APOLLO: The economic consequences of injury

Final report

Project-team
Suzanne Polinder [1]
Hidde Toet [2]
Saakje Mulder, project leader [2]
Ed van Beeck, project leader [1]

[1] Erasmus Medical Center, Department of Public Health, Rotterdam, the Netherlands
[2] Consumer Safety Institute, Amsterdam, the Netherlands

Project group
Robert Bauer/Georg Nossek, Austria
Bjarne Laursen, Denmark
Marc Nectoux, France
Janis Misins, Latvia
Hidde Toet/Martien Panneman, the Netherlands
Eleonora Paixão, Portugal
Petra Nadrag/Mateja Rok Simon, Slovenia
Steven Macey, UK-Wales

Expert committee
Ronan Lyons, United Kingdom
Robert Bauer, Austria
Maria Segui Gomez, Spain
Marc Koopmanschap, the Netherlands

APOLLO: The economic consequences of injury

Final report

Acknowledgements
APOLLO is a project that is co-sponsored by the European Commission DG SANCO under the Public Health Programme 2003-2008, Grant Agreement nº: SCP.2004119. The project aims to identify strategies and best practices for the reduction of injuries within the EU and is led by the Centre for Research and Preventing of Injuries (CEREPRI) of the University of Athens.

The subproject "The economic consequences of injury" is part of APOLLO Work Package 2 (The burden of injuries in the EU: indicators and recommendations for prevention and control) and was co-ordinated by the Consumer Safety Institute, Amsterdam, the Netherlands.

Amsterdam, September 2008

Contents

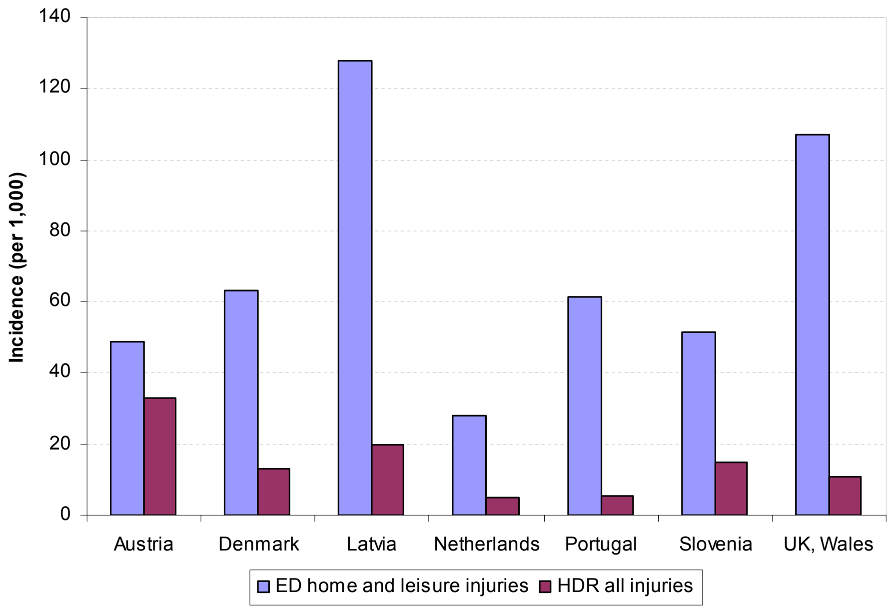
Summary

Recently (2001-2004) within the framework of a project named EUROCOST, a uniform injury based method to calculate medical costs of injury was developed and applied to ten EU countries. This method allowed calculation of medical costs of injury by sex, age, external cause and type of injury at country level and EU level. Within the current project (as part of APOLLO) the methodology as developed in the EUROCOST project was used to support EU countries in calculating the direct medical costs of injury, by developing a manual, guidelines and electronical tools and making this method available on the internet.

In the current project, named APOLLO, seven EU countries participated in a pilot study on the use of the digital EUROCOST instrument. Participating countries were the Netherlands, UK-Wales, Austria, Denmark, Portugal, Slovenia and Latvia. Data processors from the working groups of these countries received a ‘hands-on’ training on how to compute direct medical costs of injury with their country specific databases using the online EUROCOST instrument. The instrument was tailored for implementation with the most common standardized data sets in the EU, the ICD based hospital discharge data (for all injuries) and the ICE-CI based IDB data (Emergency Department data for home and leisure injuries). This pilot study provided information on convenience of using the instruments autonomously and furthermore additional and/or updated data on injury costs in European countries. Participating countries made new country specific calculations on the direct medical costs of injury themselves with the available tools based on the most recent available data.

The incidence of home and leisure injury varied most substantial between countries (see figure 1) and was highest in Latvia and lowest in Austria, Slovenia and the Netherlands. Hospital inpatient rates (see figure 1) were highest in Austria and lowest in the Netherlands and Portugal. Mean costs per injury patient were highest in Austria and lowest in Latvia. The mean average costs of the participating countries per injury patient was €2,685. Of all injury groups spinal cord injuries caused the highest costs, followed by fractures of the femur shaft and hip fractures. Lowest cost were caused by complex soft tissue injury and dislocation/sprain/strain of the hip.

Figure 1 ED incidence of home and leisure injuries and HDR incidence of all injuries by country (per 1,000 person years)



Finally this report provides information about indirect costs of injury. These are societal costs that are indirectly caused by illness and disability. Indirect costs of injuries generally refer to productivity costs (lost wages). Productivity costs are the monetary value of productivity lost and/or the costs incurred to maintain productivity as a result of workers illness and or treatment. Guidelines towards calculating productivity costs due to injuries are developed and basic data requirements for estimating lost productivity are described. The guidelines involve three steps, namely identification of cost categories, measurement of utilization, and valuation in monetary terms.

1. Introduction

1.1 Introduction

The injury field is very dynamic (specific problems may almost instantaneously rise or return) and heterogeneous (several causes may lead to a wide variety of injury types, ranging from minor to life-threatening). Therefore, priority setting (i.e. addressing those problems with the most urgent need to implement interventions at a specific moment) is extremely important for policy makers within this area to efficiently reduce the national burden of injuries. Priority setting is preferably based on a set of reliable indicators of population health, including information on the medical costs of injury. Information about costs is an important supplement to epidemiological data, such as the incidence and mortality rates. High costs involved in a certain injury category and/or age group are an argument for policy makers to put extra effort in injury prevention addressing this problem. Recently, within the framework of the EUROCOST project, a uniform injury based method to calculate medical costs of injury was developed and applied in 10 European countries (*1, 2*). This method allows the calculation of medical costs of injury by age, sex, external cause and type of injury at country level and EU level. Moreover, due to several harmonization procedures, meaningful international comparisons of injury incidence and costs can be made.

1.2 Description of the project

Comparisons of the economic impact can be made by assessing the direct medical costs of injury. A model for the assessment of direct medical costs of injury has already been developed and implemented in a number of European countries within a project called EUROCOST (*1*). In 2006 a project called 'The economic consequences of injury' started as part of Work Package 2 of the APOLLO project. This new project elaborates on the EUROCOST project (see boxes 1-2).

The methodology developed by the EUROCOST project, including the steps to further harmonize the surveillance data, has been used within this APOLLO-project to support EU countries to calculate new direct medical costs of injury.

Box 1

The EUROCOST project, funded by the EC, started in 2001 and ended in 2004.

The main objectives for EUROCOST were:

1. To collect, analyse and harmonise data on: injury incidence, health care consumption, unit costs of health care products (ED attendance, hospital inpatient day).
2. To estimate the medical costs in ten European countries by means of a uniform methodology. Several countries had made their own calculations on medical costs of injury before, but all making their own choices on the inclusion criteria and methods used. This led to confusing and incomparable information.
3. To explore the possibilities for the assessment of international differences in the medical costs of injury in relation to the underlying variation in demography, epidemiology and health service organisation between countries.

see box 2 on conclusions based on the EUROCOST project.

Box 2

Major conclusions of the EUROCOST project

- Costs of injury are a valuable indicator of population health, quantifying the combined effects of the incidence and severity (in terms of health care consumption) of injury.
- International comparisons of injury incidence and costs are well possible, and should account for surveillance system bias and cost model bias.
- Injuries, and home and leisure injuries in particular, are a major source of hospital costs in Europe and should be a priority area in public health policy in all European countries.
- International variation in injury costs can for a large part be explained by real differences in price level and injury incidence between the participating countries, and only partly be explained by variation in registration and health care systems. However, inadequate extrapolation of ED data towards national level is still a possible source of variation in injury incidence and costs.
- Finally, this EUROCOST model marks the first step towards calculating the direct medical costs of injury for countries in the European Union following a uniform injury based method.
- Also, the further development and harmonization of EU-wide injury surveillance, namely the EU Injury Data Base (IDB), is strongly encouraged in order to provide a standardized input of injury data for calculating the direct medical costs for a variety of external causes.

Information on the EUROCOST project is available in two reports:

- Meerding, W.J., H. Toet, S. Mulder, E.F. van Beeck, et al., A surveillance based assessment of medical costs of injury in Europe: phase 1. 2002, Consumer Safety Institute: Amsterdam. **>** http://www.euroipn.org/grd/attachments/23/Final%20Report.pdf
- Polinder, S., W.J. Meerding, H. Toet, M.E. van Baar, et al., A surveillance based assessment of medical costs of injury in Europe: phase 2. 2004, Consumer Safety Institute: Amsterdam. **>** http://www.euroipn.org/grd/attachments/80/Final%20Report.pdf

The two objectives of this APOLLO project were:

- Making electronical tools available to support EU countries, including the new member states, in assessing direct medical costs of injury with a uniform methodology.
- Exploration of methods and data to support EU countries, including the new member states, in assessing indirect costs of injury with a uniform methodology.

While in the EUROCOST project the research team applied the developed method of harmonization of data and calculation of direct medical costs on a number of countries, in the APOLLO project EU countries had to apply the EUROCOST method (collection, harmonisation and analysis of data on injury incidence and related healthcare consumption and costs calculations) themselves by making use of developed guidelines and tools.

The second objective focused on the indirect costs of injury. The economic costs of disease generally are divided into direct costs within the health care sector, direct costs outside the healthcare sector, indirect costs within the healthcare sector and indirect costs outside the healthcare sector (see box 3). Apart from direct medical costs of injury, indirect costs are among the major economic consequences of injury (*3*). Indirect costs outside the healthcare system mainly exist of productivity costs. Therefore, in chapter 4 we will focus on productivity costs. Productivity costs are the monetary value of productivity lost and/or the costs incurred to maintain productivity as a result of workers illness and or treatment (*3*).

