Predicting Use of Specialized Hospital Discharge Planning Services

Running Head: Discharge Planning Screen

Diane E. Holland, MS, MBS, RN *
Cynthia L. Leibson, PhD †
V. Shane Pankratz, PhD ‡
Kathleen Krichbaum, PhD, RN §
Marcelline R. Harris, PhD, RN ||

*Research Specialist, Division of Nursing Research, Department of Nursing, Mayo Clinic, Rochester, MN and Doctoral Candidate, University of Minnesota School of Nursing, Minneapolis, MN
† Associate Consultant, Epidemiology, Mayo Clinic, Rochester, MN
‡ Senior Associate Consultant, Division of Biostatistics, Mayo Clinic, Rochester, MN.
§ Associate Professor, University of Minnesota School of Nursing, Minneapolis, MN
|| Clinical Nurse Researcher, Divisions of Nursing Research & Biomedical Informatics Research, Mayo Clinic, Rochester, MN

Corresponding Author:
Diane E. Holland, MS, RN
Mayo Clinic/Department of Nursing
Eisenberg SL-41
201 West Center Street
Rochester, MN 55902
Telephone: (507) 284-4354
Fax: (507) 2556-8873
(e)mail: holland.diane@mayo.edu

Acknowledgements

At the time of this study, Diane E. Holland was a King Hussein Nursing Research Scholar in the Clinical Research Training Program at Mayo Clinic, Rochester MN. Additional support was provided by the John A. Hartford Foundation's Building Academic Geriatric Nursing Capacity Scholar Program. The authors wish to thank members of the Center for Gerontological Nursing, University of Minnesota School of Nursing, for their manuscript review.

Abstract

Background: To date there is no rigorously developed and empirically validated screening tool to identify early in the hospital stay those adults who will use specialized hospital discharge planning services.

Objectives: To develop and validate a screen using hospital admission clinical data that discriminates between adults who use or do not use specialized discharge planning services.

Methods: Similar but separate cohorts were prospectively assembled for both the development and validation of the tool. Predictor variables identified from the literature were obtained from direct participant interviews, record review, and administrative databases. The outcome was defined as the involvement of specialized discharge planning personnel with the patient's plan of care, identified from review of records for documented referrals.

Results: The tool development sample size was 991 while 303 different adults participated in the validation sample. Of 24 variables examined, only age, disability, living alone, and a self-reported walking limitation were jointly predictive of use of specialized discharge planning services ($P < 0.001$). Standardized coefficients from the joint model were used to estimate a simple screening score. A cut-point was derived and had a sensitivity of 75% and specificity of 78% in the development sample. The screen performed as well in the validation sample as in the development sample (McNemar's test, $P < 0.001$).

Discussion: A screen that targets a critical first step in the discharge planning process – the early identification of hospitalized adults who use specialized discharge planning services – can substantially improve the timely delivery of appropriate hospital services to patients.

Key Words: Discharge Planning; Elderly; Hospitalizations; Screening tools

Predicting Use of Specialized Hospital Discharge Planning Services

Although millions of hospital discharge decisions are made each year, there are no generally accepted, empirically-derived screening tools to assist in identifying persons early in their hospital stay who will benefit from specialized or "non-routine" hospital discharge planning services. Systematic screening to identify persons whose hospital discharge plans are not routine has long been recommended as a critical first step in the discharge planning process (Medicare, 1994; Potthoff, Kane, & Franco, 1997). Despite the abundance of studies related to discharge planning, the focus of research on screening tools has been on the outcomes of discharge planning, not on the early identification of persons who are likely to *use* specialized discharge planning services. Without early identification of persons who use specialized hospital discharge planning services, the services are often not engaged in a timely fashion with the potential continuing care needs are not satisfactorily met.

Background

Screening related to discharge planning is not a new focus of activity in hospitals. Over a decade ago, Medicare Conditions of Participation emphasized that discharge plans of all patients be in writing, and particularly emphasized was "Identify at an early stage all patients likely to suffer adverse health consequences upon discharge if there is not adequate planning" (Medicare, 1994 p. 64142). This implies that hospital staff identify the subset of patients whose discharge plans are not routine, e.g., their discharge plans include multifaceted, complex post-hospital care needs that require coordination between hospital and community-based care providers (Domanski, Jackson, Miller, & Jeffery, 2003). However, there is limited research that relates screening to use of specialized hospital discharge planing services.

