IMPLEMENTING ACG SYSTEM IN ITALY: VALIDATION OF PREDICTED PROBABILITY OF HOSPITAL ADMISSION

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Introduction
Understanding the healthcare needs of a population is fundamental to improve the cost-effectiveness and sustainability of public health systems as a guide to appropriately distribute resources. In 2012 the Veneto Region, first in Italy, started a pilot project for implementing ACG System using available claims data. This study analyzes the prospective application of case-mix measures and statistical forecasting to predict health resource needs. The purpose of the present study is to compare the predicted probability of hospitalization calculated in 2013 with the observed events in 2014, in order to validate the ACG System.

Methods
This study analyzes the total Veneto Region population (4,856,471 inhabitants) in 2013 and 2014. For each individual, data on diagnoses, drugs, procedures and costs experienced during 2013 were analyzed using the Johns Hopkins University ACG System v.1.0.0.1. Sources of data were all the routinely available administrative databases (Hospital Discharge Abstracts, ER visits, copayment exemptions, Ambulatory visits, Medications) and the needs. The type of predictive models used is the DrRx-PM, a combined model that includes all available data streams, diagnosis and pharmacy codes.

http://acg.regione.veneto.it
The implementation of ACG system in VENETO REGION (ITALY)

2012

1,000,000 inhabitants
20% of the population of the Veneto region

2013

2,000,000 inhabitants
40% of the population of the Veneto region

2014....

≈5,000,000 inhabitants
40% of the population of the Veneto region
Validation of ACG system

Percent increase in R squared of costs from multiple linear regression adjusted for sequential set of variables

Model 1: Age+Gender
Model 2: Age+Gender+RUBs
Model 3: Age+Gender+ACG
Model 4: Age+Gender+ACG+Rx_MG

Multiple linear regression models
Methods

This study analyzes the total Veneto Region population (4,856,471 inhabitants) in 2013 and 2014. For each individual, data on diagnoses, drugs, procedures and costs experienced during 2013 were analyzed using the Johns Hopkins University ACG System v.10.0.1. Sources of data were all the routinely available administrative databases (Hospital Discharge Abstracts, ER visits, copayment exemptions, Ambulatory visits, Medications) and the disease registries (Rare diseases, Psychiatry). The type of predictive models used is the DxRx-PM, a combined model that includes all available data streams, diagnosis and pharmacy codes. For each person the ACG System generates a probability score indicating the likelihood of a future hospitalization event, intended as an acute care inpatient hospital admission within the 12 months subsequent to the observation period. The probability predicted on data 2013 was compared with the observed hospitalization events 2014.

The model performance is measured by how well true cases are identified and false positives are avoided. The sensitivity, the positive predictive value and the C-Statistic were used as measures of model fit. To find the optimal cut-off value, sensitivity, specificity, Positive Predictive Value (PPV) and Youden Index were assessed.
## Results

<table>
<thead>
<tr>
<th>Risk Group</th>
<th>Evaluation Metric*</th>
<th>ACG Hospitalization Predictive Model (C=0.75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youden TOP ~20% of Risk Scores</td>
<td>Sensitivity</td>
<td>65%</td>
</tr>
<tr>
<td></td>
<td>Specificity</td>
<td>74%</td>
</tr>
<tr>
<td></td>
<td>ppy</td>
<td>16%</td>
</tr>
<tr>
<td>TOP 10% of Risk Scores</td>
<td>Sensitivity</td>
<td>37%</td>
</tr>
<tr>
<td></td>
<td>Specificity</td>
<td>92%</td>
</tr>
<tr>
<td></td>
<td>PPV</td>
<td>26%</td>
</tr>
<tr>
<td>TOP 5% of Risk Scores</td>
<td>Sensitivity</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td>Specificity</td>
<td>96%</td>
</tr>
<tr>
<td></td>
<td>PPV</td>
<td>34%</td>
</tr>
</tbody>
</table>

* Youden Index (Sensitivity-(1-Specificity))

* outcome is inpatient hospitalization next year
Conclusions

1. Sensitivity or specificity?

2. The ACG System hospitalization predictive model showed a fair accuracy once applied to Italian data as it is.

3. The performance could be improved after a calibration of the System using local data.