Box 3
Cost categories
The costs associated with injuries can be divided into three main categories: direct, indirect and intangible. Direct costs may be characterized as medical or non-medical. Direct medical costs of injuries generally refer to the expenses of treating acute injuries and the sequelae of untreated or inadequately treated acute injuries. Direct medical costs can include costs such as clinical services, diagnostic tests, and medications. Other expenses associated with receiving medical treatment, such as the cost of transportation to and from medical services, are classified as direct non-medical costs. Indirect costs of injuries generally refer to productivity losses (lost wages) attributable to injury related illness. The indirect costs represent the economic consequences of injuries beyond the health care sector, resulting from absence from work, disability and death. Intangible costs of injuries are related to the pain and suffering associated with injuries, but they are difficult to quantify and are seldom included in cost calculations.

Involvement of countries in the project
The project was led by the Dutch Consumer Safety Institute and the Erasmus Medical Center. This project team released guidelines and tools for computing direct medical costs of injury and made an inventory of data sources for measuring indirect costs of injury.
Ten European countries originally participated in the study in the role of data processors. These data processors had to collect, harmonise and analyse the data systems and calculate direct medical costs of their country themselve with help of the developed guidelines and tools, and report results to the project team. For the selection process of which countries of the EU-25 should participate in the project we were limited to countries having hospital discharge and emergency department registers available. The availability of a national hospital discharge register was a prerequisite for participation. Those countries with operational and representative emergency department registers were given high priority in the selection process.
The following countries participated in the project: Austria (AT), Denmark (DK), France (FR), Latvia (LV), Netherlands (NL), Portugal (PT), Slovenia (SI), UK-Wales. These countries represent the geographical and economical variation between the EU-25 countries. Initially also Italy and Malta participated in the project, but they were unable to attend the instruction workshop and could not be convinced to calculate direct medical costs for their country. Participating countries also involved in the EUROCOST-project (Austria, Denmark, Netherlands, UK-Wales) calculated the direct costs of injury for their country again with more recent available data and the use of the developed tools.

Model for calculating direct medical costs
A injury based model for the assessment of direct medical costs of injury had already been developed and implemented for ten European countries (*1, 2*). The model was based on hospital-based surveillance systems (Injury Data Base, IDB and Hospital Discharge Register, HDR). The model excludes data on hospital outpatient care, non-institutional care, nursing homes and rehabilitation institutions, ambulance transport and medicine use. Therefore, costs only include ED costs and inpatient hospital costs.
A modular approach towards estimating injury incidence, health care consumption and direct medical costs by external cause had been used, because not all countries had similar data available for all external causes. Two minimum sets were defined with incidence data from all countries: ED incidence of home and leisure injury (Minimum set I), and hospital admitted unintentional and intentional injuries (Minimum set II).

Material development

To make this model workable for other European countries the following materials were developed:

- Guidelines with an explanation of the methods for the data analysis of surveillance data
- Electronic tools for the data analysis have been made:
- Scripts/syntaxes to analyse and further harmonize ED and HDR data bases
- Scripts/syntaxes for aggregating and coupling/merging ED and HDR data
- Scripts/syntaxes for calculating direct medical costs

Questionnaire on data quality

A Questionnaire was developed to get an overview of the data systems that could be used (baseline model minimum sets and modules) and information that was available (in the data systems) by country with respect to incidence (accident groups, injury groups) health care consumption (cost elements, healthcare sectors) and unit costs of health care.

- The project team calculated comprehensive unit costs for Emergency Department visits and hospital stay per country.

Workshop

A workshop was given in the Netherlands (Amsterdam, June 25th and 26th 2007) to provide a hands-on training to the data processors of the participating countries on how to compute direct medical costs of injury with their country data bases.

With a questionnaire for the data processors the applicability of the methodology was evaluated. Results of this interim evaluation have been finalised after all participating countries delivered their results and experienced the use of available guidelines and tools.

Data analysis countries

All participtaing countries collected, harmonised, analysed new data and calculated costs themselves based on the most recent available data.

A methods and results chapter has been developed by the project team with predefined tables.

The data processors of participating countries, with exception of France, delivered the results of their analyses in predefined tables, defining the minimum data delivery. The finalized country analyses and calculations were delivered to the project team to be included in the final report. The launch of the webpage on the EuroSafe-website is planned after the final evaluation of available guidelines and tools.

- Continues process: Instructions / support data processors by the project team.
- Expert team has had a meeting in the Netherlands (Breukelen, January 9th 2007) to discus, working plan, draft guidelines and tools, select participating countries and to make preparations for a workshop for data processors of selected countries.

Promotion/dissemination

Final results have been shared among all participants of the work package.

Guidelines and tools for the calculation of the direct medical costs have been made available on a webpage of the EuroSafe-website:

http://www.eurosafe.eu.com/csi/eurosafe2006.nsf/wwwVwContent/l4module2economicconsequencesofinjury.htm

Evaluation

With a questionnaire participating countries were asked to evaluate the activities and developed products related to the calculation of direct medical costs of this project (see Annex I).

2. Methods

2.1 Description of the methods of the project

The method has been extensively described in the final report on the EUROCOST project (*1*). In this chapter we only refer to the major characteristics of the method.
The method uses an incidence-based approach (bottom-up method), calculating the medical costs of injuries occurring in a specific year. The incidence-based approach multiplies the incidence of specific patient groups (defined by injury type and severity level (hospitalised), age and sex) with the average medical costs of that patient group. Subsequently, the costs of all patient groups are aggregated.
The developed model is injury-based and not accident-based. There is no primary information on medical costs of accidents available. Information on injuries is used to get to the accident information. This link between injuries and accidents is possible because data-sets are collected which include information on injuries and accidents on record level.
The injury-based model uses the main diagnosis to calculate and allocate costs. When a patient sustains multiple injuries, a primary diagnosis is formed on the basis of a hierarchical classification of the most severe injury. For patients with multiple injuries in the model only costs for the most severe injury are allocated to the injury patient.
Two primary data sources were used to estimate the incidence of injuries: Emergency Department (ED) based surveillance systems and Hospital Discharge Registers (HDR). For this reason, the calculation of medical costs of injury is restricted to ED costs and inpatient hospital costs. This decision was guided by the lack of reliable data on other health care sectors in the vast majority of participating European countries. Injury-specific data on hospital outpatient care, non-institutional care, nursing homes and rehabilitation institutions, ambulance transport and medicine use is therefore excluded from the EUROCOST model.

In the EUROCOST project, consensus was reached on the data inclusion criteria, and definitions and classifications of data used in all participating countries. Based upon this international agreement, similar selections of accidents (i.e. external causes) and injuries (i.e. medical diagnoses) could be studied in all countries. Because the availability of incidence data of specific external causes differed by country, a modular approach was developed. It was agreed upon, that all participating countries would use ED-based data on home and leisure injury and HDR-based data on all injuries combined (intentional and unintentional, excluding medical adverse events). In addition, subsets of countries used ED-based information on specific selections of external causes (traffic injury, occupational injury, all injury, intentional injury).

The unit costs (costs per ED-visit and costs per in-hospital day) were internationally harmonised as well in this project. The cost calculations are directed primarily at the economic costs of injury. Hence it does not include the ‘human costs’ (see box 3). The direct medical costs (costs within the healthcare sector), which are calculated in the EUROCOST model, consist of costs of emergency department treatment and inpatient costs in hospital. It does not cover direct non-medical costs and indirect costs. All cost calculations were made with a model originally developed in the Netherlands (*4*).

In box 4 the baseline model for analysing injury incidence based on ED and HDR data systems is summarized. For detailed descriptions see the manual (Annex C) and other Annexes (D-H).

Box 4	
Incidence	Grouping of accident groups by minimum sets and modules (ED + HDR)
	Grouping of 39 injury groups and clustering of these injury groups in 3 levels (ED + HDR)
	Selection external causes: exclusion medical procedures and late consequences of injury (HDR)
	Proportional distribution of unknown/unspecified injuries (ED + HDR)
	Exclusion of day cases (HDR)
	No exclusion of readmissions (HDR)
	No selection of specific more severe injuries (ED + HDR)
	Extrapolating data with extrapolation factor (ED-incidence)
Healthcare consumption	Selection of ED attendances, hospital inpatient admissions (length of stay), and day cases
	Registered admitted patients in ED were corrected by transition probability (correction with HDR admissions)
	HDR cases without corresponding ED cases by patient group were added Mean length of stay per injury group of the HDR data system was used Extrapolated data are presented (note: not standardised for age and sex)
Costs	Comprehensive unit costs per country (for ED visits and hospital stay) are used for calculations

2.2 International comparability of injury incidence data

The baseline model gives an overview of the uniform methodology that has been used for analysing the injury incidence, health care consumption and costs in the EUROCOST project. This uniform methodology, or baseline model, is the starting point for the international comparisons of the data that have been conducted.

Injury incidence data provide a basis for determining priorities, emerging issues, and trends injury. The quality and consistency of injury incidence data is crucial for valid cost of illness analyses. There are, however, a number of important issues to be considered in estimating injury incidence using hospital based data sources. International comparisons can be disturbed by cross-national differences in registration practice, health systems, and health care policy. We showed in earlier research related to the EUROCOST project that standardization of the operational definition of ‘injury’, inclusion and exclusion criteria, and clustering of injury groups improved the international comparability of injury incidence (*6*).

Furthermore, injury indicators were developed and tested in the EUROCOST project. They can be used to standardize injury severity in order to detect real rather than artificial variation in injury incidence between countries. Injury indicators based on outcome criteria (disability weights) and anatomical criteria (long bone fractures and selected radiological verifiable fractures (SRVF)) improved the comparability of hospital based injury incidence data, by comparing more homogeneous patient groups in terms of health care consumption (*5*).

The choice of indicators will depend on the specific research or policy question addressed. For international comparison of the clinical incidence of home and leisure injuries, the long bone fractures indicator might satisfy, because the impact on health among this group is largely dominated by fractures, particularly in the elderly. For international comparison of the clinical incidence of traffic injuries, a combined indicator based on mortality and disability weights might be preferable, since these indicators also include injuries to the head, spine and internal organs, which are frequently fatal or very disabling for a substantial part of hospital-admitted traffic victims.
We recommend avoiding the naïve use of hospital-based data systems for international comparisons and national trend analyses. The risk of measuring artificial instead of real differences in injury incidence between countries, patient groups, or time periods is large (*5*).

