IMPROVING THE SWISS NATIONAL ACCIDENT STATISTICS BY PROVIDING AIS DATA TO CLASSIFY INJURY SEVERITY

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ABSTRACT

To provide more detailed data on the injury severity of persons involved in a traffic accident, Switzerland has implemented various measures. The key component was the establishment of AIS coded injury severity data. Linking the national hospital statistics to the national traffic accident statistics allowed identifying persons that were injured in a police recorded traffic accident. Using information on the diagnosis given in the hospital statistics (ICD code) the corresponding AIS code was derived. An ICD-to-AIS translator was developed, mapping the medical information to corresponding AIS codes. Since not all ICD codes correspond to a unique AIS code the translator made use of additional medical information in order to map as many cases as possible. Applying the translator to the data sets of 2011 and 2012, a MAIS could be derived for approximately 95% of all cases. Using the newly implemented procedures, it is now possible to report the share of MAIS3+ injuries sustained on Swiss roads.

INTRODUCTION

Information on the severity of injuries sustained in traffic accidents is a key factor for policy making. To develop strategies for road safety such basic data is required. While the number of traffic fatalities is usually very reliable, information on the number of surviving casualties and the severity of their injuries is of a lesser quality. To date, many countries rely on police-recorded data on the injury severity. In Switzerland and various other countries the police coarsely classifies injury severity as “not injured”, “minor injuries”, “severe injuries”, “died on the spot”, “died within 30 days” or “unknown”, respectively. The definitions when an injury is to be regarded as minor or severe are often not very precise and /or the application of the definitions is not particularly strict. In Switzerland, a person was by definition regarded as severely injured when he/she sustained an impairment that prohibits normal activity at home for at least 24h, for example, due to a stay in hospital. Practically every person that was admitted to hospital was thus regarded as severely injured independent of the duration of hospitalization which could range from a day to several weeks. Analysis of the data showed that injuries classified as severe include fairly simple fractures as well as life-threatening brain injury. With politics currently shifting their focus from road fatalities to addressing severely injured persons, more detailed information on injury severity is needed to be able to appropriately analyze this group.
To improve the data basis, the use of the Abbreviated Injury Scale (AIS) is recommended [1, 2] where "serious" injuries are generally regarded as injuries with a maximum AIS of 3 or greater (MAIS3+). Currently there is no general agreement on how such AIS data should be derived. Depending on the national data available, different approaches are pursued.
This study presents the different measures that Switzerland has implemented to improve injury severity data. The key component of this approach is the establishment of AIS coded data based on hospital statistics. The strategy how to derive AIS data along with first results is presented.

METHODS

To improve the Swiss national accident statistics, data acquisition was addressed on two levels. Generally the police will continue to record injury severity when reporting a traffic accident. Gathering all relevant information needed to investigate an accident is a responsibility of public administration. However, to improve data collection a slightly altered scheme was introduced. Furthermore, these efforts were complemented by retrospectively deriving AIS data based on the hospital statistics. An algorithm mapping ICD to AIS codes was developed and implemented.

Improved police reports

The classification of the injury severity that was used in the national police reports until the end of 2014 was coarse. It allowed differentiating the injury outcome of a person as “not injured”, “minor injuries”, “severe injuries”, “died on the spot”, “died within 30 days” or “unknown”, respectively. Given the prerequisite that injury severity data must be reported by the police, complex medical schemes are not applicable. Furthermore, practical aspects must be considered in order not to increase the administrative work load of police officers too much. Therefore it was decided to change the currently used classification scheme in police reports such that a further category was introduced. The classification “severe injuries” was replaced by the two categories “life-threatening injuries” and “serious injuries”. Similarly to countries like, for instance, Norway, life-threatening injuries should be recorded separately from all other injuries requiring medical treatment in a hospital (i.e. “serious injuries”). All other categories remain unchanged. Detailed guidelines were provided to the police, and the new national reporting system became effective on 1 Jan 2015. Based on this concept the current scheme of police reporting was slightly changed with the benefit of identifying life-threatening injuries.

