Capacity Building on Maximum Abbreviated Injury Scale (MAIS) 3+

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SafetyCube

Serious Road injuries
Current practices & problems
Discussion on possible solutions

George Yannis - NTUA & Niels Bos – SWOV

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- Severity by Police and Hospital
- SafetyCube guidelines
- Problems
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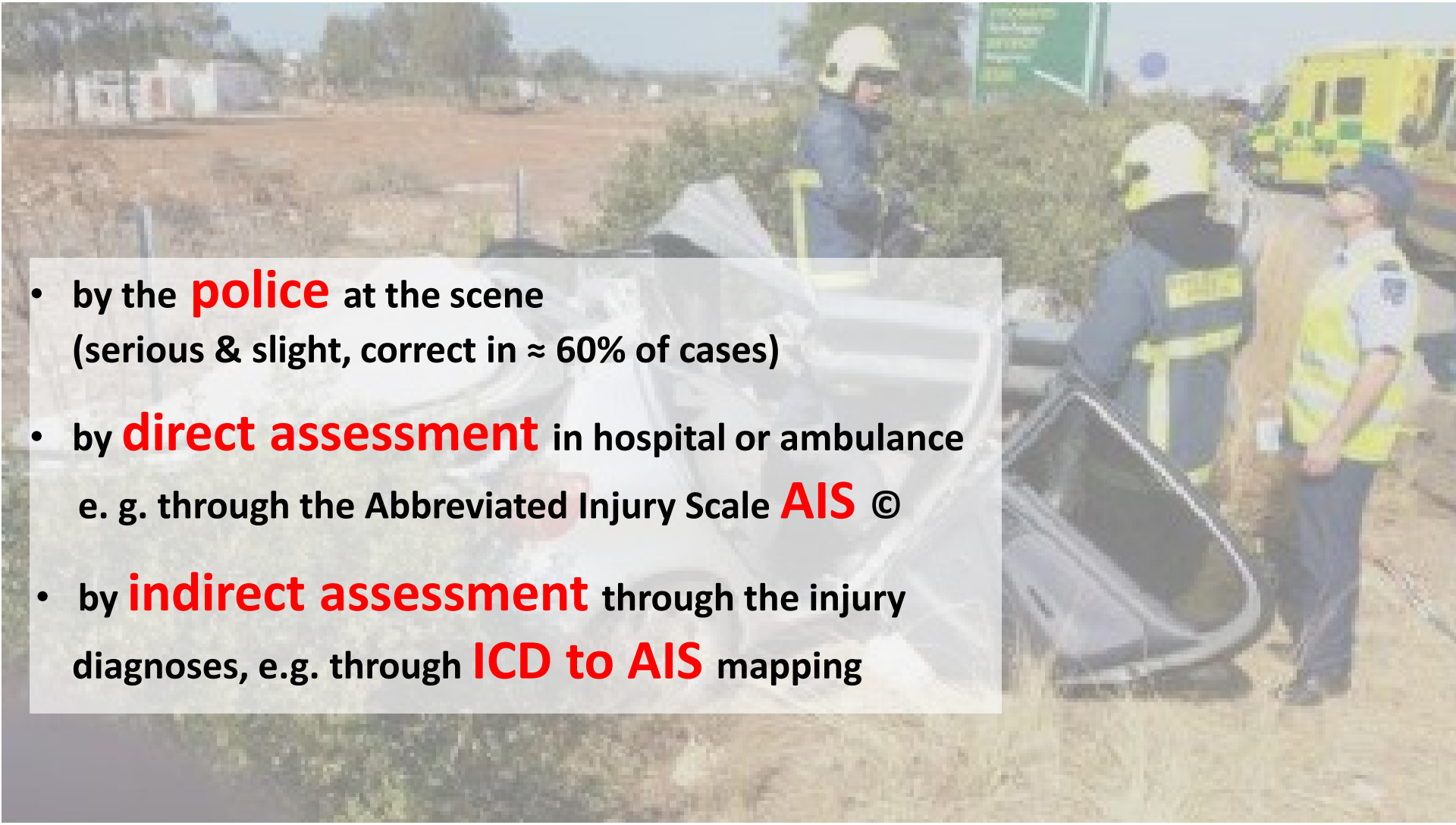
How to assess injury severity?