2.3 Description of the data systems of the participating countries

Availability of injury incidence data

Injury incidence data can be derived from two data sources:

- Emergency Department register (ED-system) and related surveillance systems; records patients treated at an emergency department.
- Hospital Discharge Register (HDR-system); records patients admitted to hospital (hospital inpatient rate).

In all countries, ED-based surveillance systems are running in a sample of all hospitals. HDR data are generally population based. For all participating countries ED and HDR data were available.
In table 2.1 an overview is given of the countries that participate in the minimum sets and modules for injury incidence.

Table 2.1 Availability of ED and HDR injury incidence data for Minimum sets and Modules

		Minimum set I ED - home and leisure injury	**Minimum set II** Hospital admissions of unintentional and intentional injury	**Module I** ED - traffic injury	**Module II** ED - occupational injury	**Module III** ED - unintentional and intentional injury	**Module IV** ED - intentional injury
Austria	ED-system HDR	YES	 YES	No	No	No	No
Denmark	ED-system HDR	YES	 YES	YES	YES	No	No
Latvia	ED-system HDR	YES	 YES	YES	YES	YES	YES
Netherlands	ED-system HDR	YES	 YES	YES	YES	YES	YES
Portugal	ED-system HDR	YES	 YES	No	No	No	No
Slovenia	ED-system HDR	YES	 YES	YES	No	YES	YES
UK, Wales	ED-system HDR	YES	 YES	YES	No	YES	YES

All countries used data on ED home and leisure injuries (Minimum set I). HDR data (Minimum set II) were available of unintentional and intentional injuries for all countries. In chapter 3 only results based on Minimum set I en II will be presented.
Data on ED incidence of traffic injuries (Module I) are available in five countries and data on occupational injuries (Module II) are available in four countries. Four countries have also injury incidence data available of both unintentional and intentional injuries presenting at an ED (Modules III and IV).

In table 2.2 an overview is given of the availability of the coding systems used in the ED and HDR-systems. Because ED-systems do not have nation-wide coverage, the country-specific ED-incidence data were extrapolated towards national level.

Table 2.2 Available ED and HDR coding systems per participating country

	ED coding system	**HDR coding system**
Austria	IDB	ICD-10
Denmark	NOMESCO, ICD-10	NOMESCO, ICD-10
France	IDB	ICD-10
Italy	IDB > n.a.	ICD-10 > n.a.
Latvia	IDB	ICD-10
Malta	IDB > n.a.	ICD-10 > n.a.
Netherlands	ISS, IDB	ICD-9
Portugal	ISS	ICD-9
Slovenia	IDB > n.a.	ICD-10
UK, Wales	AWISS, IDB	ICD-10

n.a. = not available

Countries have used extrapolation factors based on existing extrapolation factors or based on for this project calculated extrapolation factors (see box 5). For most countries with already existing extrapolation factors it is unclear how these extrapolation factors are calculated, although a national calculation method probably exists. Therefore the reliability of the extrapolated and used injury incidence data is uncertain.

Box 5
Nation-wide estimates of the ED-incidence of injury can be arrived at using an extrapolation factor that is the inverse of the coverage. This factor can be calculated following two methods. The method used depends on the available information. The calculations are described in order of preference:

1 The population of the country divided by the population covered by the catchment area (distinguished by age and sex).
2 The total number of ED attendances (or HDR admitted injury patients) nation-wide divided by total number of ED attendances (or ED admitted injury patients) of the participating hospitals. This extrapolation may be age, sex and accident-specific.

Availability of cost data
The EUROCOST model is designed to calculate the direct medical costs of injuries. The aim is to calculate as accurately as possible the country specific direct medical costs of accident-related injuries, including costs for ED visits and inpatient stay in hospital. This means that the health care volume units (e.g. length of stay in hospital) and the unit costs should reflect the actual use of resources.
International comparisons of the costs of injury can only be made, when comparable unit costs of each country are available. Unit costs are internationally comparable when the same cost categories (e.g. nursing, therapy, overhead) are included/excluded in the same way in different countries. In order to make calculations with the EUROCOST model the country specific unit costs were adjusted in such a way that in all countries similar costs categories were included and similar years were used. This resulted in 'comprehensive unit costs' (see box 6).

Box 6
The term **'comprehensive unit cost per hospital inpatient day'** is used for the unit cost for one inpatient day in hospital for medium care (costs for ICU are not included), on average for all patients (not only injury patients) for general and university hospitals, public and private hospitals. The comprehensive unit cost includes costs for staff, costs for diagnostics, therapy and medication, and overhead costs (e.g. hotel costs and management costs).

For some of the participating countries the unit costs were available from the EUROCOST project. In case the information about unit costs was absent for a country, these were estimated based on the mean unit costs of the other countries (participating in APOLLO and/or EUROCOST), adjusted for differences in price level among countries. We used information on purchasing power parities from the OECD (see box 7). All costs were converted to the average price level in the EU.

Box 7
The **purchasing power parity** (PPP) can adjust unit costs for differences in price levels among countries. The purchasing-power parity theory states that the exchange rate between one currency and another is in equilibrium when their domestic purchasing powers at that rate of exchange are equivalent. An international dollar has the same purchasing power as the U.S. dollar has in the United States. Costs in local currency units are converted to international dollars using PPP exchange rates. A PPP exchange rate is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States. An international dollar is therefore a hypothetical currency that is used as a means of translating and comparing costs from one country to the other using a common reference point, the U.S. dollar. We used the PPP exchange rates from the OECD Health Data.

In table 2.3 an overview is given of the comprehensive unit cost per inpatient day in hospital and ED visit for each country.

Table 2.3 Unit costs (€) of inpatient days and ED visit per participating country

	Unit cost inpatient day	Unit cost ED visit
Austria [1]	538	171
Denmark	539	131
France	441	115
Italy	421	94
Latvia	254	66
Malta	325	86
Netherlands	431	144
Portugal	346	90
Slovenia	338	88
UK, Wales	263	119
Mean EUROCOST	436	115

[1] Source unit costs Austria: *Values for Austria from "AUVA Jahresbericht 2005".

2.4 Description of cost calculations

The uniform method to estimate the direct medical costs of injuries, developed in the EUROCOST project, was applied in the APOLLO project by the participating countries.
The participation APOLLO countries calculated the direct medical costs according to an incidence based approach, multiplying the incidence of specific patient groups with the average costs of that patient group. The cost calculations are restricted to ED costs (based on Emergency Department based surveillance system) and inpatient hospital costs (based on Hospital Discharge Register). It does not cover direct non-medical costs and indirect costs.
During a workshop a ‘hands-on’ training was given to the data processors of the participating countries on how to compute direct medical costs of injury with their country data bases. At our webpage, http://www.eurosafe.eu.com/csi/eurosafe2006.nsf/wwwVwContent/l4module2economicconsequencesofinjury.htm, the guidelines and tools for calculating costs are presented.

3. Results

3.1 injury incidence

3.1.1. ED injury incidence

It appears that large international differences exist in injury incidence on the aggregated level of accident categories (see table 3.1).

Table 3.1 ED injury incidence rates (per 1,000 person years) by accident group and country

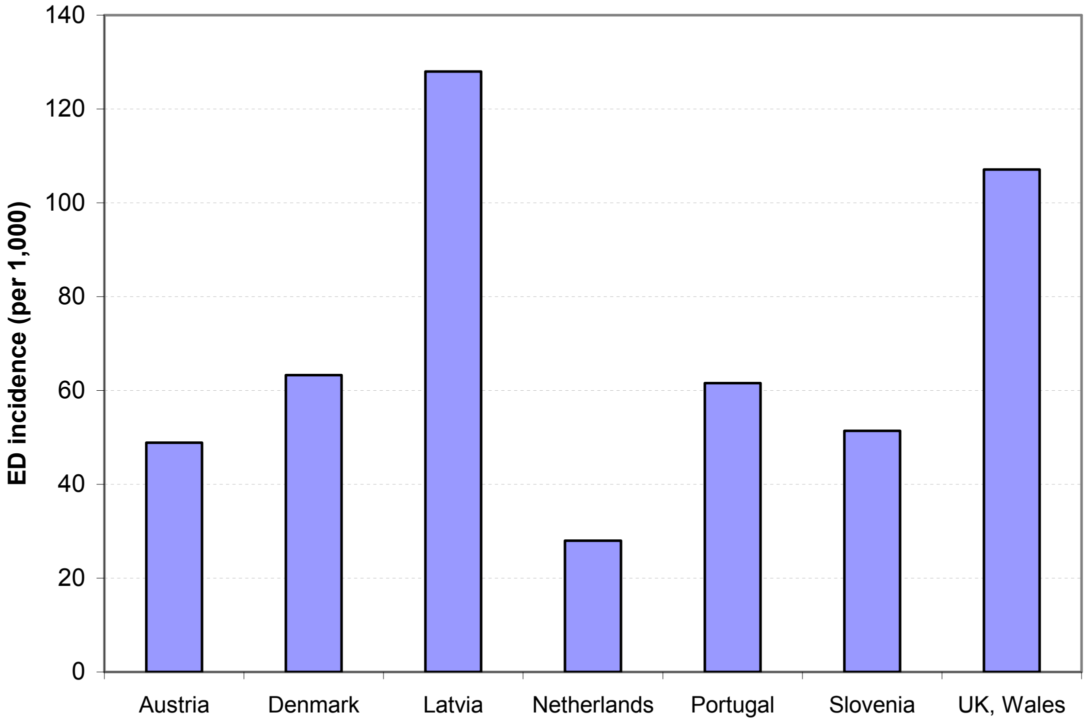
	Total ED	Home and Leisure	Traffic	Sports	Occupational	Intentional	Unspecified
Austria	n.a.	48	n.a.	26	n.a.	n.a.	
Denmark	104	63	11	15	16	n.a.	
Latvia	170	128	10	3	6	15	8
Netherlands	52	28	8	9	4	3	
Portugal	n.a.	62	n.a.	n.a.	n.a.	n.a.	
Slovenia [1]	70	51	16	n.a.	n.a.	1	2
UK, Wales	134	100	8	n.a.	n.a.	14	12

n.a. = not available

[1] HLA incidence includes sports and occupational injury

ED incidence rates for home and leisure injury (Minimum set I) vary substantially between the participating countries 28 for the Netherlands to 128 for Latvia (per 1,000 person years) as is shown in figure 3.1.