ICD-AIS-Mapping

Every in-patient in a Swiss hospital is registered and the medical data related to this stay in hospital is recorded in the national hospital statistics. For each patient, the relevant data includes the main diagnosis and up to eight further diagnoses. All diagnoses are coded using ICD-10-GM, i.e. the German version of the International Statistical Classification of Diseases and Related Health Problems issued in 2008. It was decided to use the ICD codes as a basis to derive AIS codes for each person injured in a traffic accident. An ICD-to-AIS translator was therefore developed and applied to the data sample to generate a better assessment of the injury severity. Figure 1 illustrates the decision tree model that forms the basis for the translator.

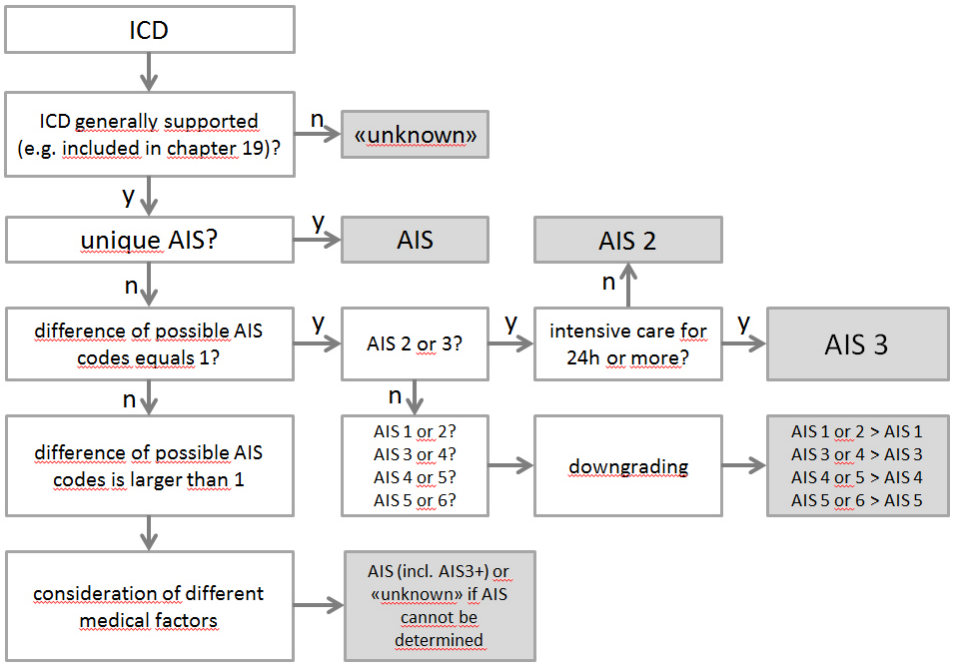

Figure1. Simplified schematic of the decision tree model used to derive AIS codes based on ICD.

Only ICD codes of chapter 19 (injuries) were considered. The translator automatically derives AIS codes for given ICD codes and then determines the patient's maximum AIS (MAIS) and the body region(s) that correspond to the MAIS. Since not all ICD codes correspond to a unique AIS code, a decision scheme also considering further medical information was developed and implemented. The most important of these additional parameters was the information whether a patient required intensive care and the duration (in hours) which a patient spent in an intensive care unit. Generally, a conservative approach was implemented; in cases where one ICD code corresponded to two possible AIS codes differing only by 1, the lower AIS code was chosen, i.e. the true injury severity was at least the chosen AIS code.

ICD chapter 19 consists of 2026 diagnoses of which 1204 were regarded relevant in the context of traffic accidents. Of these 1204 entries only 480 correspond to a unique AIS code. 215 diagnoses can be transferred to a set of AIS codes of the same severity (e.g. an ICD describing a fracture can correspond to several entries in the AIS dictionary all having the same code). Consequently these 215 diagnoses result in the same AIS. For a further 229 ICD codes several options of AIS coding exist where the difference of these AIS codes is only 1. Using a conservative approach, the lower of two possible codes was chosen. The remaining 280 ICD codes can be mapped to AIS codes of different severity. The ICD code for concussion, for instance, can correspond to AIS codes ranging from 1 to 5 depending on the duration of unconsciousness, whereas this duration is mostly unknown in the available medical data set.

