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Prospective Validation of the Redin-SCORE to
Predict the Risk of Rehospitalization for Heart
Failure in a Contemporary Cohort of Outpatients

Validación prospectiva del Redin-SCORE para predecir el riesgo de reingreso por insuficiencia cardíaca en una cohorte actual de
pacientes ambulatorios

To the Editor,

The natural history of heart failure (HF) is marked by
decompensations, which usually require hospitalization. In Spain,
the number of hospital admissions for HF has increased in recent
decades.1,2 In addition to the inherent cost, in-hospital mortality is
also high.3 Prevention of readmission should therefore be one of
the main objectives of the treatment of outpatients with HF. Most
models for predicting readmission are based on data from
hospitalized patients and so they do not reliably reflect the clinical
condition of outpatients. Recently, our group has developed a
new tool, the Redin-SCORE,2,3 to calculate the risk of readmission due to
HF in the short- and long-term for outpatients. The score is easy
to calculate and uses 6 parameters regularly monitored in patients
with HF: presence of signs of left HF (paroxysmal nocturnal
dyspnea, orthopnea, third heart sounds or crackles); heart rate
> 70 bpm; anemia (hemoglobin < 130 g/L in men and < 120 g/L in
women); N-terminal fraction of brain natriuretic peptide
> 1000 ng/L; glomerular filtration rate < 60 mL/min/1.73 m²;
dailated left atrium in the echocardiogram (> 26 mm²/m²). However,
one of the limitations inherent in any score is the need of
validation in other populations and, in our particular case, the low
incidence of events (17%) recorded in the original sample.
Therefore, to extend the validity of this new risk scale, it was
decided to assess its predictive and discriminatory capacity in a
contemporary cohort of outpatients with heart failure.

To this end, a prospective study was undertaken with patients
referred for the first time to the HF unit of our hospital between
June 2012 and December 2014 (n = 237). Follow-up was performed
by a trained group of cardiologists and nursing staff through
review of medical records and telephone calls to register data on
hospitalization for HF during the following year. The discrimina-
tory capacity was calculated using the C statistic. The calibration,
slope, and intersection of the model were assessed using the
 Hosmer-Lemeshow goodness-of-fit test. The decision curves were
analyzed to determine when application of the Redin-SCORE
increased the number of true positives without increasing the
number of false negatives.4,5

Of the 237 patients included, 5.4% (13 patients) required
admission for HF during the first month and 29.5% (70 patients)
during the first year. The main characteristics of the cohort
according to the presence of events at follow-up are shown in the
Table. The patients who were admitted for HF were older and a
higher proportion had ischemic heart disease. They were also in a
more advanced functional class. In the laboratory tests, these