Figure 3.1 ED incidence of home and leisure injury (Minimum set I) by country (per 1,000 person years)



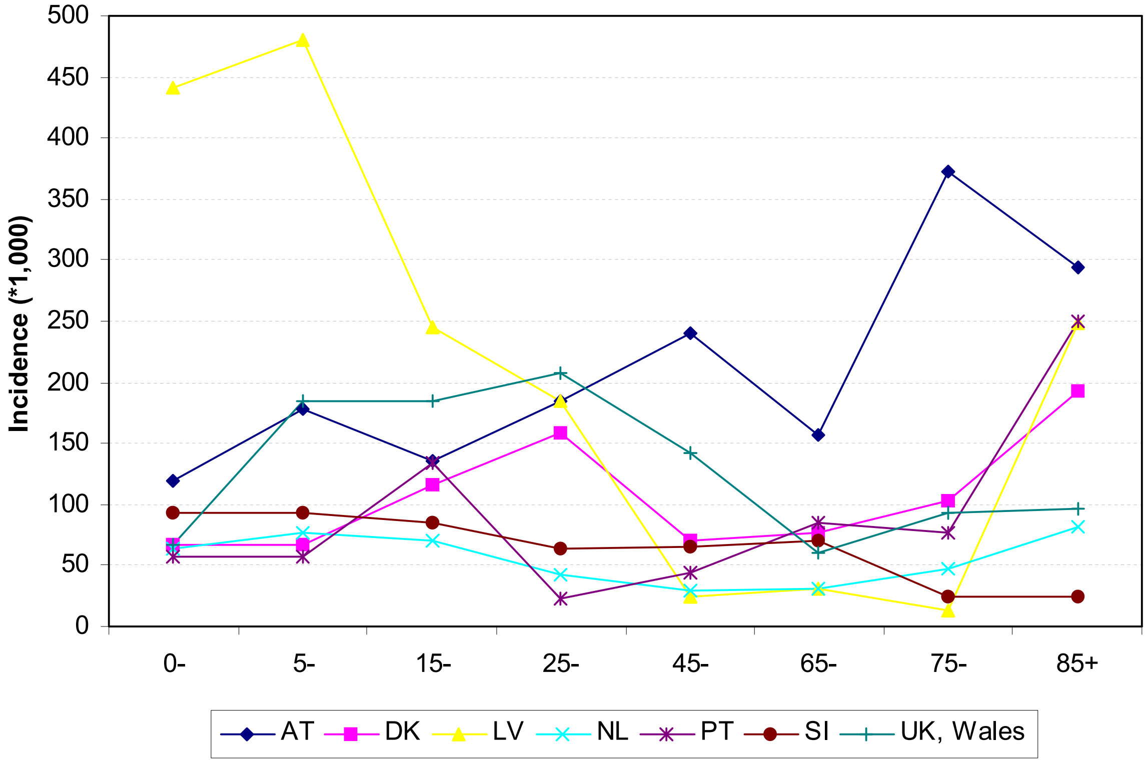
Although there are large differences in the injury incidence rates between the countries, the distribution of frequencies by injury groups is quite similar (see table 3.2). For home and leisure patients (ED), the most frequently registered injuries were superficial injuries including contusions, open wounds, and upper and lower extremity injuries. For 50% of the patients of Portugal, the type of injury is unspecified.

Table 3.2 Distribution (%) of ED home and leisure injury (Minimum set I) by injury group (level 3) and country

	AT	**DK**	**LT**	**NL**	**PT**[1]	**SI**	**UK, Wales**
Head and facial injury (excl. eye injuries)	14	12	5	11	10	7	11
Eye injury	1	5	3	3	4	0	2
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	3	2	2	1	2	4	2
Upper extremity injury (excl. nerves)	19	15	14	20	0	24	21
Lower extremity injury	23	17	16	18	0	26	20
Superficial injury, including contusions and open wounds	29	40	41	37	34	30	25
Burns	2	2	2	2	1	1	2
Poisoning	0	3	8	1	0	0	0
Foreign body	0	0	9	1	0	0	0
Unspecified injury	10	5	0	6	49	7	17

[1] For Portugal the injury distribution is questionable mainly because the registration of the variable «type of injury» is not made by a practitioner, but is made using a "proxy" without medical confirmation.

Figure 3.2 ED home and leisure injury (Minimum set I) incidence rates (per 1,000 person years) by age and country



Note: for Slovenia no distinction can be made at the age 65 and older.

The general pattern is that the ED incidence for home and leisure injuries is high for children in the age of 0-4 years, with a peak at 10-15 years (see figure). After the age of 75 years, the incidence rate increases again for Denmark, the Netherlands and Portugal.

Figure 3.3 Percentage of admitted injury patients of ED treated patients (only HLA, Minimum set I)

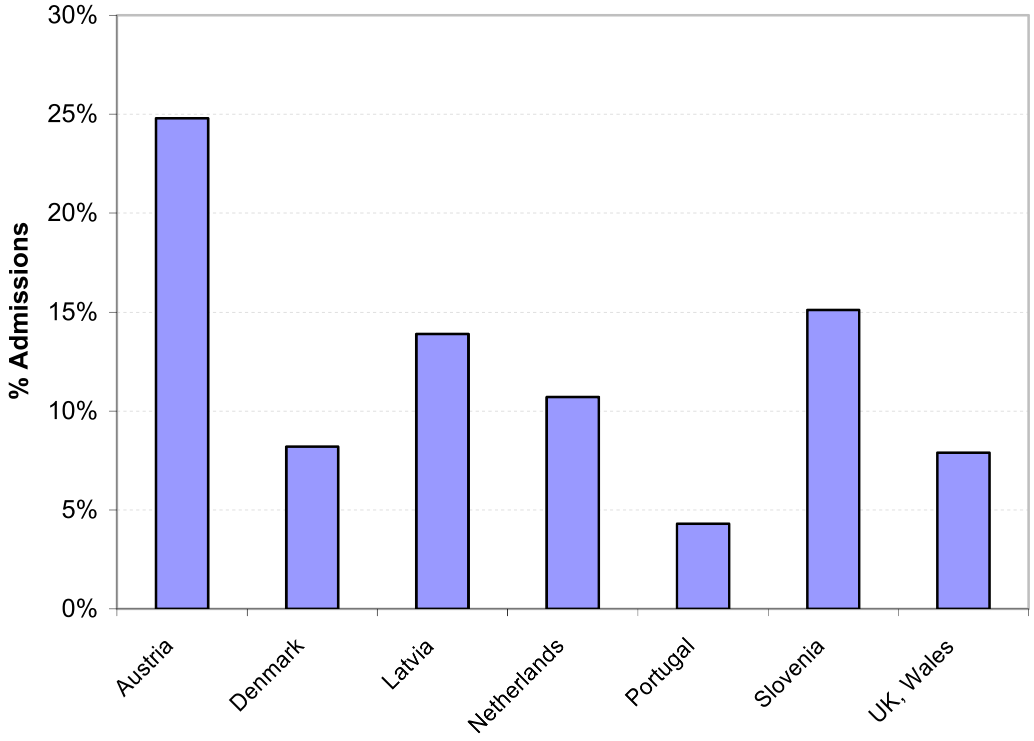


Figure 3.3 shows the percentage of admitted ED patients with home and leisure injury. There are remarkable differences in admission rates of ED treated patients between the countries, varying from 25% for Austria to 4% for Portugal.

<u>3.1.2. HDR injury incidence</u>

The hospital inpatient rate (Minimum set II) ranges from 33 (Austria) to 5 (Portugal and Netherlands) per 1,000 person years, as is shown in figure 3.4.

Figure 3.4 HDR injury incidence rates (per 1,000 person years) by country (Minimum set II)

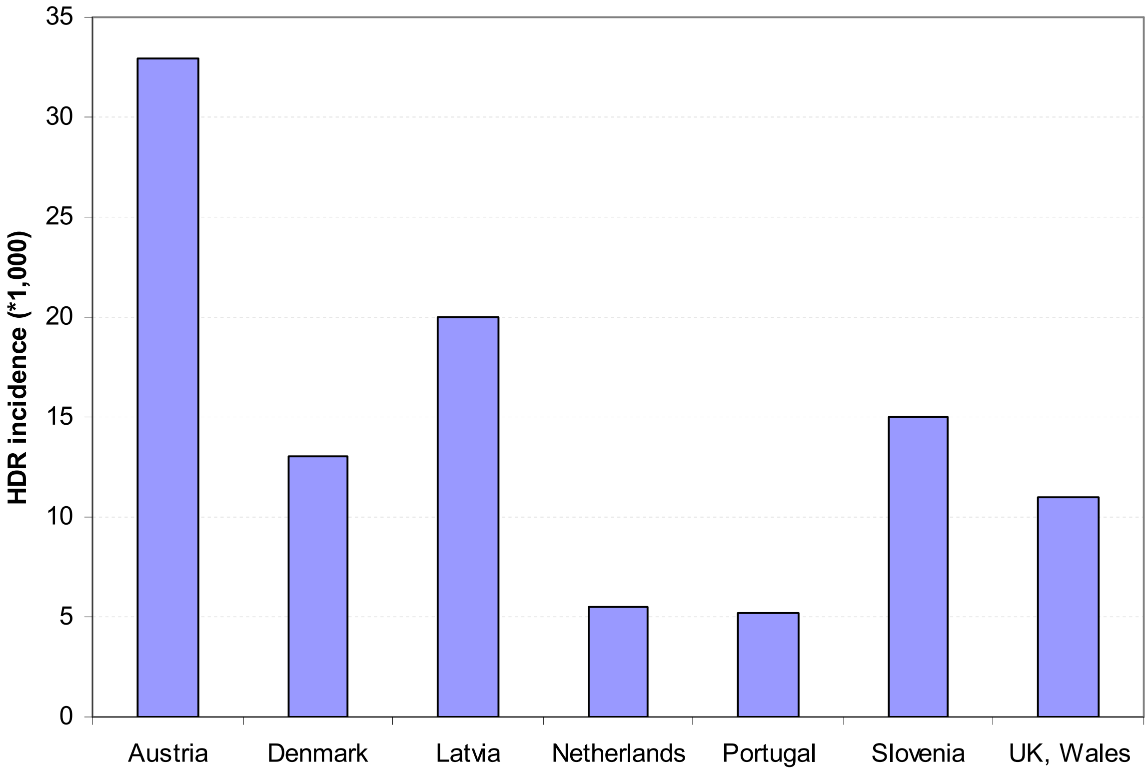
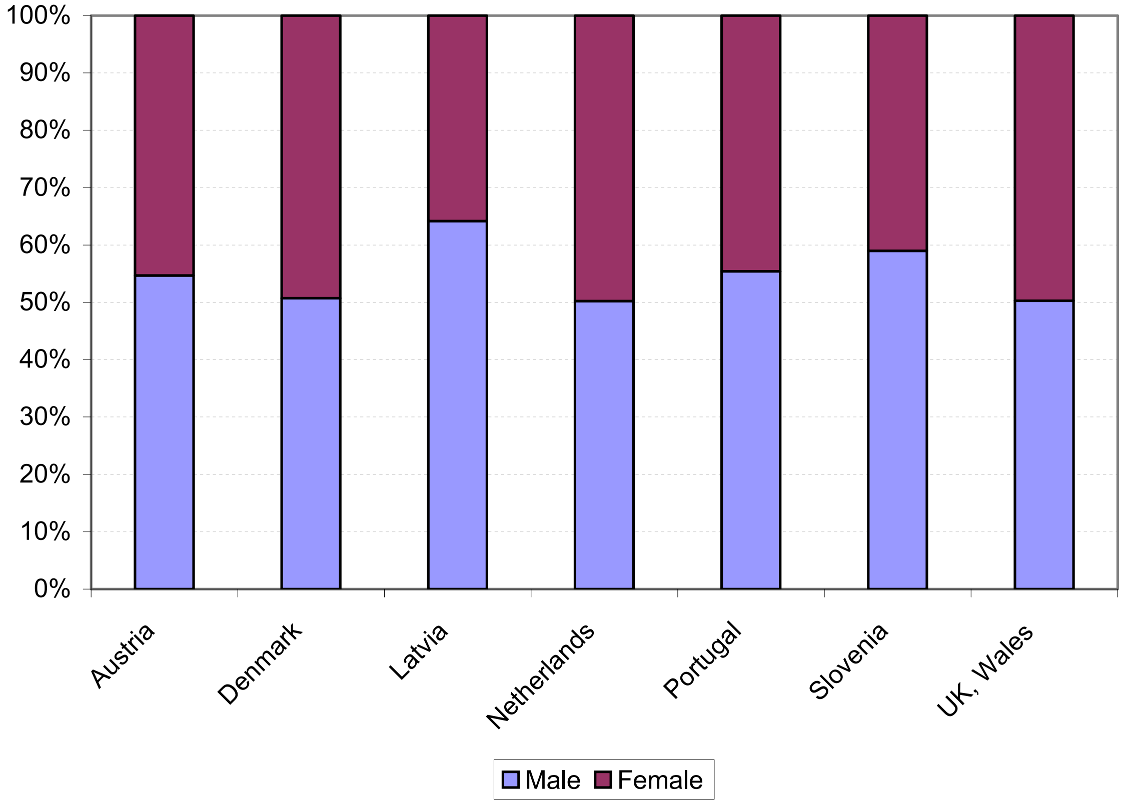


