Screening for hospitalization and nutritional risks among community-dwelling older persons[1–3]

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ABSTRACT

Background: The potential for the use of nutritional screening to identify older persons at risk of hospitalization has not been contrasted with the use of tools developed for predicting hospital admissions.

Objective: Our goal was to compare the associations of items from the Level II Nutrition Screen (LII) and the Probability of Repeated Admissions (P_{ra}) questionnaire with the outcome of hospitalization.

Design: This was a cohort study of participants in a Medicare managed-risk health plan who completed both the LII and P_{ra} ($n = 386$). All hospitalizations within 1 y of screening were recorded. Hierarchical multivariate logistic regression was used to model associations with hospitalization.

Results: P_{ra} items that retained significant associations with hospitalization were self-reported health, hospitalization in the past year, and >6 doctor visits in the past year (positive predictive value: 20%; sensitivity: 53.1; specificity: 69.7). LII items that retained significant associations with hospitalization were eating problems and polypharmacy (positive predictive value: 17.9%; sensitivity: 58.0; specificity: 56.3). Those persons designated by the P_{ra} score as being at high risk of hospitalization ($P_{ra} \geq 0.30$, 75th percentile) were also more likely to report weight loss, polypharmacy, consumption of a special diet, and functional limitation on the LII.

Conclusions: Retained items from the P_{ra} and the LII were comparable in identifying participants at risk of hospitalization. These observations suggest that nutritional risk factors such as eating problems, weight loss, and consumption of special diets should be considered in the management of older persons at risk of hospitalization, irrespective of the screening approach selected. *Am J Clin Nutr* 2001;74:201–5.

See corresponding editorial on page 155.

INTRODUCTION

The Nutrition Screening Initiative was established in 1990 as a multifaceted effort to promote better nutritional care of older Americans (1–3). It is a collaborative effort of the American Academy of Family Physicians, the American Dietetic Association, and the National Council on Aging. The Nutrition Screening Initiative promotes a 3-tiered approach to screening for nutritional risk: the Determine Checklist, a 10-item questionnaire designed to heighten the awareness of older adults and health care providers to the warning signs of poor nutritional health, and the Level I (LI) and Level II (LII) Nutrition Screens, more comprehensive assessments used to evaluate nutritional risk by professionals in health and social services settings or medical settings, respectively.

These screening tools have been widely disseminated and are being used in capacities that far exceed those for which they were originally intended. Limited validation testing of the use of these screens to predict specific health or nutrition status outcomes has been performed (4, 5). Jensen et al (6) reported that selected LI and LII screening items were associated with self-reported functional limitation and health care charges in a population of rural older Pennsylvanians participating in a Medicare managed-risk health plan. They concluded that further testing of the screening instruments is needed with use of objective resource measures, such as hospital admissions. A focus on hospital admission is warranted given that many older persons are malnourished at the time of hospital admission (7). Hospital admission is also a proxy indicator of poor health status.

The Probability of Repeated Admission (P_{ra}) is a screening instrument specifically developed to identify older persons most likely to be hospitalized (8, 9). This instrument focuses on age, sex, self-rated health, prior hospital admissions, physician contacts, chronic disease processes, and caregiver status, variables that are strongly related to risk of hospitalization. The reliability and validity of this instrument was previously reported (10–12).

The ability of nutritional risk screening to identify persons at risk of hospital admission has not been rigorously shown. The objective of this investigation was 2-fold: *1*) to compare the associations of items from 2 screening instruments, the LII and P_{ra}, with hospitalization outcomes in screened older persons,

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and *2*) to then compare the nutritional risk status of those designated by the P_{ra} as being at high risk of hospital admission with those who were not.

SUBJECTS AND METHODS

Subjects

Subjects for this study were patients of the Penn State Geisinger Health System (PSGHS), a nonprofit group practice serving a predominantly rural population in central and northeastern Pennsylvania. This service area has one of the largest concentrations of rural older persons in the United States (13). This project was approved by the Office for Regulatory Compliance at the Pennsylvania State University and by the PSGHS Institutional Research Review Board.

