The Community Assessment Risk Screen (CARS): Identifying Elderly Persons at Risk for Hospitalization or Emergency Department Visit

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Abstract

Objective: **To develop and validate an instrument for identifying community dwelling elderly patients at increased risk for hospitalizations or emergency department (ED) encounters.**

Study Design: **Prospective cohort study.**

Patients and Methods: **The development cohort consisted of 411 Medicare fee-for-service patients and the validation cohort consisted of 1054 individuals enrolled in a Medicare Risk Demonstration. Baseline demographic, health status, and utilization measures were obtained from telephone interviews and mailed questionnaires. Service utilization data for the development cohort were obtained from Medicare claims files. Utilization and cost data for the validation cohort were obtained from submitted claims.**

Results: **Logistic regression identified 3 characteristics that were predictors of hospitalizations or ED visits during the following year in the development cohort: having 2 or more comorbidities, taking 5 or more prescription medications, and having had a hospitalization or ED encounter in the previous 12 months. A scoring system (range 0 to 9) was developed for each predictor variable and patients in the validation cohort were assigned to low (0 to 3) and high (4 to 9) risk categories. When compared with the low-risk group, the high-risk group was significantly ($P < .01$) more likely to be hospitalized (33% versus 14%), to have an ED visit (34% versus 15%), and to have higher per-member-per-month (PMPM) charges ($977 versus $445) during the following 12 months.**

Conclusion: **The Community Assessment Risk Screen (CARS) is a simple instrument that can be used to identify elderly patients who are at higher risk for health service use and increased costs.**

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Improving the management of chronic diseases has become increasingly important because of the rapid growth of the elderly population and the enrollment of a large number of elderly persons in Medicare managed care organizations. The need to improve care management while at the same time reduce costs has highlighted the limitations of the current system of primary care and led to the development of models of care that extend beyond traditional practice. Although many different models of care management have been developed,[1-12] most programs share the following characteristics: (1) care is extended beyond the office visit to include telephone monitoring, home visits, or organized attempts at health promotion and education occurring outside usual office hours; (2) care is provided by an integrated interdisciplinary team, usually composed of a core physician, nurse, and/or social worker who share responsibility for care management; (3) care is organized to meet the psychosocial as well as the medical needs of patients; and (4) care is proactive,

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seeking to prevent illness and thus maintain the health of the patient.

Central to the success of any model of care management is the ability to identify patients who need, and therefore potentially might benefit from, more comprehensive care. Although the general consensus is that targeting higher-risk populations for care management is important, no commonly agreed upon criteria exist for identifying these patients. As a result, some care management models target enrollees with specific diseases, some rely on physician and healthcare professional referral, and others rely on a combination of clinical, psychosocial, and administrative data to select patients.[13-16]

In 1992, a dilemma arose at the Carle Clinic (Urbana, IL) regarding identifying a group of higher-risk patients who might benefit from a collaborative model of primary care designed to enhance chronic illness management and lower healthcare costs. This paper reports the results of a series of analyses in which elderly patients receiving usual care under fee-for-service (FFS) in this project are used to identify those factors that predict an acute hospitalization or emergency department (ED) visit during the subsequent 12 months. Hospitalization or an ED visit was chosen as the dependent variable in these analyses because both a hospitalization and an ED visit can be viewed as failures of chronic disease management in primary care practices. This paper addresses the question of whether the results of these previous analyses in a FFS population are valid predictors of health service use in a Medicare managed care population where the incentives to control costs through better care management are high and where primary care is a cornerstone of medical practice.

··· METHODS ···

Study Populations

The development cohort consisted of 411 patients who participated as control patients in the Generalist Physician Initiative[17-18] at the Carle Clinic site, Urbana, Illinois. They were enrolled between May 1993 and May 1994 and received usual and customary care from their primary care physicians. All patients were 65 years of age or older, survived for 12 months after enrollment, had Medicare Part A and B coverage, were not enrolled in a Medicare risk product, were community dwelling, and had 1 or more of the following characteristics: hospitalized in the previous 6 months before entering the study, lived alone, lacked a caregiver, were taking 4 or more prescription medications, had difficulty walking, had limitations in activities of daily living (ADLs), had memory difficulties, were incontinent of urine or stool, or had multiple illnesses or disabilities.

