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MEETING ABSTRACT

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Who is most likely to require a higher level of care: predicting risk of hospitalization

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Introduction

Health-care services are increasingly focused on care of individuals with chronic illness. Predicting those who are at greatest risk is critical in the design of case or disease management programs. The goal of this project is to develop models that can be used to identify people who are at high risk for hospitalization, and who would potentially benefit from participating in chronic disease management programs.

Methods

We developed a predictive model using the 2002-2007 Regione Emilia-Romagna longitudinal health-care administrative database, which includes linked demographic, hospital, outpatient pharmacy, and referral data for laboratory, x-ray and specialist physician visits for 3.3 million adult residents of the region. We defined the dependent variable as a "hospitalization (or death) for problems that are potentially avoidable in patients who have diseases or problems amenable to disease management." The independent variables included demographic variables, morbidity indicators, and quality-of-care indicators.

A boosted regression tree predictive model was developed using an enriched case-control training sample of 50,000 adults. Predictive performance and calibration of the model was assessed on an independent validation sample. Model discrimination was assessed using the C-statistic, the area under the Receiver-Operator Characteristics curve. Calibration was assessed using a Hosmer-Lemeshow table of predicted versus observed proportions hospitalized, stratified by risk category.

Results

Model discrimination was good (C-statistic = 0.82). The overall rate of hospitalization in Emilia-Romagna for the selected conditions was 6.0%. We tabulated the actual (observed) and the predicted hospitalization rate within each category. Model calibration was excellent. For example, in the highest risk decile, 26% of the patients were hospitalized. The model predicted a hospitalization rate of 27% for this group.

We then applied the model to the entire adult population of the Emilia-Romagna region (n = 3.3 million) to identify those residents with the highest predicted risk of hospitalization.

The population was divided into 4 groups based on predicted risk of hospitalization:

Very high risk: predicted risk of hospitalization is ≥ 50%

High risk: predicted risk of hospitalization is 25-49%

Moderate risk: predicted risk of hospitalization is 10-24%

Low risk: predicted risk of hospitalization is < 10%

162,140 residents of the region, or 4.9% of the population, were identified as high risk. Of these people, 34% were hospitalized in the following year for one of the selected conditions and 12.8% died. Despite being less than 5% of the population, the high-risk group accounted for more than 30% of hospital expenditures for selected problems: €440.1 million.

In addition to patient age, the variables with the greatest relative influence on predicted risk of hospitalization included the number of chronic diseases, polypharmacy, and the presence of potentially inappropriate prescription drugs for elderly patients. Chronic diseases affecting the cardiovascular, gastrointestinal, musculoskeletal, respiratory and neurological systems were prevalent in high-risk patients, as were mental health problems. For those patients hospitalized in previous years, specific

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Table 1 Number of patients by predicted risk group, hospitalization, and cost

Risk of Hospitalization	High Risk 25-49%		Very High Risk 50-100%		Total	
	No.	%	No.	%	No.	%
Total population	**162,140**	**4.9%**	**1,385**	**0.0%**	**3,333,943**	**100%**
Hospitalized for selected conditions*	55,833	34.4%	815	58.8%	201,590	6.0%
Died from selected conditions	20,678	12.8%	453	32.7%	42,306	1.3%
Hospital costs for selected conditions *	€440,109,568		€6,713,382		€1,446,983,397	
% of hospital costs for selected conditions (row%)	30.4%		0.5%			

* Patients who were hospitalized for >2 days for selected conditions.

severity stages of certain chronic diseases (e.g., coronary artery disease, diabetes mellitus) were predictive of future risk. Table 1.

Conclusions

The longitudinal database available in the Emilia-Romagna region made it feasible to develop models that could identify individuals at high risk of future hospitalization. Of course, identifying those at risk is only one step in helping patients modify those risks. The Emilia-Romagna region includes 11 Local Health Authorities (LHA); each LHA is further organized into up to 6 health districts. Model results were prepared for each LHA and health district in order to assist the directors general and medical directors to identify residents at high risk. In addition, to assist them in their efforts to improve chronic care management, a review of the international literature was performed to identify chronic disease management programs that have shown promise.

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