

Michel Machado Dutra<sup>I</sup>

Emilio Hideyuki Moriguchi<sup>II</sup>

Melissa Agostini Lampert<sup>III</sup>

Carlos Eduardo Poli-de-Figueiredo<sup>I</sup>

# Predictive validity of a questionnaire to identify older adults at risk for hospitalization

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## ABSTRACT

**OBJECTIVE:** To test the predictive validity of the Probability of Repeated Hospital Admissions questionnaire among older adults.

**METHODS:** A population-based cohort study with a 6-month follow-up was implemented with 515 non-institutionalized older people ( $\geq 60$  years) cared for by the Family Health Strategy in the city of Progresso, Southern Brazil, in 2005. Participants answered eight objective questions that were entered in a logistic regression model to estimate the risk of future hospital admission, by risk strata. Survival analysis and the receiver operating characteristics curve were utilized to assess instrument validity.

**RESULTS:** Among participants, 56.1% were women and 10.1% were hospitalized. The high-risk group had a 6.5 times greater frequency of hospitalization in comparison to the low-risk category.

**CONCLUSIONS:** The instrument is effective in assessing the risk of hospitalization among older adults attended by the Family Health Program of the National Unified Health Care System.

**DESCRIPTORS:** Aged. Risk Factors. Hospitalization. Family Health Program. Validation Studies.

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## INTRODUCTION

Spending by the Sistema Único de Saúde (SUS –Brazilian National Unified Health System) will increase considerably over the next decades with an increased older population and greater frequency of chronic degenerative diseases. In 2004, the hospitalization rate in the SUS was 41.8 admittances per 1,000 residents among the 0 to 14 year age group, 61.2 for the 15 to 59 year age group and 143.3 for the 60 or older group.<sup>3,5,8</sup>

In 2004, 25% of SUS expenses were attributed to hospitalization of older adults, which were 8.4% of national population in this period. Expenditures on hospitalizations were R\$ 20.6 (US\$ 7.36<sup>a</sup>) per person/year for the younger group, R\$ 33.2 (US\$ 11.86) for the 15 to 59 year age group and R\$ 107.3 (US\$ 38.32) for the group equal to or older than 60 years. In the period from 2001 to 2004, hospitalization expenses increased 7% per individual in the 0 to 14 group, 9% in the 15 to 59 year group and 13% in the 60 or older group.<sup>15,b,c</sup>

<sup>I</sup> Programa de Pós-Graduação em Medicina e Ciências da Saúde. Faculdade de Medicina. Pontifícia Universidade Católica do Rio Grande do Sul. Porto Alegre, RS, Brasil

<sup>II</sup> Programa de Pós-Graduação em Saúde Coletiva. Universidade do Vale do Rio dos Sinos. São Leopoldo, RS, Brasil

<sup>III</sup> Departamento de Clínica Médica. Faculdade de Medicina. Universidade Federal de Santa Maria. Santa Maria, RS, Brasil

### Correspondence:

Emilio Hideyuki Moriguchi  
Av. Carlos Gomes, 1000, Conj. 401  
90480-001 Porto Alegre, RS, Brasil  
Email: moriguch@terra.com.br

Received: 2/17/2010  
Approved: 6/6/2010

Artigo disponível em português e inglês em:  
[www.scielo.br/rsp](http://www.scielo.br/rsp)

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<sup>a</sup> US\$ 1.00 was worth R\$ 2.80 in 2004.

<sup>b</sup> Ministério da Saúde. Departamento de Informação e Informática do SUS - DATASUS. Informações de Saúde: Nota Técnicas. [cited 10 Nov 2009] Available from: <http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sih/cnv/miuf.def>

<sup>c</sup> Dutra MM. Identificação do idoso sob risco de hospitalização no Programa Saúde da Família [master's dissertation]. Porto Alegre: Pontifícia Universidade Católica do Rio Grande do Sul; 2005.