The validation cohort consisted of individuals who enrolled in a Medicare Risk Demonstration (Champaign/Urbana, Peoria, and Springfield, Illinois service areas)[19] implemented by the Health Care Financing Administration (HCFA) in 1997. The validation cohort consisted of those individuals who enrolled in the Demonstration during the first 5 months of operation (December 1997 to April 1998), remained enrolled for 12 continuous months, were 65 years of age or older, completed a voluntary 50-item health questionnaire after HCFA verification, and had claims data for a 12-month period. The response rate to the 50-item survey was 90%. Although 1072 individuals met this criteria, 18 (2%) questionnaires were missing data. Therefore, the validation cohort was comprised of 1054 patients.

Data Collection and Measurements

Development Cohort. After informed consent was obtained, a telephone interview was conducted by trained interviewers following standardized protocols to collect baseline data on patient demographics, current health status, and healthcare utilization during the 6 months prior to enrollment. Demographic data included age, sex, race, education, marital status, and living arrangements. Health status included the number of prescription medications being taken, the number of comorbid illnesses (including heart disease, diabetes, myocardial infarction, stroke, chronic obstructive pulmonary disease, and cancer) present, 5 health status measures of the Health Status Questionnaire (HSQ)[20] (health perception, physical health, mental health, presence of pain, and energy/fatigue level), and the number of restricted-activity bed days. Data were again obtained at 12 and 24 months after enrollment.

Measures of healthcare service utilization included hospital admissions, hospital days, and ED encounters. Hospital admissions and hospital days were determined from Medicare Part A claims history files obtained from HCFA and included use 12 months prior to enrollment and for the entire study period. Self-reports of ED encounters, which included visits to a hospital ED or an urgent care center, were obtained by telephone interview at baseline and every 6 months throughout the study. To vali-

date the self-reported emergency encounters, administrative data were analyzed for a sample of the population who obtained their care from Carle's main clinic in Urbana, where administrative data about ED visits were available. For 172 patients who represented 42% of the development cohort, no significant differences were seen between self-report and administrative measures of ED visits at baseline (κ= .83, P < .01) or at the end of the first year of the study (κ= .78, P < .01).

Validation Cohort. Measurements similar to those obtained in the development cohort were collected from the validation cohort by a mailed self-administered 50-item health assessment.[18] Measures of baseline healthcare utilization included the number of hospitalizations, number of hospital days, primary care and specialist physician visits, and ED or urgent care center visits in the prior 6 months.

Health service utilization and cost measures at the end of the first year of operation came from claims files. Encounters included hospitalizations, hospital days, physician visits, and ED visits. Costs included both billed charges and net allowed capitation payments.

Analysis

Comparisons were made using the t test for normally distributed continuous variables, chi-square tests for categorical variables, and the Wilcoxon signed rank test for nonnormally distributed continuous variables. Backward stepwise logistic regression was used to identify significant variables in the development cohort that predicted the dependent variable, any hospitalization or ED visit during the next 12 months. Independent variables used in the model included age, female sex, living arrangement, race, marital status, less than a high school education, taking 5 or more prescription medications daily, comorbid illness category, restricted-activity bed days category (confined to bed for at least 1 day during the past 12 months), 5 health status measures of the HSQ, and the baseline indicator of any hospitalization or ED encounter. To test for multicollinearity, Pearson correlation coefficients were determined for all independent variables. The highest correlation (r = 0.69) was between 2 variables, unmarried and living alone, while all other correlations were less than 0.5. Adjusted odds ratios and 95% confidence intervals were calculated for each independent variable.

The independent predictor variables were then used to construct a risk score based on the adjusted odds ratios derived from the logistic regression model. The predictive validity of the risk score was evaluated by calculating the area under the receiver operating characteristic (ROC) curve.[21,22] All statistical analyses were performed using the Statistical Package for the Social Sciences, SPSS for Windows, CD-ROM version 9.0 (SPSS, Inc, Chicago, IL).

