Review of Swedish experiences concerning analysis of people injured in traffic accidents

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Preface
This report concerning the Swedish road traffic accident information system STRADA was commissioned by the Belgian Road Safety Institute (BRSI).

The report is largely based on information provided by the Swedish Transport Agency. Primary contact persons were Khabat Amin and Marie Skyving.

At VTI, Astrid Linder was responsible for defining the aim, structure and scope of the report. Christian Howard performed the information and data gathering and was responsible for writing the report.

Linköping, January 2014

Christian Howard
Quality review

Internal peer review was performed on 17 January 2014 by Jenny Eriksson. Christian Howard has made alterations to the final manuscript of the report. The research director of the project manager, Astrid Linder, examined and approved the report for publication on 20 January 2014.

Kvalitetsgranskning

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Review of Swedish experiences concerning analysis of people injured in traffic accidents
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Summary
This report commissioned by the Belgian Road Safety Institute (BRSI) provides a review of Swedish experiences concerning the national road traffic accident information system STRADA (Swedish Traffic Accident Data Acquisition). STRADA contains information on accidents occurring in the Swedish road transport system as reported by the police, and medical data on persons injured as reported by the hospitals. By combining data from two sources, the STRADA system can provide more comprehensive information on both the circumstances and the consequences of road traffic accidents.

The aim is to provide a review of accident and injury data in STRADA, including methods for collecting, sharing and analyzing the data. The primary focus is on the injury data provided by the hospitals and how these can be used in conjunction with police data. Furthermore, the aim is to describe the organizations involved in maintaining and developing the STRADA system.

Information about STRADA was compiled mainly from material provided by the responsible authority – The Swedish Transport Agency. In addition, a literature review was performed in order to identify examples of how hospital data has been used in different projects.

The main results provided in this report are descriptions of how the STRADA database is structured and what data are available, how the police and hospitals collect data, and how the data are made available to various stakeholders. A number of examples of how hospital data has been used in various projects are also provided.
Sammanfattning

Denna rapport framtagen på uppdrag av Belgisch Instituut voor de Verkeersveiligheid (BIVV) ger en översikt av nyttjandet av informationssystemet STRADA (Swedish Traffic Accident Data Acquisition). STRADA innehåller information om olyckor som sker i det svenska vägnätet, som inrapporteras av polis, samt medicinsk data om personskador, som inrapporteras av sjukhus. Genom att kombinera dessa två källor kan STRADA tillhandahålla omfattande information om såväl omständigheterna som konsekvenserna av trafikolyckor.

Syftet är att ge en översikt av olycks- och skadeinformationen i STRADA, samt de metoder som används för datainsamling, tillhandahållande av data och dataanalys. Huvudsakligt fokus är informationen om skador som sjukhusen tillhandahåller och hur denna kan användas tillsammans med polisens information. Vidare är målet att beskriva de organisationer som är inblandade i att underhålla och utveckla STRADA.

Fakta om STRADA har sammanställts främst utifrån material framtaget av den ansvariga myndigheten Transportstyrelsen. Därtill utfördes en litteraturstudie för att ge exempel på hur sjukhusinformation har använts tidigare i olika projekt.

De främsta resultaten i denna rapport är beskrivningar av hur STRADA-databasen är strukturerad och vilka data den innehåller, hur polis och sjukhus samlar in informationen och hur data görs tillgängligt för de olika aktörerna. Ett antal exempel på hur sjukhusinformation har använts i olika projekt hittills ges också.
1 Introduction

STRADA (Swedish Traffic Accident Data Acquisition) is a national information system containing data on traffic accidents and injuries occurring in the Swedish road transport system. The data is based on two separate sources: traffic accident reports provided by the police, and medical reports provided by the hospitals that are part of the STRADA system. By combining data from two sources, more detailed descriptions of traffic accidents and their consequences can be provided. In particular, the hospitals’ reporting of diagnoses broadens the knowledge of injuries sustained and their degree of seriousness. Furthermore, because the police have limited knowledge about certain types of road traffic accidents (mainly those including unprotected road user such as pedestrians, cyclists and moped drivers), including hospital data decreases the total number of unrecorded cases. Conversely, the police reports often contain information that is not available in the hospital reports, for instance, information regarding specific traffic elements and the circumstances of an accident.

The Swedish Transport Agency is the authority responsible for STRADA. Nationwide reporting to STRADA by the police has been carried out continuously since 2003 (early trials of the system began in 1999). Hospital reporting to STRADA has increased gradually from 29 hospitals in 2003 to 68 hospitals in 2012 (Sweden has around 80 hospitals in total). According to the Swedish Transport Agency, the goal is that STRADA should encompass all hospitals that have emergency wards with orthopedic or other surgical capabilities. Currently, 69 hospitals in Sweden fulfill this criterion. This means that only one single hospital remains to be included to reach the established goal.