Table 3.3 Distribution (%) of admitted HDR patients (Minimum set II) by injury group (level 3) and country

	AT	**DK**	**LV**	**NL**	**PT**	**SI**	**UK, Wales**
Head and facial injury (excl. eye injuries)	18	13	21	16	18	19	13
Eye injury	1	0	0	0	1	1	1
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	9	5	5	7	10	12	4
Upper extremity injury (excl. nerves)	16	21	16	20	16	17	16
Lower extremity injury	32	31	21	33	36	33	24
Superficial injury, including contusions and open wounds	14	8	11	8	5	11	10
Burns	1	1	5	2	3	2	2
Poisoning	3	6	11	10	7	3	27
Foreign body	1	1	0	1	1	1	0
Other and unspecified injury	5	14	11	3	2	2	4

Table 3.3 gives an overview of the distribution of admitted HDR patients by injury group. In all countries most patients are admitted due to lower extremity injuries, followed by upper extremity and head and facial injuries.

Figure 3.5 Distribution (%) of total admitted HDR patients (Minimum set II) by sex and country



In all countries, males are more often admitted in hospital due to an injury than females (figure 3.5). In Latvia even 64% of total admitted injury patients are males.

Table 3.4 Distribution (%) of admitted HDR patients (Minimum set II) by length of stay in hospital, mean length of stay and country

	AT	**DK**	**LV**	**NL**	**PT**	**SI**	**UK, Wales**
0 days (= day cases)	7	19	-	-	3	0	19
1-3 days	47	50	41	60	38	49	45
4-6 days	19	13	21	13	17	19	10
7+ days	27	19	38	27	42	32	26
Mean length of stay	6.2	4.2	7.3	6.2	8.9	7.3	10.0

In all countries almost half of the patients are shortly admitted (1-3 days) patients and in the Netherlands even 60% is admitted for 1-3 days. Portugal and Wales have the highest mean length of stay per admitted injury patient and are both countries with a low hospital inpatient rate.

3.2 Costs

Total costs: All hospital costs for injury patients per country. The hospital costs include ED visits, inpatient days in hospital, and readmissions. Total costs are calculated for Minimum set I (HLA admitted and not-admitted patients) and Minimum set II (only admitted patients).
Costs per patient: Costs per patient are calculated for Minimum set I (total costs Minimum set I divided by total HLA patients) and for Minimum set II (total costs Minimum set II divided by total admitted patients).
Costs per capita: Costs per capita are calculated for Minimum set I and II, by dividing total costs by inhabitants per country.

In this paragraph we will first give an overview of the total costs due to injury patients (costs of admitted and non-admitted injuries together). Additionally, we will present the costs of only admitted injury patients (Minimum set II).

Figure 3.6 shows the mean total costs per injury patient by country. The figure shows that the Netherlands has by far the highest costs per patient (€1,201), followed by Austria (€848). In Portugal the mean costs per injury patient are €515. All other countries have mean hospital costs for an injury patients around €300-400.

Figure 3.6 Mean total costs per injury patient by country (admitted and non-admitted patients)

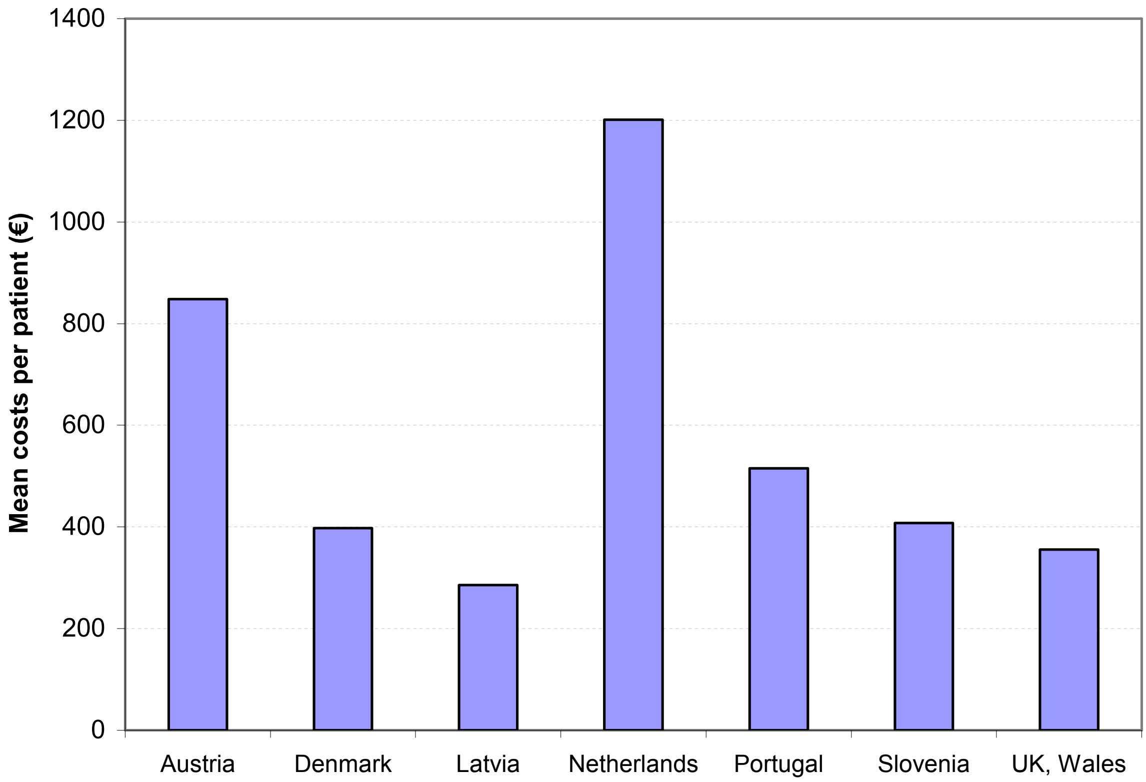
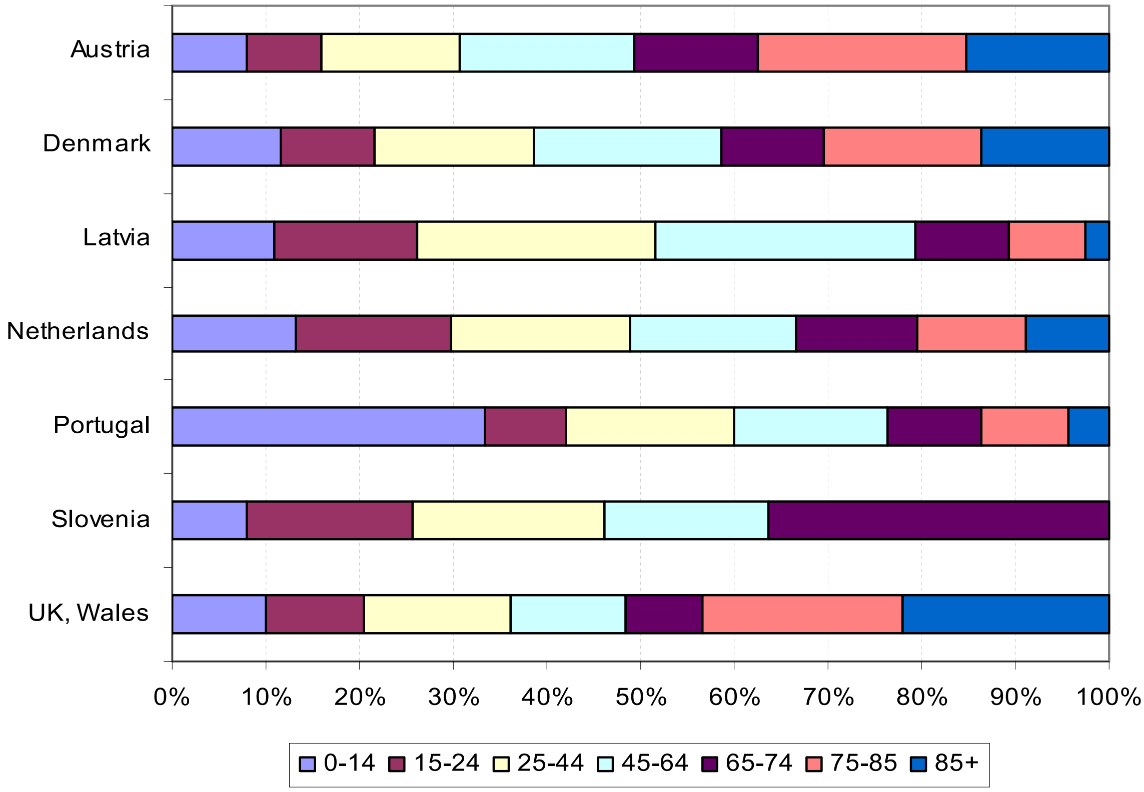


Figure 3.7 shows that the total costs of injuries are dominated by persons of 65 years and older. In UK, Wales, the Netherlands, Denmark and Austria people above the age of 65 generate around 50% of the total costs.