- by the **police** at the scene
  (serious & slight, correct in ≈ 60% of cases)
- by **direct assessment** in hospital or ambulance
  e. g. through the Abbreviated Injury Scale **AIS** ©
- by **indirect assessment** through the injury diagnoses, e.g. through **ICD to AIS** mapping

DG Move: focus on serious injuries

- Reducing the number of serious traffic injuries is a key priority in the road safety programme 2011-2020 of the European Commission (EC, 2010)
- In 2013, the High Level Group on Road Safety, representing all EU Member States, established the definition of serious traffic injuries as road casualties with an injury level of MAIS ≥ 3
- EU member states use different procedures to determine the number of MAIS ≥ 3 traffic injuries, dependent on the available data, a harmonised definition is required
- Valetta declaration (2017) targets a SI reduction by 50% in 2030 compared to 2020

SafetyCube (2015-2018)

- Three main ways Member States can report on serious traffic injuries (MAIS ≥ 3):
  1. by applying a correction on police data
  2. by using hospital data
  3. by using linked police and hospital data
- Methodological choices and data availability have an effect on the estimated number of MAIS3+ casualties
- Method 3 gives the best possible estimate; the other methods should be calibrated to produce a 'similar' result
- → Additional choices need to be made to harmonize results

SafetyCube Objectives

- Describe the **current state of collection** of data on serious traffic injuries across Europe.
- Provide **practical guidelines** for the estimation of the number of serious traffic injuries for each of the three ways identified by the High Level Group.
- Examine how the estimated number of serious traffic injuries is affected by **differences in methodology**.

SafetyCube

SafetyCube method

- Description of current and planned practices
  - *Survey among EU countries (inspired by FERSI survey)*
  - *Current practices and experiences from number of countries*
- Analysis of consequences 3 ways
  - *Application of different ways to the same data*
- Analysis of consequences methodological differences
  - *Application of different methods to the same data*

SafetyCube results

→ Practical guidelines

→ Leaflet to summarize main methodological differences and corrections to result in harmonized estimates

SafetyCube survey results
Current practice in the EU (June 2016)

- 17 of the 26 countries: MAIS ≥ 3 estimates to DG-MOVE

- Difficulties to get access to hospital discharge data

- 9 hospital data, 2 corrections to police data, and 4 record linkage of police and hospital data. France and Germany apply a combination

- The ratio of MAIS ≥ 3 casualties / fatalities differs considerably between these countries, from **0.6** MAIS ≥ 3 in Poland to **13** MAIS ≥ 3 in the Netherlands

FERSI Road Safety Research

SafetyCube

irtad International Traffic Safety Data and Analysis Group

Care Experts

Source: State of data collection on serious traffic injuries across Europe (June 2016). http://www.safetycube-project.eu

Severity Indicators

- Police can determine
  - killed on the spot (fatal)
  - transported to hospital (fatal, serious, slight)
  - treated on the spot (slight)

  Underreporting when casualties or witnesses call for medical care and do not inform police

  Follow up after transport to hospital:
  - Privacy GDPR – no detailed info from hospitals
  - Hospitalised
  - MAIS3+ cannot determined from police data
- Alternative sources: ambulance data?

Severity Indicators

- Hospital entry
  - *Treated at Accident & Emergency, Admitted (in-patient) (Trauma Register)*
  - *Admissions: detailed info is recorded however not always available for research, selection of traffic casualties can be difficult*
  - *A&E: detailed data is lacking, sometimes a sample of hospitals can be used (Eurosafe IDB)*

  Hospital Discharge Registers
  - *Even admitted casualties are often slightly injured*
  - *Increase in number of admissions for observation*
  - *Increase in day-treatment/short stay*
  - *Length of stay is decreasing (average from 15 to 5 days over last 20 years in many countries)*
  - *Detailed injury diagnosis codes can be used*

What is MAIS3+?

