ASSESSING HOSPITAL LENGTH OF STAY IN PORTUGAL USING DIAGNOSIS RELATED GROUPS AND DISEASE STAGING

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Setting the Scene

✓ The reform process in the Hospital Sector
  ▪ Hospital Corporatization
  ▪ Public Private Partnerships – Project Finance Initiatives
  ▪ The Performance Evaluation Movement

✓ The Patient Classification Systems Utilization and Goals
  ▪ DRGs and hospital funding
  ▪ The need for future applications
    • Quality (mortality, complications and re-admissions)
    • Efficiency (costs and length of stay)
    • Appropriateness of Admissions
Data / Methods

- Year – 2001

- Coronary Artery Disease (n=26,163), except who left against medical advice or discontinued care or transferred to another short-term hospital and hospitals and DRGs with 100 or less admissions (n=22,038)

- Observed Average Length of Stay (ALOS) for trimmed data

- Expected Average Length of Stay (ELOS) for trimmed data (Disease Staging output)

Data

<table>
<thead>
<tr>
<th>DRGs</th>
<th>Type</th>
<th>Description</th>
<th>Admis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>Surg</td>
<td>Coronary bypass with cardiac catheterization</td>
<td>344</td>
</tr>
<tr>
<td>109</td>
<td>Surg</td>
<td>Coronary bypass without cardiac catheterization</td>
<td>1,643</td>
</tr>
<tr>
<td>112</td>
<td>Surg</td>
<td>Percutaneous cardiovascular procedures</td>
<td>2.077</td>
</tr>
<tr>
<td>116</td>
<td>Surg</td>
<td>Oth perm cardiac pacemaker implant or PTCA w coronary art stent</td>
<td>1.740</td>
</tr>
<tr>
<td>121</td>
<td>Med</td>
<td>Circulatory disorders w AMI &amp; major complications discharge alive</td>
<td>1.469</td>
</tr>
<tr>
<td>122</td>
<td>Med</td>
<td>Circulatory disorders w/o AMI &amp; major complications discharge alive</td>
<td>3.574</td>
</tr>
<tr>
<td>123</td>
<td>Med</td>
<td>Circulatory disorders w AMI, expired</td>
<td>0.589</td>
</tr>
<tr>
<td>124</td>
<td>Med</td>
<td>Circulatory disorders except AMI, w card cath &amp; complex diag</td>
<td>1.149</td>
</tr>
<tr>
<td>125</td>
<td>Med</td>
<td>Circulatory disorders except AMI, w card cath w/o complex diag</td>
<td>3.496</td>
</tr>
<tr>
<td>127</td>
<td>Med</td>
<td>Acute &amp; subacute endocarditis</td>
<td>1.021</td>
</tr>
<tr>
<td>132</td>
<td>Med</td>
<td>Atherosclerosis w cc</td>
<td>1.772</td>
</tr>
<tr>
<td>133</td>
<td>Med</td>
<td>Atherosclerosis w/o cc</td>
<td>0.745</td>
</tr>
<tr>
<td>140</td>
<td>Med</td>
<td>Angina pectoris</td>
<td>2.089</td>
</tr>
<tr>
<td>144</td>
<td>Med</td>
<td>Other circulatory system diagnoses w cc</td>
<td>1.74</td>
</tr>
<tr>
<td>145</td>
<td>Med</td>
<td>Other circulatory system diagnoses w/o cc</td>
<td>1.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>22,038</td>
</tr>
</tbody>
</table>
**Disease Staging**  
*Clinically based classification system*

**INPUTS:**  
- ICD diagnosis & procedure codes  
- Patient sex  
- Age  
- Discharge status

**OUTPUTS:**  
- Primary Disease category  
- Secondary Disease category  
- Severity Substages

**Generic Stage Definition**

<table>
<thead>
<tr>
<th>Stage 1:</th>
<th>Condition with no complications; problems of minimal severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 2:</td>
<td>Condition with local complications; problems limited to an organ or system</td>
</tr>
<tr>
<td>Stage 3:</td>
<td>Multiple site involvement; generalized systemic involvement</td>
</tr>
</tbody>
</table>

Gonnella JS, Louis DZ, Gozum ME, (editors). *Disease Staging Clinical Criteria, Fourth Edition*, The MEDSTAT Group, Santa Barbara, CA,
## Coronary artery disease