A screen with a cutpoint score that suggests a course of action can serve as a clinical prediction rule. Methodological criteria for the development of clinical prediction rules have been described. Two of the methodological criteria of interest in this study are an explicit definition of the outcome and prospective validation in a separate group of patients but similar to the group used to develop the rule (Laupacis, Sekar, & Stiell, 1997; Wasson, Sox, Neff, & Goldman, 1985).

A number of tools have been developed to predict discharge planning outcomes. The most frequently cited include the Hospital Admission Risk Profile [HARP] (Sager et al., 1996), the Probability of ReAdmission [PRA] (Boult et al., 1993), the Blaylock Risk Assessment Screen [BRASS] (Blaylock & Cason, 1992), a tool designed to screen for use of post-discharge health care resources (Fairchild et al., 1998), and a tool to screen for prolonged length of stay, facility placement, and hospital readmission within 60 days (Evans, Hendricks, Lawrence, & Bishop, 1988).

There are a number of reports in the literature encouraging clinicians to use these screens to help identify patients who will use specialized hospital discharge planning. However, the implicit assumption is that predicting outcomes of the discharge planning process using these tools also predicts likely use of specialized discharge planning services. A methodological concern is that the screens were developed for hospital outcomes associated with, but not specific to, use of specialized discharge planning services. The HARP was developed to predict decline in function (Sager et al., 1996). The PRA was developed to predict hospital readmission, an outcome often related in the literature to poor discharge planning (Boult et al., 1993). The BRASS was developed to identify elderly hospitalized patients at risk for more frequent admissions and longer lengths of stays (Blaylock & Cason, 1992). Evans et al. (1993) designed

Deleted: than other adults

a tool to screen for frequent users of health care resources (hospital readmission, transfer to a skilled care facility, or longer than expected hospital stays) (Evans et al., 1988). Fairchild et al. (1998) stratified patients by risk of using post-discharge medical services. All of these outcome measures are linked to outcomes of the discharge planning process as a whole (Bowles, Naylor, & Foust, 2002; Bull, 2000; Hedges, Grimmer, Moss, & Falco, 1999; Jackson, 1994) rather than the provision of specialized discharge planning services. Assigning the same outcomes for an individual component of a process as the outcome of the whole process results in an inability to evaluate the contribution of any one component to the process. Screening in the discharge planning process is designed to assist the practitioner in identifying which patients are candidates for intervention by specialized discharge planning personnel in formulating the hospital discharge plans.

A second methodological concern is that of generalizability. The PRA and HARP tools were developed using a sample of persons aged 65 years or older (Boult et al., 1993; Sager et al., 1996). The PRA sample was derived from community dwelling rather than hospitalized elders. Evans et al. (1993) sampled a population of military veterans only. Other studies have excluded hospitalized surgical patients, non-verbal patients, patients on intensive care units, and patients 85 years of age or older (Blaylock & Cason, 1992; Evans et al., 1988; Fairchild et al., 1998). Absent a sensitive, specific, and generalizable screening tool, patients likely to benefit from specialized discharge planning services are not likely to be identified early, making it difficult to deploy services appropriately and in a timely fashion.

Purpose of Study

The purpose of this research was to develop and validate a practical screening tool that, using patient characteristics available early in a hospital stay, discriminates between those who use and those who do not use specialized hospital discharge planning services.

Methods

Setting and Participants

The study was conducted at two hospitals within a large Midwestern, tertiary care, referral-based system. As part of the standard discharge planning practice at both hospitals, the direct-care staff identifies discharge situations as routine vs. non-routine. Routine discharge situations are then coordinated by the direct care nurses with physicians and clinical nurse specialists. When discharge situations are identified as non-routine, referrals are made for involving additional personnel (e.g., discharge planning nurses, social workers, home infusion therapy nurses, enteral therapy dietitians, and parenteral therapy team members) in roles specifically related to discharge planning.

Two independent samples were included in this study. The first sample was used to develop the screen based on retrospective analyses. This sample, acquired for a separate study, included 991 adults (aged 18 years or older) hospitalized in 1998 for medical or surgical reasons, admitted to acute care with a stay of at least 48 hours, and is described elsewhere (Holland et al., 2003). Potential participants were identified from the previous day's admission list using a random starting point daily. Non-verbal or very confused patients were included if family members were available to serve as proxy representatives. A second similar and independent sample was recruited of persons hospitalized in 2002 for prospective validation of the screen (n = 303). The size of this second sample was determined *a priori* based on the dichotomous

dependent variable, use of specialized hospital discharge planning resources, and the number of factors in the screen.

