

MEasuring NUtrition Risk in Hospitalized Patients: MENU, A Hospital-Based Prevalence Survey

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ABSTRACT: **Background:** Depending on the definition used, malnutrition is prevalent among 20–50% of hospitalized patients. Routine nutritional screening is necessary to identify patients with or at increased risk for malnutrition. The Nutrition Risk Screening (NRS 2002) has been recommended as an efficient tool to identify the risk of malnutrition in adult inpatients.

Objectives: To utilize the NRS 2002 to estimate the prevalence of malnutrition among newly hospitalized adult patients, and to identify risk factors for malnutrition.

Methods: During a 5 week period, all adult patients newly admitted to all inpatient departments (except Maternity and Emergency) at Wolfson Medical Center, Holon, were screened using the NRS 2002. An answer of “yes” recorded for any of the Step 1 questions triggered the Step 2 screen on which an age-adjusted total score ≥ 3 indicated high malnutrition risk.

Results: Data were obtained from 504 newly hospitalized adult patients, of whom 159 (31.5%) were identified as being at high risk for malnutrition. Malnutrition was more prevalent in internal medicine than surgical departments: 38.6% vs. 19.1% ($P < 0.001$). Body mass index was within the normal range among subjects at high risk for malnutrition: 23.9 ± 5.6 kg/m² but significantly lower than in subjects at low malnutrition risk: 27.9 ± 5.3 kg/m² ($P < 0.001$). Malnutrition risk did not differ by gender or smoking status, but subjects at high malnutrition risk were significantly older (73.3 ± 16.2 vs. 63.4 ± 18.4 years, $P < 0.001$). Total protein, albumin, total cholesterol, low density lipoprotein-cholesterol, hemoglobin and % lymphocytes were all significantly lower, whereas urea, creatinine and % neutrophils were significantly higher in patients at high malnutrition risk.

Conclusions: Use of the NRS 2002 identified a large proportion of newly hospitalized adults as being at high risk for malnutrition. These findings indicate the need to intervene on a system-wide level during hospitalization.

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KEY WORDS: malnutrition, screening, Nutrition Risk Screening (NRS 2002), hospitalization, prevalence

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The prevalence of malnutrition has been estimated to be as high as 50% among acutely hospitalized adults, depending on the definition employed and the population assessed [1-3]. Malnutrition is consistently associated with adverse clinical outcomes, including increased morbidity, mortality and length of hospital stay, and reduced quality of life [4,5].

Identification of malnourished individuals and those at increased risk for malnutrition is the essential first step of a comprehensive nutrition care program. The European Society for Enteral and Parenteral Nutrition (ESPEN) recommends several nutrition screening tools to assess malnutrition risk in populations; for example, it recommends the Malnutrition Universal Screening Tool (MUST) for use in community-dwelling adults and the Mini Nutritional Assessment for use in home-dwelling and hospitalized elderly [6]. ESPEN recommends the NRS 2002 for use in hospitalized adults [6,7]. The NRS 2002 has been shown to have high sensitivity, specificity, and positive and negative predictive values compared to a clinical definition of malnutrition [8].

Nutrition care plans can be developed and implemented for identified patients only. The Nutrition Risk Screen 2002, a two-step nutrition screening tool designed to predict the likelihood of clinical outcomes due to nutrition factors, was developed using a retrospective analysis of nutrition data and clinical outcomes of controlled clinical trials [8]. The concept underpinning the screening tool is that nutrition intervention is indicated by the severity of malnutrition and increased nutrition requirements. The screen identifies presently malnourished patients as well as those at risk of malnutrition due to a disease state and/or its treatment. The NRS 2002 has been recommended for use in adult hospitalized adults based on its superior predictive validity compared to other screening tools [9].

The purpose of the present study was to utilize the NRS

ESPEN = European Society for Enteral and Parenteral Nutrition
NRS = Nutrition Risk Screening

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2002 to estimate the prevalence of malnutrition and the proportion of individuals at increased risk for under-nutrition in hospitalized adult patients and to examine demographic and medical characteristics (anthropometric and biochemical indicators) associated with impaired nutrition status. Specifically, the study was designed to estimate the number of individuals with a total NRS 2002 score ≥ 3 as well as the number of individuals scheduled for major surgery with a total NRS 2002 score < 3 .