Data collection

Nutritional screening data were collected at >100 clinic sites as part of a regional program initiated by the PSGHS in September 1994 that targets all participants in a Medicare managed-risk health plan. A modified LII questionnaire was included in the health plan enrollment packet and was completed by health plan members at the time of a required enrollment history and physical examination. The questionnaire has been extensively tested, as described previously (6). The overall response rate has averaged 52%, with responders well representing nonresponders (6). A validated scoring algorithm is not available. The questionnaire includes check boxes for 34 items and also requests self-reported height and weight. It requires ≈5 min to complete and includes queries about recent weight change (volitional or not), living and eating habits, alcohol and medication use, depression, dentition, and limitations in functional status. Arm circumferences and triceps skinfold thicknesses were deleted from the LII because it was not possible to obtain reliable measures at multiple clinic sites. Formal testing of cognition and depression were also deleted because of the limitations in training multiple clinic staff and the time constraints in administering the screening tool at busy clinics. The single question, "Do you feel depressed?" was substituted. Members' responses were reviewed with the clinic nurse, who also recorded measured height and weight. Height and weight were measured by using metric wall rules and counterweight balance-beam scales. Subjects were clothed but did not wear overgarments or shoes for these measurements. The subjects were assisted as needed in completing the screening questionnaire, and proxies were used at the discretion of clinic personnel to provide all or part of the information.

Serum albumin and cholesterol data were obtained from routine surveillance measurements taken at the discretion of the primary physicians within 12 mo before or 2 wk after completion of the screening questionnaire. Serum albumin and cholesterol results were available for 114 and 144 individuals, respectively; 70% of the measurements were made within 90 d of the screening. All laboratory analyses were completed at the accredited laboratory facilities of the PSGHS by using a Hitachi 717 analyzer (Hitachi, Indianapolis) and Boehringer Mannheim (Indianapolis) reagents and manufacturer-provided guidelines. The Boehringer Mannheim reagent system uses an enzymatic cholesterol method (cholesterol/HP; catalog no. 1039033) and a bromcresol green dye-binding albumin method (albumin BCG; catalog no. 1039025).

The P_{ra} health survey was conducted semiannually by the PSGHS. Computer-scannable surveys and preaddressed, postage-paid return envelopes were mailed to all current enrollees of the Medicare managed-risk health plan who did not have a completed P_{ra} form on file. Nonresponders were targeted with ≤2 subsequent mailings. The overall response rate has approached 70%. The P_{ra} screen, originally developed by Boult et al (8–12), consists of 8 questions. The 8 factors used to identify those at high risk of hospitalization are older age, male sex, self-rated health, availability of an informal caregiver, having ever had coronary artery disease, and having had a hospital admission, >6 doctor visits, or diabetes in the past year. A P_{ra} risk score between 0 and 1 is assigned by using a regression equation, with higher values indicating higher risk. A cutoff point at the 75th percentile (0.30) was considered to represent high risk in the present analysis.

Six hundred twenty-four individuals aged >65 y who were new enrollees in the PSGHS Medicare managed-risk health plan completed the LII between 1 December 1996 and 28 February 1997. A total of 15 337 individuals responded to a mailing of the P_{ra} health survey in February 1997. The sample population consisted of the 386 individuals who completed both the LII and P_{ra} surveys during this time frame. The sample was 99% non-Hispanic white. Hospital admissions data for this sample were available through 31 January 1998. Hospitalization outside the PSGHS is rare and is captured by the admissions database used in this study. A cutoff of 1 y from the time of screening to hospital admission was used for analysis.