AIS: Abbreviated Injury Scale **BTSSLL.s**

B = Body Region
T = Type of Anatomical Structure
SS = Specific Anatomical Structure
LL = Level
S = Severity Score
Example: 419200.2 “inhalation injury NFS (heat, particulate matter, noxious agents)

Severity Score (AIS©)distribution in HDR

		fatal	survive
	Unknown	7%	7%
1.	Minor	2%	16%
2.	Moderate	8%	51%
3.	Serious	20%	17%
4.	Severe	34%	7%
5.	Critical	26%	1%
6.	Maximum	2%	<0.1%

Severity Score Examples

1 superficial laceration

2 fractured sternum

3open fracture of humerus

4 perforated trachea

5 ruptured liver with tissue loss

6 total severance of aorta

MAIS = Maximum AIS for a casualty; MAIS≥3 = **MAIS3+**

Survey on current practices (2016)

SafetyCube questionnaire of health/hospital data

- Data sources
- Inclusion criteria (e.g. outpatients, day care patients, re-admissions, scheduled admissions, fatalities within 30 days)
- Injury coding: AIS/ICD versions used
- Nr. of diagnoses & nr. of digits
- Conversion algorithm
  - *Proportion of failed transformations (ICD > MAIS)*
- Which ICD injury codes
- Which External causes
- …

AIS versions

Association for the Advancement of Automotive Medicine
http://www.aaam.org/

Versions of AIS

1985		
1990, 1998	*1200 codes*	*Direct coding in FR, DE (Rhône, Gidas)*
2005, 2008	*2000 codes*	*Direct coding in DE*

Differences: New codes (more specific), revised severity due to better data or medical improvements.

SafetyCube result: in AIS2005 the number of MAIS3+ casualties is about 10% lower than in AIS1998 or AIS1990

Recent developments: Crosswalk converting AIS1998 to AIS2005 v.v.

AIS2015: A significant number of injury descriptors were refined to better describe threat to life and impairment, and coding rules and guidelines were clarified or expanded to promote intercoder reliability

ICD9 International Classification of Diseases

- ICD9 or ICD9cm – Clinical Modification
- Injury codes: 800.xx – 999.xx approx 2.880 codes
- Countries: BE, EL, IT, NL, PT, ES
  all use the clinical modification
- Tools: 800-959
  - *AAAM9 (3x)* *to AIS2005 in AIS3+=Yes, No, Unknown*
  - *ICDpic (1x)* *to AIS1985 in AIS, BR*
  - *DGT (-)* *to AIS1998 in predot.AIS*
  - *ICDmap90 (1x) to AIS1990 in predot.AIS*

  In SafetyCube some countries applied more tools; here the official tool is shown in (*x*)
  - *New: AIS ICD ISS Map (AAAM, 2018) $500 (non-commercial use)*
    AIS 1,2,3,4,5,6 and body region to calculate ISS

ICD10 International Classification of Diseases

- ICD10 or ICD10cm – Clinical Modification
- Injury codes: S00.00 – T99.99 or S00.xxx – T99.xxx
  approx 3.900 and 17.500 codes, Left/Right, first encounter
- Countries: AT, DK, FI, HU, NL, PO, SI, UK, CH
  all ICD10, CH uses German modification, IE uses Australian modification, no country uses Clinical modification
- Tools:
  - *AAAM10 (6x)* — ***cm*** *to AIS2005 in AIS3+=Yes, No, Unknown*
  - *ECIP navarra (-)* — *to AIS1998 in predot.AIS*
  - *AGU (1x)* — *swiss, combines other variables e.g. LoS*
  - *ICDmap90 (1x)* — *after conversion to ICD9cm*

  T00-T19 (multiple injuries) are not mapped by these tools

  In SafetyCube some countries applied more tools; here the official tool is shown in (*x*)