In Portugal and Latvia the share of persons above the age of 65 in total costs is the lowest. In Portugal a third of the total costs can be described to children below the age of 15 (33% of total ED injury patients are below the age of 15). This can be explained by the fact that in the ED home and leisure injury dataset of Portugal a child hospital is included. So the results may still have an overestimation after extrapolating the data.

Whereas in Latvia more than half of the total costs are caused by persons in the age of 25-64 years. Variation in costs per capita is high for persons above the age of 65. This variation is caused by relatively high variation in injury incidence, and health care consumption (high variation in length of stay). This reflects variation in health care consumption, based on rather large differences in injury incidence rates among older people.

Figure 3.7 Cost distribution for total costs by age and country (admitted and non-admitted patients)



Note: for Slovenia no distinction can be made at the age 65 and older. All patients aged 65 and older are in the 65-75 group.

Table 3.5 shows the mean costs by injury group by country. Injury patients admitted with a hip fracture or femur shaft fracture and spinal cord injury have by far the highest mean costs per patient, followed by fractures of the knee and lower leg. Injury groups with a low admission rate (e.g. eye injury, soft tissue head injuries, fracture hand/finger, superficial injuries and open wounds) result in relatively low mean costs per patient.

Table 3.5 Mean costs (€) by injury group and country (admitted and non-admitted patients)

	AT	DK	LV	NL	PT	SI	UK, Wales
1. brain injury	864	493	592	939	-	355	123
2. other skull-brain injury	1,515	1,281	2,053	2,015	949	5,987	847
3. soft tissue head injuries	222	144	378	171	2,737	148	144
4. eye injury	590	142	118	277	2,012	565	139
5. fracture facial bones	1,435	376	513	591	0	725	277
6. open wound face	359	142	124	195	4,364	127	197
7. fractures/dislocations/ sprain/strain	3,403	1,885	944	2,165	0	1,023	630
8. whiplash/neck sprain/distorsion cerval spine	1,405	186	1,039	-	5,480	128	149
9. spinal cord injury	6,010	12,331	3,623	6,097	-	9,529	-
10. internal organ injuries	2,501	1,448	1,908	3,158	-	4,495	687
11. fracture rib/sternum	1,676	1,108	492	1,226	-	577	556
12. fracture of clavicle/scapula	462	302	311	378	-	386	305
13. fracture of upper arm	2,366	2,627	911	838	-	853	2,265
14. fracture of elbow/forearm	543	679	172	622	-	647	340
15. fracture of wrist (incl. carpal bones)	2,321	345	912	271	-	235	297
16. fracture of hand/fingers	284	217	100	170	-	188	147
17. dislocation/sprain/strain shoulder/elbow	582	189	155	227	-	254	151
18. dislocation/sprain/strain wrist/hand/fingers	253	145	75	163	-	107	121
19. injury of nerves	1550	817	456	249	-	639	570
20. complex soft tissue injury	343	397	346	528	226	931	319
21. fracture of pelvis	4,670	3,393	2,966	4,135	-	1,286	5,949
22. fracture of hip	8,999	5,130	4,311	4,853	-	2,818	9,250
23. fracture of femur shaft	5,501	5,297	1,361	5,141	-	2,725	9,242
24. fracture of knee/lower leg	3,272	2,521	1,589	2,439	-	1,204	2,379
25. fracture of ankle	1,732	789	433	1,514	-	639	516
26. fracture of foot (exc. Ankle)	572	269	142	239	-	270	234
27. dislocation/sprain/strain knee	1,454	219	254	277	-	279	136
28. dislocation/sprain/strain ankle/foot	414	138	73	176	-	99	124
29. dislocation/sprain/strain hip	3,875	1,531	1,364	1,346	-	746	252
30. injury of nerves	3,892	1,621	672	1,191	-	228	130
31. complex soft tissue injury	245	346	691	445	316	460	764
32. superficial injury (incl. contusions)	369	167	103	345	124	128	182
33. open wounds	265	164	103	335	919	184	170
34. burns	770	483	844	1,406	1,146	1,756	316
35. poisoning	1,022	429	777	1,301	24	644	723
36. multi trauma	-	-	-	-	-	-	-
37. foreign body	925	610	75	674	-	832	-
38. no injury after examination	-	131	-	-	-	-	-
39. other and unspecified injury	283	545	379	673	100	177	141

Note: Mean costs above €2,000 are coloured grey.

Table 3.6 and gives an overview of incidence, the total costs, costs per patients and costs per capita for admitted patients for each country. Table 3.6 show that large international differences exist in injury incidence, mean costs per patient and costs per capita using the baseline model for Minimum set II. Costs per capita are the multiplication of the incidence rate and costs per patient. For example, costs per capita of non-admitted patients are highest in Austria, because of relatively high costs per patient. Although Latvia has the highest incidence rate of home and leisure injuries, costs per capita are average because of lowest costs per patient.

Table 3.6 Injury incidence rate, cost per patient, cost per capita and total costs of admitted injury patients (Minimum set II) by country

	AT	DK	LV	NL	PT	SI	UK, Wales
Incidence rate (*1,000)	15[a]	13	20	5	5	13	11
Cost per patient (€)	3,344	2,388	1,917	2,867	2,921	2,303	2,769
Cost per capita (€)	50	27	32	19	13	32	27
Total costs (* million €)	410	167	86	315	160	73	90

[a] For Austria the HDR incidence differ from the incidence rate presented in figure 3.4, since only HLA accidents are included in the cost calculations.

Figure 3.8 gives an overview of the mean cost per capita for admitted injury patients. There exist large variation between the countries, with the lowest cost per capita for Portugal (€ 13), mainly due to the low incidence. Admissions due to injuries cause the highest cost per capita in Austria (€50), due to a combination of high incidence rate and high cost prices.

Figure 3.8 Cost per capita (€) for admitted injury patients (Minimum set II) by country

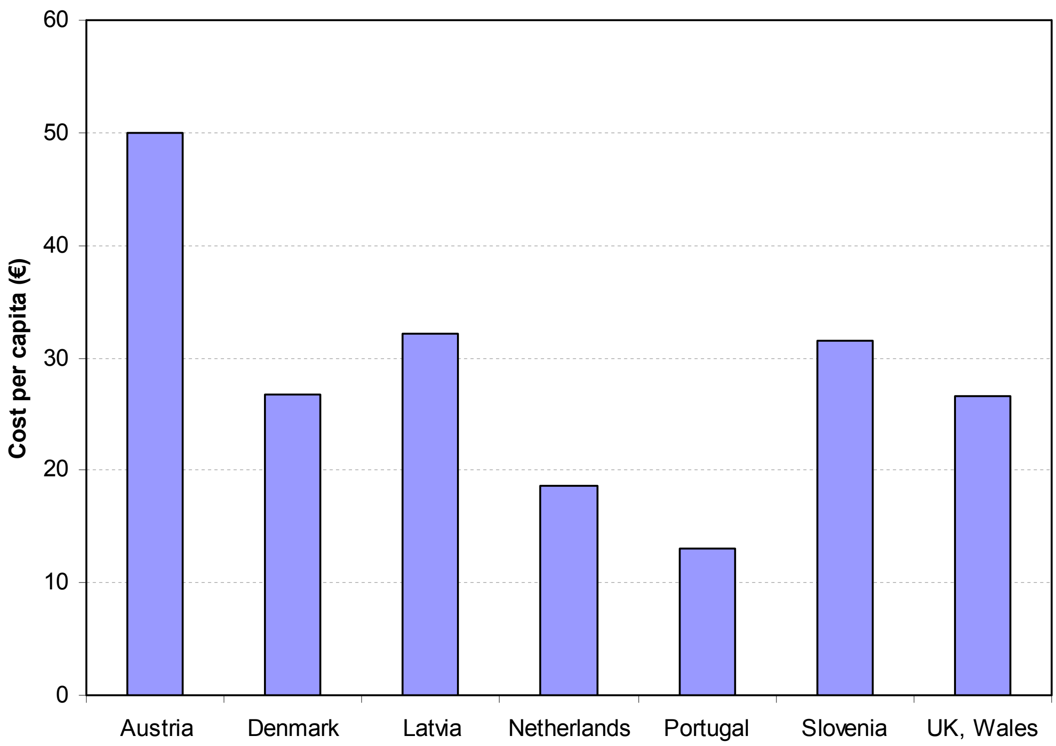
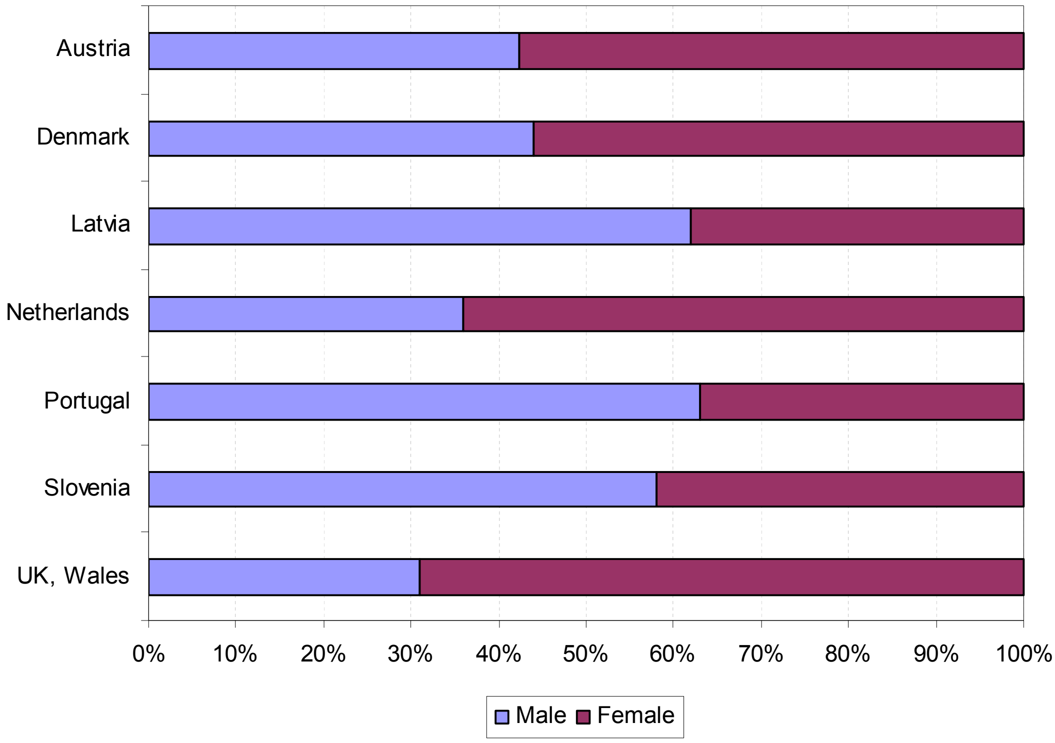