Statistical analysis

Statistical analyses were conducted by using SAS for PC (version 8; SAS Institute Inc, Cary, NC). Data analysis consisted of 4 phases. First, descriptive statistics were calculated for all of the individual items in the LII and P_{ra} screens. Continuous variables were summarized by using means and SDs and categorical variables were summarized as frequencies and percentages. Second, potential differences in all of the individual data items between hospitalized and nonhospitalized subjects and between subjects with high- and low-risk P_{ra} scores were examined by using *t* tests for continuous variables and analysis of variance for categorical variables, with $P < 0.05$ considered significant. Third, summary models were developed to predict hospitalization from *1*) the P_{ra} survey items, *2*) the LII items, and *3*) a hybrid model of retained items from both the P_{ra} and LII. In each case, a hierarchical modeling scheme was used with retained items having adjusted P values < 0.10. Fourth, receiver operating characteristics curves were used to select the best cutoff for maximizing sensitivity and specificity for the complete P_{ra} score, the retained items from the P_{ra}, the retained items from the LII, and the hybrid model of retained items from both the P_{ra} and the LII. Positive predictive values were calculated as (true positives)/(all predicted to be hospitalized).

RESULTS

Of the 386 subjects, 13.0% (n = 50) were hospitalized at least once in the year after screening. The total sample was nearly evenly composed of men and women (47% and 53%, respectively) and about one-third (32%) were aged ≥75 y (data not shown). Eighty-three percent of the sample rated their health as good or better (data not shown). Fifteen percent reported being hospitalized within the previous year and 14% reported seeing a physician >6 times in the previous year (data not shown). The

TABLE 1
Frequency of positive responses for scored Probability of Repeated Admission (P_{ra}) items by admission outcome

	Not hospitalized (n = 336)	Hospitalized (n = 50)
	n (%)	
Self-rated health		
Excellent[1]	26 (7.7)	1 (2.0)[2]
Very good or good	260 (77.4)	35 (70.0)
Fair or poor	47 (14.0)	12 (24.0)
Heart disease	29 (8.6)	10 (20.0)[3]
Diabetes	33 (9.8)	8 (16.0)
Hospitalization (one overnight stay in past year)	44 (13.1)	15 (30.0)[3]
Doctor visits (>6 in past year)	38 (11.3)	16 (32.0)[3]
No informal caregiver	21 (6.2)	2 (4.0)
Age (y)		
65–74[1]	235 (69.9)	27 (54.0)[2]
75–79	64 (19.0)	14 (28.0)
80–84	26 (7.7)	7 (14.0)
≥85	11 (3.3)	2 (4.0)
Male sex	159 (47.3)	23 (46.0)

[1] No points are given for this response category.
[2] Significant test for trend, $P < 0.05$ (ANOVA).
[3] Significantly different from not hospitalized, $P < 0.05$ (t test).

frequency of positive responses to the 8 P_{ra} items for those hospitalized compared with those not is shown in **Table 1**. Those who were hospitalized within the 12 mo after the screening were more likely to have reported hospitalization and physician contact in the previous year and to have reported having heart disease. Analysis of variance also indicated significant trends favoring older age and poorer reported health status among those who were hospitalized. At a high-risk P_{ra} score of ≥0.30, 23.5% of subjects were hospitalized compared with 10.0% of subjects who did not meet this P_{ra} cutoff ($P < 0.007$ by t test).

The most commonly reported items on the LII were polypharmacy (ie, the use of >3 drugs, over-the-counter medications, or supplements daily; reported by 41% of subjects) and intakes of vegetables, milk, juices, and grains below the indicated frequencies (>50% of subjects for each). Those who were hospitalized in the 12 mo after screening were more likely to report polypharmacy and having a body mass index (BMI; in kg/m^2) >27 (**Table 2**). Those designated by the P_{ra} as being at high risk of hospitalization were more likely to report risk factors such as weight loss, polypharmacy, special diets, eating problems, and functional limitation on the LII than were those not at high risk of hospitalization (**Table 3**).