This report provides a summary of Swedish experiences of using STRADA in the analysis of persons injured in road traffic accidents. This includes both information about the STRADA system as well as lessons learned through its implementation and use. The report has the following structure: Section 2 states the aim of the study. Section 3 presents the methods used for data gathering. Finally, Section 4 provides the results of the study. This includes descriptions of the information found in the STRADA database, the organizations involved and their methods for collecting data, and how STRADA data can and have been used. Section 4 concludes with a discussion on the benefits of having two separate data sources through the police and hospital reports.
2 Aim of the study

The aim of this study is to provide a review of Swedish traffic accident and injury data in STRADA, including methods for collecting, sharing and analyzing the data. The main focus is on the injury data provided by the hospitals and how these can be used in conjunction with data provided by the police. The aim is also to describe the organizations involved with STRADA and their respective roles in developing and maintaining the system.
3 Methods

Information about the STRADA system was compiled primarily from material provided by the Swedish Transport Agency. This includes information available on their web site and through the STRADA user web system, STRADA user manuals, and PowerPoint presentations. Contact persons at the Swedish Transport Agency were Marie Skyving and Khabat Amin. They provided answers to questions not covered – and clarifications to any ambiguities – in the material provided (primarily through email contact). Other sources include reports published by The Swedish Road Administration - the authority previously responsible for STRADA, and the STRADA database itself which was provided by the Swedish Transport Agency in the form of an MS Access file.

Section 4.4.3 contains a list with examples of projects that have used STRADA hospital data. This list was compiled mainly by performing web searches in Transguide (a Swedish portal for transportation projects and research), TRID, Scopus, Web of Science, as well as Google and Google Scholar. The words used in the search were “STRADA”, “hospital” and/or “medical” (both in English and in Swedish, using the words “STRADA” “sjukhus”, “sjukvård” and “medicinsk”). Some reports were also found by visiting authority’s web sites and by speaking to researchers at VTI.
4 Results

This section provides the results of the study, beginning with an overview of the STRADA database’s structure and contents. This is followed by a description of the organizations involved, methods for collecting and sharing data, and documented uses of STRADA hospital data. The section ends with a brief discussion on the benefits of having two data sources.

4.1 Description of STRADA - Swedish Traffic Accident Data Acquisition

The STRADA database contains information concerning road traffic accidents and injuries, as reported by the police and the hospitals. The database is hierarchically structured and consists of eight primary data tables: three tables with police specific data, two tables with hospital specific data, and another three tables containing data found in both the police and hospital reports (note that the actual database contains additional tables, but only the ones available and relevant for the user are presented here). The database is also linked to national registries containing information on vehicles and driver’s licenses that are registered in Sweden. These data are organized in two additional separate tables. Table 1 provides an overview of the different data tables found in STRADA.

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both police and hospital</td>
<td>Accident</td>
<td>Used to match police reports with hospital reports.</td>
</tr>
<tr>
<td></td>
<td>Report</td>
<td>Accident information available in both police – and hospital reports.</td>
</tr>
<tr>
<td></td>
<td>Road</td>
<td>Information on the road where the accident occurred.</td>
</tr>
<tr>
<td></td>
<td>TrafficElements</td>
<td>Information on specific traffic elements (e.g., vehicles) involved in the accident.</td>
</tr>
<tr>
<td></td>
<td>Person</td>
<td>Information on specific persons involved in the accident.</td>
</tr>
<tr>
<td>Hospital</td>
<td>HospitalReport</td>
<td>Hospital specific information on accident, person and hospital care.</td>
</tr>
<tr>
<td></td>
<td>Injury</td>
<td>Information on specific injuries sustained.</td>
</tr>
<tr>
<td>External registries</td>
<td>PersonInfo</td>
<td>Driver’s license information.</td>
</tr>
<tr>
<td></td>
<td>VehiclleInfo</td>
<td>Vehicle information.</td>
</tr>
</tbody>
</table>

An important distinction between police and hospital reporting is that the police produce one report per accident, whereas the hospitals produce one report per person. Note that although the Report table contains data from both types of reports, each report
produces a separate entry in this table (the information is kept separate). That is, for a specific police report, some information in the report (e.g., date and location) is added to the Report table (with a unique id) and some is added to the PoliceReport table and the other police specific tables (using the same unique id as in the Report table).

