Prospective Evaluation of a Screen for Complex Discharge Planning in Hospitalized Adults

Diane E. Holland, MS, RN,¶ Marcelline R. Harris, PhD, RN,† V. Shane Pankratz, PhD,‡ Diane C. Closson, MS, RN,§ Natasha N. Matt-Hensrud, MPH, RN,‖ and Mary A. Severson, MA, RN#*

OBJECTIVES: To test the predictive ability of the Probability of Repeated Admission (PRA) screen for nonroutine discharge planning (requiring new referrals for formal services).

DESIGN: Prospective cohort.

SETTING: Two hospitals within a large Midwestern, tertiary care, referral-based system.

PARTICIPANTS: Nine hundred ninety-one hospitalized adults identified using a systematic sampling strategy.

MEASUREMENTS: The PRA screen was administered, and use of nonroutine discharge planning resources and nonroutine discharge disposition were determined using observation and open record review. Prolonged length of stay was determined by comparing the actual length of stay with the combined average length of stay for diagnosis-related groupings.

RESULTS: Significant differences in PRA scores existed in two of three endpoints, but the differences were small, and the ranges of scores overlapped almost completely. Using, logistic regression, items predicting use of nonroutine discharge-planning resources were self-rated health, caregiver availability, age, and sex (chi-square (χ^2) = 105.7, df = 9, $P < .001$), accounting for 17.9% of the variability and area under receiver operating characteristic curve (AUC) of 0.74. Self-rated health and sex predicted prolonged length of stay (χ^2 = 15.3, df = 5, P = .009), but only explained 2.2% of the variability, with an AUC of 0.58. The predictors of nonroutine discharge disposition were self-rated health, caregiver availability, age, sex, and diabetes mellitus (χ^2 = 125.8, df = 11, $P < .001$), accounting for 23.0% of the variability, with an AUC of 0.79.

CONCLUSION: The clinical utility of using the PRA as a screen for early identification of persons who use nonroutine discharge planning is limited, although certain individual items may be useful. **J Am Geriatr Soc 51:678–682, 2003.**

Key words: discharge planning; hospital discharge; screening; elderly

Discharge planning is widely recognized as a critical component of hospital-based care.[1,2] Although many discharge plans are routine, a subgroup of persons exists for whom nonroutine hospital discharge plans are required (those who require new referrals for formal services such as home health care or nursing homes to meet continuing care needs). Unfortunately, nonroutine plans are often formulated within abbreviated time frames. For many persons, and particularly for older adults, poor decisions can have a devastating effect, potentially resulting in compromised clinical outcomes, family distress, and financial hardships.

Researchers have argued that, although systematic screening to identify persons whose discharge plans require nonroutine services is a critical first step in the decision-making process, an empirically based discharge-planning decision-making framework is missing.[3] In the absence of a sensitive screening tool, persons likely to use nonroutine discharge planning services are not likely to be identified early in the hospital stay, making it difficult to deploy services appropriately and in a timely fashion.

Although not specifically designed for hospital discharge planning, the Probability of Readmission (PRA) is an eight-item instrument that provides early identification of older persons likely to benefit from services that delay and reduce hospital readmissions and the use of expensive services.[4] Introduced in 1993, multiple studies have dem-

From the *Department of Nursing, †Divisions of Nursing Research and Medical Informatics Research, ‡Division of Biostatistics, §Nursing Research Administration, ‖Department of Nursing, #Department of Systems and Procedures, Mayo Clinic, Rochester, Minnesota; and ¶University of Minnesota School of Nursing, Minneapolis, Minnesota.

Diane E. Holland's predoctoral study at the University of Minnesota School of Nursing is sponsored by the John A. Hartford Foundation's Building Geriatric Nursing Capacity Scholar Program.

This project was supported in part by the Mayo Clinic Department of Nursing, Rochester, Minnesota, Mayo/King Hussein Nursing Research Scholarship. The research was conducted at the Mayo Clinic, Rochester, Minnesota.

A version of this paper was presented at the 25th Annual Research Conference of the Midwest Nursing Research Society, Cleveland, Ohio, March 2001.

