Internationally Comparable Diagnosis-Specific Survival Probabilities for Calculation of the ICD-10 Based Injury Severity Scores

Wellington, New Zealand
29 September 2012
Holly Hedegaard, MD, MSPH
Office of Analysis and Epidemiology
Background

- Desire to develop internationally comparable indicators of injury morbidity using administrative datasets
- Decision to hospitalize can vary over time and from country to country
- A standard method to identify patients of similar injury severity level is needed
  - Consensus derived vs empirically derived
  - AIS; ISS vs DSP, “SRR”; ICISS
Diagnosis-specific Survival Probability (DSP; “SRR”)

- Determined for each individual ICD diagnosis code
- **Number of patients with a given injury code who survived**
  Total number of patients with that injury code
- Values range from 0-1

ICD-based Injury Severity Score (ICISS)

- The product of the DSPs for each injury
- \( \text{ICISS} = \text{DSP}_{\text{inj1}} \times \text{DSP}_{\text{inj2}} \times \text{DSP}_{\text{inj3}} \), etc.
- ICISS used in logistic regression models to predict probability of death
Background

- For a more accurate estimate of the DSP, a large number of observations is needed.

- At the 2008 Boston ICE meeting, researchers from several countries agreed to pool data to generate the international DSPs (ICE-DSPs).
### Contributors

- Rolf Gedeborg, MD, PhD | Sweden
- Margaret Warner, PhD | USA
- Li-Hui Chen, PhD | USA
- John Langley, PhD | New Zealand
- Pauline Gulliver, PhD | New Zealand
- Colin Cryer, PhD | New Zealand
- Yvonne Robitaille, PhD | Canada
- Robert Bauer, PhD | Austria
- Clotilde Ubeda, MD, MSc | Argentina
- Jens Lauritsen, MD, PhD | Denmark
- James Harrison, MD, MDDS, MPH | Australia
Objectives of the Study

- To develop DSPs from pooled data (ICE-DSPs)
- To compare the performance in predicting inpatient mortality of ICISS based on ICE-DSPs to ICISS based on country-specific DSPs
Methods

Seven countries provided data for creating the ICE-DSPs

- Australia
- Argentina
- Austria
- Canada
- Denmark*
- New Zealand*
- Sweden*

*Provided record level data
Methods

• The pooled data included nearly 4 million injury diagnoses
  • 1168 dx had at least 1 observation in the pooled data
  • 88% had at least 20 observations to calculate DSP
  • 66% had at least 100 observations to calculate DSP
Four methods were used to calculate ICE-DSPs using the pooled data:

- Summation
- Arithmetic means
- Trimmed means
- Combined approach

Summation method is recommended (simplest)
Methods

• For the 3 countries that provided record level data, the performance of a logistic regression model using ICE-DSP-derived ICISS to predict mortality was compared to that of a model using ICISS calculated using the country-specific DSPs

  • Discrimination: c-statistic
  • Calibration: Nagelkerke’s $R^2$
Results

- Variability among country-specific DSPs
  - Range = the difference between the highest and lowest country-specific DSPs for an injury diagnosis
Diagnoses with the **least** variability in DSPs between countries

<table>
<thead>
<tr>
<th>ICD-10 code</th>
<th>Diagnosis</th>
<th>Range in DSPs</th>
<th>Mean of DSPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>S807</td>
<td>Multiple superficial injuries of lower leg</td>
<td>0.033</td>
<td>0.974</td>
</tr>
<tr>
<td>S799</td>
<td>Unspecified injury of hip and thigh</td>
<td>0.035</td>
<td>0.979</td>
</tr>
<tr>
<td>S211</td>
<td>Open wound of front wall of thorax</td>
<td>0.040</td>
<td>0.963</td>
</tr>
<tr>
<td>T141</td>
<td>Open wound of unspecified body region</td>
<td>0.041</td>
<td>0.976</td>
</tr>
<tr>
<td>S122</td>
<td>Fracture of other specified cervical vertebra</td>
<td>0.044</td>
<td>0.954</td>
</tr>
<tr>
<td>S829</td>
<td>Fracture of lower leg, part unspecified</td>
<td>0.049</td>
<td>0.970</td>
</tr>
<tr>
<td>T149</td>
<td>Injury, unspecified</td>
<td>0.050</td>
<td>0.968</td>
</tr>
<tr>
<td>T589</td>
<td>Toxic effect of carbon monoxide</td>
<td>0.052</td>
<td>0.970</td>
</tr>
<tr>
<td>S212</td>
<td>Open wound of back wall of thorax</td>
<td>0.056</td>
<td>0.976</td>
</tr>
<tr>
<td>S141</td>
<td>Other/unspecified injuries of cervical spinal cord</td>
<td>0.064</td>
<td>0.917</td>
</tr>
</tbody>
</table>
## Diagnoses with the most variability in DSPs between countries