Data Collection and Measurements

The dependent variable was use of specialized discharge planning services. This was identified utilizing daily review of the participant's hospital records for any documented referrals to specialized discharge planning personnel (listed earlier) and descriptions of their involvement with the participant's continuing plan of care. Based on a review of the literature, we generated a list of likely predictor variables. After obtaining Mayo Clinic Institutional Review Board approval for the study, we merged data from three sources in order to test the relationship of these predictor variables to use of specialized discharge planning services: 1) data obtained from record review, limited to that recorded within 48 hours of admission, 2) data from participant interviews, and 3) administrative databases. See Table 1 for the list of variables, definitions and sources. Direct-care staff and specialized hospital discharge planning resource staff were not informed of the study.

Analysis of Data

The analysis of the data had two principal stages: tool development and tool validation. In the tool development stage, data were summarized for each of the potential predictors of the use of specialized discharge planning services (sample 1, n=991). Then, Chi square tests were used to assess the univariate associations between categorical variables and use of specialized discharge planning services. Univariate logistic regression was used to examine the association between continuous variables and use of specialized discharge planning services. For all of the variables of interest, odds ratios, with corresponding 95% confidence intervals, were derived. For the categorical variables, one of the categories was selected to serve as the referent group in

the calculation of the odds ratio. For the continuous variables, the odds ratio corresponds to a one unit increase in the variable. After summarizing the univariate associations, a backward stepwise procedure was applied within a logistic regression framework to identify a subset of the independent variables that were significantly associated with use of specialized discharge planning services after adjusting for other model variables. In the backward regression procedure, a multiple degree of freedom test was used as the criterion for variable exclusion at each step. The final model was the one in which all independent variables retained statistical significance ($p<0.05$) in the presence of the other variables.

The regression coefficients were extracted from this final model and used to create a simple score that reflected the predicted likelihood that a given participant would have used specialized discharge planning services. This was achieved by first multiplying all of the coefficients by a constant value such that the product was approximately equal to an integer for each of the coefficients. For these results, the constant multiplier that was selected was a value of 4.0. The scaled coefficients were then rounded to the nearest integer. Using these integer values, a score was created for each participant first by identifying the scaled rounded coefficients that corresponded to that participant, and then by summing the values across all of the variables retained in the final model. The sensitivity and specificity corresponding to using each of the identified score values were then calculated, and a receiver operating characteristics (ROC) curve was constructed from these values. This ROC curve was used to select a single threshold score that would serve as the cut-point indicating increased risk for using specialized discharge planning services.

In the tool validation stage, required in order to examine the degree to which this screening score could be used in an independent sample of hospitalized patients (sample 2,

n=303), data were collected and a score was computed for each participant in the same manner as described above. The sensitivity and specificity of the previously identified score cut-point were computed. To assess the utility of this cut-point, we assigned a score to each participant in the validation sample to test for consistency in tool performance, and examined the agreement between the observed use of specialized discharge planning services and the prediction provided by the score derived from the development study. All analyses were performed using the SAS statistical software package (SAS Institute, Inc., Cary, NC).

Results

Study Populations

Characteristics of the development sample and the validation sample were similar in age, gender, and percent of participants admitted to medical and surgical services. In the development sample, the mean ($\pm$ SD) age was 62.6 (15.7) years and ranged from 21 to 101 years. Males accounted for approximately half (48%) of the sample. Medical and surgical diagnostic groupings were observed with almost equal frequency (48% and 51% respectively). In the validation sample, consisting of 303 participants, the mean age was 60 $\pm$ 17.7 years and ranged from 18 to 94 years. Gender was similarly split (51% male) as was the observed medical/surgical grouping (50% surgical).

There were slightly more participants who used specialized discharge planning services in the validation sample than in the development sample. In the validation sample (n=303) there were 58 (19%) participants who used specialized discharge planning services while in the development sample (n=991), 145 (14.6%) used specialized discharge planning services.