A P value of .05 was considered to indicate statistical significance.

··· RESULTS ···

Study Populations

The baseline demographic, comorbid illness, health status, and prior health service utilization measures for the development and validation cohorts are shown in Table 1. As expected, significant differences are seen in all categories between the sicker FFS development cohort and the validation cohort who were enrolled in the Medicare Risk Demonstration.

Development of the Community Assessment Risk Screening (CARS) Instrument. Logistic regression was used to identify factors that predicted the dependent variable, a hospitalization or ED visit during the first year of the study. As indicated in Table 2, 3 variables were identified as significant: having 2 or more comorbid illnesses (odds ratio, 1.7; 95% confidence interval [CI], 1.1, 2.9), taking 5 or more prescription medications (odds ratio, 2.9; 95% CI, 2.2-4.1), and having been hospitalized or had an ED visit in the past year (odds ratio, 3.4; 95% CI, 2.7-4.5). When interaction terms for significant variables were included in the model, none were significant.

To construct a risk score, each variable was assigned a score based on the odds ratio. To adequately weight the predictive contribution of each predictor variable in developing the risk score, each odds ratio was divided by 0.9, the largest common denominator. The result was then rounded to determine each score. In this way, 2 or more comorbidities was assigned a value of 2, 5 or more medications was assigned a value of 3, and a prior hospitalization or ED visit was given a value of 4. This resulted in a range of scores from 0 to 9. The distribution of scores in the development cohort was as follows: 0 = 186 (45%), 2 = 29 (7%), 3 = 63 (15%), 4 = 40 (10%), 5 = 29 (7%), 6 = 24 (6%), 7 = 24 (6%), and 9 = 16 (4%).

Testing of the Community Assessment Risk Screening (CARS) Instrument. To test the predictive validity of the CARS Instrument in the validation cohort, low- and high-risk categories were constructed using a score of 4 or more to define the

high-risk group. A score of 4 or more was used as the cut-off point because analyses in the development cohort indicated that this risk score had the higher predictive validity as indicated by the ROC curve. The area under the ROC curve using this risk classification was 0.74, representing a moderate degree of predictive discrimination. The distribution of scores was as follows: 0 = 790 (75%), 2 = 26 (3%), 3 = 68 (6%), 4 = 106 (10%), 5 = 20 (2%), 6 = 5 (0%), 7 = 18 (2%), and 9 = 21 (2%). A total of 170 patients were classified as high risk (16%) and 884 were classified as low risk (84%).

The baseline demographic, health status, and health service utilization measures for the low- and high-risk groups are shown in Table 3. No significant demographic differences were seen between the 2 groups. The high risk group had a significantly higher prevalence of chronic illness, were taking more medications, reported a higher incidence of restricted-activity bed days, and had significantly lower HSQ scores (except mental health), higher prior hospitalization, and higher ED utilization rates.

An analysis of utilization data from a 12-month period identified significant differences between the low- and high-risk groups (shown in Table 4) in both the development and the validation cohorts. In the validation cohort, the high-risk group had significantly higher hospital (33% versus 14%) and ED use (34% versus 15%) than the low-risk group. They also had higher hospitalizations per thousand (461 versus 171), hospital days per thousand (1957 versus 763), and ED visits per thousand (489 versus 181). The high-risk group also had more physician visits than the low-risk group (mean visits 8.9 versus 5.8), and the average per-member-per-month (PMPM) billed charges for the high-risk group was $532 more than for the low-risk group (mean PMPM $977 versus $445). When using a score of 4 or more to identify high-risk patients in the validation cohort, the area under the ROC curve was 0.67.