Analogously, for a specific hospital report, some information (again, e.g., date and location) is added to the Report table (with its own unique id, regardless if there is a police report describing the same accident) and some is added to HospitalReport and the other hospital specific tables. Thus, no matching of reports is performed when the data is entered in the system and all report data, both police and hospital, is available in the database (matching is performed at a later stage using the Accident table, see Section 4.1.3). The unique id given to all reports consists of two numbers denoted ExtendedReport_id and report_id. Figure 1 depicts the structure of the tables presented.

![Figure 1](structure-of-the-strada-database-including-examples-of-value-fields.png)

**Figure 1** Structure of the STRADA database including examples of value fields.
4.1.1 Police data

Police reporting became mandatory nationwide in 2003. Currently, STRADA contains data from close to 190,000 police reports (excluding early reports filed before 2003, source: STRADA database dump 30 August, 2013). The information available in a report can be divided into three categories: accident (tables: Report, PoliceReport) traffic element (tables: TrafficElements, VehicleInfo) and person (tables: Person and PersonInfo). The accident category includes all data regarding the circumstances of the accident. That is, data such as the date, location, weather – and road conditions, as well as a classification of the type of accident that has occurred. The traffic elements refer to the motor vehicles (or cyclists, pedestrians etc.) that are involved in the accident. The role that each element played in the accident is registered and a police sketch describing the course of events is also available in the database.

A traffic element can have one or more persons linked to it. The police classify each person involved in a traffic accident as either slightly injured, severely injured, or killed. The driver of a vehicle can also be classified as uninjured, but passengers that do not sustain any injuries are generally not included in the police report.

Table 2 provides an overview of police information that can be found in the STRADA database. Note in Table 2 that only the person’s age, not the date of birth, is available to the user (however, person identification numbers including the date of birth are stored internally in the database). Furthermore, note that the police only register if a driver of a traffic element is suspected of being influenced by alcohol. No further details on alcohol or drug influence are available. Regarding the passenger’s position in the vehicle, the police mainly register this information for cars. For most other types of vehicles (such as bicycles, motorcycles and busses) the field is marked as “irrelevant” or “unknown”.
Table 2 An overview of the main police information available in STRADA.

<table>
<thead>
<tr>
<th>Category</th>
<th>Field</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident</td>
<td>Date and time</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>(Police’s description of what happened)</td>
</tr>
<tr>
<td></td>
<td>Light condition</td>
<td>Daylight, twilight, dark</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>GPS coordinates, road, municipality</td>
</tr>
<tr>
<td></td>
<td>Place elements</td>
<td>Traffic light, give way sign, lighting</td>
</tr>
<tr>
<td></td>
<td>Place type</td>
<td>Crossing, bridge, tunnel</td>
</tr>
<tr>
<td></td>
<td>Road state</td>
<td>Dry, wet, ice</td>
</tr>
<tr>
<td></td>
<td>Sketch</td>
<td>(Depicting the course of events)</td>
</tr>
<tr>
<td></td>
<td>Speed restriction</td>
<td>30, 50, 120 km/h</td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>Single vehicle, frontal collision, side collision</td>
</tr>
<tr>
<td></td>
<td>Weather condition</td>
<td>Clear, rain, fog</td>
</tr>
<tr>
<td>Traffic element</td>
<td>Type</td>
<td>Car, motorcycle, pedestrian</td>
</tr>
<tr>
<td></td>
<td>State</td>
<td>Reversing, overtaking, walking with traffic</td>
</tr>
<tr>
<td></td>
<td>Suspected alcohol</td>
<td>Yes, no, unknown</td>
</tr>
<tr>
<td></td>
<td>Vehicle details</td>
<td>Make, model, weight</td>
</tr>
<tr>
<td>Person</td>
<td>Age</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Driver</td>
<td>Yes, no, unknown</td>
</tr>
<tr>
<td></td>
<td>Injury extent</td>
<td>Slightly injured, severely injured, killed</td>
</tr>
<tr>
<td></td>
<td>Passenger position</td>
<td>Front seat, back seat, irrelevant</td>
</tr>
<tr>
<td></td>
<td>Reference number</td>
<td>(Anonymized id to distinguish persons)</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>Male, female, unknown</td>
</tr>
</tbody>
</table>

4.1.2 Hospital data

STRADA currently contains data from just over 340,000 hospital reports (excluding early reports filed before 2003, source: STRADA database dump 30 August, 2013). There is no national policy mandating hospital reporting, the decision whether a hospital reports to STRADA is made locally (see Section 4.2.3 for more information on hospital reporting).