Figure 3.9 Total costs for admitted injury patients (Minimum set II) for all accident groups (if available) by sex and country



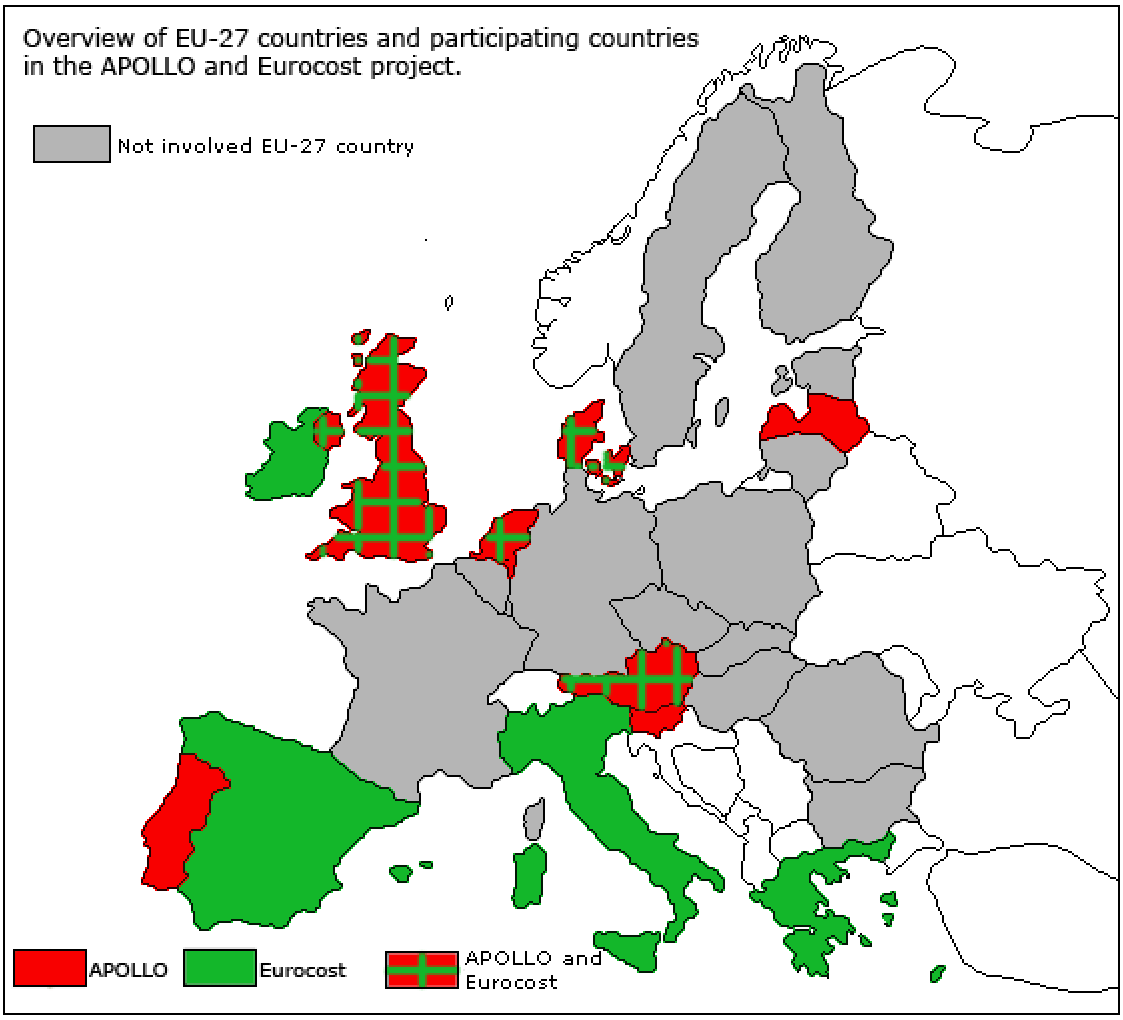
In figure 3.9 we present the total costs by sex for admitted injury patients. The contribution of females in the total costs differs remarkably between the countries, varying from 38% for Latvia to 69% for Wales.

3.3 Costs of injury in the European Union

3.3.1 Methodology

The European Union (EU) consists of 27 countries (until June 2008). In the APOLLO and EUROCOST project together 12 countries of the EU participated. In this paragraph the mean costs per capita are described for the APOLLO countries. Furthermore, the data of the 12 participating APOLLO and EUROCOST countries were combined, to give an estimate of the 'mean' costs of injury per capita by age and sex. In this chapter we extrapolate the incidence and cost estimates to all 27 EU countries, including countries that did not participate in the project. Figure 3.10 gives an overview of the participating APOLLO, EUROCOST and other EU countries. In table 3.6 an overview was given of the costs per capita (by age and sex) for the participating APOLLO countries for admitted injury patients (minimum set II). For the non-participating countries the costs of injury were calculated based on their population distribution by age and sex as follows: costs were calculated by multiplying the total population by age and sex with the cost per capita by age and sex (7 age groups * male/female = 14 groups).

Figure 3.10 Overview of EU-27 countries and participating countries in the APOLLO and EUROCOST project



3.3.2 Mean cost of injury for APOLLO countries

In this paragraph an overview is given of the costs of injury for all participating APOLLO countries together. The total costs of the APOLLO countries are the sum of the costs of all countries combined (standardized for age and sex). In the calculations Portugal and Slovenia are excluded. The ED data of Portugal had only HLA data available with insufficient data by injury groups and Slovenia used somewhat different age groups and no distinction can be made at the age above 65.

In table 3.7 and 3.8 the mean costs per capita are given for the APOLLO countries for total injury patients and admitted injury patients only, respectively. For the year 2005 the costs per capita for the participating APOLLO countries were €36.1 for admitted and non-admitted patients together and €30.2 for admitted injury patients.

Table 3.7 Mean costs (€) per capita for total admitted and non-admitted (ED visits) injury patients for the APOLLO countries by age and sex

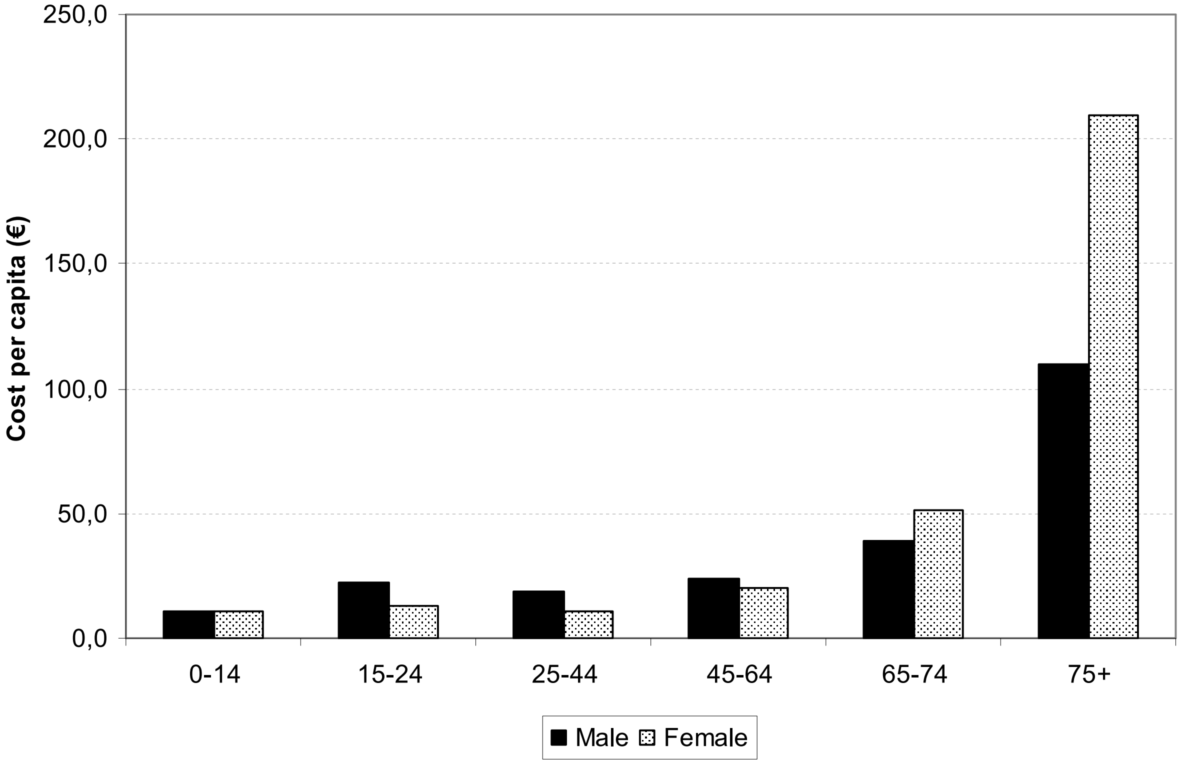
Total costs admitted and non-admitted patients	**Male**	**Female**	**Total**
0-14	24	14	19
15-24	40	15	28
25-44	29	12	21
45-64	30	22	26
65-74	43	53	48
75-84	91	164	136
85+	220	352	317
Total	35	37	36

Table 3.8 Mean hospital costs (€) per capita for total admitted injury patients for the APOLLO countries by age and sex (Minimum set II)

Minimum set II	**Male**	**Female**	**Total**
0-14	11	11	11
15-24	22	13	18
25-44	19	11	15
45-64	24	20	22
65-74	39	51	45
75-84	86	161	133
85+	212	347	312
Total	25	35	30

The mean costs per capita are higher for women compared to men. The costs per capita are higher for males under the age of 65 and are (much) higher for females above the age of 65 (figure 3.11). This is mainly because many of the injuries suffered by older women require a high level of care.

