Healthcare Databases and Population Based Case-Mix Systems to Support Decision Makers on Heart Failure Management in an Italian Region

Authors: Pietro Barbieri¹, Mauro Maistrello¹, Cristina Mazzali³, Alessandra DI MAIO⁴, Maria Frigerio²

Introduction
Healthcare organizations in Lombardy share a common set of administrative and textual databases. Information is collected in the data warehouse of each healthcare organization and can be retrieved by regional regulatory authority for quality assessment and for healthcare planning. Available information is based on administrative data on inpatients and outpatients, drug prescription claims and on textual data (hospital discharge, ER and ambulatory reports). The integration of different informative sources can allow the development of an extensive but coherent set of indicators that timely can support the understanding of the value generated by the healthcare services in order to overcome performance-based reimbursement systems in a patient-oriented perspective.

Methods
The eligible population of heart failure patients has been selected from inpatients administrative data for the period 2000-2014 by retrieving incident cases according to ICD-9-CM codes. From 2005 to 2012 subsequent admissions for any cause, ambulatory encounters, ER visits, drug prescriptions and mortality have been linked to each incident case. The cumulative incidence was 216 782 cases; the 2011 prevalence was 172 808 patients. Clinical Risk Groups (CRG) classification system was used to profile health services utilization, to describe heart failure sub-populations and to stratify outcome measures. CRG is a population based classification systems that assigns each individual into mutually exclusive clinical categories and assigns a severity level if chronically ill. The CRG reads enroll descriptors, diagnoses, procedures and resource data. It assigns all diagnosis codes to one of 537 diagnostic category (acute or chronic) and 37 body systems and assigns procedure codes to a procedure category. Each individual is grouped to a hierarchically health status group and then to a CRG category and severity of illness (SOI). There are 9 health care status groups (from non-users to catastrophic conditions), 272 base CRGs and with SOI , a total of 1080 final CRGs. Statistical analysis was performed by means of SAS 9.2 software: GLM proc was used for multiple regression analysis on financial burden of disease and LIFETEST proc for survival analysis.

Results
Out of 172 808 heart failure patients 98.7% of cases are in status from 5 to 9: 51.7% in status 5 (significant chronic disease), 35.13% in status 6 (significant chronic diseases in multiple organ systems), 6.9% in status 7 (dominant chronic disease in 3 or more organ systems), 2.76% in status 8 (dominant/metastatic malignancy) and 2.21% in status 9 (catastrophic). The distribution of CRG aggregations highlights that only 21% of patients are assigned to pure heart failure category; 79% of patients are assigned to categories with a combination of one or more chronic diseases other than heart failure.

Two main factors (CRG status and severity levels) are related with resources burden due to hospital admissions, ambulatory care and drug consumption. A multivariate regression analysis was performed to predict individual overall burden (log of the overall cost, given the asymmetry of the distribution) as a function of some measurable independent variables; a significant predictive value was found for: age, gender, age*gender interaction, CRG status, CRG severity levels and death with R-square=0.46. The strata generated by CRG status are related to significant differences in overall mortality. The Table depicts a decreasing survival related to an increasing status with the exception of status 9 that overlaps with status 7 while status 8 is associated with the poorest survival. Most of subjects in status 9 are heart failure patients with end stage renal disease in dialysis.

Conclusions
The heart failure population is characterized by high risk and high cost subgroups across multiple chronic conditions and several levels of severity of illness. A fair agreement has been measured between the weights of the CRG classes and the financial burden of different heart failure sub-groups of patients.
The classification system can assure useful comparisons among different local settings in order to support healthcare planning.

The classification system is clinically meaningful and can generate homogeneous strata which are related to different outcomes. The only found exception can be explained by the availability of treatments with an higher degree of efficacy in status 9 than in status 8.

**Kaplan Meier Method: Survival at 500 days**

<table>
<thead>
<tr>
<th>CRG status</th>
<th>survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>85.0 %</td>
</tr>
<tr>
<td>6</td>
<td>73.5 %</td>
</tr>
<tr>
<td>7</td>
<td>62.0 %</td>
</tr>
<tr>
<td>8</td>
<td>29.5 %</td>
</tr>
<tr>
<td>9</td>
<td>62.0 %</td>
</tr>
</tbody>
</table>

1. Azienda Ospedaliera di Melegnano, Cernusco sul Naviglio, Italy.
2. Cardiologia 2 - Insufficienza cardiaca e Trapianto, A.O. Ospedale Niguarda Ca' Granda, Milano, Italy.
3. Dipartimento di Ingegneria Gestionale, Politecnico di Milano, Milano, Italy.
4. 3M Health Information Systems, Pioltello, MI, Italy.