Address correspondence to Diane E. Holland, MS, RN, Mayo Clinic/Department of Nursing, Eisenberg SL-41, 201 West Center Street, Rochester, MN 55902. E-mail: holland.diane@mayo.edu

© 2003 by the American Geriatrics Society
0002-8614/03/$15.00

onstrated the predictive value of the PRA screen in various community-based groups of older adults.[5–10] Persons with high PRA scores are characterized as chronically ill, functionally impaired, highly medicated, and at increased risk for health-related crises, requiring nursing home placement and expensive health care. These characteristics are similar to individuals who tend to use nonroutine discharge planning resources and, in addition to repeated hospital admissions, also experience longer than average hospital stays and discharges to formal postacute care services.[11–17]

The purpose of this study was to test the predictive validity of the PRA screen when administered in a hospital setting across all adult age groups for use of nonroutine discharge planning hospital resources and two outcomes frequently associated with discharge planning: prolonged length of stay and nonroutine discharge disposition.

METHODS

Setting

The study was conducted at a midwestern acute care facility with more than 1,000 medical and surgical beds. When the direct care staff determined discharge situations to be routine, the nurses who provided direct care coordinated discharge planning with physicians and clinical nurse specialists. When discharge situations were determined to be nonroutine, referrals for involvement of additional hospital discharge planning personnel (e.g., discharge planning nurses, social workers, home infusion therapy nurses, enteral therapy dietitians, and parenteral therapy team members) were made.

Design and Sample

A prospective cross-sectional design was used. A sample of 1,000 individuals was targeted. This sample size provided 80% power, using a two-sided $\alpha = .05$ level test, to detect an odds ratio greater than 1.3 (or less than 0.76) if 15% of the patients experienced one of the endpoints.

Inclusion criteria included age 18 and older, within 24 hours of admission to a medical or surgical unit, and able to understand and speak English. Because the PRA screen is reliable with proxy respondents,[5] nonverbal or confused patients were included if family members were available. Participants whose hospitalization was less than 48 hours were dropped from the study because such stays are often for observational purposes and rarely require complex discharge plans. After institutional review board approval, enrollment proceeded from May through October 1998. Verbal consent was obtained from family members if participants were unable to give consent.

Measurements

The PRA includes eight self-report questions: health status, age, sex, caregiver availability, history of diabetes mellitus and coronary artery disease, and history of using clinical or hospital services in the past year. A score is derived by summing across weighted responses, with a possible range of 0.07 to 0.8. Higher scores indicate a greater risk of future use of health services.[4]

The endpoints in this study were use of nonroutine discharge planning resources, prolonged length of stay, and nonroutine discharge disposition. Use of nonroutine discharge planning resources and nonroutine discharge disposition were determined by reviewing participants' hospital charts and attending discharge-planning conferences on patient care units. Prolonged length of stay was determined by comparing actual length of stay to the hospitals' combined average length of stay for diagnosis related groupings obtained from an administrative database.

Procedures

Using a systematic sampling strategy with a random start point, every fifth individual was invited to participate in the study. After verbal consent was obtained, study personnel administered the PRA and followed participants until discharge. All other hospital personnel were blinded to the PRA scores and performed their discharge planning functions as usual. Three nurses were trained in data collection before study initiation. Interrater reliability achieved during training was greater than 95%, and agreement of 90% or greater was maintained throughout the study.

Statistical Analyses

A PRA score for each participant was computed and summarized graphically and statistically. Relationships between PRA scores and the three endpoints of interest were then examined, and logistic regression was used to determine whether the PRA score predicted each outcome separately. These regression models provided estimates of the sensitivity and specificity of the PRA for each endpoint by selecting as the cutoff the PRA value that simultaneously maximized sensitivity and specificity. The overall ability of the PRA score to predict the outcomes was summarized by the area under the receiver operating characteristic curve (AUC). AUC values near 0.5 indicate that the model does not predict the endpoint well, whereas AUC values near 1.0 indicate perfect discrimination between the two response categories. Assuming that the individual PRA items are reasonable choices for predictors of each of the three endpoints of interest, the associations between the individual PRA items and each endpoint were summarized. After summarizing these single-item associations, a backward stepwise procedure was used to determine which combinations of PRA items best predicted each of the three endpoints of the study. All analyses were performed using the SAS statistical package (SAS Institute, Inc., Cary, NC).

RESULTS

One thousand four hundred forty-two persons met the inclusion criteria. A final sample size of 991 participants was obtained as a result of 245 nonverbal persons not having a family member to serve as proxy, 147 persons discharged before a 48-hour stay, 27 persons declining to participate, and 12 persons inadvertently enrolled twice. The mean age $\pm$ standard deviation was 62.6 ± 15.7 and ranged from 21 to 101. The men (48.7%) and women (51.3%) each accounted for approximately half of the sample. Likewise, medical (47.9%) and surgical (50.2%) diagnostic groupings were observed with almost equal frequency, with a small proportion of participants being both surgical and medical (1.9%).