Tool Construction and Validation

In the development sample, of all variables included in Table 1, those that were jointly predictive of use of specialized discharge planning services in the multivariable analysis were age, disability, living alone, and self-reported walking limitation ($X^2 = 176.9$, df = 8, $P < 0.001$) (See Table 2). A composite screening score was developed from the resulting multivariable model, as described in Methods. Possible scores ranged from zero to 23 points, and had a mean (± SD) of 8.6 (5.1). Persons with the minimum score were those who were 45 years of age or younger, had no significant disability, lived with others in the community or in a facility prior to admission, and self-reported no limitation in walking (n=67). The maximum score of 23 was assigned to 7 persons who were aged 80 years or greater (8 points), had moderate or greater disability (9 points), lived alone prior to admission (3 points), and self-reported a walking limitation (3 points). To obtain a single cut-off score, we constructed a ROC curve from sensitivity and specificity values calculated from 2 x 2 tables obtained using all possible cut-off scores (Figure 1). Classifying those having a score of 10 or higher as being at risk for using specialized discharge planning services resulted in a sensitivity of 75.2% and specificity of 78.5%. Therefore, this score was chosen as the cut-point in an attempt to simultaneously maximize both sensitivity and specificity. The factors we considered in choosing this cut-point were based on the clinical implications of misclassification. We were more willing to tolerate false positives (i.e. expected to use specialized discharge planning services when, on observation, they did not use those services, than false negatives (i.e. not expected to use specialized discharge planning services when they did actually use those services. After applying the scoring algorithm to the validation set, the resulting scores were similar to those observed in the development set. The minimum value was zero, while the maximum – observed in 3 participants – was 21. The mean was 8.2 (± SD 5.7). Using the cut-point identified in the development study

(10) to categorize participants in the validation study into high and low risk categories produced a classification having a sensitivity of 65.5% and a specificity of 78.8%.

In addition to examining the cut-point score by comparing expected and observed scores as described above, we also examined the association between the individual screening score values and the use of specialized discharge planning services using logistic regression estimates of the odds. Figure 2 illustrates the odds of using specialized discharge planning services at every observed value of the screening score in the validation sample. The agreement between the observed and logistic regression estimates of the odds is remarkable.

The logistic regression model indicated that the odds of using these discharge planning services increased by 22% for every one unit increase in the screening score ($P<0.001$). At the extremes, the odds that an individual whose screening score was zero were 31 to 1 against use of specialized discharge planning services, while the odds for an individual with a screening score of 21 were 2.2 to 1 in favor of using specialized discharge planning services.

Finally, we studied the misclassifications in the validation sample i.e., low scores for participants who received specialized discharge planning and high scores for persons who did not use specialized services. The false positives were largely participants who resided in nursing homes prior to hospitalization and who returned to the same nursing homes after discharge. The false negatives were largely participants who required assistance with arranging for transportation home from the hospital, applying for medical insurance, or arranging for outpatient intravenous antibiotic or anticoagulant therapy. These factors warrant consideration in future refinements of the screening tool.

Deleted: [?

Discussion

The screening tool we have developed and validated consists of four variables available from routine hospital admission clinical data (age, living alone, disability, self-reported walking limitation) that exhibit high sensitivity and specificity for use of specialized discharge planning services. The variables have clinical sensibility, are easy to measure, and are available early in the hospital stay. The score is simple to calculate. The screening tool is easy to use and suggests a course of action. The score has acceptable sensitivity and specificity for use as a clinical prediction rule; a score of 10 or above obtained early in the hospital stay is associated with use of specialized hospitalized discharge planning services. Thus we have identified early in the stay an method to potentially engage specialized discharge planning services in a more timely and appropriate manner. Importantly, our outcome measure – use of specialized hospital discharge planning services - is specific to the first step in the discharge planning process.

We then prospectively validated the screening tool performance in a different sample. The screen score cutpoint performed almost as well in the prospective validation sample as in the development sample. The validation data indicate that scores are related to very different odds of using specialized discharge planning services. We included all ages of hospitalized adults, and both the derivation and validation samples in this study were representative of the target population of adults admitted to an acute care hospital, whether admitted to medical, surgical, or intensive care units. Therefore, we are hopeful for the generalizability of this screen to other institutions.

There were a number of interesting observations made when we examined the relationships among the variables considered for inclusion in the screen. First, while age was predictive of use of specialized hospital discharge planning services, comorbidities and severity of illness were not. These two characteristics, although associated with age, are often more

related to outcomes of the discharge plan as a whole such as institutionalization (Miralles et al., 2003). Second, self-reported walking limitation remained significant in the regression equation along with disability as reported by the clinician. It is likely that self-reported walking limitation and clinician reported disability are correlated. Further investigations are planned to determine the extent to which self-report is an important aspect in determining the use of specialized discharge planning services.