<table>
<thead>
<tr>
<th>ICD-10 code</th>
<th>Diagnosis</th>
<th>Range in DSPs</th>
<th>Mean of DSPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>S271</td>
<td>Traumatic haemothorax</td>
<td>0.263</td>
<td>0.940</td>
</tr>
<tr>
<td>S368</td>
<td>Injury of other intra-abdominal organs</td>
<td>0.264</td>
<td>0.925</td>
</tr>
<tr>
<td>S027</td>
<td>Multiple fractures involving skull and facial bones</td>
<td>0.294</td>
<td>0.893</td>
</tr>
<tr>
<td>T689</td>
<td>Hypothermia</td>
<td>0.294</td>
<td>0.852</td>
</tr>
<tr>
<td>S066</td>
<td>Traumatic subarachnoid haemorrhage</td>
<td>0.379</td>
<td>0.816</td>
</tr>
<tr>
<td>S361</td>
<td>Injury of liver or gall bladder</td>
<td>0.386</td>
<td>0.932</td>
</tr>
<tr>
<td>S064</td>
<td>Epidural haemorrhage</td>
<td>0.391</td>
<td>0.920</td>
</tr>
<tr>
<td>T175</td>
<td>Foreign body in bronchus</td>
<td>0.408</td>
<td>0.971</td>
</tr>
<tr>
<td>S272</td>
<td>Traumatic haemopneumothorax</td>
<td>0.411</td>
<td>0.944</td>
</tr>
<tr>
<td>S065</td>
<td>Traumatic subdural haemorrhage</td>
<td>0.539</td>
<td>0.826</td>
</tr>
</tbody>
</table>
Performance of model using ICE-DSP-derived ICISS: Data from New Zealand

N = 264,348  Inpatient Mortality Rate = 1.2%

<table>
<thead>
<tr>
<th>Factors in the model</th>
<th>C-statistic (Discrimination)</th>
<th>Nagelkerke’s $R^2$ (Calibration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICISS from NZ DSPs</td>
<td>0.876</td>
<td>0.2263</td>
</tr>
<tr>
<td>ICISS from ICE-DSPs</td>
<td>0.868</td>
<td>0.2088</td>
</tr>
</tbody>
</table>
Performance of model using ICE-DSP-derived ICISS: Data from Sweden

N=707,968  Inpatient Mortality Rate = 1.6%

<table>
<thead>
<tr>
<th>Factors in the model</th>
<th>C-statistic (Discrimination)</th>
<th>Nagelkerke’s $R^2$ (Calibration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICISS from Swedish DSPs</td>
<td>0.829</td>
<td>0.1678</td>
</tr>
<tr>
<td>ICISS from ICE-DSPs</td>
<td>0.815</td>
<td>0.1489</td>
</tr>
<tr>
<td>Age + Sex + ICISS from Swedish DSPs</td>
<td>0.877</td>
<td>0.2385</td>
</tr>
<tr>
<td>Age + Sex + ICISS from ICE-DSPs</td>
<td>0.871</td>
<td>0.2232</td>
</tr>
</tbody>
</table>
Performance of model using ICE-DSP-derived ICISS: Data from Denmark (one hospital)

N=23,449  Inpatient Mortality Rate = 10.8%

<table>
<thead>
<tr>
<th>Factors in the model</th>
<th>C-statistic (Discrimination)</th>
<th>Nagelkerke’s R² (Calibration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICISS from Danish DSPs</td>
<td>0.725</td>
<td>0.1311</td>
</tr>
<tr>
<td>ICISS from ICE-DSPs</td>
<td>0.681</td>
<td>0.0756</td>
</tr>
<tr>
<td>Age + Sex + ICISS from Danish DSPs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age + Sex + ICISS from ICE-DSPs</td>
<td>0.816</td>
<td>0.2490</td>
</tr>
</tbody>
</table>
Next Steps: International DSPs

• Are the ICE-DSPs ready for use or do they need to be further refined or tested?
  • Include out of hospital deaths?
  • Include data from more countries?
  • Create ICE-DSPs for different age groups (pediatric vs adult vs older adult)
  • Create ICE-DSPs for comorbidities?
  • Test discrimination/calibration using data from less resourced countries?
Next Steps: International DSPs

- Do we need to generate standard methods for how to use the ICE-DSPs?
  - Post the international DSPs to the web?
  - Create a toolkit on how to use?
    - Multiplicative model vs single worst injury
    - Include ICE-DSPs for comorbidities when calculating ICISS?
Next Steps: Other Considerations

• Do we continue on the path of international DSPs or do we consider other methods?
  • Excess Mortality Ratio-adjusted ISS, Kim et al, 2009
  • Trauma Mortality Prediction Model, Osler, et al, 2007
  • ICD-10 to AIS crosswalk, Haas, Nathans, et al, 2012
Questions and Discussion

Thank you!
Next Steps: International DSPs

• Should we use the ICE-DSPs to define broader injury severity categories for international comparisons (ordinal scale)?

• Should we use the ICE-DSPs to identify a “basket of injuries” that could be used when ICD-10 coded data are not available (threshold)?
Next Steps: International DSPs

- Should the ICE-DSPs be updated, and if so, how often?
  - Include the same countries each time?