 (16)	.30
Urinary tract infection	4 (10)	16 (7)	.52
Admitted to a Surgical Service			
	(n = 62)	(n = 168)	
Arthritis for joint replacement	7 (11)	28 (17)	.31
Benign prostatic hypertrophy	3 (5)	14 (8)	.57
Coronary artery or valvular heart disease	8 (13)	15 (9)	.37
Hernia	4 (6)	14 (8)	.79
Localized bladder cancer	3 (5)	14 (8)	.57
Gastrointestinal tract disorder	16 (26)	11 (7)	.001
Prostate cancer	8 (13)	4 (2)	.004

*Subjects whose average daily energy intake while hospitalized was less than 50% of their calculated maintenance requirements.

Figure. Average Daily Energy Intake as a Function of Hospital Length of Stay Maintenance



Energy requirements estimated using the Harris-Benedict equation for basal metabolic rate plus a 25% activity and stress factor.[28] Three patients had a length of stay or energy intake outside the range of the figure and are not shown.

Patient Characteristics Associated With Low Nutrient Intake

At the time of admission, patients in the low nutrient group had greater body mass index, midarm muscle circumference, and subcutaneous fat stores compared with remaining patients (Table 1). Patients in the low nutrient group were also more likely to have been admitted to a surgical service (compared with a medical service), to have been admitted electively (as opposed to urgently or emergently), to consider their health to be good or excellent, to be male, and to have had an admission primary or secondary diagnosis of a gastrointestinal disorder or cerebrovascular accident (Table 1). Patients in the low nutrient group who were admitted to a surgical service were more likely to have a primary diagnosis of prostate cancer (Table 2). Those in the low nutrient intake group did not otherwise differ from the remaining patients with respect to any of the other admission assessments and indicators of illness severity ($P > .09$ for all analyses).

Although comparable in terms of admission illness severity, the 2 groups experienced different clinical outcomes. The low nutrient intake group had lower mean discharge serum total cholesterol levels, albumin and prealbumin concentrations, and experienced greater weight loss during the hospitalization (Table 3). Although change in weight is a crude indicator of how much body mass was lost during hospitalization, this statistic probably underestimates the severity of fat and protein depletion experienced by study patients. A total of 13 patients (13%)

in the low nutrient group had edema or ascites at the time of death or discharge that was new or more severe than what was present at admission compared with 8 (2%) of the remaining patients. As shown in TABLE 4, the low nutrient group also experienced higher rates of in-hospital mortality and mortality within 90 days of admission, and they were more likely to be functionally dependent at discharge compared with remaining patients.

Potential Contributors to Low Nutrient Intake

At 38% of the meals at which a patient within the low nutrient intake group had a nutrient intake of below the 50% threshold, the patient had been ordered to have nothing by mouth and was not fed by another route (43% of meals of all patients fell into this category). In most cases, the patient had a nonfunctioning gastrointestinal tract, was being prepared for a diagnostic test, or had a suppressed level of consciousness, but in 17% of incidences, the reason for the nothing-by-mouth order was not readily apparent, suggesting that there may have been unwarranted delays in restarting oral feedings in some cases (this was true for 20% of meals for all patients).

Other commonly identified potential contributors of low nutrient intake among subjects in the low nutrient intake group included dislike of, or lack of appetite for, the food provided (21% of low intake meals and 24% of meals for all patients) and persistent nausea (12% for low intake patients and 13% for all patients). In 7% of low intake meals, the patient was on a clear liquid diet and was not receiving nutrients from another source (8% of all patient meals). Although 47 subjects in the low nutrient intake group (46%) were assessed as needing feeding assistance at 1 or more times during their hospitalization, lack of adequate feeding assistance was identified by the research staff as a potential contributor to poor nutrient intake in fewer than 5% of low intake meals. For the study patients overall, 173 (35%) were assessed as needing assistance but lack of adequate feeding assistance was a potential contributor in 4% of incidences.

Use of Nutrition Support

Equal percentages of both patient groups received canned oral supplements at least once during their hospitalization (26 patients [25.5%] vs 96 patients [24.3%], $P = .82$). Of these, the period during which supplements were given (median [interquartile range]) did not differ by group (25% [15%-47%] vs 28% [15%-67%] of the hospital stay, $P = .63$); however, patients in the low nutrient group consumed less of the nutrients (median [interquartile range]) than did the other supplemented patients (0 [0-1214] kJ/d supplemented [0 {0-289} kcal/d] vs 1214 [907-4250 kJ/d supplemented] [289 {216-1012 kcal/d}], $P = .001$).