The overall mean PRA score was 0.35 ± 0.13 and ranged from 0.09 to 0.75, with a positively skewed distribution. The median, 0.34, was only slightly lower than the

Table 1. Probability of Repeated Admission (PRA) Scores for the Endpoints of Interest

Endpoint	Endpoint Observed	PRA score n	PRA score Mean ± SD	PRA score Range	PRA Cutoff	Sensitivity	Specificity	AUC	*P*-value
Use of nonroutine discharge planning resources	Yes	145	0.396 ± 0.149	0.120–0.738	0.14	55.9	56.7	0.61	<.001
	No	846	0.338 ± 0.128	0.093–0.750					
Prolonged length of stay	Yes	404	0.355 ± 0.141	0.142–0.738	0.42	56.2	49.4	0.53	.054
	No	539	0.338 ± 0.125	0.093–0.750					
Nonroutine discharge disposition	Yes	121	0.394 ± 0.145	0.120–0.738	0.12	58.7	57.7	0.62	<.001
	No	848	0.337 ± 0.128	0.093–0.750					

AUC = area under receiver operating characteristic curve; SD = standard deviation.

mean. For individuals aged 65 to 84, the mean PRA score was 0.37 ± 0.12 and ranged from 0.09 to 0.64, whereas for persons aged 85 and older, the mean PRA score was 0.43 ± 0.16 and ranged from 0.16 to 0.75. The ranges of scores from both age groups overlapped as well.

The correlation between PRA scores and prolonged length of stay (see Table 1) was suggestive of an association but did not reach statistical significance. Although the PRA score was significantly associated with use of nonroutine discharge-planning resources and nonroutine discharge disposition, the score was not particularly predictive. Differences in mean PRA score were at the second decimal point, and the ranges of the PRA scores overlapped almost completely. This is reflected in the fact that the AUC values contained in Table 1 were only slightly larger than 0.5, as reflected in the low sensitivity and specificity values listed in Table 1, selected by choosing cutoffs to simultaneously maximize both quantities.

Table 2 summarizes associations between each item in the PRA screen and the endpoints of interest. The sensitivity, specificity, and AUC values for the associations between these individual items and each of the three endpoints at times rival the comparable values for the PRA score.

Backwards stepwise logistic regression models were employed to examine alternative predictive models for the three endpoints of interest (see Table 3). Items that were jointly predictive of nonroutine discharge planning were self-rated health, caregiver availability, age, and sex (chi-square (χ^2) = 105.7, $df = 9$, $P < .001$), accounting for 17.9% of the variability in the endpoint and an AUC of 0.74. Self-rated health and sex were jointly predictive of

Table 2. Associations between Probability of Repeated Admission (PRA) Factors and the Three Endpoints of Interest

PRA Factor	n (%)	Nonroutine Dismissal Planning Sensitivity	Nonroutine Dismissal Planning Specificity	Nonroutine Dismissal Planning AUC	Long Stay Sensitivity	Long Stay Specificity	Long Stay AUC	Dismissal Disposition Sensitivity	Dismissal Disposition Specificity	Dismissal Disposition AUC
Age		46.9	79.0	0.668	20.8	85.5	0.537	73.6	65.1	0.721
<69	596 (60.1)									
70–74	149 (15.0)									
75–79	125 (12.6)									
80–84	73 (7.4)									
≥85	48 (4.8)									
Gender		55.9	52.5	0.542	52.2	54.7	0.535	58.7	52.4	0.555
Female	483 (48.7)									
Male	508 (51.3)									
Self-rated health status		44.8	74.2	0.64	32.9	74.4	0.558	44.6	74.9	0.637
Excellent	135 (13.6)									
Very good	207 (20.9)									
Good	366 (36.9)									
Fair	193 (19.5)									
Poor	90 (9.1)									
Hospital admission in past year	465 (46.9)	54.5	54.4	0.544	48.8	55.3	0.520	55.2	84.8	0.557
More than 6 clinic or physician visits in past year	468 (47.2)	51.0	53.4	0.522	48.3	54.5	0.514	51.2	53.8	0.525
Coronary artery disease	261 (26.3)	32.4	74.7	0.536	100	0	0.502	31.4	74.8	0.531
Diabetes mellitus	155 (15.6)	24.1	85.8	0.550	100	0	0.500	26.4	86.2	0.563
Informal caregiver available	957 (96.6)	9.7	97.6	0.536	100	0	0.500	12.4	98.0	0.552

AUC = area under receiver operating characteristic curve.