PATIENTS AND METHODS

OVERALL STUDY DESIGN AND PLAN

This single-center cross-sectional study utilized the NRS 2002 to screen all newly admitted patients hospitalized at the Wolfson Medical Center, Holon, Israel. Screening was conducted for malnutrition and increased risk for malnutrition. If an answer of “yes” was provided for any of the NRS 2002 Step 1 Screen answers, the Step 2 screen was triggered. An age-adjusted score of ≥ 3 on the Step 2 screen, or an age-adjusted total NRS 2002 score < 3 in subjects scheduled for major surgery, indicated increased risk for malnutrition.

The present study was approved by the Institutional Ethics Committee (Helsinki Committee) as an observational (no intervention) study.

STUDY POPULATION

A convenience sample of all individuals aged 18 and older, regardless of gender, ethnicity or reason for hospitalization, admitted to the Wolfson Medical Center during a 5 week period from 17 March to 20 April 2011 comprised the study group. Subjects admitted to all inpatient departments, except Maternity and Emergency, were included. Every week a different set of departments was sampled for all new admissions during the sampling period.

INCLUSION/EXCLUSION CRITERIA

All adult patients newly admitted to Wolfson Medical Center were eligible for participation in the present study. Excluded were those individuals who expired prior to undergoing the nutrition screen.

DEMOGRAPHICS, MEDICAL HISTORY, LABORATORY VALUES

Demographic characteristics including patient age, gender, smoking, family status and ethnicity were extracted from the patient's medical record. Lifestyle characteristics including present smoking were elicited from the patient or family member if not recorded in the medical record. Blood chemistry determined on admission, including chemistry, lipid profile and complete blood count, was extracted from the patient record.

ANTHROPOMETRIC MEASURES

Patients were weighed on the scale in the department in which they were hospitalized. Height was measured using the height rod on the department's balance scale. For patients who could not stand for weighing/measuring, knee height was measured as the distance between the thigh prominence with the knee bent at 90° and the plantar aspect of the foot at the heel with the ankle bent at 90° [10]. Gender-specific calculations for stature estimation from knee height were:

Males: Height (cm) = $[64.19 - (0.04 \times \text{years of age}) + (2.02 \times \text{knee height}) \text{ (cm)}]$

Females: Height (cm) = $[84.88 - (0.24 \times \text{years of age}) + (1.83 \times \text{knee height}) \text{ (cm)}]$

Estimation of standing stature from knee height has been shown to correlate well with measured standing stature [11]. To estimate body weight in patients who could not be weighed on a balance scale, mid-arm circumference was used. MAC was measured with the patient's sleeve rolled up above the shoulder and the right arm bent to 90° degrees. The midpoint between the accordion and the colcannon was marked with a pen. The MAC was measured with the measuring tape snug, touching the skin at all points, but not compressing the soft tissue. The gender-specific calculation for weight estimate was [12]:

Males: Weight (kg) = $[\text{knee height (cm)} \times 1.10] + [\text{MAC (cm)} \times 3.07-75.81]$

Females: Weight (kg) = $[\text{knee height (cm)} \times 1.01] + [\text{MAC (cm)} \times 2.81-66.04]$

Self-reported height and weight as well as anthropometric measures are acceptable substitutes for directly measured height and weight when using the NRS 2002 [6]. To reduce variability, all anthropometric measurements were performed by one trained person in charge of data acquisition. Body mass index was calculated as weight (kg)/height (m^2) using either directly measured or estimated values for weight and height [13]. All height measures were recorded to the nearest 0.5 cm and weight to the nearest 0.5 kg.

DATA QUALITY ASSURANCE

All documentation relating to the survey was open to inspection. A range was set for each variable, and out-of-range values were verified.

STATISTICAL ANALYSIS

A convenience sample including all individuals newly hospitalized in a given department during the data acquisition period participated in the study. Based on prior hospitalization rates, a sample size of 1000 was anticipated, which provided a

MAC = mid-arm circumference

confidence level of 95% and a 3% margin of error to estimate the prevalence of malnutrition. However, only 540 subjects were sampled due to physician and nurse strikes during the data acquisition period. This sample size provided a prevalence estimate confidence level of 95% and a 4% margin of error.