The hospital reports are centered on the person seeking medical care, as opposed to the police reports that are centered on the traffic accident. Consequently, the hospital reports feature more detailed information on a person’s medical state and less information about the actual accident. STRADA contains information on the position and severity of each injury. Measures of injury severity include:
1. Abbreviated Injury Scale (AIS-2005 from 2007, AIS-1990 before 2007). Measures the severity of each injury on a scale from one (slight injury) to six (untreatable usually fatal injury).
2. Maximum AIS (MAIS). The highest AIS-score out of all injuries.
3. Injury Severity Score (ISS). A summarizing measure of a person’s injuries. Is calculated as the sum of the three highest AIS-scores squared in different body regions. Thus, for the three highest scores A, B and C, ISS = A² + B² + C², with a maximum value of 75 (if one of the AIS-values is equal to 6, ISS is automatically set to 75).
5. Functional Capacity Index (FCI). Measures the person’s level of function after sustaining an injury on a scale one to five.

AIS classification is available for essentially all injuries registered in STRADA (over 99% of all injuries have an AIS-value assigned to them, STRADA database dump 30 August, 2013). In 2007 the system switched to the AIS-2005 standard from the AIS-1999 standard. A nurse uses a handbook on AIS-classification to register the AIS-values based on the medical information available. The ISS and MAIS-scores are generated by the system automatically based on the AIS-values entered (see Section 4.2.3 for more information on hospital registration). Similarly to AIS, ICD classification is available for essentially all injuries (over 99%), while FCI reporting began in 2010 and is available for about 33% of the total amount of reports. This means that all measures mentioned above, except FCI, are available for essentially all patients.

Based on the same categories used in the previous section, Table 3 provides an overview of the type of hospital information that is available in the STRADA database. Note in Table 3 that GPS coordinates are often obtained by locating the site on a map based on the patient’s description of where the accident occurred (see Section 4.2.3 for more details). Furthermore, it is noteworthy that possible alcohol or drug influence is not registered in STRADA by the hospitals (variables for influence were initially used in the database, but have been removed following low usage by the hospitals). Also note in Table 3 that similar to the police data, the person’s position in the vehicle mainly applies to cars.
Table 3  An overview of the main hospital information available in STRADA.

<table>
<thead>
<tr>
<th>Category</th>
<th>Field</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident</td>
<td>Date and time</td>
<td></td>
</tr>
<tr>
<td>(Report, HospitalReport)</td>
<td>Description</td>
<td>(Patient’s own description of what happened)</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>GPS coordinates, road, municipality</td>
</tr>
<tr>
<td></td>
<td>Road state</td>
<td>Dry, wet, ice</td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>Single vehicle, frontal collision, side collision</td>
</tr>
<tr>
<td>Traffic element</td>
<td>Patient was</td>
<td>In a car, on a motorcycle, a pedestrian</td>
</tr>
<tr>
<td>(HospitalReport)</td>
<td>Patient collided</td>
<td>With a car, with a bus, with a tree</td>
</tr>
<tr>
<td>Person</td>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>(HospitalReport, Injury)</td>
<td>Care</td>
<td>Sent home, admitted, length of hospital care</td>
</tr>
<tr>
<td></td>
<td>Care location</td>
<td>Which hospital, clinic, ward</td>
</tr>
<tr>
<td></td>
<td>Injury extent</td>
<td>AIS, MAIS, ISS</td>
</tr>
<tr>
<td></td>
<td>Injury position</td>
<td>Head, arms, external</td>
</tr>
<tr>
<td></td>
<td>Position</td>
<td>Driver, passenger front seat, irrelevant</td>
</tr>
<tr>
<td></td>
<td>Protection</td>
<td>Seat belt, helmet, air bag</td>
</tr>
<tr>
<td></td>
<td>Reference number</td>
<td>(Anonymized id to distinguish persons)</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>Male, female, unknown</td>
</tr>
</tbody>
</table>

4.1.3  Report matching and handling of duplicate items

The police and hospitals use separate systems for reporting to STRADA. Therefore, there is no simple way to directly link a police accident report to one or several hospital reports. However, to provide such information, an algorithm that matches reports to specific accidents is used within the STRADA database. The criteria for matching two reports are that the person identification numbers are the same, the accident times differ no more than 24 hours, and that the accident locations are within a 1,000 meter radius. If a match is successful, all reports that are believed to be linked to the same accident are given a unique accident number. This number is stored in the Accident table along with an estimate of the quality of the match (referred to as the Q-value). This quality estimate is based on the differences in time and location and ranges from zero to 100 (the higher the better).