Living alone prior to admission was independently significant in our model. Measures of social support, living arrangements, marital status, and the identification of formal or informal caregiver availability have long been cited in the discharge planning literature (Inui, Stevenson, Plorde, & Murphy, 1981; Parfrey et al., 1994). Often, these measures are examined in relation to resource availability and willingness of others to participate in the continuing care of an individual *after* discharge from the hospital. Our findings suggest living alone is a predictor of use of specialized hospital discharge planning services. It is likely these other factors are more closely related to the plan that is actually developed than to the use of specialized hospital services for planning.

On a related note, the false negative scores (low scores but used services) raise the question of why otherwise functionally able individuals were unable to identify or engage resources that they used at discharge. In future studies, we intend to investigate whether the addition of a variable that characterizes self-determination will improve the predictive ability of the screen.

There are limitations to the use of this screen. Reproducibility of the screen in terms of intra-observer and inter-observer reliability in practice has not been evaluated. Similarly, the effect of the screen on processes when used in clinical practice have yet to be determined. While

the samples in the study were representative of the target population of adults admitted to an acute care hospital, they were obtained from one referral-based tertiary care health system in the Midwest. Other populations in other settings may have alternate risk factors. Additional studies are necessary to assess more general applicability in other clinical settings.

Hospital discharge planning remains a focus of considerable interest. The early identification of adults who are likely to use specialized discharge planning services is a critical first step in the discharge planning process. This study is among the first to target early identification for use of specialized discharge planning services.

References

Blaylock, A., & Cason, C. (1992). Discharge planning: Predicting patients' needs. *Journal of Gerontological Nursing, 18*(7), 5-10, 37-18.

Boult, C., Dowd, B., McCafferey, D., Boult, L., Hernandez, R., & Krulewitch, H. (1993). Screening elders for risk of hospital admission. *Journal of the American Geriatrics Society, 41*(8), 811-817.

Bowles, K. H., Naylor, M. D., & Foust, J. B. (2002). Patient characteristics at hospital discharge and a comparison of home care referral decisions. *Journal of the American Geriatrics Society, 50*, 336-342.

Bull, M. J. (2000). Discharge planning for older people: A review of current research. *British Journal of Community Nursing, 5*(2), 70-74.

Domanski, M. D., Jackson, A. C., Miller, J., & Jeffery, C. (2003). Towards the development of a paediatric discharge planning screening tool. *Journal of Child Health Care, 7*(3), 163-183.

Evans, R. L., Hendricks, R. D., Lawrence, K. V., & Bishop, D. S. (1988). Identifying factors associated with health care use: A hospital-based screening index. *Social Science & Medicine, 27*(9), 947-954.

Fairchild, D. G., Hickey, M. L., Cock, E. F., McCarthy, R. M., Rossi, L. P., Timmons, S. C., Mangione, C. M., & Lee, t. H. (1998). A prediction rule for the use of postdischarge medical services. *Journal of General Internal Medicine, 13*, 98-105.

Hedges, G., Grimmer, K., Moss, J., & Falco, J. (1999). Performance indicators for discharge planning: A focused review of the literature. *Australian Journal of Advanced Nursing, 16*(4), 20-28.

Holland, D. E., Harris, M. R., Pankratz, V. S., Closson, D. C., Matt-Hensrud, N. N., & Severson, M. A. (2003). Prospective evaluation of a screen for complex discharge planning for hospitalized adults. *Journal of the American Geriatrics Society, 51*(5), 678-682.

Inui, T., Stevenson, K., Plorde, D., & Murphy, I. (1981). Identifying hospital patients who need early discharge planning for special disposition. *Medical Care, 19*(9), 922-929.

Jackson, M. F. (1994). Discharge planning: Issues and challenges for gerontological nursing. A critique of the literature. *Journal of Advanced Nursing, 19*, 492-502.

Laupacis, A., Sekar, N., & Stiell, I. G. (1997). Clinical prediction rules. A review and suggested modifications of methodological standards. *Journal of the American Medical Association, 277*(6), 488-494.

Medicare. (1994). Medicare and Medicaid Programs; Revisions to Conditions of Participation for Hospitals. *Federal Register, 59*(238), 64141-64144.

