Registration and analysis of traffic injuries

Wouter Van den Berghe
Research Director, Belgian Road Safety Institute

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Introduction

- Belgian Road Safety Institute

- Serious injuries
Mission: to develop, share and apply knowledge in road safety in view of reducing road fatalities and traffic injuries.

Some key figures

- Not for profit organisation, partially publicly funded
- 120 staff (25 in research)
- Turnover of some 13 million euro

Main departments

- Knowledge Centre (= Research Department) – 22 staff
- PAIR (Public Affairs, Innovation and Regulation)
- RS@W - Road Safety at Work (training, consulting, campaigns)
- Laboratories
- Driver Improvement Training
- CARA - Fitness to drive assessment
- Reintegration Assessment
The 12 research lines of BRSI

- Impact of crashes on people and society
- Nature and distribution of road crashes
- Crash causation
- Macroscopic factors in road safety
- Competences for safe behaviour in traffic
- Assessment of fitness to drive
- Behaviour of road users
- Achieving behavioural change
- Technology for road safety
- Design of safe roads
- Evidence-based road safety policy
- Effective and efficient enforcement
3 main challenges in relation to serious injuries

- Definition of ‘serious’ injuries
- Data availability and accessibility
- Estimation of the correct numbers
Criteria for the definition of a serious (traffic) injury (ITF-OECD, 2010)

- Be readily comprehensible
- Be based on diagnosis – on anatomical or physiological damage
- Ascertain the same injury diagnoses over time and between places
- Include all cases that the indicator aims to reflect, or a well-defined sample of them
- Be robust to potential or known changes/differences in coding frames or coding practice between places or over time
- Offer unbiased case ascertainment: the probability of a case being ascertained should be independent of extraneous factors
Serious injuries and the MAIS scale
What indicators to use for measuring the seriousness of an injury?

<table>
<thead>
<tr>
<th>AIS</th>
<th>AIS P</th>
<th>DALY</th>
<th>Days in hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>EISS</td>
<td>ICISS</td>
<td>ISS</td>
<td>MAIS</td>
</tr>
<tr>
<td>Medical cost</td>
<td>Mortality</td>
<td>Permanent invalidity</td>
<td>NISS</td>
</tr>
<tr>
<td>Revalidation cost</td>
<td>TMPM</td>
<td>Total cost</td>
<td>…</td>
</tr>
</tbody>
</table>
Different measures exist for the “severity” or “seriousness” of injuries

“MAIS” (and in particular MAIS3+) is becoming the “de facto” standard and policy indicator in road safety

- AIS = Abbreviated Injury Scale
- Score from 1 (minor severity) to 6 (unsurvivable severity)
- MAIS = Maximum Abbreviated Injury Scale = AIS of the most severe injury

Main reasons for using MAIS and MAIS3+

- Relatively simple to calculate
- Achievable for many countries and hence potential of comparability across countries
- Limited underregistration (almost all MAIS3+ victims are hospitalized)
"for comparison"
What is (M)AIS?

- **AIS**
  - Acronym for Abbreviated Injury Scale
  - Score from 1 (minor severity) to 6 (unsurvivable severity) per injury
  - Severity = Probability of dying
  - Used worldwide to encode the type and severity of injuries, but not used everywhere (e.g. Belgian hospitals: no AIS registration)

- **MAIS**
  - Acronym for Maximum Abbreviated Injury Scale
  - The AIS of the most severe injury
  - Seriously injured = all casualties with MAIS score of 3 or more = MAIS3+

<table>
<thead>
<tr>
<th>MAIS-scores</th>
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<tbody>
<tr>
<td>1</td>
<td>Minor</td>
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<tr>
<td>2</td>
<td>Moderate</td>
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<tr>
<td>3</td>
<td>Serious</td>
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<td>4</td>
<td>Severe</td>
</tr>
<tr>
<td>5</td>
<td>Critical</td>
</tr>
<tr>
<td>6</td>
<td>Unsurvivable</td>
</tr>
</tbody>
</table>
Examples of MAIS

Under the knee
- AIS 1: Sprained ankle
- AIS 2: Closed fracture shinbone/tibia
- AIS 3: Open fracture shinbone/tibia
- AIS 4: Amputation
Developments in Europe

› In January 2013, the High Level Group on Road Safety representing all EU Member States, established the definition of serious injuries as in-patients with an injury level of MAIS3+

› EU countries should provide data of serious injuries from 2014 on (but many have problems doing so)

› Currently, EU Member States use different procedures to determine the number of serious road injuries and use different methods
   › applying a correction on police data
   › using hospital data
   › using linked police and hospital data
   › Combinations of the above or other data

› The quality of the data differs by Member State and the numbers are not yet fully comparable between Member States.
### FERSI questionnaire (2014-2015): issues