  - *New: AIS ICD ISS Map (AAAM, 2018) $500 (non-commercial use)*
    AIS 1,2,3,4,5,6 and body region to calculate ISS

AIS to MAIS and ISS

- If any injury is AIS in (3,4,5,6) then MAIS3+
  - *So ignoring any AIS in (1,2) or 9 (unknown)*
- ISS Injury Severity Score
  - *ISS = sum of 3 severest body regions AIS - squared*
  - *E.g. ISS = $2^2 + 3^2 + 4^2 = 29$*
  - *Ranging from 1 .. 75 (any AIS=6 results in ISS=75)*
  - *Medically ISS ≥ 16 is considered Severe (AIS=4 or 3+3 or 3+2+2)*
  - *Only possible if you have AIS severity score by body region*
  - *Only sensible if more than 1 injury is provided*

How to determine MAIS3+

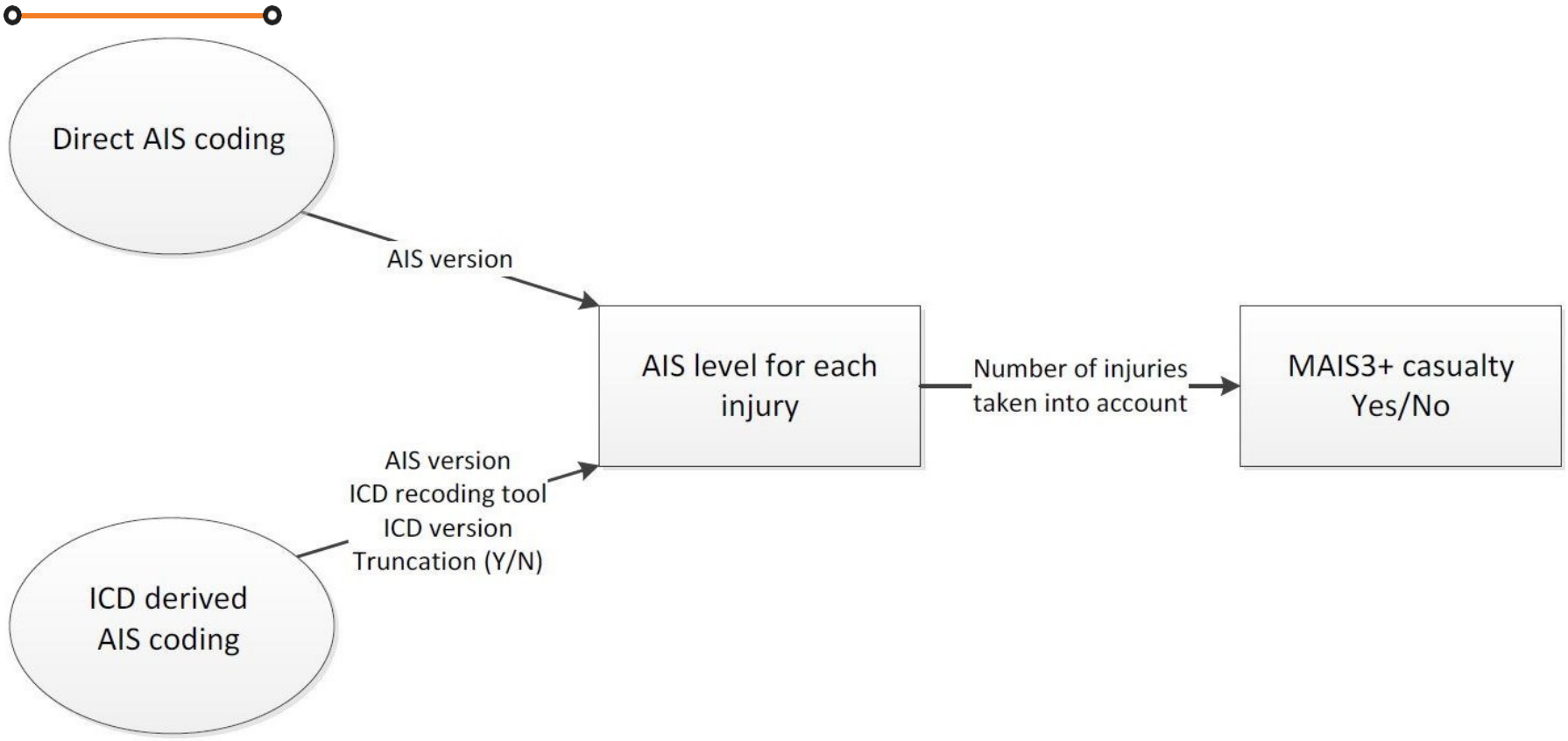


Figure 6-2 Issues related to deriving MAIS ≥ 3 that may influence the number of MAIS ≥ 3 casualties

Problems encountered

- Principle *from many codes to a more limited set*: could work
- ICD9cm → AIS2005 is ok.
  AAAM9 works well, limited info on Body regions and impossible to derive ISS for multiple injury
  solved by AIS ICD ISS Map (AAAM, 2018)
- ICD10 – AIS2005 is difficult
  - *Missing codes in the AAAM-list*
    - *many countries trunk*
    - *AAAM10 was build for CM*
    - *Some countries use Australian or German modification*
  - *The number of injuries available is limited in many countries*
  - *ECIP maps to AIS1998 and is not officially accepted by AAAM*

To check, ICD10-workarounds

- Check the mapping/join
  - *Avoid misjudgement because of leading or trailing spaces*
- Apply ECIP + Crosswalk AIS1998 → AIS2005
  - *Conversion after conversion, # of codes*
- Multiple injury (T00-T18):
  - *check that the detailed single injuries are present*
  - *If you only have a limited number of injury codes or principal diagnosis only, check that this is not a code for multiple injury*

Solutions?

- AAAM asks to report missing codes
  https://www.aaam.org/get-updates-missed-code
  So maybe this gives an opportunity to have them added?
  - *truncated codes*
  - *(older) European ICD10-codes (i.e. not clinical modification)*