Miralles, R., Sabartes, O., Ferrer, M., Esperanza, A., Llorach, I., Garcia-Palliero, P., & Cervera, A.-M. (2003). Development and validation of an instrument to predict probability of home discharge from a geriatric convalescence unit in Spain. *Journal of the American Geriatrics Society, 51*, 252-257.

Naessens, J. M., Leibson, C. L., Krishan, I., & Ballard, D. J. (1992). Contribution of a measure of disease complexity (COMPLEX) to prediction of outcome and charges among hospitalized patients. *Mayo Clinical Proceedings, 67*, 1140-1149.

Parfrey, P. S., Gardner, E., Vavasour, H., Harnett, J. D., McManamon, C., McDonald, J., & Dawe, J. (1994). The feasibility and efficacy of early discharge planning initiated by the admitting department in two acute care hospitals. *Clinical & Investigative Medicine, 17*(2), 88-96.

Potthoff, S., Kane, R. L., & Franco, S. J. (1997). Improving hospital discharge planning for elderly patients. *Health Care Financing Review, 19*(2), 47-72.

Rankin, J. (1957). Cerebral vascular accidents in patients over the age of 60: Prognosis. *Scottish Medical Journal, 2*, 200-215.

Sager, M. A., Rudberg, M. A., Jalaluddin, M., Franke, T., Inouye, S. K., Landefeld, C. s., Siebens, H., & Winograd, C. H. (1996). Hospital admission risk profile (HARP): Identifying older patients at risk for functional decline following acute medical illness and hospitalization. *Journal of the American Geriatrics Society, 44*, 251-257.

Wasson, J. H., Sox, H. C., Neff, R. K., & Goldman, L. (1985). Clinical prediction rules. Applications and methodological standards. *NEJM, 313*(13), 793-799.

Table 1. Univariate associations: Variables and use of specialized discharge planning services

Variable	Did Not Use Specialized Discharge Planning	Did Use Specialized Discharge Planning	Univariate S		
	n (%)	n (%)	Odds Ratio	(95% Conf Interv	
Abstracted from Medical Record					
Age (years)					
18-44	147 (17.4)	7 (4.8)	1.00	(Ref	
45-64	286 (33.8)	27 (18.6)	1.98	(0.84, 4	
65-79	335 (39.6)	68 (46.9)	4.26	(1.91, 9	
80+	78 (9.2)	43 (29.7)	11.58	4.97, 26	
Sex					
Female	402 (47.5)	81 (55.9)	1.00	(Ref	
Male	444 (52.5)	64 (44.1)	0.72	(0.5, 1.	
Self-rated eating limitation					
Yes	797 (97.6)	123 (90.4)	4.21	(2.21, 8	
No	20 (2.5)	13 (9.56)	1.00	(Ref	
Self-rated bathing limitation					
Yes	765 (93.6)	97 (71.3)	5.92	(3.71. 9	
No	52 (6.4)	39 (28.7)	1.00	(Ref	
Self-rated dressing limitation					
Yes	765 (93.8)	96 (70.6)	6.25	(3.93. 9	
No	51 (6.3)	40 (29.4)	1.00	(Ref	
Self-rated walking limitation					
Yes	691 (84.9)	69 (50.7)	5.46	(3.7, 8.	
No	123 (15.1)	57 (49.3)	1.00	(Ref	
Self-rated using toilet limitation					
Yes	790 (96.8)	111 (82.8)	6.3	(3.47, 11	
No	26 (3.2)	23 (17.2)	1.00	(Ref	
Self-rated housekeeping limitation					
Yes	690 (85.2)	75 (56)	4.52	(3.06, 6	
No	120 (14.8)	59 (44)	1.00	(Ref	
Nutrition: BMI calculated from height and weight	817(85.9)	134(14.1)	0.98	(0.95, 1	