Hospitalization of older adults generates a series of events that frequently culminate in diminished functional capacity and quality of life, complications unrelated to the reason for admission.<sup>4,7,18</sup>

Therefore, for many older adults hospitalization does not result in improved health and on the contrary, is often correlated with increased mortality and morbidity rates, worse prognosis and predisposition for frailty.<sup>7,18</sup>

In SUS, health care for older adults is defined from an understanding of population heterogeneity in terms of health service utilization. According to this concept, care for older adults should be hierarchized and health actions for healthy older people should be prioritized, together with programs suited for those already sick. The Family Health Strategy is responsible for managing care of older people in SUS, performing risk stratification and identifying fragile adults.<sup>12,16,17,b</sup>

To enable these actions, the development of an objective method to identify older adults at risk of hospitalization is fundamental. This procedure should have measurement validity, be easy to administer and produce easy to understand results so that Community Health Agents and Family Health Teams can utilize results to establish care priorities and preventive interventions among the population.<sup>6,10</sup>

In a cohort study, Boulton et al<sup>1</sup> (1993) identified eight risk factors for increased use of hospital services by older adults (age greater than 75 years, male sex, willingness of caretaker, self-perceived poor health, cardiovascular disease, diabetes mellitus, hospitalization in previous 12 months and more than six medical visits in previous 12 months), which are also valid for the identification of fragile adults. Based on these results, Boulton et al<sup>1</sup> developed a Probability of Repeated Hospital Admissions (Predição de Risco de Admissão Hospitalar – PRA) questionnaire.<sup>1,3,12,13</sup> In accordance with the presence or not of risk factors, the logistic regression model applied to PRA generates a value from 0 to 1. Higher values correspond to increased risk of hospital admittance.

Two studies evaluated the validity of PRA in Brazil. The first study, performed by Veras et al<sup>19</sup> (2000), administered PRA at the reception of a geriatric ambulatory clinic, and the second, by Negri et al<sup>12</sup> (2004), utilized PRA in the reception of a Family Health Basic Unit. In both studies, the PRA showed validity as an instrument to identify and classify older adults into risk strata for hospitalization. Nonetheless, these studies were cross-sectional and therefore did not allow correlation of PRA risk strata for hospitalization to the outcome hospitalization. In addition, samples were restricted to older adults that sought care in specific health services.

PRA validity for prediction of hospitalization among older adults in the United States can not be generalized to the Brazilian older population, due to characteristics of SUS and other country-specific factors, such as: availability of hospital sites, access to medical assistance and to basic health care and determinants of health service utilization.<sup>20,21</sup>

This study's objective was to evaluate PRA predictive validity for hospital admittance of older adults.

## METHODS

A population-based prospective cohort study was performed in the municipality of Progresso, Southern Brazil, in 2005. Progresso has 6,256 residents, including 694 (11.1%) age 60 years or older. The human development index was 0.738.<sup>d</sup> The municipality relies on a low complexity hospital accredited by SUS.

The Municipal Health Secretary of Progresso, in partnership with the Medical and Health Sciences Post-Graduate Program of Pontifícia Universidade Católica do Rio Grande do Sul, developed a publicly available database on health status of older adults registered in the Basic Care Information System of the Family Health Strategy. The questionnaire, used to create the municipal database, has 20 questions, eight pertaining to the PRA and the others evaluating functioning and health.<sup>b</sup>

Information on the PRA questionnaire, logistic equation and regression coefficients are described by Pacala et al<sup>13</sup> (1995).

Collection of primary data was performed in February and March of 2005, with non-institutionalized older people of both sexes, in rural and urban areas. Community Health Agents were trained to administer the research tool and conducted household visits.

In February of 2005, 551 people age 60 years or older were registered in the Basic Care Information System in Progresso municipality. Among these older people, 36 (6.5%) were excluded from analysis, 18 because the questionnaire was answered by or with assistance from the caretaker and 14 had a terminal or advanced-stage illness. The sample contained 515 people, which corresponded to 74.2% of the elderly population in Progresso.

Study participants were classified into strata according to PRA value and cutoff points suggested by Veras<sup>19</sup> (2003) and Lourenço et al<sup>9</sup> (2005): low risk (PRA<0.30), medium risk (PRA=0.30-0.39), medium-high risk (PRA=0.40-0.49) and high risk (PRA≥0.500).

<sup>d</sup> Instituto Brasileiro de Geografia e Estatística. Resultados da amostra do Censo Demográfico 2000 - Malha municipal digital do Brasil: situação em 2001. Rio de Janeiro: IBGE, 2004 [cited 2010 May 12]. Available from: <http://www.ibge.gov.br/cidadesat/topwindow.htm>

The primary outcome studied was occurrence of hospital admittance within six months (182 days) after questionnaire administration.