Table 1. Characteristics of the Study Populations

	Development Cohort (n = 411)	Validation Cohort (n = 1054)	*P*
Demographic Characteristics			
Age (y), mean (SD)	75.4 (6.4)	74.6 (6.5)	.04
% Female (n)	75 (308)	56 (590)	0
% Living alone (n)	48 (197)	27 (285)	0
% Not married (n)	55 (226)	47 (495)	.02
% Having less than high school education (n)	26 (107)	16 (169)	.001
% Nonwhite race (n)	4 (16)	26 (274)	0
Health Conditions			
% 2 or more comorbidities (n)	24 (99)	11 (116)	0
% 5+ prescription medications (n)	32 (132)	12 (126)	0
% Restricted-activity bed days (n)	24 (99)	5 (53)	0
Health Status (HSQ scores)*			
Health perception, mean (SD)	61.9 (22.6)	70.1 (21.7)	0
Physical health, mean (SD)	63.1 (28.8)	79.4 (29.2)	0
Mental health, mean (SD)	79.5 (17.3)	68.7 (26.5)	0
Pain, mean (SD)	70.7 (26.5)	79.0 (21.2)	0
Energy/fatigue, mean (SD)	52.5 (24.2)	67.7 (24.8)	0
Health Service Utilization			
% Any hospitalization in prior year† (n)	21 (86)	9 (95)	0
% Any ED visit in prior 6 months (n)	18 (74)	10 (105)	0
% Any hospitalization or ED visit before program entry‡ (n)	29 (119)	14 (148)	0

ED = emergency department; HSQ = Health Status Questionnaire.
*HSQ scores are based on a 100-point scale with higher scores representing better functioning.
†For the validation cohort the time period was for the previous 6 months.
‡Any hospitalization 12 months prior to program admission and ED visit 6 months prior to program admission.

··· DISCUSSION ···

Patients at risk for being hospitalized or having an ED encounter during the subsequent 12 months were successfully identified based on 3 patient characteristics.

These 3 variables (having 2 or more comorbidities, taking 5 or more prescription medications, and having been hospitalized or having visited an ED during the previous 12 months [see Appendix]) are variables that can be identified easily at an office visit or at the time of enrollment into a healthcare plan. The contribution of each of these predictor variables to the desired outcome varied; as a result, the contribution of each variable was weighted based on the odds ratios. This resulted in a scoring system ranging from 0 to 9, with 9 identifying patients at the highest risk for being hospitalized or having an ED visit during the ensuing 12 months.

When the CARS instrument was applied to the validation cohort, the high-risk group differed significantly from the low-risk group in almost all health status and health service utilization measures. Using a cut-off score of 4 or more to identify higher-risk patients, 16% of patients were categorized as high risk. These high-risk patients were significantly sicker in terms of health status and prior healthcare utilization than those patients classified as low risk. As expected, none of the low-risk group had a prior hospitalization or ED visit and only 8% were taking 5 or more prescription medications. In spite of these health status differences, the 2 risk groups did not differ significantly in their demographic profiles, illustrating the limitations of these variables in risk stratification.

When the CARS instrument was tested in the validation cohort, high-risk patients were significantly more likely to be hospitalized (33% vs 14%), to have more physician visits (8.9 versus 5.8) and to visit an ED (34% versus 15%). High-risk patients also had higher PMPM billed charges ($977 vs $445). Although patients in the high-risk group comprised only 16% of the validation cohort, they accounted for 31% of all hospitalizations and 28% of all billed charges.

CARS was developed in a FFS population that had been selected as a comparison group for a demonstration project.[17-18] Because of this preselection, the development cohort was not only sicker than the persons enrolled in the Medicare managed care plan but was also probably sicker than the typical FFS patient. In spite of these differences in the development and validation cohorts, CARS effectively identified patients in the validation cohort who

Table 2. Logistic Regression Model Identifying Significant Variables Predicting a Hospitalization or Emergency Department Visit in the Development Cohort (n = 411)

Independent Variable	Adjusted Odds Ratio (95% CI)	Risk Score
Age (years)	1.0 (.89, 1.1)	—
Sex (female)	.75 (.44, 1.3)	—
Living alone	1.5 (.67, 3.2)	—
Marital status (not married)	.68 (.44, 1.1)	—
Having less than high school education	1.8 (.75, 3.0)	—
2 or more comorbidities	1.7 (1.1, 2.9)*	2
Restricted-activity bed days	1.7 (.86, 2.9)	—
5+ prescription medications	2.9 (2.2, 4.1)†	3
Any hospitalization or ED visit in prior year	3.4 (2.7, 4.5)†	4
Health perception score	1.0 (.98, 1.0)	—
Physical health score	.99 (.98, 1.1)	—
Mental health score	1.0 (.98, 1.1)	—
Pain score	1.0 (.97, 1.1)	—
Energy/fatigue score	(.99, 1.2)	—