Variable	Did Not Use Specialized Discharge Planning	Did Use Specialized Discharge Planning	Univariate S		
	n (%)	n (%)	Odds Ratio	(95% Conf Interv	
Rankin Disability Score[a]					
No significant disability	376 (44.8)	16 (11.3)	1.00	(Ref	
Slight disability	371 (44.2)	50 (35.2)	3.17	(1.78, 5	
Moderate or greater disability	93 (11.1)	76 (53.5)	19.40	(10.7, 3	
Cognitive Status					
Alert/oriented	203 (46)	31 (33.3)	1.00	(Ref	
Not alert/oriented	20 (4.5)	10 (10.8)	3.27	(1.4, 7.	
Some cognitive or emotional data of questionable interpretation	218 (49.4)	52 (55.9)	1.56	(0.96, 2	
Prior living status					
With others	706 (83.5)	91 (62.8)	1.00	(Ref	
Alone	125 (14.8)	43 (29.7)	2.67	(1.77, 4	
Lived in facility	15 (1.8)	11 (7.6)	5.69	(2.54, 1	
Resources available to person in community					
None	621 (74.7)	51 (37.5)	1.00	(Ref	
Informal help only	13 (1.56)	2 (1.5)	1.87	(0.41, 8	
One formal service, but no caregiving	94 (11.3)	27 (19.9)	3.50	(2.10, 8	
Multiple formal services but no caregiving	15 (1.8)	7 (5.2)	5.68	(2.22, 1	
Formal caregiving only	46 (5.5)	17 (12.5)	4.50	(2.41, 8	
Formal caregiving and multiple other formal/informal services	42 (5.1)	32 (23.5)	9.28	(5.4, 15	
Abstracted from Participant Interview					
Hospital Admission in past year					
Yes	460 (54.4)	66 (45.5)	1.43	1.00, 2.	
No	386 (45.6)	79 (54.5)	1.00	(Ref	
More than 6 clinic or physician visits in past year					
Yes	452 (53.4)	71 (49)	1.20	(0.84, 1	
No	394 (46.6)	74 (51)	1.00	(Ref	
Coronary artery disease					
Yes	632 (74.7)	98 (67.6)	1.42	(0.97, 2	
No	214 (25.3)	47 (32.4)	1.00	(Ref	
Diabetes					

Variable	Did Not Use Specialized Discharge Planning	Did Use Specialized Discharge Planning	Univariate S		
	n (%)	n (%)	Odds Ratio	(95% Conf Interv	
Yes	726 (85.8)	110 (75.9)	1.93	(1.26, 2	
No	120 (14.2)	35 (24.1)	1.00	(Ref	
Informal caregiver available					
Yes	20 (2.4)	14 (9.7)	0.23	(0.11, 0	
No	826 (97.6)	131 (90.3)	1.00	(Ref	
Self-rated health status					
Excellent	129 (15.3)	6 (4.1)	1.00	(Ref	
Very good	182 (21.5)	25 (17.2)	2.95	(1.12, 7	
Good	317 (37.5)	49 (33.8)	3.23	(1.39, 7	
Fair	156 (18.4)	37 (25.5)	5.1	(2.09, 12	
Poor	62 (7.3)	28 (19.3)	9.7	(3.82, 24	
Abstracted from Administrative Database					
Comorbidities - a. (Pre-existing number of diseased body systems)					
0/1	185 (21.9)	17 (11.7)	1.00	(Ref	
2	208 (24.6)	21 (14.5)	1.10	(0.56, 2	
3	200 (23.7)	31 (21.4)	1.69	(0.91, 3	
4	140 (16.6)	28 (19.3)	2.18	(1.15, 4	
5 or greater	111 (13.2)	48 (33.1)	4.71	(2.58, 8	
Comorbidities - b. (Number of all diseased body systems)					
0/1	151 (17.9)	11 (7.6)	1.00	(Ref	
2	203 (24.1)	20 (13.8)	1.35	(0.63, 2	
3	197 (23.3)	24 (16.6)	1.67	(0.79, 3	
4	164 (19.4)	32 (22.1)	2.68	(1.30, 5	
5 or greater	129 (15.3)	58 (40)	6.17	(3.11, 12	
Number of body systems $\geq$ Stage 2 (COMPLEX[b] score)					
0	268 (31.8)	26 (17.9)	1.00	(Ref	
1	402 (47.6)	62 (42.8)	1.59	(0.98, 2	
2	142 (16.8)	35 (24.1)	2.54	(1.47, 4	
3 or greater	32 (3.8)	22 (15.2)	7.01	(3.61, 13	
Number of pre-existing diseased body systems $\geq$ 2 (Pre-existing COMPLEX score)					