- AAAM developed an additional mapping which includes the AIS-level and Body region, enabling the ISS calculation and also other severity cut-offs such as MAIS2+. see AIS ICD ISS Map (AAAM, 2018)
- Ask hospitals to map the AIS severity before they trunk the ICD-codes or limit the number of injuries delivered to you
- Develop our own indication of the severity
- If the codes are not detailed enough to specify one AIS or MAIS3+, we can opt to return a distribution over AIS instead
  - *if from observed detailed counts, it appears that for example 10% of the cases is AIS=4, 70% is AIS=3 and 20% is AIS=2, one could say that 80% of them is MAIS3+.*
  - *In order to estimate the number of MAIS3+ cases (statistically, not at the casualty record level) this may work well.*
- .....

Guidelines: correction factor on police data

WHEN:

- In case you there is no hospital data for the entire country and/or every year
- In case hospital data becomes available at a too late stage

HOW

- Use a sample of hospital data (previous years and/or part of the country)
- Derive and apply multiple correction factors
- Update correction factors on a regular basis.

Guidelines: use of hospital data (I)

WHEN:

In case hospital data of good enough quality is available and record linkage with police data is not available

HOW

Select patients with **external causes for road traffic injuries** (public road): ICD9CM: E810-E819, E826, E827, E829, E988.5; ICD10: V01-89 for those codes for traffic injuries and/or weighting -correcting for non-public road- for non-traffic injury codes

Exclude hospitalized fatalities within 30 days

Exclude readmissions (as well as scheduled admissions when they are a second episode of a previous emergency injury)

Select all cases with any **injury diagnosis** (ICD9CM: 800-999; ICD10: S00-T88; AIS injury)

In case of ICD coded injuries, **assess the severity (AIS)** of each injury using a ICD to AIS recoding tool (e.g. ICDpic, AAAM, ECIP/Navarra)