Data were recorded on paper documents and uploaded to Exel Spreadsheet for storage. SPSS v. 11.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. Distributions of continuous variables were assessed for normality using the Kolmogorov-Smirnov test (cutoff $P < 0.01$). The proportion of malnourished individuals was estimated by dividing this number by the total number of newly hospitalized patients surveyed. Continuous variables were described using mean \pm standard deviation. Categorical variables such as malnutrition, gender and comorbidities were described using frequency counts and expressed as n (%). Associations between continuous variables were described by calculating Pearson's or Spearman's correlation coefficient as appropriate. Continuous variables were compared by high malnutrition risk using the *t*-test for independent samples or the Mann-Whitney U test. Associations between categorical variables were assessed using the chi-square test. All tests were two-sided and considered significant at $P < 0.05$.

RESULTS

The study population comprised 504 individuals. This represents 25% of all individuals newly hospitalized in participating departments (all inpatient departments except for Maternity and Emergency) during the data acquisition period.

Altogether 159 patients (31.5%) were identified as high risk for malnutrition. The response pattern to the NRS 2002 is shown by malnutrition risk status in Table 1. The majority of screened patients (70%) had at least one "yes" answer to the phase 1 questions of the NRS 2002 and therefore required the completion of phase 2 of the nutrition screen.

The study population is described by nutrition status in Table 2. As can be seen, malnutrition risk did not differ by gender or smoking status, but subjects at high malnutrition risk were significantly older (73.3 ± 16.2 vs. 63.4 ± 18.4 years, $P < 0.001$). The association of age quartile and malnutrition risk is shown in Figure 1. A clear increase in malnutrition risk is detected with increasing patient age. Body mass index differed significantly by nutrition category: it was significantly lower among subjects identified at high risk for malnutrition but was still within normal range. Malnutrition was more prevalent in internal medicine than surgical departments: 38.6% vs. 19.1% ($P < 0.001$). Total protein, albumin, total cholesterol, low density lipoprotein-cholesterol, hemoglobin and % lymphocytes were all significantly lower, while urea, creatinine and % neutrophils were significantly higher in patients at high malnutrition risk.

Table 1. Distribution of NRS 2002 scores by malnutrition risk status

	Malnutrition risk not elevated (n=345)	High malnutrition risk (n=159)	P value
Section 1 (% answering "yes")			
Is BMI < 20.5?	2.5	32.5	< 0.0001
Has the patient lost weight within the last 3 months?	17.5	61.0	< 0.0001
Was the patient's dietary intake less than usual during the past week?	10.5	50.3	< 0.0001
Is the patient severely ill?	57.5	92.0	< 0.0001
Section 2 (Score)			
Impaired nutritional status score	0.2 \pm 0.4	1.8 \pm 0.9	< 0.0001
Severity of disease score	1.0 \pm 0.5	1.6 \pm 0.8	< 0.0001
Total NRS 2002 score	0.9 \pm 0.9	4.0 \pm 1.0	< 0.0001

Figure 1. Malnutrition by age quartile

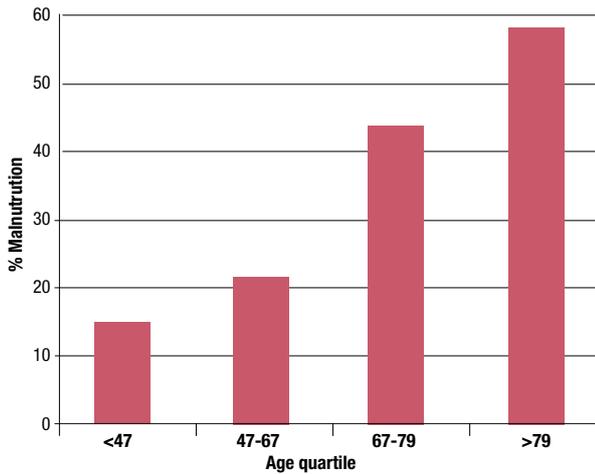


Table 3 shows nutrition risk by diagnosis/comorbidity. As shown, risk was elevated with the following diagnoses: ischemic heart disease, infection (non-pneumonia), stroke and pneumonia. Increased malnutrition risk was not associated with other diagnoses/comorbidities in our sample.