Based on (a) the official handbook for hospitals how to record data for the national hospital statistics, (b) the results of a first correlation between injury severity and the length-of-stay in hospital [3] and (c) considering the characteristics of the Swiss health system it was assumed that a more severe injury most likely results in a longer stay in intensive care. Hence, cases in which an ICD code can correspond to a range of AIS codes and in which the patient did stay in intensive care for more than 24h, the AIS is most likely AIS3 or more. These cases were therefore translated into a code called AIS3+, i.e. the AIS is expected to be at least AIS3. If the duration on an intensive care unit was below 24h, the AIS code was downgraded. The introduction of the code "3+" also reflects the fact that there is a particular political interest in identifying the number of MAIS3+ victims.

Data sources

The Swiss national hospital statistics and the national traffic accident database were used. While the accident data base is continuously updated, unfortunately the hospital statistics linked to the accident data can only be provided annually and – due to administrative processes – it is only available with a delay of two years, i.e. in 2014 the hospital data of 2012 were made available. To improve injury severity data for road traffic accidents, it is necessary to match both available databases. The accident data formed the basis of this approach such that the hospital statistics was checked whether it included a person registered in the accident statistics. As there is no unique identifier that allows matching personal data, different criteria (such as age and postal code) were used to link the two data sets. Matching of the data was performed by the Swiss Federal Statistical Office. For this study the data sets of 2011 and 2012 were made available.

RESULTS

The national traffic accident statistics for 2011 and 2012 include a total of 113’240 and 112’598 cases, respectively. In the corresponding hospital statistics 4’277 and 4’123 cases, respectively, were identified that could be matched with traffic accident data (Table 1), i.e. these persons received treatment as in-patients in a hospital after being injured in a road traffic accident. As can be seen from Table 1, the police-reported injury severity does not match well with the cases identified in the hospital statistics. There are, for example, some cases in which the police records indicated that a person was not injured, although the person was actually treated as in-patient in hospital.

Table1.
Number of cases available in the accident and hospital statistics.

	2011		2012	
Injury severity according to police reported accident data	**Number of cases in traffic accident data base**	**Number of these cases identified in hospital data (ICD available)**	**Number of cases in traffic accident data base**	**Number of these cases identified in hospital data (ICD available)**
not injured	83’510	321	83‘647	301
minor injuries	18’805	1’898	18‘016	1‘780
severe injuries	4’437	2’022	4‘202	1‘998
died on the spot	195	0	217	4
died within 30 days	125	35	122	33
unknown	6’168	1	6‘394	7
total	**113’240**	**4’277**	**112‘598**	**4‘123**

The ICD-to-AIS translator was applied to determine the MAIS code for all cases identified in the hospital statistics. Table 2 summarizes the results, i.e. it shows the distribution of AIS code for cases which could be considered by the ICD-to-AIS translator. The score 3+ indicates cases in which the MAIS could not be established clearly, but the medical data suggests that the injury severity was at least MAIS 3. Using the translator it was possible to assign a MAIS code to approximately 95% of the cases for which ICD codes were available; for the remaining cases no MAIS was derived.

Table2.
MAIS codes that were derived based on ICD data.

	2011	2012
MAIS	**Number of cases**	**Number of cases**
0	14 (0.3%)	19 (0.5%)
1	610 (15.0%)	587 (15.0%)
2	2’523 (61.9%)	2’355 (60.1%)
3	362 (8.9%)	349 (8.9%)
3+	521 (12.8%)	563 (14.4%)
4	5 (0.1%)	8 (0.2%)
5	19 (0.5%)	20 (0.5%)
6	1 (0.0%)	0 (0%)
unknown	22 (0.5%)	18 (0.5%)
total	**4’077 (100%)**	**3’919 (100%)**

As shown in Table 2, the distribution of MAIS codes is very similar for both years investigated here. Approximately 76% of the persons injured in traffic accidents sustained an MAIS1 or MAIS2 injury while approximately 23% sustained in MAIS3+ injury.

The potential of the improved injury severity data is illustrated in the following example. In Table 3 the injury severity for different kinds of two-wheelers is compared (inclusion criteria: injured person was driver, ICD diagnosis was available). The example demonstrates that more detailed information is now available thanks to AIS-based injury severity data. It can be observed that the number of injured e-bikers increased between 2011 and 2012, but the MAIS distribution of injured e-bike users seems very similar to injured cyclists. Also the MAIS distribution for motorbike users is similar to the bicyclists and e-bikers, but there are clearly more cases with MAIS 4 and MAIS 5 injuries.