The threshold Q-value is 65. That is, if the Q-value is higher or equal to 65, the reports are considered successfully matched. Around 30% of all hospital reports (persons) filed from 2003 and onwards have been matched with a police report (STRADA database dump 30 August, 2013). Conversely, around 40% of all police reports have at least one hospital report matched to them. The possible reasons for an unmatched report are numerous. For a person in a police report, for example, the hospitals may have missed to register the person involved, or the person might not have sought medical attention at a hospital linked to STRADA, or not sought medical attention at all. For a person in a hospital report, many cases involving unprotected road users never come to the police’s
attention, or the police may have missed to register the person for some other reason. Another possible reason for an unsuccessful match is that one of the reports contains incorrect information regarding the location or time of the accident.

When two reports have been matched, the database still maintains all information from both reports (the only difference is that their respective report id’s now are linked to the same accident number in the Accident table). This means that users with access to database dumps (see Section 4.4.2) can choose which data to use in cases of discrepancies between the police and hospital reports. Because the Q-values are available as well, these users can also choose a higher level of match quality than 65 if needed. Users that extract data through the STRADA web-based client (see Section 4.4.1) are more restricted regarding certain choices, for example, the match quality level is automatically set to 65. However, these users also have access to both the police and hospital reports enabling them to choose the source that best suits their purpose.

In some cases the hospitals produce multiple reports for the same person and accident. This occurs, for instance, when a person is transferred between hospitals. To avoid duplicates in the database, it is only the hospital that first received the patient that reports to STRADA. As an additional safeguard, the Swedish Transport Agency performs monthly checks to find and remove any duplicate hospital reports.

4.2 Description of organizations involved and methods for collecting data

In 1996 the Swedish government commissioned the Swedish Road Administration to develop a new information system for accidents and injuries in the Swedish transport system. The system, which would later become the STRADA system, was to encompass the entire process, from data gathering to making the data available on both a local and national level. In 2010 the Swedish Road Administration was merged with several other government agencies and became the Swedish Transport Administration. The year before, the responsibility for STRADA was shifted to the Swedish Transport Agency, where it remains today.

4.2.1 The Swedish Transport Agency

The Swedish Transport Agency is responsible for maintaining and developing the STRADA system. Within the agency, the unit directly responsible is the Statistics and Analysis unit, which currently has 12 employees. This responsibility includes gathering data from the police and the hospitals, data registration to the STRADA database, maintenance and quality control, as well as making the data available to various stakeholders. However, the main responsibility for analyzing the actual data and producing the official yearly accident statistics which are based on STRADA, lies with another agency – Transport Analysis. Note that the official statistics are currently based only on the police reports, although a supplemental report containing the hospital data is published alongside the official statistics.

4.2.2 Police

The Swedish police consists of 21 regional agencies which are coordinated by the National Police Board. In 2003 it became mandatory for all 21 regional agencies to report to STRADA, thus ensuring nationwide coverage. The Swedish Transport Agency estimates that currently around 17,000 police reports are added to STRADA each year. The police does not receive any additional funding for the registration in STRADA.
The police are directed to report any road traffic accident involving personal injury. The exact routines for reporting vary between different regional agencies, but generally most accident data (see Table 1) is gathered directly at the accident site. This includes the severity of personal injuries. Once a report has been produced, the police (or civilian police employees with STRADA training) add the information to STRADA themselves through a web-based client provided by the Swedish Transport Agency. To decrease the risk of incorrect user input, the client provides drop down menus and boxes for entering the data. The accident location is marked on a map using a GIS-based mapping system (an example of the user interface is provided in Figure 2). Using the mapping tool, a sketch of the accident can also be produced directly in the client (Figure 3).

![Figure 2 Example of the mapping tool’s user interface (source: STRADA User Guide for Police Web Client version 3.2.0).]
4.2.3 Hospitals

Hospital participation in the STRADA system is voluntary. The hospitals that choose to participate receive funding from the Swedish Transport Agency. The funding consists of a fixed amount that covers costs for meetings, training and materials, and a variable amount per report filed. The fixed amount is 30,000 SEK (≈ 3,400 EUR) per hospital and year. The variable amount consists of four parts:

2. Quality bonus 1: 25 SEK (≈ 3 EUR) extra per report filed within 45 days.
3. Quality bonus 2: 25 SEK (≈ 3 EUR) extra for each report that includes the accident location.
4. Scale bonus: 50 SEK (≈ 6 EUR) extra per report if the hospital files 1,000 reports or more per year.