Height and weight were estimated using knee height and mid-arm circumference in 186 patients (37%). Compared to subjects whose height and weight were directly measured or reported, a significantly greater proportion of patients whose height and weight were estimated were malnourished: 50.8% vs. 19.3% ($P < 0.0001$). The estimated risk of malnutrition more than doubled in internal medicine departments (25.3% vs. 53.8%, $P < 0.0001$), but tripled in surgical departments (13.8% vs. 40.9%, $P < 0.0001$). Patients with estimated anthropometric measures were significantly

Table 2. Subject characteristics by malnutrition risk status

	Malnutrition risk not elevated (n=345)	High malnutrition risk (n=159)	P value
Age (yrs)	63.4 ± 18.4	73.4 ± 16.2	< 0.0001
Females (%)	47.9	50.3%	0.62
BMI (kg/m ²)	27.9 ± 5.3	23.9 ± 5.6	< 0.0001
Ethnicity			0.57
Jewish (%)	70.4	67.8	
Arab (%)	4.6	3.3	
Other (%)	25	28.9	
Family status			0.009
Single (%)	11.9	5.7	
Married (%)	55.4	50.9	
Widowed (%)	17.9	30.2	
Divorced (%)	14.7	13.2	
Smoking (%)	37.0	28.6	0.12
Internal medicine department (%)	51.2	73.6	< 0.0001
Biochemistry			
Sodium (mEq/L)	139.0 ± 3.5	138.6 ± 5.0	0.24
Potassium (mEq/L)	4.3 ± 0.5	4.2 ± 0.6	0.12
Urea (mg/dl)	43.9 ± 28.7	63.6 ± 49.9	< 0.0001
Creatinine (mg/dl)	1.08 ± 1.0	1.3 ± 1.2	0.02
Uric acid (mg/dl)	5.9 ± 2.1	6.4 ± 3.0	0.06
Phosphorus (mg/dl)	3.7 ± 0.8	3.8 ± 1.5	0.37
Glucose (mg/dl)	136.6 ± 68.9	141.6 ± 71.5	0.46
Nutrition markers			
Total protein (g/L)	6.7 ± 0.7	6.5 ± 0.8	0.009
Albumin (g/L)	3.7 ± 0.5	3.4 ± 0.5	< 0.0001
Liver function enzymes			
Alkaline phosphatase (IU)	72.1 ± 28.6	89.9 ± 73.7	0.001
ALT (IU)	26.9 ± 59.2	51.8 ± 180.7	0.05
AST (IU)	33.2 ± 67.9	45.9 ± 77.9	0.95
Lipid profile			
Total cholesterol (mg/dl)	176.5 ± 70.7	161.5 ± 49.2	0.04
Triglycerides (mg/dl)	124.1 ± 65.2	116.1 ± 70.9	0.31
HDL (mg/dl)	43.3 ± 12.9	40.5 ± 14.4	0.08
LDL (mg/dl)	105.7 ± 37.5	96.0 ± 39.1	0.03
Complete blood count			
WBC (cells per µl/1000)	9.2 ± 3.7	9.7 ± 4.8	0.17
Hemoglobin (g/dl)	12.2 ± 2.1	11.4 ± 2.3	< 0.0001
MCV	93.3 ± 27.9	93.7 ± 36.9	0.88
Platelets	214.7 ± 82.4	221.4 ± 95.7	0.43
% Lymphocytes	21.1 ± 11.2	16.2 ± 9.9	< 0.0001
% Neutrophils	69.3 ± 13.4	74.3 ± 12.9	< 0.0001

ALT = alanine aminotransferase, AST = aspartate aminotransferase, HDL = high density lipoprotein, LDL = low density lipoprotein, WBC = white blood cells, MCV = mean corpuscular volume