Table 3. Odds Ratios from the Multivariate Logistic Regression Models Built Using the Individual Probability of Repeated Admission Items to Predict the Endpoints of Interest

PRA Item	Use of Nonroutine Discharge Planning Resources	Long Stay	Nonroutine Discharge Disposition
	Odds Ratio (95% Confidence Interval)		
General health			
Excellent	0.11 (0.04–0.28)	0.58 (0.33–1.01)	0.17 (0.06–0.48)
Very good	0.25 (0.13–0.49)	0.47 (0.28–0.78)	0.25 (0.11–0.54)
Good	0.31 (0.17–0.54)	0.67 (0.42–1.07)	0.38 (0.19–0.74)
Fair	0.40 (0.22–0.74)	0.77 (0.46–1.29)	0.54 (0.27–1.10)
Poor	1.0 (ref)	1.0 (ref)	1.0 (ref)
Overnight hospital stay in past 12 months	NS	NS	NS
Physician or clinic visits in past 12 months	NS	NS	NS
Diabetes in past 12 months	NS	NS	1.67 (1.00–2.77)
History of cardiac disease	NS	NS	NS
Male	0.66 (0.45–0.97)	0.75 (0.57–0.97)	0.58 (0.38–0.88)
Female	1.0 (ref)	1.0 (ref)	1.0 (ref)
Help available at home	0.40 (0.18–0.88)	NS	0.23 (0.10–0.53)
Age			
18–44	0.06 (0.02–0.17)	NS	0.07 (0.02–0.21)
45–64	0.12 (0.06–0.24)		0.08 (0.04–0.20)
65–74	0.23 (0.11–0.45)		0.34 (0.16–0.70)
75–84	0.34 (0.17–0.69)		0.55 (0.27–1.13)
≥85	1.0 (ref)		1.0 (ref)

NS = not significant.

prolonged length of stay ($\chi^2 = 15.3$, $df = 5$, $P = .009$), but only explained 2.2% of the variability in the outcome. The AUC was 0.58, further reflecting poor prediction of this endpoint. The jointly significant predictors of nonroutine discharge disposition were self-rated health, caregiver availability, age, sex, and diabetes mellitus ($\chi^2 = 125.8$, $df = 11$, $P < .001$). The model containing these items explained 23.0% of the variability in the endpoint. The AUC from this model was 0.79.

DISCUSSION

This study investigated the predictive validity of the PRA for its use as a screen of nonroutine hospital discharge planning, nonroutine discharge disposition, and prolonged length of stay. One reason that the predictive validity of the PRA in the present study differs from previous reports of the PRA may be that the predictor variables within the PRA are an incomplete representation of the factors that put persons at risk for poor discharge-planning outcomes. Characteristics of persons at risk for poor discharge-planning outcomes found in the literature are similar to variables in the PRA, but the discharge-planning literature suffers from a limited research base.

Although the overall PRA score did not effectively screen for the endpoints in this study, specific items within the PRA did independently and jointly predict the endpoints of interest. When the total PRA score was used to predict the main outcome variable—use of nonroutine discharge planning resources—the AUC was 0.61, with 4.0% of the variability explained, similar to an AUC of 0.61 with 1.2% of the variability reported in the original publication of the PRA screen, a minimal improvement over chance.[4]

These findings indicate that, for the endpoints of this study, specific items within the PRA resulted in a better prediction model than the eight items that make up the total PRA score. For example, age and self-rated health status each demonstrated a somewhat better predictive validity than the total PRA, as suggested by AUCs of 0.67 and 0.64, respectively. Similarly, AUCs of 0.72 and 0.64 were found when age and self-rated health status were evaluated for nonroutine discharge disposition. Age, self-rated health, sex, and help available at home remained significant predictor variables in the logistic regression equations.

Only one other study was identified that tested the predictive validity of a screening tool to identify early in the hospital stay which patients would require more-extensive discharge-planning services.[18] The screening tool used in that study was the Blaylock Risk Assessment Screening Score (BRASS).[19] Results indicate that the sensitivity and specificity of the BRASS by receiver operating characteristic analysis was optimized at a cutpoint score of nine (possible scores range from 0 to 40), limiting the clinical utility of the tool. As in the current study, this suggests that a complete set of relevant factors has not yet been identified.