According to the Swedish Transport Agency the amount of bonuses paid out varies from hospital to hospital, with no further details provided at this time. The hospitals typically have 2-3 nurses employed with the responsibility of registering data in STRADA. The Swedish Transport Agency estimates that currently around 40,000 hospital reports are added to STRADA each year, though this number has been increasing constantly as more and more hospitals are added to the system.

The number of hospitals that are included in the system has gradually increased from 29 hospitals in 2003 to 68 hospitals in 2012 (Sweden has around 80 hospitals in total). According to the Swedish Transport Agency, the goal is that STRADA should encompass all hospitals that have emergency wards with orthopedic or other surgical capabilities. Currently, only one single hospital remains to be included in order for this goal to be achieved. This means that the STRADA system today includes almost all larger hospitals that are likely to receive patients injured in road traffic accidents. However, the system will never achieve full coverage as this would require that all
facilities that may encounter road traffic injuries (such as hospitals without emergency wards, local primary care units, health centers, private practices etc.) report to STRADA, which is not deemed feasible by the Swedish Transport Agency. Though no estimates on the number of missing cases are available, the Swedish Transport Agency is currently running trials of connecting primary care facilities in sparsely populated areas of Sweden to STRADA. The reasoning behind this is that people in these areas have a longer traveling distance to the nearest hospital and are therefore more likely to visit their local primary care unit for treatment of non-severe injuries.

The hospitals are directed to report to STRADA any persons seeking emergency care because of an accident occurring in the traffic environment. Information is registered in the STRADA database through a web-based client similar to the police client. Registration requires consent from the patient, and the patient provides most of the information about the accident herself by filling in a standard form. The exact routines vary between hospitals, but usually a nurse is available if help is needed to fill in the form. In some cases a nurse may also ask for additional information if the patient has neglected to fill in certain fields, but in other cases these fields are simply marked as “unknown”.

The nurse responsible for STRADA at the hospital registers the patient form data together with additional medical data in the web client. The medical data is gathered from the hospital’s internal information system (consisting of journal notes from the doctor, ambulance reports, x-ray scans etc.). For the classification of injuries, the web-based client provides a graphical interface with a depiction of the human body (example in Figure 4). Each injury is marked in the appropriate position and the type and severity of the injury is entered. AIS-values are entered using an AIS-classification handbook by the Association for the Advancement of Automotive Medicine (AAAM). MAIS and ISS-values are generated automatically based on the AIS-values. The location of the accident is marked using the same GIS-mapping system that is used by the police. However, unlike the police who can often use GPS devices at the accident site, the hospitals have to rely on the patient’s own accounts of where the accident occurred. The accident location is then marked on a map in the web client and the GPS-coordinates are generated automatically. In some cases, ambulance reports are also available to help with determining the location of the accident.
4.3 Quality of data, missing data and other problems

The police and The Swedish Transport Administration perform in-depth investigations whenever a person is killed in a road traffic accident. As a result the number of persons killed is generally deemed to be accurate. When it comes to the police classification of slightly or severely injured persons, comparisons between police and hospital data (Larsson and Björketun, 2007) indicate that the police reporting can be inaccurate in many cases. Understandably, the hospitals are better equipped to assess personal injuries.

The quality of the hospital data entered in STRADA is difficult to establish, as no studies investigating these issues appear to be available at this time. In general, the location data and accident positioning are deemed less accurate compared to those obtained by the police. As mentioned previously, this is because the hospitals often have to rely solely on the patient’s own accounts in order to obtain these data. The Swedish Transport Agency is also currently investigating reports of shortfalls in the number of cases being reported by some STRADA hospitals. However, no further details on this are available at this time. Reporting to STRADA requires the patient’s consent, but the Swedish Transport Agency estimates that only a small number (less than 1%) choose not to be registered.

Concerning the analysis of hospital data, it is important to note that the number of hospitals has increased gradually since STRADA was initiated. Thus, when performing any type of time series analysis one must take into account the increase in reported cases due to the increase in hospitals. To help with this analysis, the Swedish Transport
Agency provides a list of dates when each hospital entered the STRADA system on their web site.

4.4 How to use crash and injury data from STRADA

The Swedish Transport Agency offers two main ways of gaining access to the data in the STRADA database: either through a web-based client, or through a so-called database dump. To gain access to either of these methods, the Swedish Transport Agency requires that one becomes a registered user and participates in a one day course about the STRADA system. This is to ensure that the system as well as its data are used correctly. The STRADA services provided by the Swedish Transport Agency are free of charge for Swedish organizations such as VTI. International requests are handled on a case by case basis.

The system currently has around 1,300 users. The majority of users are persons working with traffic questions locally, on a municipal level.