Guidelines: use of hospital data (II)

Other issues to consider with hospital data

- **External causes** (E/V-codes) may be **missing or misspecified** for many casualties. Compensate for these missing E-codes by using information from additional sources.
- Traffic Crashes happening on **public roads** should be selected.
- **Different versions of AIS:** correction factor when injuries are coded in AIS1990 or AIS1998 instead of AIS2005 or AIS2008: 0.89
- **ICD to AIS recoding tool** applied. No weighting factors could be determined. Current version of the AAAM10 (2016) tool results in a clear underestimation of the number of MAIS3+ casualties and the tool is not able to deal with truncated codes
- **Limited number of diagnoses:** can result in an underestimation. Weighting factors: 1.28 in case of 1 injury, 1.11 in case of 2 injuries, 1.05 in case of 3 injuries
- **Truncated ICD codes** result in a less reliable selection of MAIS3+ casualties. Don't use ICDpic and AAAM10 tools in case of truncated codes. Weighting: 1.06 in case of ICDmap90 or DGT, 1.03 in case of ECIP,1.11 in case of AAAM9

Guidelines: applying record linkage

WHEN:

In case the selection of MAIS3+ road traffic casualties is problematic (missing Ecodes)

In case one aims for the best possible estimate of the number of serious road injuries

HOW

Link hospital and police (and possibly other sources) on the basis of variables that are common in both data sources

Ideally, linkage is based on a unique personal identification number (**deterministic linkage**), but this is rarely available for privacy reasons

When deterministic linkage is not possible, **probabilistic or distance based** linkage is recommended.

Once the linkage is completed, the number of serious traffic casualties recorded in hospital data but not identified as such can be estimated using the **capture-recapture method**.

Comparison of different methods

- Linking of police and hospital data results in most reliable estimate, followed by use of hospital data
  - *In case you apply correction factors to police data, you should be alert to changes in police registration*
- Differences due to different in/exclusion criteria and differences in the selection of MAIS3+ casualties
  - *Missing External causes*
  - *AIS version*
  - *ICD to AIS recoding tool applied*
  - *Number of diagnoses taken into account*
- Each method is subject to limitations. The number of serious injury casualties identified should be considered an **estimate**. The biggest limitation for all methods is the quality of the data being used.

Summary of advantages and limitations of the three methods

Method	Advantages	Limitations
Correction factor applied to police Data	- Police data is commonly available in most countries - Potentially the easiest and cheapest data to obtain -Most information available about crash circumstance -In countries where police data are earlier available than hospital data, correction factors make it possible to estimate the number of MAIS≥3	- Police data do not contain injury severity. In order to generate the correction factors, access to hospital data is required. -Results are influenced by the number of items considere when deriving correction factors e.g. transport mode, age and gender. A single correction factor should not be used - Correction factors should be regularly recalculated and updated. - Each country should calculate its own correction factor - The output is only as good as the data to which the correction factor is applied - Limited information about injuries
Hospital data	-Almost all countries have hospital discharge registers at national level -More comprehensive record of injury than police data -Enables to assess the injury severity MAIS converting from injury diagnoses - More reliable than applying correction to police data	- May be difficult or expensive to obtain - Personal data protection - Cause of injury as traffic related may not be accurately recorded or missing - Relies on recording of ICD codes to AIS for MAIS≥3 calculation, which has its own limitations - Limited information about crash circumstance - Weighting factors should be applied to correct for missing data. - Not all hospitals are always included. E.g. private hospitals may not be included in the register - The reliability of injury coding in hospitals must be assumed - The number of digits used in ICD coding may be limited
Linked police and hospital data	-Most reliable estimate of the number of MAIS≥3 casualties - Detailed information available about both injuries and crashes	- Requires access to both police and hospital data - Frequently lack of personal identifiers - Affected by the limitations of both police and hospital data. - Not all cases can be matched - Often has a longer time lag than the other methods -Cases are matched based on the probability they are the same, the criteria used for this influences the probability that a match is accurate