### Coded Criteria

<table>
<thead>
<tr>
<th>STAGE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Stable angina pectoris, or old myocardial infarction, coronary atherosclerosis, or chronic ischemic heart disease</td>
</tr>
<tr>
<td>2.1</td>
<td>Progressing angina pectoris</td>
</tr>
<tr>
<td>2.2</td>
<td>Angina pectoris with other abnormal cardiac findings</td>
</tr>
<tr>
<td>2.3</td>
<td>Angina pectoris with congestive heart failure</td>
</tr>
<tr>
<td>2.4</td>
<td>Unstable angina pectoris or Prinzmetal’s variant angina</td>
</tr>
<tr>
<td>3.1</td>
<td>Acute myocardial infarction</td>
</tr>
<tr>
<td>3.2</td>
<td>Acute myocardial infarction and heart block or pericarditis</td>
</tr>
<tr>
<td>3.3</td>
<td>Acute myocardial infarction and congestive heart failure</td>
</tr>
<tr>
<td>3.4</td>
<td>Acute myocardial infarction and ventricular thrombus formation</td>
</tr>
<tr>
<td>3.5</td>
<td>Acute myocardial infarction and ventricular aneurysm</td>
</tr>
<tr>
<td>3.6</td>
<td>Acute myocardial infarction and pulmonary embolism or cerebrovascular accident</td>
</tr>
<tr>
<td>3.7</td>
<td>Acute myocardial infarction and papillary muscle rupture or ventricular septal rupture</td>
</tr>
<tr>
<td>3.8</td>
<td>Acute myocardial infarction and ventricular fibrillation or shock</td>
</tr>
<tr>
<td>3.9</td>
<td>Acute myocardial infarction and cardiac arrest</td>
</tr>
</tbody>
</table>

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## Disease Staging Criteria

- **Stages are ordinal within each disease**
  - Stage 1 of one disease may have different implications than Stage 1 of another disease.
  - Stage 2 is not “twice” as sick as Stage 1.

- **Substages have been defined to allow more precise classification.**

- **Staging software uses ICD codes and standard data set**
Staging Scales

✓ *Disease Staging Scales* allow comparisons across disease categories

✓ *Variables considered in the models:*
  - Principal Disease Category and Stage
  - Number and severity of co-morbid conditions
  - Age and sex
  - Procedure performed
  - Admission source (transfer)
  - Admission type (emergency)

Staging Scales

✓ *Scales allow comparisons across disease categories, controlling for case mix, in terms of:*

  → Length of stay
  → Resource use
  → Mortality
  → Complications
  → Repeated admissions
Staging Scales

- Scales can be referenced to different populations to calculate “expected values” (e.g., Expected length of stay – ELOS, Expected mortality rates) taking account of case mix differences.

- USA, Italy, Japan, Portugal,…

- Hospital types
  - University and Central Hospitals
  - Regional Hospitals
  - Hospital “firms”

The Recalibration Process In Portugal - Mortality Models

- Fit one logistic regression for each DRG on the surgical group
- Fit one logistic regression for each Disease Staging principal disease category (PDXCAT) on the non-surgical group

- \[ Y = a + b \times \text{logit}(p), \] where “Y” is the observed mortality; “p” is the Disease Staging predicted mortality for each patient and \[ \text{logit}(p) = \log \left( \frac{p}{1-p} \right) \]

- Check the goodness of fit and c-statistic for each DRG and PDXCAT

- Recalibration of the predicted mortality (also by surgical and non-surgical admissions)
  - New predicted mortality = \( \frac{1}{1 + \exp \left[ -a \times b \times \text{logit}(p) \right]} \)
The Recalibration Process in Portugal – Length of Stay