<table>
<thead>
<tr>
<th>Country</th>
<th>Data protection / corresponding restrictions</th>
<th>Legal regulations</th>
<th>Financing</th>
<th>Cooperation between institutions</th>
<th>Other</th>
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<tr>
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## SafetyCube survey (2016): methods used

<table>
<thead>
<tr>
<th>Country</th>
<th>Correction coefficient on police data</th>
<th>Use of hospital data alone</th>
<th>Using linked / matched police and hospital data</th>
<th>Other Methods</th>
<th>Changes planned?</th>
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<tbody>
<tr>
<td>Austria</td>
<td>(2015)</td>
<td>(from 2016)</td>
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<td>Cyprus</td>
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<tr>
<td>Czech Republic</td>
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<td>Refinement of method</td>
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<td>Denmark</td>
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<td>Estonia</td>
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<td>Finland</td>
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<td>Extrapolation of the data around Lyon (Rhone registry) to France</td>
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<tr>
<td>France</td>
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<td>Refine current method</td>
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<tr>
<td>Ireland</td>
<td>x</td>
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<tr>
<td>Italy</td>
<td>x</td>
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<td>Latvia</td>
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<td>Lithuania</td>
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<td>Malta</td>
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<tr>
<td>Netherlands</td>
<td>x</td>
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<td></td>
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<td>Change from ICD9/AIS1990 to ICD10/AIS2008</td>
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<td>Improvement of reliability</td>
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<tr>
<td>Portugal</td>
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<td></td>
<td>Linking police and hospital data</td>
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<td></td>
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<td>no</td>
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<td>UK (derived from data England)</td>
<td>England only</td>
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<td>Switzerland</td>
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</table>
MAIS (and MAIS3+) becomes the (policy) indicator. But there are still many questions open, e.g.:

Are the numbers of victims and their respective MAIS levels a good predictor of:
- (in hospital) mortality
- medical cost
- duration of hospital stay
- permanent invalidity
- road safety in general
- ...?

How does MAIS relate to some other measures of severity, that might be more appropriate?

More specifically:
- Is the AIS of the principal diagnosis a good proxy of MAIS?
- Is the burden of MAIS3+ a good indicator of the total burden of traffic victims?
- What – policy relevant - information do we lose when only looking at MAIS3+?
SafetyCube deliverable with guidelines for the registration and monitoring of serious injuries
SafetyCube is a major European Commission funded project (6 million €) in order to establish a Decision Support System for policy makers in road safety.

BRSI is a key partner in the project, leads the work package on methodology and is involved in most other work packages.

Part of the project (“Work Package 7”) is concerned with “serious injuries”, in particular estimates of the actual numbers and the costs related to serious injuries.

The project will finish in April 2018, but the deliverable “Practical guidelines for the registration and monitoring of serious road injuries” will be available late September 2016.
4 Tasks within SafetyCube WP7

- Assess and improve the estimation of the numbers of serious road injuries
- Determine and quantify health impacts of serious road injuries
- Estimate economic and immaterial costs related to serious road injuries
- Identify key risk factors related to serious injuries and their health impacts
Analysis and guidelines based on case studies (Belgium, France, Spain, the Netherlands, Austria, …)

› Estimation of the number of serious traffic injuries by applying correction factors to police data.
  › *Data from Belgium, France and Austria.*

› Estimation of the number of serious traffic injuries using the linkage of police and hospital records.
  › *Data from France, the Netherlands and Slovenia*

› Determination of inclusion and exclusion criteria for hospital data.
  › *Data from Spain and The Netherlands*

› Assessing the impact of using different methods for obtaining MAIS3+ numbers
  › *Data from Spain, Belgium, the Netherlands and Germany.*
In- and exclusion criteria for hospital data records

Include

• All injury diagnoses
  • ICD9CM: 800-999
  • ICD10: S00-T88
• Injuries with the following external causes
  • ICD9CM: E810-E819, E826, E827, E829, E988.5
  • ICD10: V01-89 for those codes for traffic injuries (on public roads)

Exclude

• Fatalities after 30 days
• Readmissions/duplicate records
• Crashes on non-public roads / Non traffic injuries
Effects of different ICD versions and conversion tools (MAIS3+ casualties)