Since the PRA predicts hospitalization resulting from non-communicable, chronic degenerative diseases,<sup>2,3,13,14</sup> the analysis excluded 14 (13.7%) hospitalizations that were unrelated health problems, medical issues of minor clinical importance and admittances for elective surgical procedures. These exclusions corresponded to admittances for: unspecified dizziness (1), fall due to environmental factor (1), contact with spider (2), anxiety (2), medical complication of skin graft (1), watery diarrhea (3), surgical correction of utero-vaginal prolapse (1), unspecified abdominal pain (1), prosthetic hip surgery (1) and mandibular disease (1).

Descriptive statistics and a 95% confidence interval were calculated to estimate average frequency of hospitalizations according to risk strata.

The association between the frequency distribution of nominal variables from the questionnaire and the outcome were analyzed by contingency tables. Chi-square test was used to analyze the association between qualitative variables.

Survival analysis was performed to determine the probability of older adults presenting the outcome hospitalization within six months, according to PRA risk strata. Outcome probability distribution was estimated by the Kaplan-Meier method with censoring.

Survival functions were estimated separately for each group, and a log rank test was used to compare survival curves of different risk groups.

Receiver Operating Characteristics analysis was used to ascertain PRA validity for prediction of hospitalization within six months, by calculating sensitivity and specificity of different cutoff points.

Data analysis was done with SPSS 11.5.

During the study period, the Municipal Health Secretary of Progresso and the Family Health teams did not have access to study data.

This research project was approved by the Research Ethics Committee of São Lucas Hospital, Pontifical Catholic University of Rio Grande do Sul (Approval number: 05/02501 of 07/08/2005).

## RESULTS

Of the total older adults studied (515), 289 were female, with average age 70.0 years (SD=7.16), and among the 226 males, average age was 69.9 years (SD=6.77).

Among participants, 31.6% (n=163) considered their

health excellent or very good and 21.9% (n=113) average or poor. In addition, 77.3% (n=398) were less than 75 years (Table 1).

Of the total participants, 52 (10%) had 88 hospital admittances, and 17 (3.3%) had hospital readmissions and were responsible for 53 (60.2%) hospitalizations. The hospitalization rate for men was 7.1% (n=16) and among women was 12.5% (n=36) (chi-square test,  $X^2 = 0.03$ ).

In the high risk group, the frequency of hospital admittance was 6.5 times greater than low risk groups (Table 2).

**Table 1.** Distribution of the population age 60 years or older, by variables of the Probability of Repeated Hospital Admissions questionnaire. Progresso, Southern Brazil, 2005.

Variables	Total	
	n	%
Self-perceived health		
Excellent	49	9.5
Very good	114	22.1
Good	239	46.4
Medium	97	18.8
Poor	16	3.1
Hospitalization <sup>a</sup>		
None	378	73.4
> 1 time	137	26.6
Medical Visit <sup>b</sup>		
None	97	18.8
> 6	90	17.5
Diabetes mellitus		
Yes	44	8.5
Cardiovascular disease <sup>c</sup>		
Yes	108	21
Sex		
Male	226	43.9
Caretaker <sup>d</sup>		
No	86	16.7
Age (years)		
60 to 74	398	77.3
75 to 79	70	13.6
80 to 84	22	4.3
≥85	25	4.9

<sup>a</sup> Hospitalization during 12 months preceding household visit by

Community Health Worker

<sup>b</sup> Number of doctor visits during 12 months preceding household visit

by Community Health Worker

<sup>c</sup> Angina, myocardial infarction and vascular disease

<sup>d</sup> Assistance from friend, family or neighbor, if necessary

**Table 2.** Hospitalization rates among the population age 60 years or older during six months by sex, according to risk strata. Progresso, Southern Brazil, 2005.

Risk Strata	Sex		Total n (%)	Hospitalizations			Overall <sup>a</sup> IC 95%
	Male	Female		Male	Female	Overall <sup>a</sup>	
	%	%	%	%	%		
Low	60.2	67.5	331 (64.3)	2.9	6.7	5.1	3.1;7.9
Medium	18.6	17	91 (17.7)	4.8	22.4	14.3	8.2;22.6
Medium-high	12.8	9.7	57 (11.1)	10.3	25	17.5	9.3;29.0
High	8.4	5.9	36 (7.0)	36.8	29.4	33.3	19.5;49.8
Total	226	289	515 (100)	7.1	12.5	10.1	

<sup>a</sup> Chi-square test:  $\chi^2 = < 0.001$

The outcome prevalence changes for PRA scores between 0.3 and 0.5. Using a value of 0.5 it was possible to identify 7% of the study population that had 33.3% hospital admittance prevalence (Table 3).