4.4.1 Web-based data client

The web-based data client provides a graphical interface where the user can search for data based on geographical region, municipality, road and authority responsible for the road (Figure 5).

Figure 5 Example of the graphical user interface in the web-based client (figure captured from STRADA web client 11 November 2013).
In addition to geographical location, data selection can be performed based on a range of criteria, for example, time interval, type of accident, traffic elements, place type, injury severity, person age and sex. All available options are chosen by ticking the appropriate boxes in the user interface. One can also choose whether to include police reports, hospital reports or both. Furthermore, it is possible to search only for reports that have been matched to an accident by the STRADA system. When searching for hospital reports it is also possible to choose a specific hospital and to specify injury position and severity (AIS). Once a selection has been made, the reports are plotted on a map (Figure 6). The user can then choose to select and open a specific report, or export summarized data to Excel.

![Figure 6. A selection of matched police and hospital reports on motor vehicle accidents in the Stockholm region (figure captured from STRADA web client 11 November 2013).](image)

The strength of the web-based client lies in its graphical interface and its ease of use. However, the user is limited to extracting data based on predetermined alternatives. This may be too limiting for some users who want to perform analysis based on their own selection criteria. Limitations in computational capabilities also makes the client more suitable for analyzing smaller areas and less suitable for extracting large data sets, for instance, on a national level. For these reasons the Swedish Transport Agency also provides access to database dumps.

### 4.4.2 Database dumps

The Swedish Transport Agency offers database dumps in the form of a MS Access database file containing all relevant report data up to the current date. The data are
organized in the tables described in Section 4.1. This allows for data selection and analysis of the user's own choosing.

Figure 7 provides an example of an Access query of the STRADA database. This particular query extracts the yearly number of male and female car drivers, respectively, with at least one AIS2-level (that is, MAIS2+) injury, involved in head-on collisions with another car (STRADA database dump 30 August, 2013).

![Example of an Access query using the Report and Hospital report data tables.](image)

**Figure 7 Example of an access query using the Report and Hospital report data tables.**

4.4.3 Projects that have used STRADA hospital data

This section provides a list with examples of projects that have used hospital data from STRADA. For each entry, the title, affiliation and year, as well as a brief summary of the purpose is given. The entries are ordered according to year and title. Because all reports are written in Swedish, English translations are given here. Complete references in Swedish are available in Section 5.3.

Looking at the list of projects, it is noteworthy that most of them are focused on unprotected road users. Furthermore, the analyses of injuries are based around the AIS classifications and mainly the resulting ISS. The interpretations of ISS vary, but typically a person with an ISS of 16 or higher is categorized as *very severely injured*, 9-15 as *severely injured*, 4-8 as *moderately injured*, and 1-3 as *slightly injured*. In some cases, fewer categories are used, for example, *severely injured* for a score of 9 or higher, and *slightly injured* for a score below 9. None of the projects have used the ICD or FCI classifications that are also available in STRADA.
   Investigates why some people survive traffic accidents where someone else in the vehicle was killed. STRADA is used to identify accidents containing both fatalities and survivors (using police reports and hospital reports matched by the STRADA system). The injury classifications (AIS, ISS) in the hospital reports are used when studying the severity of injuries.

   Analyzes the accuracy of police reporting, both in terms of response rate and injury classification. Hospital reports are compared to police reports to identify discrepancies. The hospital reports are also used to identify accidents that have not been reported by the police. The main results are that the calculated nonresponse factors (expansion factors) vary with the type of accident and road user, injury severity, and type of environment. Notably, the factors used for cyclist accidents occurring without the involvement of motor vehicles should have significantly higher nonresponse rates. That is, these types of accidents are significantly underreported by the police. Furthermore, the results show that the police’s reporting of injury severity can vary significantly from the hospital’s reporting. It was found that only 35% of those classified as seriously injured by the police were deemed seriously injured by the hospitals. However, note that these results are based on accident data from 2003 to 2005, when the STRADA system was relatively new and few hospitals were connected to STRADA. No other, more recent, studies on this subject have been found.

   Provides an overview of traffic accidents occurring in Region Väst (a region in the west of Sweden) in 2006. Hospital data provides information on unprotected road users, and ISS is used to describe the severity of injuries.

   Describes the accident and injury situations associated with cyclists. Uses the accident descriptions provided by the patients to map the events leading up to the accidents, as well as ISS-scores from the hospital reports. The results show that single accidents were the most common accidents among cyclists (accounting for around 70% of all injury cases). The biggest contributory causes for these accidents were slippery surfaces due to snow and ice, and loose gravel or grit from winter maintenance. Furthermore the study indicates that male and female cyclists are at equal risk of being injured in traffic.