There are limitations to this study. First, the results are from a single study at a single site, which may limit the generalizability to other settings. Second, this study evaluated the predictive validity of a screening instrument against a different endpoint (use of nonroutine discharge planning) but characteristics of the target population de-

scribed by the original instrument developers are similar to characteristics of persons likely to benefit from nonroutine discharge-planning services. Furthermore, the goal of the original PRA developers was to screen for older persons likely to benefit from early deployment of evaluation and management services, similar to this study's goal of early deployment

Further research is necessary to develop an empirical base for factors that predict use of nonroutine hospital discharge-planning resources and subsequent poor outcomes. Potential benefits include improved technical efficiency and effectiveness of the discharge-planning decision-making process and a contribution to the understanding of fundamental outcome issues for patients, their families, and healthcare institutions.

The evaluation of predictive models in health care is a topic of increasing importance, particularly given the emergence of computer-based clinical systems that can algorithmically derive and issue alerts when a multivariate estimate of risk for specific outcomes is known. It is likely that additional research will yield a more-complete set of factors that identify persons likely to benefit from nonroutine hospital discharge-planning interventions early in their hospital stay.

ACKNOWLEDGMENTS

The authors acknowledge the assistance in this project by Charlene Wenninger, RN, Peter Bennett, MS, RN, Suzanne Kennebeck, MS, RN, and. Megan Mauer, BS. We would like to thank Chad Boult, MD, MPH, for consulting on the initial proposal development and data review. We would also like to thank members of the Center for Nursing Research on Elders, University of Minnesota School of Nursing, for their manuscript review.

REFERENCES

1. Medicare and Medicaid Programs: Revisions to conditions of participation for hospitals. Fed Regist 1994;59:64141–64144.
2. Joint Commission on Accreditation of Healthcare Organizations. Hospital Accreditation Standards. Oakbrook Terrace, IL: 2001.
3. Potthoff S, Kane RL, Franco SJ. Improving hospital discharge planning for elderly patients. Health Care Financ Rev 1997;19:47–72.
4. Boult C, Dowd B, McCafferey D et al. Screening elders for risk of hospital admission. J Am Geriatr Soc 1993;41:811–817.
5. Boult L, Boult C, Pirie P et al. Test-retest reliability of a questionnaire that identifies elders at risk for hospital admission. J Am Geriatr Soc 1994;42: 707–711.
6. Boult C, Pacala JT, Boult LB. Targeting elders for geriatric evaluation and management: Reliability, validity and practicality of a questionnaire. Aging 1995;7:159–164.
7. Pacala JT, Boult C, Reed RL et al. Predictive validity of the PRA™ instrument among older recipients of managed care. J Am Geriatr Soc 1997;45: 614–617.
8. Reardon GT, Zimba DM. Managing capitated high-risk enrollees. Physician's News Digest, Inc. (Delaware Valley, Texas, Western Pennsylvania edition) 1997 Available at http://www.physiciansnews.com/business/497capitation.html Accessed August 24, 2001.
9. FitzHenry F, Shultz EK. Health-risk-assessment tools used to predict costs in defined populations. J Healthcare Inf Manag 2000;14:31–57.
10. PhDx Systems, Inc. John Deere Health enters into agreement with PhDx e-systems to expand capabilities for population health management. PhDx e-systems, 2000. Available at http://www.phdx.com Accessed August 24, 2001.
11. Kitto J, Dale B. Designing a brief discharge planning screen. Nurs Manage 1985;16:28–30.
12. Cunningham LS. Early assessment for discharge planning. QRB Qual Rev Bull 1981;7:11–16.
13. Fethke CC, Smith IM, Johnson N. Risk factors affecting readmission of the elderly into the health care system. Med Care 1986;24:429–437.
14. Marchette L, Holloman F. Length of stay significant variables. J Nurs Adm 1986;16:12–19.
15. Freeborn DK, Pope CR, Mullooly JP et al. Consistently high users of medical care among the elderly. Med Care 1990;28:527–540.
16. Johansson I, Hamrin E, Larsson G. Evaluation of the prognostic value of the health assessment form among patients clinically ready for discharge. J Nurs Manag 1994;2:77–85.
17. Sager MA, Rudberg MA, Jalaluddin M et al. Hospital admission risk profile (HARP). Identifying older patients at risk for functional decline following acute medical illness and hospitalization. J Am Geriatr Soc 1996;44:251–257.
18. Mistiaen P, Duijnhouwer E, Prins-Hoekstra A et al. Predictive validity of the BRASS index in screening patients with post-discharge problems. J Adv Nurs 1999;30:1050–1056.
19. Blaylock A, Cason CL. Discharge planning: Predicting patients' needs. J Gerontol Nurs 1992;18:5–10.