Table 3. Average Daily Protein and Energy Intake by Nutrient Intake Group and Nutritional Outcomes Controlling for Illness Severity and Nutritional Status at Admission*

Parameters	Low Nutrient Intake† (n = 102)	All Others (n = 395)	*P* Value
Average daily nutrient intake			
Energy, kJ/d [kcal/d]	2810 (1355) [671 (323)]	6829 (1687) [1632 (403)]	NA‡
Protein, g/kg, IBW	0.34 (0.18)	0.92 (0.26)	.001
Discharge body mass index, kg/m^2			
Unadjusted mean	25.8 (5.4)	24.8 (5.2)	.08
Adjusted mean (95% CI)§	24.9 (24.8-25.1)	25.0 (24.9-25.1)	.37
Discharge total cholesterol, mg/dL [mmol/L]			
Unadjusted mean	154 (44) [3.98 (1.14)]	173 (42) [4.5 (1.08)]	.001
Adjusted mean (95% CI)§	152 (146-158) [3.93 (3.78-4.08)]	174 (171-177) [4.5 (4.4-4.6)]	.001
Discharge albumin, g/L			
Unadjusted mean	29.1 (6.7)	33.2 (6.1)	.001
Adjusted mean (95% CI)§	29.3 (28.3-30.3)	33.2 (32.7-33.7)	.001
Discharge prealbumin, mg/L			
Unadjusted mean	162 (69)	205 (68)	.001
Adjusted mean (95% CI)§	161 (149-172)	205 (200-211)	.001
In-hospital weight loss, kg, median, interquartile range	1 (0-3.5)	1 (0-2)	.02¶

*Results reported as mean (SD) unless otherwise indicated. NA indicates not applicable; IBW, ideal body weight; and CI, confidence interval.
†Subjects whose average daily nutrient intake while hospitalized was less than 50% of their calculated maintenance energy requirements.
‡Between-group differences in average daily energy intake consistent with how the 2 groups were defined.
§Adjusted value based on analysis of covariance controlling for hospital length of stay; admission body mass index; levels of albumin, cholesterol, and prealbumin; functional status; total APACHE score[20]; calculated diagnosis related group length of stay; and the Charlson Weighted Index of Comorbidity.[21]
¶Wilcoxon rank-sum test.

Table 4. Clinical Outcomes Between the Low Nutrient Intake Group and All Other Subjects

Clinical Outcome	No. (%) Low Nutrient Intake* (n = 102)	No. (%) All Others (n = 395)	Adjusted Relative Risk (95% CI)†
Discharged home‡	78 (76.5)	337 (85.3)	0.6 (0.3-1.3)
Functionally dependent at discharge§	28 (27.5)	63 (16.0)	2.3 (1.1-4.6)
In-hospital mortality	12 (11.8)	6 (1.5)	8.0 (2.8-22.6)
Death within 90 days of admission	16 (15.7)	23 (5.8)	2.9 (1.4-6.1)

*Subjects whose average daily nutrient intake while hospitalized was less than 50% of their calculated maintenance requirements (see "Methods" section).
†Adjusted relative risk based on logistic regression controlling for admission albumin level, functional status, total APACHE score,[20] calculated diagnosis related group length of stay, the Charlson Weighted Index of Comorbidity,[21] whether residing in a nursing home at the time of admission. Other than mortality, also controlled for hospital length of stay. CI indicates confidence interval.
‡Discharged directly home as opposed to a nursing home or rehabilitation center.
§Completely dependent in 1 or more activities of daily living using the Katz Index of Activity of Daily Living Scale.[18]

Few patients from either group received any form of parenteral nutrition support (2 patients [2.0%] vs 3 patients [0.8%], $P = .27$). Those in the low nutrient intake group were more likely to have started receiving enteral tube feedings (9 patients [8.8%] vs 13 patients [3.3%], $P = .03$); however, patients in this group who had received enteral or parenteral support received fewer nutrients per day (median [interquartile range]) from these sources than did the other nutritionally supported patients (630 [328-1035] kJ/d [150 {78-247} kcal/d] vs 4065 [2088-5575] kJ/d [968 {497-1327} kcal/d], $P = .009$).

COMMENT

The results of this study indicate that nutrient intake is strongly correlated with several clinical outcomes, including risk of death and change in serum secretory protein concentrations. Although a causal relationship cannot be established based on the present study and the current literature, it is likely that the older patient's clinical course both affects and is affected by his or her nutrient intake. This is part of the downward spiral that is often seen clinically. In response to a physiologic stress, older patients are more likely than younger ones to lose their appetites.[33] The resultant energy deficits further diminish their already marginal reserve capacities and render them even less able to maintain homeostasis. In this weakened state, they are at increased risk of developing additional complications before they are able to recover from the first insult. Numerous studies have demonstrated strong correlations between the severity of nutritional deficits, as indicated by the concentration of serum secretory proteins, amount of weight lost, or other putative indicators of protein-energy undernutrition, and an increased risk of in-hospital and long-term complications.[14,34,35] Repletion of established nutritional deficits in the older patient often proves to be an unobtainable goal, and the aggressive use of nutritional support has rarely been shown to have significant impact on clinical outcomes.[36] Consequently, institution of measures to prevent the development of nutritional deficits among elderly patients would seem prudent.