Conclusions

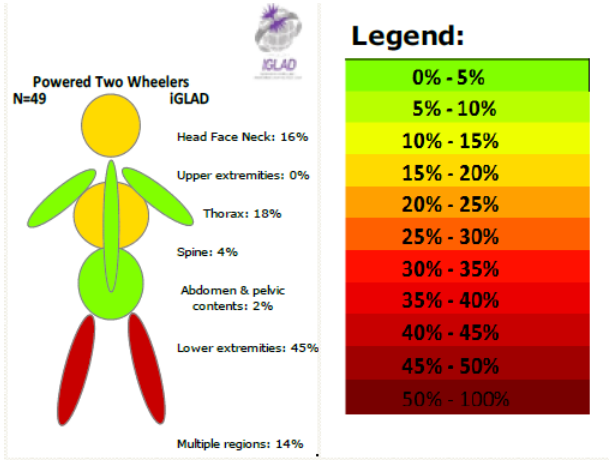
- A common definition very good, but only first step
- All three methods for estimating the number of serious traffic injuries have both **advantages and limitations**. Which method(s) to choose will depend on the context and constraints of each individual country.
- Attempts should be made to access **data of the highest quality possible**.
- Further **harmonisation of methods** over the next years is desirable in order to ensure that the estimated numbers of MAIS ≥ 3 road traffic injuries are comparable across Europe.
- At a European level **institutional collaboration** with Eurostat, WHO and DG-MOVE would improve reporting serious road traffic injuries in Europe.

Expectation after SafetyCube?

→ The MAIS3+ new methodology should yield more reliable and comparable data than the old reporting system

→ In the longer term, the Commission will be able to monitor and benchmark Member State performance

→ Also, the new data (*) shows that fatal crashes and crashes resulting in serious injury have different characteristics. This will help to see where more work is needed, such as on safety for vulnerable road users or safety in urban areas



* SUSTAIN project:
https://road-safety.transport.ec.europa.eu/document/download/af4cc578-9c16-4f26-93d1-41bab8c53f41_en?filename=injuries_study_2016.pdf

What still needs to be done?

→ Further harmonisation of methods (HLG 1,2,3) over the next years is desirable in order to ensure that the estimated numbers of MAIS ≥ 3 road traffic injuries are comparable across Europe

→Improve on mapping tools from ICD10 to AIS2005

→Ongoing research on application of the MAIS3+ Guidelines

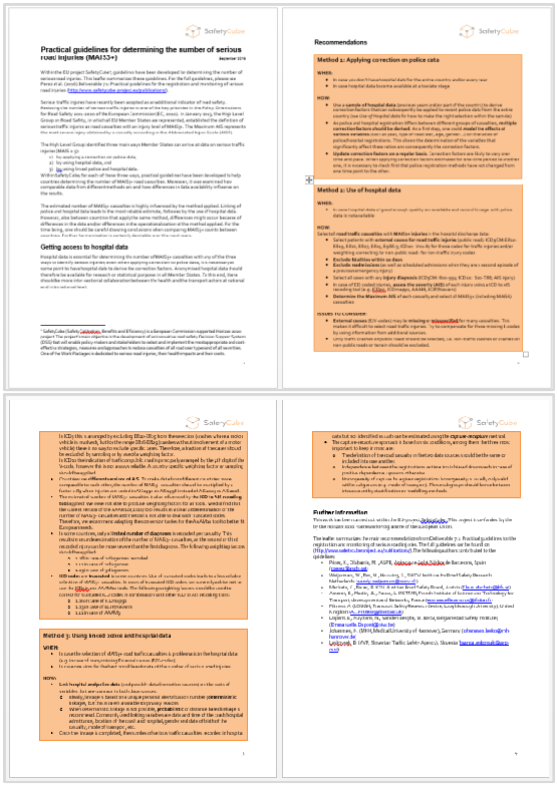
→Current status (2024)