The ROC curve showed a predictive accuracy of 0.674 (95%CI: 0.588;0.760) (Figure 1). With a cutoff point of 0.4, the sensitivity and specificity for prediction of hospitalization were 42.3% and 84.7% respectively, with 18.1% of older adults classified in this stratum.

Survival curves (proportion of patients free of hospitalization) for the risk strata showed no statistical difference between the medium risk and medium-high risk strata (log rank test:  $p=0.618$ ). The same phenomenon occurs when comparing medium-high risk to high risk (log rank test:  $p=0.076$ ). However, statistically significant differences were found between the other strata during study period (log rank test:  $p<0.01$ ) (Figure 2).

The grouping of strata in low risk (PRA<0.30), medium risk (PRA=0.30-0.49) and high risk (PRA≥0.500) generates survival curves with statistically significant differences for outcomes (log rank test  $p<0.001$ ).

The three main causes of admittances among women were circulatory system diseases (36.1%), respiratory system diseases (19.4%) and endocrine, nutritional and metabolic diseases (16.7%). Among men, the three main causes were respiratory system diseases (53.3%), nervous system diseases (13.3%) and endocrine, nutritional and metabolic diseases (13.3%).

## DISCUSSION

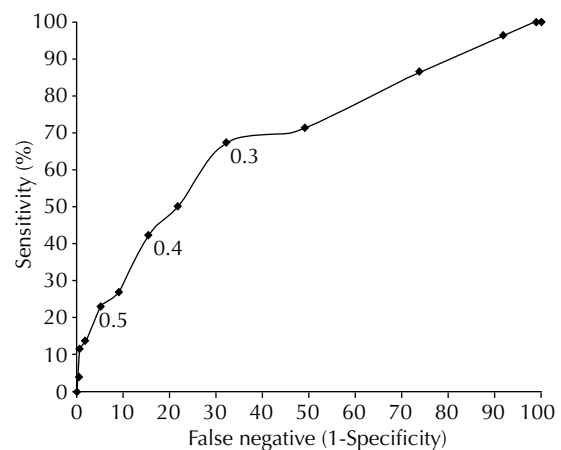
PRA allowed identification of 7% of older adults as high risk for hospitalization within six months, a similar result as found in United States (7%) and Europe (4% to 7%).<sup>1,11,21</sup> Nonetheless, some study limitations should be mentioned.

The logistic regression model for prediction of hospitalization is based on data from the United States elderly

population that participated in the original study.<sup>3</sup> Therefore, the present study has the same limitations, including the definition of elderly (age 70 years or older) and omission from the logistic equation of factors that could influence hospitalization, such as lifestyle, dementia and psychological conditions.<sup>1,21</sup>

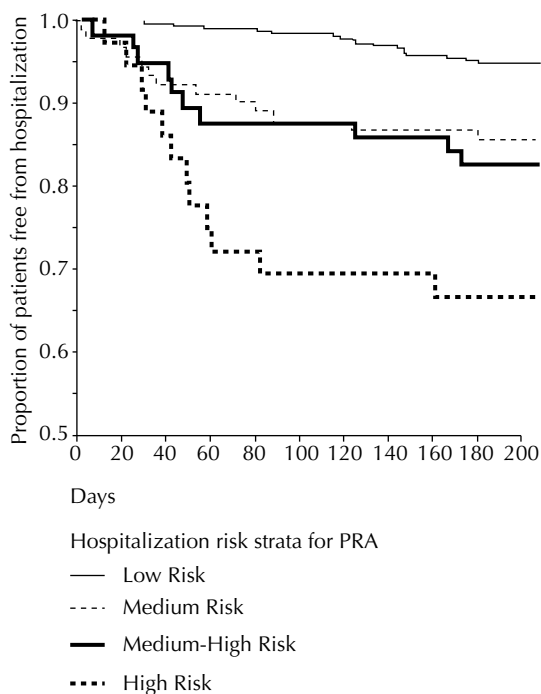
The follow-up period was six months, while Boulton et al<sup>1</sup> (1993) extended the follow-up for four years. Nonetheless, other studies evaluated PRA for shorter follow-up periods, such as Wagner et al<sup>21</sup> (one year), Pacala et al<sup>13</sup> (1995) and Vojta et al<sup>20</sup> (2001) (six months) and obtained a predictive performance similar to the original study.<sup>1</sup>