<table>
<thead>
<tr>
<th>Table</th>
<th>Baseline Characteristics of the Population According to Risk of Heart Failure at 1 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No admission (n = 167)</td>
</tr>
<tr>
<td>Men</td>
<td>114 (68)</td>
</tr>
<tr>
<td>Age, y</td>
<td>65 ± 14</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>60 (36)</td>
</tr>
<tr>
<td>Ischemic origin</td>
<td>44 (26)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>53 (32)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>118 (71)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>73 (44)</td>
</tr>
<tr>
<td>History of smoking</td>
<td>115 (69)</td>
</tr>
<tr>
<td>NYHA III–IV</td>
<td>53 (32)</td>
</tr>
<tr>
<td>COPD</td>
<td>40 (27)</td>
</tr>
<tr>
<td>SBP, mmHg</td>
<td>126 ± 21</td>
</tr>
<tr>
<td>LVEF, %</td>
<td>40 ± 17</td>
</tr>
<tr>
<td>NT-proBNP, ng/L</td>
<td>2.968 ± 5.481</td>
</tr>
<tr>
<td>GFR (CKD-EPI, mL/min/1.73 m²)</td>
<td>62 ± 20</td>
</tr>
<tr>
<td>Hemoglobin, g/L</td>
<td>134 ± 18</td>
</tr>
<tr>
<td>β-blockers</td>
<td>146 (87)</td>
</tr>
<tr>
<td>ACEI/ARA-II</td>
<td>147 (88)</td>
</tr>
<tr>
<td>Furosemide</td>
<td>129 (77)</td>
</tr>
<tr>
<td>Aldosterone antagonists</td>
<td>75 (45)</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>19 (13)</td>
</tr>
<tr>
<td>Resynchronization</td>
<td>13 (8)</td>
</tr>
<tr>
<td>ICD</td>
<td>29 (17)</td>
</tr>
<tr>
<td>Heart transplant</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Signs of left HF</td>
<td>25 (15)</td>
</tr>
<tr>
<td>HR &gt; 70 bpm</td>
<td>89 (53)</td>
</tr>
<tr>
<td>Anemia</td>
<td>51 (31)</td>
</tr>
<tr>
<td>NT-proBNP &gt; 1000 ng/L</td>
<td>94 (56)</td>
</tr>
<tr>
<td>GFR &lt; 60 mL/min/1.73 m²</td>
<td>60 (36)</td>
</tr>
<tr>
<td>LA &gt; 25 mm²/m²</td>
<td>77 (46)</td>
</tr>
<tr>
<td>Overall mortality, %</td>
<td>4 (2)</td>
</tr>
</tbody>
</table>

Discrimination and
calibration in the
overall population

<table>
<thead>
<tr>
<th>C statistic</th>
<th>P value: Hosmer-Lemeshow</th>
<th>Slope</th>
<th>Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readmission for HF at 1 mo</td>
<td>0.67</td>
<td>.458</td>
<td>0.54</td>
</tr>
<tr>
<td>Readmission for HF at 1 y</td>
<td>0.71</td>
<td>.601</td>
<td>1.05</td>
</tr>
</tbody>
</table>

ACEI, angiotensin converting enzyme inhibitor; ARA-II, angiotensin II receptor
antagonist; CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; COPD,
chronic obstructive pulmonary disease; GFR, glomerular filtration rate; HF, heart
failure; HR, heart rate; ICD, implantable cardioverter device; LA, left atrium; LVEF,
left ventricular ejection fraction; NYHA, New York Heart Association functional
class; SBP, systolic blood pressure.

Data are expressed as No. (%) or mean ± standard deviation.
patients had a lower glomerular filtration rate and more frequently had anemia and elevated N-terminal fraction of brain natriuretic peptide. Mortality and need for heart transplant were also higher in these patients.

The analysis of risk categories according to the Redin-Score obtained showed a progressive increase in the percentage of events, both at 1 month (<20 points, 3.2%; ≥ 20 points, 9.4%; \( P = .04 \)) and at 1 year (≤12 points, 12.2%; 13–20 points, 36%; 21–30 points, 47%; \( P < .001 \)). Given the difference in recorded events between the derived population and the external validation population, the probabilities of different scores were recalibrated and nonsignificant values were obtained in the goodness-of-fit test (Table). In addition, the C statistics in the current cohort were not significantly different from the discrimination measures generated in our original series (C = 0.67 vs C = 0.73 at 1 month, \( P = .459 \); C = 0.71 vs C = 0.67 at 1 year, \( P = .293 \)). In the external validation performed previously in the MUSIC cohort, values for a C index of 0.71 and 0.69 were obtained at 6 months and 1 year, respectively. The Figure shows the decision curves analysis, which shows that application of the Redin-Score improves the net benefit with respect to the strategy of not applying any discrimination to the population of patients with HF.

The present study provides external validation for the Redin-Score, a new scale for predicting short- and long-term readmission for HF in outpatients. In a contemporary cohort of patients with HF, the Redin-Score showed acceptable discriminatory capacity and calibration, particularly at 1 year. This study supports its clinical usefulness as a stratification tool for patients with HF in Spain.

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