- Use Disease Staging Software to get LOS Scale for each patient
- If admission date = discharge date, then set LOS = 1
- Identify LOS outliers for each DRG
  - Outlier threshold = exp(\(\log(Q1) - 1.5 \times [\log(Q3) - \log(Q1)]\)), where Q1 is the first quartile and Q3 is the third quartile and LOS is an outlier if LOS < Outlier threshold
  - Outlier threshold = exp(\(\log(Q3) + 1.5 \times [\log(Q3) - \log(Q1)]\)), where Q1 is the first quartile and Q3 is the third quartile and LOS is an outlier if LOS > Outlier threshold
- Run the LOS regression for each DRG
  - \(\log(\text{observed LOS}) = a + b \times \log(\text{LOS Scale})\)
- Check the goodness of fit for each equation
- Recalibration of the LOS Scale
  - Calculate predicted LOS for cases
    - Predicted LOS = \(f \times (a + b \times \log(\text{LOS Scale}))\), where \(f\) is a retransformation factor called the smearing estimate, \(f\) = average (exponentiated residuals from the regression equation).
  - New LOS Scale = 100 \(*\) (predicted LOS / mean predicted LOS)

Results (1)

**Coronary Artery Disease**

*Admissions, Total, Medical and Surgical*

<table>
<thead>
<tr>
<th>Type of Patients</th>
<th>Total</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adm.</td>
<td>Adm. %</td>
<td>Adm. %</td>
<td>Adm. %</td>
</tr>
<tr>
<td>All</td>
<td>22,038</td>
<td>7,668</td>
<td>34.79</td>
<td>6,428</td>
</tr>
<tr>
<td>Surgical</td>
<td>5,804</td>
<td>2,800</td>
<td>48.24</td>
<td>1,134</td>
</tr>
<tr>
<td>Medical</td>
<td>16,234</td>
<td>4,868</td>
<td>29.99</td>
<td>5,294</td>
</tr>
</tbody>
</table>
## Results (2)

**Coronary Artery Disease**  
*Medical Admissions, ALOS and ELOS*

<table>
<thead>
<tr>
<th></th>
<th>ADM</th>
<th>ALOS</th>
<th>ELOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>16,234</td>
<td>7.67</td>
<td>8.11</td>
</tr>
<tr>
<td>Stage 1</td>
<td>4,868</td>
<td>3.61</td>
<td>4.09</td>
</tr>
<tr>
<td>Stage 2</td>
<td>5,294</td>
<td>8.61</td>
<td>8.50</td>
</tr>
<tr>
<td>Stage 3</td>
<td>6,072</td>
<td>10.10</td>
<td>10.98</td>
</tr>
</tbody>
</table>

## Results (3)

**Coronary Artery Disease**  
*ALOS for the Major Hospitals*
Results (4)
Coronary Artery Disease
ELOS for the Major Hospitals

Results (5)
Coronary Artery Disease
Ratio ALOS to ELOS for the Major Hospitals
Note: the patients with cardiac catheterization were identified by the procedure codes. So, all patients with this procedure are included in the analysis.

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Results (8)

Coronary Artery Disease
Cardiac Catheterization

Ratio ALOS to ELOS for the Major Hospitals

Note: The patients with cardiac catheterization were identified by the procedure codes. So, all patients with this procedure are included in the analysis.

Results (9)

Coronary Artery Disease - Other

ALOS for the Major Hospitals
Results (10)
Coronary Artery Disease - Other
ELOS for the Major Hospitals

Results (11)
Coronary Artery Disease - Other
Ratio ALOS to ELOS for the Major Hospitals
Conclusions

✓ Using the same data inputs we were able to use two different Patient Classification Systems – the DRGs and Disease Staging;

✓ With this methodology we were able to use both a resource consumption and a clinical approaches and consequently to be able to have different applications;

✓ We could also introduce the severity issue in the Portuguese hospital setting, showing its relevance, not only in identifying different resource consumption by the stages of the disease, but also to identify the hospital performance by comparing the observed and expected values of the length of stay;

✓ The main results of this analysis also presented that the severity adjustment it is a very useful tool to assess the hospital performance, since the hospitals with the best ratio of its observed to expected length of stay, were not always among the hospitals with the lowest ALOS.

The Road Ahead

✓ In the near future we are going to make broader analysis of the Portuguese hospitals performance, namely:

  ▪ Assessing the quality through the mortality, complications and re-admissions comparisons;
  ▪ Assessing the hospital efficiency, both at the resource costs and length of stay;
  ▪ Evaluate the appropriateness of admissions, identifying early and late admissions.

✓ For some of these issues we also intend to make some comparisons with the Disease Staging and the DRGs, using the International Refined version.