The complete P_{ra} score had a positive predictive value for hospitalization of 21.3% (sensitivity: 52.0; specificity: 71.3). Those items that retained significant associations with hospitalization by multivariate logistic regression were self-reported health, hospitalization in the past year, and >6 doctor visits in the past year (**Table 4**). These P_{ra} items gave a positive predictive value of 20% (sensitivity: 53.1; specificity: 69.7). The LII items that retained associations with hospitalization by multivariate logistic regression were eating problems and polypharmacy. These LII items had a positive predictive value of 17.9% (sensitivity: 58.0; specificity: 56.3). When those items that maintained significant associations with hospitalization from both the P_{ra} and the LII were combined in a hybrid multivariate logistic regression model, there was little improvement in positive predictive value (21%; sensitivity: 59.2; specificity: 68.2) and the polypharmacy item was not retained.

DISCUSSION

The LII was developed by the Nutrition Screening Initiative to be used in clinical settings to identify older adults at risk of poor nutritional status (1–3). Despite widespread dissemination of the LII, data are lacking on its application in relation to specific health or nutritional status outcomes (4, 5). The P_{ra} was specifically designed to predict hospitalization in older adults and its validity and reliability were previously shown (8–12).

The overall frequencies of the LII items reported in Table 2 are similar to those previously reported for a much larger sample drawn from the same population (6). In that report, the following items retained a significant association by multivariate regression with average monthly health care charges: age ≥ 75 y, male sex, albumin < 35.0 g/L, polypharmacy, loss of ≥4.5 kg (10 lb) over past 6 mo, BMI > 27, cholesterol < 4.14 mmol/L, and any limitation in activities of daily living or instrumental activities of daily living. Findings in the present study may differ because of the smaller sample size and a different outcome measure (hospitalization).

Although the P_{ra} was developed to predict hospitalization risk within 24 mo (8–12), the P_{ra} risk items in the present investigation were also more prevalent among those who were hospitalized within 12 mo. A P_{ra} score of 0.30 corresponding to the 75th percentile for hospitalization risk is also consistent with previous reports (8–12).

Those items from the P_{ra} and the LII that retained significant associations with hospitalization were comparable in the identification of at-risk participants. There was general agreement in the subjects identified by these items and there was no apparent added value of a hybrid model. Observed values for positive predictive value, sensitivity, and specificity suggest that the selected P_{ra} and LII items would have acceptable utility for screening applications. An important new observation is that those subjects designated by the P_{ra} as being at high risk of hospitalization were also more likely to report risk factors such as weight loss, polypharmacy, special diets, and functional limitation on the LII than were those not at high risk of hospitalization. These observations suggest that nutritional risk factors such as weight loss and special diets should be considered in the management of older persons at risk of hospitalization, irrespective of the screening approach selected. Of particular value may be the risk item "eating problems," comprising chewing or swallowing difficulties or pain in the mouth, teeth, or gums, which was retained in the hybrid model. Indeed, others reported the number of general oral problems to be a strong predictor of involuntary weight loss (14).

The Institute of Medicine (15) recently highlighted the limitations of nutritional risk screening at the time of hospital admission in a report titled *The Role of Nutrition in Maintaining Health in the Nation's Elderly*. Many older persons are already malnourished at the time of hospitalization (7). Because of this, an approach to identifying older persons at risk of hospitalization that includes nutritional risk items may be the best method for facilitating appropriate interventions before the need for hospitalization. Case management interventions for high-risk individuals might diminish the need for hospitalization and prevent

TABLE 2
Patient characteristics and frequency of positive responses for selected Level II (LII) Nutrition Screen items by admission outcome