<table>
<thead>
<tr>
<th>Country / dataset</th>
<th>AIS 1998</th>
<th>AIS 2008</th>
<th>ICDmap90</th>
<th>DGT</th>
<th>ICDpic</th>
<th>AAAM9</th>
<th>ECIP</th>
<th>AAAM10</th>
<th>agu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany (GIDAS)</td>
<td>1 019 (112%)</td>
<td>909 (100%)</td>
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<td></td>
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<tr>
<td>Germany (MHH)</td>
<td></td>
<td>103 (100%)</td>
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<td></td>
<td></td>
<td>116 (113%)</td>
<td>82 (80%)</td>
<td>89 (86%)</td>
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<tr>
<td>NL (1993-2013)</td>
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<td></td>
<td>107 738</td>
<td>109 605</td>
<td>103 747</td>
<td>102 900</td>
<td></td>
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<tr>
<td>NL (2012-2014)</td>
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<td>107 738</td>
<td>109 605</td>
<td>103 747</td>
<td>102 900</td>
<td>14 384</td>
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<td>19 143</td>
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<td>Spain</td>
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<td>8 274</td>
<td>7 656</td>
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</tbody>
</table>
Recommendations with regard to conversion tools

- Multiply with a factor 0.89 when injuries are coded in AIS1990 or AIS1998 instead of AIS2005 or AIS2008
- The difference in the estimated number of MAIS3+ casualties between the ICD9cm recoding tools is at most 7%.
- The AAAM10 tool needs to be adapted to better fit European needs. It leads now to severe underestimation.
- In case less than 4 injuries are taken into account for determining the number of MAIS3+ casualties, one should correct figures
  - 1.28 in cases of 1 injury
  - 1.11 in cases of 2 injuries
  - 1.05 in cases of 3 injuries
- For truncated codes, one should use the following correction factors:
  - 1.06 in case of ICDmap90 or DGT
  - 1.03 in case of ECIP
  - 1.11 in case of AAAM9
Different types of correction factors on police data

Number of RTC in police data

Corr. factors (1)
- Observed number of RTC in hospital data (Uncorrected)

Corr. factors (2)
- Actual number of RTC in hospital data (improved selection of RTC, correction for registration flaws)

Corr. factors (3)
- Actual number of RTC in society (corrected for the number of casualties never admitted to hospital)
Model development for correction factors in Belgium
Recommendations regarding using linked/matched police and hospital data

• The most ideal variable for linking is a unique personal identification number that exist in both databases (deterministic linkage), but this information is rarely available/accessible for privacy reasons.

• In the absence of a unique identifier, probabilistic or distance based linkage is recommended. Commonly used linking variables are
  ‣ date and time of the crash (and/or date and time of hospital admittance)
  ‣ location of the crash,
  ‣ gender
  ‣ age / date of birth of the casualty
  ‣ mode of transpor

• The number of traffic casualties recorded in hospital data but not identified as such can be estimated by linking these data with police data and using capture-recapture method.
General conclusions

- The adoption of a common definition for serious injuries has given an impetus for the collection of serious injuries data throughout the Member States of Europe.
- The methodologies currently used within Europe for estimating the number of MAIS3+ traffic injuries vary considerably; they depend heavily on the data that is available.
- Several countries plan to modify their methodology in the future, the majority of them towards deterministic or probabilistic linking between police and hospital data.
- The ratio between serious injuries and fatalities varies substantially between the countries. This is probably partly due to differences in data sets and method used.
- Hospital data are essential for determining the number of serious road injuries. Even when applying correction factors to police data, at some point one needs hospital data.
- Access to hospital data is problematic for some countries, due to privacy regulations.
- Linking police and hospital data identifies the greatest number of MAIS3+ casualties.
- For monitoring purposes it may be sufficient to use a particular method, which is known to under or over report the number of seriously injured. As long as any under/overreporting remains consistent across years it will still be possible to observe important trends in serious traffic injuries.
- Further harmonisation will certainly be desirable over the next years in order to ensure that the estimated numbers of MAIS3+ road traffic injuries are comparable.
The REKOVER database in Belgium
What is REKOVER?

**Project**

- An acronym for “REgistratie en KOsten van VERkeersongevallen” (=“Registration and costs of road accidents”)
- A shared project of the Belgian Road Safety Institute and the Interuniversity Centre for Health Economics Research (I-CHER) of the Vrije Universiteit Brussel (VUB – “Free University Brussels”)

**Database**

- Linking of two administrative national databases: hospital data and health insurance data (the original aim was to link/merge as well with police data, but currently upheld for legal reasons)
- National coverage (all Belgian hospitals included, except a few private ones)
- All in-patients (detailed injury information) and outpatients (limited injury information)
Key characteristics of the REKOVER database

Covers all injured traffic victims
- in all hospitals in Belgium
- for the years 2008 to 2011
- both inpatients and outpatients

Over 600,000 cases

Limited underregistration

Detailed information
- Over 75 variables for inpatients
  - Socio-demographics
  - Diagnosis and other medical information
  - Medical costs and treatments from 1 year before the accident to one year after the crash
Examples of variables in the REKOVER database

Hospital Data (more info for inpatients than for outpatients)
- Gender, age
- Road user type (indirectly)
- Admission date and discharge date
- Diagnosis (ICD-9-CM) – used for conversion towards MAIS-scale
- Death in hospital
- ...