CI = confidence interval; ED = emergency department.
*$P<.05$.
†$P<.01$.

were at high risk for having a hospitalization or an ED visit. This suggests that the results of this study may be generalizable to both the FFS and managed care populations. The results of this study may not be generalizable to institutionalized or younger populations.

CARS demonstrated a good degree of predictive discrimination as indicated by the area under the ROC curve of 0.67 when a cut-off score of 4 or more was used to categorize high-risk patients in the validation cohort. Although this is comparable to the P_{ra} Instrument that has been used to predict the risk of hospitalization,[15,23] a direct comparison of the 2 instruments is not possible because of different follow-up periods. The P_{ra} Instrument was developed to identify persons who were at risk of 2 or more hospitalizations over a 4-year period while CARS identifies persons at risk of a hospitalization or ED visit in the following year. Because of the shorter follow-up period and simple scoring system, CARS could be

Table 3. Characteristics of the Validation Cohort by Risk Categories (n = 1054)

	Validation Cohort		
	Low-Risk Group (0-3) (n = 884)	**High-Risk Group (4-9) (n = 170)**	***P***
Demographic Characteristics			
Age (years), mean (SD)	74.4 (6.4)	75.4 (7.1)	.07
% Female (n)	56 (495)	55 (94)	.87
% Living alone (n)	27 (239)	28 (48)	.76
% Not married (n)	48 (424)	51 (87)	.50
% Having less than high school education (n)	16 (141)	15 (26)	.61
% Non-white race (n)	26 (230)	29 (49)	.33
Health Conditions			
% Cancer (n)	5 (44)	14 (24)	0
% Congestive heart failure (n)	4 (35)	19 (32)	0
% COPD (n)	4 (35)	8 (14)	.01
% Diabetes mellitus (n)	9 (80)	19 (32)	0
% Myocardial infarction (n)	5 (44)	24 (41)	0
% Stroke (n)	2 (18)	9 (15)	0
% 5+ prescription medications (n)	8 (71)	33 (56)	0
% Restricted activity bed days (n)	2 (18)	17 (29)	0
Health Status (HSQ scores)*			
Health perception, mean (SD)	73.0 (20.3)	60.7 (25.5)	0
Physical health, mean (SD)	82.3 (27.4)	64.5 (33.8)	0
Mental health, mean (SD)	68.9 (26.4)	66.5 (27.0)	.27
Pain, mean (SD)	80.8 (20.2)	70.0 (24.0)	0
Energy/fatigue, mean (SD)	69.8 (23.7)	57.0 (27.4)	0
Health Service Utilization			
% Any hospitalization in prior 6 months (n)	0 (0)	52 (88)	0
% Any ED visit in prior 6 months (n)	0 (0)	62 (105)	0
% Any hospitalization or ED visit in prior 6 months (n)	0 (0)	87 (148)	0

COPD = chronic obstructive pulmonary disease; ED = emergency department; HSQ = Health Status Questionnaire.
*HSQ scores are based on a 100-point scale with higher scores representing better functioning.

used in primary care physician offices to identify patients at risk of hospitalization or ED visit in the following year. As such, the most practical use of CARS could be in the office where physicians would be prompted to review current therapies, emphasize compliance to treatment regimens, increase frequency of monitoring for changes in condition, and other actions designed to enhance the management of high-risk patients.