This data can now be used as a basis for a more detailed analysis of the injury outcome and thus provides a better foundation for policy making. In addition the newly established data provides details such as injured body regions. Depending on the research question, it can, for example, be analyzed which body region is responsible for the corresponding MAIS. While it seems not particularly helpful to present a summary table simply counting all injured body regions, it can be interesting to define specific research questions and investigate possible correlations between injury severity and injured body regions. With more data becoming available in future, such an analysis seems highly promising with respect to investigating a possible shift in injury outcome due to various measures to reduce the accident or injury risk, respectively.

Table3.
Example: MAIS data for different kind of two-wheelers.

MAIS	bicycle				e-bike				motorbike			
	2011		2012		2011		2012		2011		2012	
	n	%	n	%	n	%	n	%	n	%	n	%
0	1	0.2	1	0.2	0	0.0	0	0.0	3	0.3	0	0.0
1	47	7.5	33	5.1	3	5.1	4	5.4	102	8.9	113	10.3
2	435	69.2	428	66.5	43	72.9	50	67.6	722	62.9	664	60.6
3	58	9.2	66	10.2	4	6.8	7	9.5	147	12.8	134	12.2
3+	85	13.5	111	17.2	9	15.3	12	16.2	149	13.0	171	15.6
4	1	0.2	2	0.3	0	0.0	0	0.0	2	0.2	2	0.2
5	0	0.0	2	0.3	0	0.0	0	0.0	13	1.1	10	0.9
6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
unknown	2	0.3	1	0.2	0	0.0	1	1.4	10	0.9	1	0.1
total	**629**	**100.0**	**644**	**100.0**	**59**	**100.0**	**74**	**100.0**	**1148**	**100.0**	**1095**	**100.0**

DISCUSSION

To obtain more information on the injury severity of persons injured in traffic accidents, the Swiss national accident statistics were improved by establishing MAIS data. Today Switzerland is thus one of the few European countries providing AIS-based information on the injury severity of road traffic victims. This represents a significant improvement as such data allows a more detailed analysis of the outcome of traffic accidents.

The ICD-to-AIS translator that was developed for this purpose worked well. Besides ICD codes, also information such as the duration of intensive care was used to map the codes. Eventually the algorithm allowed assigning a MAIS code to approximately 95% of all cases. Limitations of this process include the fact that hospital statistics cover in-patients only. Currently this limitation seems acceptable as the focus is on MAIS3+ injuries which generally require treatment at a hospital. For research purposes it would, however, be interesting to add AIS based information for other patients. Mapping data from a national accident insurance database could be one option to obtain this additional data.
Furthermore it must be noted that not all ICD codes can be uniquely mapped to AIS codes. This requires implementation of certain strategies in the ICD-to-AIS translator. Of course, general strategies such as downgrading a code introduce a bias towards a more conservative estimation. Applying such rules consistently also ensures comparability of data from different years.
The introduction of MAIS3+ as a further category could be regarded as a further limitation. However, given the general interest in MAIS3+ injuries, this procedure resolved the problem of not being able to assign a unique AIS code in some cases without having to make use of further assumptions in the medical data.

A more general problem is the fact that the hospital data is currently only available with a time delay of two years. Procedures should be improved such that the medical information becomes available more rapidly. On the other hand, this highlights the necessity to also improve the police-recorded injury severity data since this data is continuously available. The introduction of a further category “life-threatening injury”, which became effective in 2015, is considered to represent an important step in this context. Future analysis will investigate how well this

category matches with AIS-based data and to which extent the police-recorded data correlates to ICD-derived AIS data.

In addition to the injury severity, the MAIS derived from ICD codes also offers the possibility to locate the body regions that were injured. This represents an interesting information which was not available in the past. Depending on the research questions, additional information with respect to changes in injury patterns can thus be retrieved.

In summary, it was shown that the implementation of an ICD-to-AIS translator allows generating injury severity data with a high relevance for policy making and research. Switzerland has established a national scheme to derive detailed injury severity data and has thus set a well-founded basis for future accident statistics.

CONCLUSIONS

ICD-to-AIS mapping was introduced on a national level which improves the available information on injury severity significantly. Injury severity data is essential to evaluate the performance of measures to improve traffic safety. Estimates of the potential benefit of safety technologies or any other preventive measure can thus be improved.

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