Ample evidence suggests that the findings from this investigation are not unique to 1 hospital. Several prior studies have found evidence to suggest that hospitalized patients often receive less than an optimal level of nutritional care.[4-13,36] In a brief retrospective study published in 1974, Prevost and Butterworth[7] found that hospitalized patients were frequently ordered to have nothing by mouth for prolonged periods while receiving only 5% dextrose solutions. Only a minority of patients in their study cohort were weighed regularly, but 22 of the 36 patients who were hospitalized for more than 2 weeks and had sufficient data for analysis lost an average of 6 kg during their hospitalization. In 1985, Sandstrom et al[12] found that 36% of elderly medical patients maintained an average daily nutrient intake less than their basal metabolic rate (estimated to be 90 kJ/kg [21 kcal/kg]) and that there was a significant correlation ($r = 0.53$) between change in body weight and energy intake among those who remained hospitalized for more than 2 weeks. Patients with intakes of less than 120 kJ/kg (28 kcal/kg) generally lost weight. Other studies indicate that 42% to 56% of elderly patients maintain nutrient intakes less than their basal metabolic rate while hospitalized.[9,10,13] As in the present study, Incalzi et al[8] found that anorexia was highly prevalent among their hospitalized elderly patients and that nutritional support services were rarely used effectively. Although the specific interventions provided were not discussed, dietary evaluations resulted in less than an 8% improvement in the older patients' nutrient intake. These findings are consistent with our own and indicate that older patients are at significant risk of developing profound and potentially irreversible energy deficits during hospitalization.

This study has strengths beyond past studies in its prospective design and rigorous bedside assessment of nutrient intake. However, with an observational study we cannot determine whether poor nutrient intake caused increased in-hospital and 90-day mortality. Patients who had lower amounts of nutrient intake may have been sicker than those with adequate nutrient intake. However, the baseline measures indicate that the low nutrient intake patients were not sicker at baseline, and, if anything, tended to have better self-reported health and a higher body mass index. The relative risk for 90-day mortality among low nutrient intake patients was not as large as the relative risk for in-hospital mortality. This difference could have been due to many factors, such as postdischarge interventions and possibly diminishing attention to nutritional needs as patients' medical conditions deteriorate in the hospital. Regardless of the reasons, low nutrient intake remained associated with increased mortality.

The attending health care team is the patient's first line of defense against the development of nutritional problems. Although we were unable to develop a quantitative measure of the staff's perception of how well their older patients were eating, it was our impression that they were often unaware of the potential seriousness of a patient's developing nutritional deficits. Most of the patients in the low nutrient intake group had marked day-to-day fluctuations in their total nutrient intakes, which may have made the staff unaware of the seriousness of the patient's developing nutritional deficits. A recent study from England by Todd et al[11] tends to confirm our suspicions. They evaluated 55 patients whom the nursing staff had indicated were eating normally and were not having meals withheld due to tests or illness. Through careful intake assessments, the research team determined that 24% of these patients had an energy intake of less than their basal metabolic rate.

In our own study, attending physicians frequently ordered patients to have nothing by mouth but usually did not provide nutrients by another route. This prescribing practice was identified to be the most common potential contributor to low-nutrient intakes among the patients studied, ultimately leading to the development of a significant energy deficit. Even after oral feedings were resumed, most of the elderly patients were still unable to eat enough to replete their nutrient deficits and they remained in negative energy balance.

Even when the nutritional problems of a patient were recognized in our study, adequate nutritional support was rarely provided. Liquid supplements were used most commonly to improve a patient's nutrient intake. However, this usually did not result in a significant improvement in the patient's nutrient intake, a finding consistent with that of other studies.[8,37] Enteral and parenteral nutrition support was used rarely and the success rates with these forms of therapy generally were not good. Attempts to provide elderly patients with enteral or parenteral support usually were abandoned after only a short course of therapy, usually because of feeding-related complications or the inability to maintain patient access (data not shown).

A more formalized system of nutrient-intake monitoring probably needs to be instituted. Serial weight measurements alone may not be adequate to detect developing nutritional deficits in the hospitalized elderly. An order for nothing by mouth should trigger a careful ongoing review of the patient's nutritional status and daily energy intake. Prescription of dietary supplements should also trigger ongoing review of daily nutrition. Patients with persistently low nutrient intakes should be considered candidates for enteral or parental nutrition support, and the use of appetite stimulants in the elderly needs to be evaluated. Ultimately, however, prospective studies are needed to assess the efficacy and cost-effectiveness of measures that prevent nutritional deficits.

This study demonstrates that nutritional deterioration is a common, potentially serious, and seemingly unrecognized problem among the nonterminally ill hospitalized elderly patient. The lack of adequate nutrient intake was associated with a significant deterioration in protein-energy nutritional status by the time of discharge and an increased risk of mortality. This suggests that the adequacy of a patient's nutrient intake may be an important determinant of clinical outcomes. Given the difficulties reversing established nutritional deficits in the elderly, greater attention should be paid to preventing the development of such deficits during periods of hospitalization.

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