The inclusion of an ED visit as a component of the dependent variable in these analyses was for a specific purpose. Many ED visits are for acute medical and surgical emergencies resulting in hospitalization. In our study sample, however, 8% of the development and 17% of the validation cohorts' high-risk patients had an ED visit without a subsequent hospitalization during the 12-month study period. ED visits are also often caused by exacerbations of chronic illness which, if unattended, could lead to hospitalization.[24-25] By including an ED visit in these analyses, we sought to identify characteristics of persons not only at risk for hospitalization but also in need of improved primary care. When hospitalization alone was used as a dependent variable in the logistic regression, the comorbidity variable was no longer a significant predictor. A similar analysis using an ED visit as the dependent variable produced results not much different from those presented here. Although persons who may be at risk for exacerbations of chronic disease may be identified by CARS, the specific reasons for the ED visits could not be identified in this study. These reasons are an area for future research and are a limitation of this study.

As in other studies, this study was limited to those variables that were collected in both patient cohorts and thus were available for inclusion as potential predictor variables in the multivariable analyses.

Table 4. 12-Month Outcomes for the Development and Validation Cohorts Based on Risk Stratification Groups

	Development Cohort Risk Category*		Validation Cohort Risk Category*	
	Low-Risk Group (n = 304)	High-Risk Group (n = 107)	Low-Risk Group (n = 884)	High-Risk Group (n = 170)
% Any hospitalization† (n)	16 (49)	37 (40)	14 (124)	33 (56)
% Any ED visit† (n)	14 (43)	37 (40)	15 (133)	34 (58)
% Any hospitalization or ED visit† (n)	24 (74)	53 (57)	25 (221)	49 (83)
% ED visit only and no hospitalization (n)	6 (19)	8 (9)	11 (97)	17 (29)‡
Hospitalizations/1000†	247	682	171	461
Hospital days/1000†	1220	3196	763	1957
Physician visits/person, mean (SD)†	NA	NA	5.8 (4.7)	8.9 (5.7)
ED visits/1000†	181	776	181	489
PMPM billed charges/person, mean (SD)†	NA	NA	$445 ($984)	$977 ($1597)

ED = emergency department; PMPM = per member per month; NA = not available.
* Low risk = Community Assessment Risk Screening (CARS) score of 0, 1, 2, or 3; high risk = CARS score of 4 or higher.
†All differences between the low-risk and high-risk groups in both cohorts are significant at $P < .001$.
‡Difference between the low-risk and high-risk group in the validation cohort is significant at $P < .05$.

Because of this, the HSQ measures were relied on to serve as proxies for other measures of health and function, such as depression and the ability to perform ADLs. For both study cohorts, self-reported prior health utilization was used except for information about prior hospitalization in the development cohort that was obtained from HCFA. In an effort to minimize reporting errors, the definition of healthcare use was limited to the presence of a hospitalization or ED visit during a given time period. As a result, the use of self-reported utilization is unlikely to have substantially affected the results of this study.

··· CONCLUSION ···

The usefulness and cost effectiveness of any risk screening instrument is dependent on both the false-positive rate and the ability to show that patients identified as high risk can benefit from special programs or interventions. The ability to reduce a person's risk of an adverse health outcome defines better care and has the potential to lower cost. The CARS instrument is currently being used to identify high-risk patients for comprehensive care management provided by collaborative primary care teams.[19] In this model, care management is extended beyond the office to include enhanced patient education to promote compliance to treatment regiments and monitoring to promote early identification of changes in condition. The high use of hospital care in the high-risk group identified by CARS would seem to make cost savings from effective interventions likely but not guaranteed. Further study is needed to identify the benefits and limitations of this approach to risk screening and the types of interventions that improve care and lower cost in higher-risk populations.

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Appendix. The Community Assessment Risk Screen (CARS)

1. Do you have any of the following health conditions?

	Yes	No
a. Heart disease?	___	___
b. Diabetes?	___	___
c. Myocardial infarction?	___	___
d. Stroke?	___	___
e. Chronic obstructive pulmonary disease?	___	___
f. Cancer?	___	___

(Score: If 2 or more conditions are "YES" score = 2)

SCORE ___

2. How many prescription medications do you take? ___
(Score: If "5 or more" medications score = 3)

SCORE ___

3. Have you been hospitalized or had to go to an emergency department or urgent care center in the past 6 months?

(Score: If the answer is "YES" score = 4)	Yes	No
	___	___

SCORE ___

TOTAL ___