Adjustment for confounding variables, such as exclusion of older adults that required caretaker assistance to answer the questionnaire, had cognitive deficits or were gravely ill, can underestimate selection bias, prevalence of hospitalization and incapacity in the study population.<sup>6</sup>



Note: Area under the ROC Curve = 0.674

**Figure 1.** ROC Curve of the Probability of Repeated Hospital Admissions (PRA) Questionnaire for hospitalization within six months in the population age 60 years and older. Progresso, Southern Brazil, 2005.



**Figure 2.** Survival curve of the population age 60 years and older for the outcome hospitalization within six months, by risk strata for hospitalization. Progresso, Southern Brazil, 2005.

An estimated 25.8% (179) of older residents in Progresso did not participate in the study. It was not possible to determine any potential differences between the participant and non-participant groups. The possibility that the non-participant group had worse health conditions should be considered.

The group identified as high risk experienced 6.5 times more hospitalizations than the low risk group. The four cutoff points for stratification of low, medium, medium-high and high risk were not statistically significant for identifying risk strata for hospitalization in six months. Nonetheless, the following strata were statistically significant: low risk (PRA<0.30), medium risk (PRA=0.30-0.49) and high risk (PRA≥0.500).<sup>1,11,19</sup>

The observed predictive accuracy of the area under the ROC curve was 0.674, similar to results by Boulton et al<sup>1</sup> (area=0.610), Mosley et al<sup>11</sup> (area=0.638), Wagner et al<sup>21</sup> (area=0.64) and Vojta et al<sup>20</sup> (area=0.68).

In our study, the PRA showed improved ability to identify elderly at risk of hospitalization within six months, when a cutoff value of 0.4 was used to define the high risk population.

**Table 3.** Proportion of the population age 60 years and older, by score on the Probability of Repeated Hospital Admissions (PRA) Questionnaire. Progresso, Southern Brazil, 2005.

PRA Score	% Population	% Hospitalization prevalence
0.1	99.2	10.2
0.2	75.1	11.6
0.3	35.7	19.0
0.4	18.1	23.7
0.5	7.0	33.3
0.6	1.7	66.7
0.7	0.0	-

A group of 17 older adults (3.3%) was responsible for 60.2% of hospitalizations. These data reinforce the fact that the group of older adults is not homogeneous in regards to use of health services. The Medicare program in the United States found that 62% of hospital expenses with older adults are due to excessive demand generated by a relatively small subgroup (5%). In addition, these older people receive care only in the most advanced stages of disease, and despite the excessive utilization of hospital resources, spending does not correspond to improved health status for this minority.<sup>1,9,14,21</sup>

The use of PRA would allow Family Health Teams to intervene with preventive actions and avoid hospitalization of older adults. In this context, the Family Health Strategy can meaningfully impact demand for basic health care among older adults.<sup>2,8,17,19,b</sup>

PRA would permit the Family Health team to define appropriate actions and establish an intervention strategy with older adults to reduce hospitalizations, considering the amount of high risk individuals. Care can be hierarchized in accordance with risk of hospitalization, and prioritization in care for older adults can be established according to cutoff value selected. This decision will be based on the desired sensitivity and specificity of PRA. The choice of a high cutoff value (PRA>0.4) would tend to increase the number of vulnerable individuals detected, with a lower proportion of misidentified cases.<sup>2,9,12,19</sup>

This study identified older adults at risk of hospitalization through household visits by Community Health Workers and concluded that PRA validity was similar to initial studies. Therefore, inclusion of PRA in the routine of Family Health Teams and in SUS information systems should be considered.

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Article based on the master's dissertation by Dutra MM, presented to the Programa de Pós-Graduação em Medicina e Ciências da Saúde da Faculdade de Medicina da Pontifícia Universidade Católica do Rio Grande do Sul in 2005. Research funded by Conselho Nacional de Desenvolvimento Científico e Tecnológico (Nº Procedure: 401221/2005-9). The authors declare that there are no conflict of interests.