→ERSO on Serious injuries
Facts&Figures (2023) and Thematic report (2021)

→ETSC PIN annual report (17th, 2023)

The report

The leaflet



The team

- Pérez, K., Olabarria, M. (ASPB, Agència de Salut Pública de Barcelona), Spain
- Weijermars, W., Bos, N., Houwing, S. (SWOV Institute for Road Safety Research), Netherlands
- Machata, K., Bauer, R. (KFV, Austrian Road Safety Board), Austria
- Amoros, E., Martin, JL., Pascal, L. (IFSTTAR, French Institute of Science and Technology for Transport, development and Networks), France
- Filtness, A. (LOUGH, Transport Safety Research Centre, Loughborough University), United Kingdom
- Dupont, E., Nuyttens, N., Van den Berghe, W. (BRSI, Belgian Road Safety Institute)
- Johannsen, H. (MHH, Medical University of Hannover), Germany
- Leskovsek, B. (AVP, Slovenian Traffic Safety Agency), Slovenia

http://www.safetycube-project.eu/

How to start

- Recognise the need, because police data is insufficient
- One hospital – discharge file?
  - *Accessibility (GDPR)*
  - *Injury codes and system (AIS, ICD)*
  - *Derive severity from injury codes*
  - *Select transport/traffic?*
  - *Options for fat30, re-admission, acute/planned admissions*
  - *Caption area, is the sample of hospitals representative for the country*
  - *Linking possibilities with police data (DayofBirth, date/time-accident-admission, gender, hosp/region)*
  - *Expand to more/all hospitals (with A&E)*
- Accident & Emergency departments –Trauma register
  - *Admitted, similar list*

Problems

- Access to hospital discharge data (~ Eurostat*)
- Injury diagnoses and derived severity (AAAM)
  - *ICD9cm, ICD10cm → national ICD-versions*
- Selection of Transport as external cause (E/V-codes)
  - *Selection of road accidents (public road, …)*
- Applying the SafetyCube corrections?
- Possibilities for linking to police data?
- Applying capture-recapture?
  - *accepting that there is underreporting, implicates that the intersection (linked data) can never be complete*

It is currently unknown how many countries experience problems in each of these stages (table 7 in ETSC, 2023 gives a little info)

* Unfortunately, Eurostat shows only diagnoses of the ICD10-chapters I, J, M and O, but national data providing institutes may have more data, e.g. Statistics Netherlands

Alternatives (ITF, 2011)

- Our own publication **Reporting on Serious Road Traffic Casualties**, *Combining and using different data sources to improve understanding of non-fatal road traffic crashes* is recommended to see how we came to MAIS3+, what alternatives there were and which requirements were formulated.
- Data Sources
  - *Police data, Hospital admissions data, Hospital emergency data, Mortality Registers, Forensic reports, Emergency ambulance data, Fire service, Insurance Data (vehicle, health insurance), Surveys, other, inDepth*
- Requirements 6 criteria
- Feasibility
- Possible measures
  - *various injury severity scales*
  - *length of stay in hospital*
  - *lists of particular injury diagnoses*
  - *polytrauma definition of ISS ≥ 16 is not considered as suitable since it is mostly useful for emergency doctors and requires accurate registration of more than one injury, which is difficult to obtain in road safety research.*

Criteria and Suitability (ITF, 2011)

- CHAPTER 6 Towards an international definition of a serious road injury
- 6.1. Background
  - *Aim*
  - *Constraints and Issues*
  - *Measuring severity – why threat to life?*
  - *Threat to life severity measures*
  - *Criteria for choosing a serious injury case definition*
- 6.2. Criteria for judging the 'severity' case definition
- 6.3. Suitability of AIS and derivatives
- 6.4. Suitability of ICISS
- 6.5. Suitability of Length of stay
- 6.6. Suitability of Sentinel serious injury diagnoses
- 6.7. Selection of a suitable injury measure to identify serious road casualties

For further details see Reporting on Serious Road Traffic Casualties