Table 3. Malnutrition by diagnosis comorbidity

Diagnosis/Comorbidity	Malnutrition risk not elevated (n=345)	High malnutrition risk (n=159)	P value
Ischemic heart disease (n=140)	24.7	34.6	0.02
Diabetes (n=133)	25.6	28.3	0.52
Neoplasm* (n=85)	16.0	18.9	0.42
Chronic obstructive pulmonary disease (n=80)	15.4	17.0	0.65
Infection (not pneumonia, n=79)	12.8	22.0	0.008
Chronic kidney disease (n=59)	9.9	15.7	0.06
Stroke (n=55)	8.7	15.7	0.02
Pneumonia (n=36)	4.1	13.8	< 0.0001
Fracture (n=31)	7.0	4.4	0.26
Peptic ulcer disease (n=17)	3.5	3.1	0.84
Enteritis (n=11)	1.5	3.8	0.09

*Neoplasm includes both present and past tumors and does not distinguish between benign and malignant tumors.

older (74.9 ± 15.2 vs. 61.2 ± 18.1 years, $P < 0.0001$), had lower BMI values (25.4 ± 6.1 vs. 27.2 ± 5.4 kg/m², $P = 0.001$), and included a greater proportion of females (60.8% vs. 39.8%, $P < 0.0001$), widows (38.5% vs. 10.5%, $P < 0.0001$), patients hospitalized in internal medicine departments (76.7% vs. 47.9%, $P < 0.0001$) and fewer smokers (14.9% vs. 28.2%, $P = 0.001$). These patients were also less likely to be admitted on an elective basis (6.3% vs. 14.1%, $P = 0.01$) but did not differ from other patients by ethnicity.

DISCUSSION

The present single-center screen of nutrition status among newly hospitalized adults estimates malnutrition risk to be 31.5%; specifically, malnutrition risk increased with age, hospitalization in internal medicine (rather than surgical) departments, and estimation of anthropometric data using alternative measures and equations rather than direct measurement. Self-reporting and use of anthropometric measures (knee height, mid-arm circumference) with validated equations are acceptable alternatives to directly measured height and weight when using the NRS 2002 [7]. Nevertheless, inability to directly measure height and weight identifies a high risk subgroup of the patient population, likely reflecting reduced functional level and increased disease severity at the time of evaluation.

Our results are consistent with reports from other hospitalized populations in Switzerland, China and Italy [14-16]. Together, these findings in diverse populations indicate

BMI = body mass index

that malnutrition among hospitalized adults is a global problem. In addition to its devastating effects on patients, malnutrition impacts significantly on the health care system. Malnourished patients have higher complication rates (including infections and organ failure) [17], slower recovery [18], and higher rates of psychosocial difficulties [19].

The present survey quantifies the problem of malnutrition in newly hospitalized patients and represents the first step towards developing a comprehensive nutrition care protocol in the framework of the hospital accreditation process. Currently, we are evaluating the nutrition intervention protocol in a pilot study. If successful, the protocol will be implemented throughout the hospital.

The duration of an average hospitalization precludes curing malnutrition in a given patient; however, it does provide a window of opportunity to identify the problem and initiate an individualized treatment. Malnutrition and its accompanying intervention will be recorded in the discharge letter, requiring health care providers in the community to address and treat the problem after discharge.

Our survey indicates that approximately one in three hospitalized adults is malnourished. A problem on this large a scale requires a system-wide response. Our program is currently being instituted at our center and represents one part of the solution to this public health problem.

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Capsule

Multiple dynamic representations in the motor cortex during sensorimotor learning

The mechanisms linking sensation and action during learning are poorly understood. Layer 2/3 neurons in the motor cortex might participate in sensorimotor integration and learning; they receive input from sensory cortex and excite deep layer neurons, which control movement. Huber et al. imaged activity in the same set of layer 2/3 neurons in the motor cortex over weeks, while mice learned to detect objects with their whiskers and report detection with licking. Spatially intermingled neurons represented sensory (touch) and motor behaviors (whisker movements and licking).

With learning, the population-level representation of task-related licking strengthened. In trained mice, population-level representations were redundant and stable, despite dynamism of single-neuron representations. The activity of a subpopulation of neurons was consistent with touch driving licking behavior. These results suggest that ensembles of motor cortex neurons couple sensory input to multiple related motor programs during learning.

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