	Not hospitalized (n = 336)	Hospitalized (n = 50)
Patient characteristic		
Self-reported height (cm)	167.7 ± 10.1 [304][1]	166.7 ± 10.6 [48]
Self-reported weight (kg)	77.6 ± 15.0 [302]	78.5 ± 15.6 [47]
Nurse-measured height (cm)	165.2 ± 9.9 [218]	163.8 ± 11.6 [32]
Nurse-measured weight (kg)	78.1 ± 15.0 [221]	79.6 ± 17.0 [33]
Body mass index (kg/m^2)	28.7 ± 5.3 [120]	29.6 ± 4.7 [32]
Serum cholesterol (mmol/L)	5.43 ± 1.26 [120]	5.67 ± 1.38 [24]
Serum albumin (g/L)	42.6 ± 3.1 [94]	42.1 ± 3.1 [20]
Frequency of positive responses [n (%)]		
BMI (kg/m^2) <22	16 (7.4)	2 (6.2)
BMI (kg/m^2) >27	126 (58.3)	25 (78.1)[2]
Serum cholesterol <4.14 mmol/L	14 (11.7)	3 (12.5)
Serum albumin <35.0 g/L	7 (7.4)	2 (10.0)
Lost ≥4.5 kg (10 lb) in past 6 mo	36 (10.7)	8 (16.0)
Gained ≥4.5 kg (10 lb) in past 6 mo	14 (4.2)	3 (6.0)
Feels depressed	11 (3.3)	1 (2.0)
Uses ≥3 prescription drugs, over-the-counter medications, or vitamin and mineral supplements daily	129 (38.4)	28 (56.0)[2]
Does not usually have enough to eat each day	15 (4.5)	0 (0.0)[2]
Usually eats alone	58 (17.3)	10 (20.0)
Does not eat anything on ≥1 d/mo	2 (0.6)	1 (2.0)[2]
Has a poor appetite	6 (1.8)	0 (0.0)[2]
Follows a special diet	16 (4.8)	6 (12.0)
Eats vegetables ≤2 times daily	180 (53.6)	31 (62.0)
Eats milk or milk products once or not at all daily	181 (53.9)	25 (50.0)
Eats fruit or drinks fruit juice once or not at all daily	177 (52.7)	32 (64.0)
Eats breads, cereals, pasta, rice, or other grains ≤5 times daily	215 (64.0)	38 (76.0)
Drinks >1 alcoholic drink/d (women); >2 drinks/d (men)	19 (3.0)	1 (2.0)
Has eating problems (difficulty chewing or swallowing or pain in mouth, teeth, or gums)	10 (1.2)	2 (4.0)
Lives on an income of <$6000/y (per individual in household)	30 (8.9)	3 (6.0)
Lives alone	69 (20.5)	9 (18.0)
Is housebound	3 (0.9)	2 (4.0)
Is concerned about home security	4 (1.2)	3 (6.0)
Lives in a home without adequate heating or cooling	9 (2.7)	1 (2.0)
Does not have a stove, refrigerator, or both	1 (0.3)	0 (0.0)
Is unable or prefers not to spend money on food (<$25–$30 per person spent on food each week)	7 (2.1)	2 (4.0)
Usually or always needs assistance with		
Bathing	6 (1.8)	2 (4.0)
Dressing	5 (1.5)	1 (2.0)
Grooming	3 (0.9)	0 (0.0)
Using toilet	2 (0.6)	0 (0.0)
Eating	0 (0.0)	0 (0.0)
Walking or moving about	7 (2.1)	2 (4.0)
Traveling (outside the home)	12 (3.6)	3 (6.0)
Preparing food	1 (0.3)	3 (6.0)
Shopping for food or other necessities	7 (2.1)	3 (6.0)
Any activities of daily living or instrumental activities of daily living	18 (5.4)	5 (10.0)

[1] $\bar{x}$ ± SD; n in brackets.
[2] Significantly different from not hospitalized, $P < 0.05$.

deterioration in nutritional status. Consistent with this approach is the development of the P_{ra} Plus by the HMO Workgroup on Care Management (16). This 4-page computer-scannable survey contains the original 8 P_{ra} questions for identification of hospitalization risk and additional items to help guide intervention that include medical history, current medical conditions, living environment, functional impairment (activities of daily living and instrumental activities of daily living), medication use, involuntary weight loss (≥4.5 kg), and depression. Because weight loss is the only additional nutritional item, consideration of some of the nutritional risk factors identified above might also be warranted. Boult et al (17) also suggested that the Determine Checklist might be used as a secondary screen of nutritional risk for those older persons already identified as being at risk of adverse outcomes such as hospitalization.