Variable	Did Not Use Specialized Discharge Planning	Did Use Specialized Discharge Planning	Univariate S		
	n (%)	n (%)	Odds Ratio	(95% Conf Interv	
0	293 (34.7)	30 (20.7)	1.00	(Ref	
1	406 (48.1)	63 (43.5)	1.52	(0.96, 2	
2	118 (14)	34 (23.5)	2.81	(1.65, 4	
3 or greater	27 (3.2)	18 (12.4)	6.51	(3.22, 13	
Primary hospital insurance					
Medicare/Medicaid	436 (51.7)	114 (79.1)	1.78	(0.68, 4	
Commercial	374 (44.3)	25 (17.4)	0.46	(0.16, 1	
Self pay/none	34 (4.0)	5 (3.5)	1.00	(Ref	

[a] (Rankin, 1957). [b] (Naessens, Leibson, Krishan, & Ballard, 1992).

Table 2. Final model: backward stepwise regression model and screening score derived from the development data s

Variable	Coefficient	Scoring Algorithm Points*	Multivariate Statistics		
			Odds ratio	95% Confidence Interval	P value
Constant	-4.59				<0.001
Age (years)					
18-44	0	0	1.0	(Ref)	-
45-64	1.02	4	2.8	(1.0, 7.7)	0.051
65-79	1.58	6	4.9	(1.8, 12.9)	0.002
80+	1.98	8	7.3	(2.6, 20.6)	<0.001
Disability					
No significant Disability	0	0	1.0	(Ref)	-
Slight Disability	0.81	3	2.3	(1.2, 4.2)	0.012
Moderate or greater Disability	2.26	9	9.6	(4.9, 18.7)	<0.001
Prior living status					
With others	0	0	1.0	(Ref)	-
Lived alone	0.75	3	2.1	(1.3, 3.5)	0.003
Lived in facility	0.09	0	1.1	(0.4, 2.9)	0.823
Self-reported walking limitation					
No	0	0	1.0	(Ref)	-
Yes	0.84	3	2.3	(1.5, .3.7)	<0.001

*Calculated by multiplying each coefficient by 4 and rounding to the nearest integer.

Figure 1. Receiver operating characteristics curves with corresponding sensitivity and specificity: (a) derived from d
(b) derived from validation data.

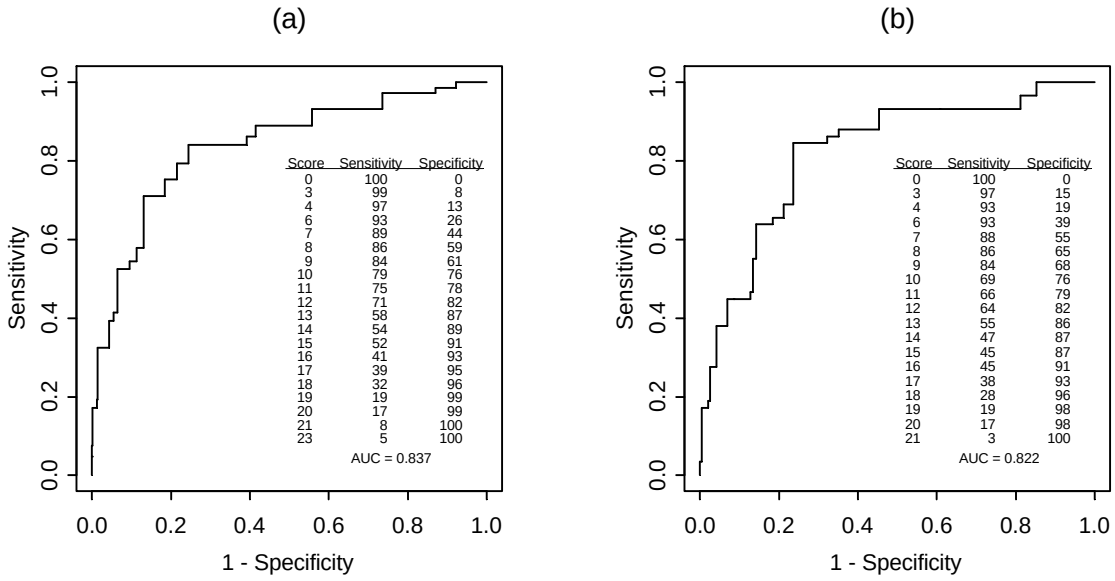

Figure 2. Observed (o) and expected (-) odds of using specialized discharge planning services in the validation data of the screening score derived from the development data set.