5. **Injured pedestrians. A focus on highway maintenance procedures through analysis of hospital registered data from STRADA.** *VTI* (2011).
   Describes the causes of pedestrian accidents with focus on deficiencies in road maintenance and operation. Hospital data is used to identify injury severity (ISS) and where the accidents occurred.
   Provides a brief overview of the frequency and severity of single-pedestrian accidents in Skåne (a region in the south of Sweden) between 2006 and 2010. The work is based entirely on the hospital data, including frequencies of different types of injuries, ISS and the patients’ own accounts of what happened.

7. **Injured pedestrians – the cost of pedestrian injuries compared to winter maintenance costs.** *VTI* (2012).
   Studies the importance of which authority or association is responsible for winter road maintenance. Compares pedestrian injury costs to the costs of winter maintenance. Hospital data (ISS and the length of hospital admission) is used to calculate the cost of injured pedestrians.

   Conducts a study on the use of helmets in three different Swedish cities. Hospital reports are primarily used to determine the frequency of helmet use in bicycle accidents. The report focuses on the frequency – not on the utility – of helmet use.

   Presents a comprehensive review of data on bicycle accidents occurring in Sweden between 2007 and 2012. The analyses are based around the STRADA hospital reports, where many factors (for example, AIS, MAIS, ISS, accident descriptions, person age and sex) are included.

    Yearly statistical report containing data tables with compiled hospital data.

    Provides a brief overview of the frequency and severity of single-bicycle accidents in Skåne between 2007 and 2011. Part of the same project as entry 6 in this list. Thus, the work is also based entirely on the hospital data, including frequencies of different types of injuries, ISS, and the patients’ own accounts of what happened.

    Analyzes how bicycle accidents can be avoided and how resulting injuries can be alleviated. Studies injury position, AIS, ISS, accident causes, as well as helmet use for single bicycle accidents registered in STRADA by the hospitals. The primary focus is on cyclists that have been killed or seriously injured. The results show that the majority (around 80%) of cyclists in need of emergency treatment were involved in single accidents. The most common reasons for the accidents were operation and maintenance, road design or cyclist-bicycle interactions. Furthermore, head injuries were the cause of death in 70% of the single accidents, and were also dominant among seriously injured cyclists.

4.5 **Benefits of having two data sources**

The two data sources have different advantages. The police have better possibilities to position and describe the circumstances of an accident, while the hospitals can determine the personal injuries sustained and their degree of seriousness. The hospital
data also includes a wider scope of accidents, with more cases involving unprotected road users. This is partly because many of these accidents never come to the police’s attention, but also because the police and the hospitals have different criteria for what should be reported. The police report road traffic accidents involving personal injury. For example, pedestrian falling accidents do not fit this criterion. The hospitals, however, report persons seeking emergency care because of an accident occurring in the traffic environment, which does include pedestrian falling accidents.

The different advantages of the police and hospital data suggest that there are benefits to be reaped by combining the two data sources. However, as indicated by the selection of projects in Section 4.4.3, it appears that most projects using hospital data have mainly focused on the unique elements of that data set. That is, most projects thus far have focused on pedestrians and cyclists. One possible explanation for this is the lack of nationwide coverage for the hospital reporting. If this is the case, given that all but one of the desired hospitals today report to STRADA, one might expect to see more projects combining the two data sources in the future.
References and contact details

For complete traceability, the references in Section 5.2 and Section 5.3 are given in Swedish (with English titles in brackets). The authorities mentioned previously have the following Swedish names:

- The Swedish Transport Agency – Transportstyrelsen
- The Swedish Road Administration – Vägverket
- The Swedish Transport Administration – Trafikverket
- Transport Analysis – Trafikanalys.

Contact persons at the Swedish Transport Agency

Amin, Khabat – Database manager STRADA. Borlänge.

Skyving, Marie – Regional coordinator of STRADA. Stockholm.

Sources used to compile information on the STRADA system


Transportstyrelsen (2013). *STRADA Användarhandledning för sjukvårdswebb version 3.3.0* [STRADA User Guide for Hospital Web Client 3.2.0].


References to Section 4.4.3


The Swedish National Road and Transport Research Institute (VTI), is an independent and internationally prominent research institute in the transport sector. Its principal task is to conduct research and development related to infrastructure, traffic and transport. The institute holds the quality management systems certificate ISO 9001 and the environmental management systems certificate ISO 14001. Some of its test methods are also certified by Swedac. VTI has about 200 employees and is located in Linköping (head office), Stockholm, Gothenburg, Borlänge and Lund.