It is not clear whether our results can be generalized to other populations of older adults beyond the larger sample of enrollees in the Medicare managed-risk health plan in the rural setting stud-

TABLE 3
Frequency of positive responses for selected Level II (LII) Nutrition Screen items by Probability of Repeated Admission (P_{ra}) risk level[1]

Item	Low P_{ra} risk (n = 289)	High P_{ra} risk (n = 97)
	n (%)	
Lost ≥4.5 kg (10 lb) in past 6 mo	26 (9.0)	18 (18.6)
Uses ≥3 prescription drugs, over-the-counter medications, or vitamin and mineral supplements daily	99 (34.3)	58 (59.8)
Follows a special diet	10 (3.5)	12 (12.4)
Drinks >1 alcoholic drink/d (women); >2 drinks/d (men)	18 (6.2)	2 (2.1)
Has eating problems (difficulty chewing or swallowing or pain in mouth, teeth, or gums)	9 (3.1)	7 (7.2)
Needs assistance bathing	3 (1.0)	5 (5.2)
Needs assistance traveling outside the home	5 (1.7)	10 (10.3)
Needs assistance with preparing meals	0 (0.0)	4 (4.1)
Needs assistance with any activities of daily living or instrumental activities of daily living	10 (3.5)	13 (12.4)

[1] A P_{ra} risk score between 0 and 1 was assigned by using a regression equation, with higher values indicating higher risk (8–12). The cutoff for determining high or low risk was 0.30, corresponding to the 75th percentile in this sample. All items listed were significantly different between those at low and high risk, $P < 0.05$.

ied. Small cell sizes preclude meaningful analysis of the association of some items with the outcome of hospitalization. Larger samples and longer follow-up will be required to clarify some possible associations. Further assessment of these screening instruments in other populations of older adults will also be necessary to confirm these findings. Potential hybrid screening instruments will need to be tested a priori to evaluate predictive value.

TABLE 4
Multivariate logistic regression models predicting hospitalization within 1 y of screening[1]

	OR	95% CI	*P*
P_{ra} health survey items[2]			
Self-rated health	1.35	(1.01, 1.79)	0.0355
Hospitalized in the past year	1.98	(0.92, 4.10)	0.0709
>6 doctor visits in the past year	2.70	(1.26, 5.58)	0.0085
Level II Nutrition Screen items[3]			
Eating problems (difficulty chewing or swallowing or pain in mouth, teeth, or gums)	1.88	(1.02, 3.49)	0.0154
Takes ≥3 prescription drugs, over-the-counter medications, or vitamin and mineral supplements daily	3.79	(1.22, 10.90)	0.0423
Hybrid screen items[4]			
Eating problems (difficulty chewing or swallowing or pain in mouth, teeth, or gums)	3.36	(1.02, 10.12)	0.0355
Self-rated health	1.32	(0.97, 1.76)	0.0578
Hospitalized in the past year	1.97	(0.91, 4.11)	0.0760
>6 doctor visits in the past year	2.56	(1.19, 5.34)	0.0139

[1] P_{ra}, Probability of Repeated Admission.
[2] Positive predictive value: 20.0%; sensitivity: 53.1; specificity: 69.7.
[3] Positive predictive value: 17.9%; sensitivity: 58.0; specificity: 56.3.
[4] Positive predictive value: 21.0%; sensitivity: 59.2; specificity: 68.2.

It is difficult to discern whether the predictive value of the screening items for hospitalization risk lies solely in their utility as indicators of general health status or whether nutritional status indicators add value. Individuals in poor health will often have resulting nutritional compromise. Malnutrition can hasten decline in health status by compromising host defense and blunting response to medical therapies. It will be of interest to ultimately learn whether interventions, nutritional or otherwise, can alter hospitalization outcomes among candidates designated as high risk by screening.

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