Health Insurance Data
- Year and month death
- Socio-economic status
- Number of days work incapacity
- Costs paid by health insurance and out-of-pocket for primary care
- Visits to specialists
- Rehabilitation
- Medication use
Overall over 600,000 traffic victims – 84% outpatients
Research topics based on REKOVER

- Analysis of the nature and distribution of the injuries of traffic victims by road user type, age, gender, etc.
- Various contributions to SafetyCube project (e.g. effect of conversion algorithms, sensitivity of inclusion/exclusion criteria, correction factors, costs, ...)
- Analysis of underreporting in police data; establishment of correction factors on police data in order to estimate the number of MAIS3+ traffic injuries
- Use of different scales to measure injury severity and implications of injuries; appropriateness of AIS scale
- Calculation of medical costs of traffic injuries during and after the crash
- Prediction of the length of stay in hospital based on crash and victim characteristics
- Etc.
Considerable underreporting in police data

*(based on the principal diagnosis only)*
Distribution by road user type: police data versus MAIS3+ (2011)

- Pedestrians and mopeds/motorcycles: same proportion
- Cyclists: 16% in police data >= 36% MAIS 3+
- Drivers and passengers of motorized vehicles: 52% in police data >= 31% MAIS 3+

Source: Statistics Belgium; BRSI; VUB; FPS Public Health
Distribution by age category: police data versus hospital data (2011)
Spearman correlation between AIS PD, MAIS, NISS and hospital duration (for people who didn’t died)

<table>
<thead>
<tr>
<th></th>
<th>MAIS</th>
<th>AIS PD</th>
<th>NISS</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIS</td>
<td>1.000</td>
<td>0.881</td>
<td>0.878</td>
<td>0.457</td>
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<td>AIS PD</td>
<td>0.881</td>
<td>1.000</td>
<td>0.723</td>
<td>0.443</td>
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<tr>
<td>NISS</td>
<td>0.878</td>
<td>0.723</td>
<td>1.000</td>
<td>0.465</td>
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<tr>
<td>Duration</td>
<td>0.457</td>
<td>0.443</td>
<td>0.465</td>
<td>1.000</td>
</tr>
</tbody>
</table>

All correlations are significant at $p < .0001$

→ MAIS is a weak indicator of duration (and hence also of medical costs)
A considerable number of traffic victims die after 30 days.

Source: FPS Public Health & IMA / Editing by BRSI and VUB
Only half of victims with MAIS6 die in hospital

Source: FPS Public Health & IMA / Editing by BRSI and VUB
More people with MAIS1 die in hospital than with MAIS5

Source: FPS Public Health & IMA / Editing by BRSI and VUB
Mortality rate by MAIS level and age category

<table>
<thead>
<tr>
<th>MAIS 1</th>
<th>MAIS 2</th>
<th>MAIS 3</th>
<th>MAIS 4</th>
<th>MAIS 5</th>
<th>MAIS 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>3%</td>
<td>9%</td>
<td>24%</td>
<td>57%</td>
<td>67%</td>
</tr>
</tbody>
</table>

Age categories:
- Black: 0-19
- Green: 20-39
- Blue: 40-59
- Gray: 60-79
- Light green: 80+
Injuries of motorcyclists due to crashes

- Analysis is based on REKOVER Database, including medical information on
  - all traffic casualties
  - in all Belgian hospitals
  - registered in 2009-2011
  - both at emergencies as staying in hospitals
- Over 38,000 records relating to motorcyclists and moped drivers
- Analysis of data has just started
- Comparisons will be made with Swedish database STRADA (2011-2013)
- No results published yet
Distribution of hospitalized PTW (Belgium 2009-2011)
Distribution of injured PTW drivers by day of the week

- **Monday**: 14% (MAIS3+), 12% (Hospitalized), 14% (Emergencies)
- **Tuesday**: 12% (MAIS3+), 14% (Hospitalized), 12% (Emergencies)
- **Wednesday**: 14% (MAIS3+), 12% (Hospitalized), 14% (Emergencies)
- **Thursday**: 12% (MAIS3+), 14% (Hospitalized), 12% (Emergencies)
- **Friday**: 14% (MAIS3+), 12% (Hospitalized), 14% (Emergencies)
- **Saturday**: 16% (MAIS3+), 14% (Hospitalized), 16% (Emergencies)
- **Sunday**: 18% (MAIS3+), 16% (Hospitalized), 18% (Emergencies)
Type of injuries of PTW admitted at the emergencies

- Contusion / abrasion / crushing: 46%
- Fracture: 17%
- Open wound: 18%
- Sprain, strain: 16%
- Luxation: 2%
- Other: 1%
More information

www.brsi.be


wouter.vandenberghe@bivv.be