Figure 3.11 Cost per capita (€) for the APOLLO countries for admitted injury patients (Minimum set II) by age and sex



<u>3.3.3 Mean cost of injury for APOLLO and EUROCOST countries</u>

In table 3.9 an overview is given of the costs per capita (by age and sex) for the participating APOLLO and EUROCOST countries for total admitted patients (Minimum set II).

The mean cost per capita for APOLLO and EUROCOST countries together is lower than the cost per capita for only APOLLO countries (€24.0 versus €30.2). The reason for higher cost per capita for APOLLO is that Austria, Denmark and the Netherlands all have high cost per capita.

Table 3.9 Mean hospital costs (€) per capita for total admitted injury patients for the APOLLO and EUROCOST countries by age and sex (Minimum set II)

Minimum set II	Male	Female	Total
0-14	14	7	11
15-24	32	14	23
25-44	14	10	12
45-64	12	16	14
65-74	35	81	59
75+	48	113	89
Total	20	28	24

In table 3.10 the mean costs per patient for admitted injury patients (Minimum set II) is presented by 39 injury groups.

Table 3.10 Mean costs per patient for admitted injuries (Minimum set II) by 39 injury groups for the APOLLO and EUROCOST countries together, with data set definitions of injury groups ICD-9CM and ICD-10

Injury groups	**Mean costs per patient in €**	**ICD-9CM**	**ICD-10**
1. brain injury	1,139	850	S06.0
2. other skull-brain injury	4,238	800-801, 803-804, 851-854, 950-951	S02.0-1, S02.7, S02.9, S06.1-9, S04.0-9, S07.1-9, T02.0, T04.0
3. soft tissue head injuries	1,159	873.0-1	S01.0, S08.0
4. eye injury	1,391	870-871, 918	S01.1, S05.0-9
5. fracture facial bones	1,379	802	S02.2-6, S02.8
6. open wound face	1,173	872, 873.2-9	S01.2-9, S08.1-9, S09.2
7. fractures/dislocations/ sprain/strain	3,344	805, 839.0-5, 846, 847.1-9	S12.0-7, S12.9, S13.0-3, S13.6, S22.0-1, S23.0-1, S23.3, S29.0, S32.0-2, S33.0-2, S33.5-7, T02.1, T03.0-1, T08, T09.2
8. whiplash/neck sprain/distorsion cerval spine	1,157	847.0	S13.4
9. spinal cord injury	4,948	806, 952	S14.0-1, S24.0-1, S34.0-1, S34.3, T06.1, T09.3
10. internal organ injuries	2,865	860-869, 900-902, 926, 929	S26.0-9, S27.0-9, S29.7, S36.0-9, S37.0-9, S39.6-9, T06.5
11. fracture rib/sternum	2,126	807.0-3, 809	S22.2-4, S22.8-9
12. fracture of clavicle/scapula	2,152	810-811	S42.0-1, S42.7-9
13. fracture of upper arm	2,818	812.0-3	S42.2-3
14. fracture of elbow/forearm	1,726	812.4-5, 813.0-3, 813.8-9	S42.4, S52.0-4, S52.7-9
15. fracture of wrist (incl. carpal bones)	1,374	813.4-5, 814	S52.5-6, S62.0-1
16. fracture of hand/fingers	1,131	815-817	S62.2-8
17. dislocation/sprain/strain shoulder/elbow	1,225	831-832, 840-841	S43.0-7, S53.0-4
18. dislocation/sprain/strain wrist/hand/fingers	775	833-834, 842	S63.0-7
19. injury of nerves	1,455	953.0-1, 953.4, 955	S14.2-4, S24.2, S44, S54, S64, T11.3
20. complex soft tissue injury	1,440	880.2, 881.2, 882.2, 883.2, 884.2, 885-887, 903, 927	S45-S49, S55-S59, S65-S69, T04.2, T05.0-2, T11.4-9
21. fracture of pelvis	4,650	808	S32.3-8
22. fracture of hip	5,481	820	S72.0-2
23. fracture of femur shaft	6,215	821.0-1	S72.3, S72.7-9
24. fracture of knee/lower leg	3,504	821.2-3, 822, 823	S72.4, S82.0-2, S82.4, S82.7-9
25. fracture of ankle	2,636	824	S82.3, S82.5-6
26. fracture of foot (exc. Ankle)	2,514	825, 826	S92.0-9
27. dislocation/sprain/strain knee	1,727	836, 844	S83.0-7

28. dislocation/sprain/strain ankle/foot	1,430	837-838, 845	S93.0-9
29. dislocation/sprain/strain hip	3,694	835, 843	S73.0-1
30. injury of nerves	3,290	953.2-3, 953.5, 956	S34.2, S34.4-8, S74, S84, S94, T13.3
31. complex soft tissue injury	3,535	890.2, 891.2, 892.2, 893.2, 894.2, 895-897, 904, 928	S15.1, S75-S79, S85-S89, S95-S99, T04.3, T05.3-5, T06.3, T13.4-9, T14.5
32. superficial injury (incl. contusions)	1,378	910-917, 919-924	S00,S10, S20, S30, S40,S50, S60,S70, S80,S90, T00, T09.0,T11.0, T13.0,T14.0
33. open wounds	1,949	874-884 (excl. 880.2, 881.2, 882.2, 883.2, 884.2), 890-894 (excl. 890.2, 891.2, 892.2, 893.2, 894.2)	S11, S21, S31, S41, S51, S61, S71, S81, S91, T01
34. burns	4,065	940-949	T20-T32
35. poisoning	1,370	960-989	T36-T65
36. multi trauma [1]		Not operational	Not operational
37. foreign body	1,083	930-939	T15-T19
38. no injury after examination	634	--	--
39. other and unspecified injury	2,117	807.4-6, 818-819, 827-829, 830, 839.6-9, 848, 953.8-9, 954, 957, 925, 959, 990-995	All other combinations
Not included		905-909 (late consequences), 958 (early complications), 996-999 (medical complications)	T90-T98 (late consequences), T79 (early complications), T80-T88 (medical complications)

[1] Can not be operationalized.

The highest costs per patient for admitted patients were found for patients with a fracture of femur (€6,210) or hip (€5,480), followed by spinal cord injury (€4,950), fracture of pelvis (€4,650) and skull-brain injury (€4,240).

3.3.4 Cost of injury for EU-27

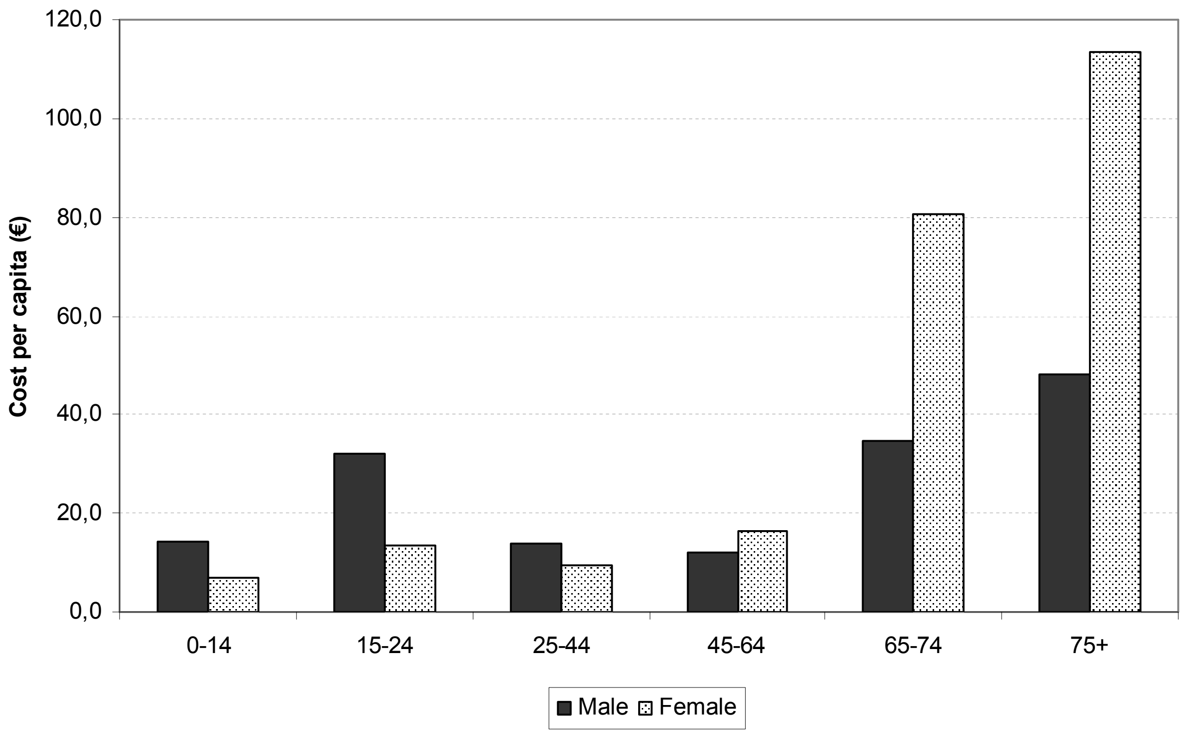
In table 3.11 the mean cost per capita are presented for admitted injury patients for the 27 EU countries. The mean costs per capita are €25.8, with higher cost per capita for females than for males (€30.7 versus €20.5).

Table 3.11 Mean costs (€) per capita for total admitted injury patients for the EU countries by age and sex (Minimum set II)

Minimum set II	**Male**	**Female**	**Total**
0-14	14	7	11
15-24	32	14	23
25-44	14	10	12
45-64	12	16	14
65-74	35	81	59
75+	48	114	89
Total	21	31	26

The costs per capita are higher for males under the age of 45 and are (much) higher for females above the age of 45 (figure 3.12). This is mainly because many of the injuries suffered by older women require a high level of care.

Figure 3.12 Cost per capita (€) for the APOLLO and EUROCOST countries for admitted injury patients (Minimum set II) by age and sex



4. Indirect costs

4.1 Introduction

Apart from direct medical costs, productivity costs (often referred to as indirect non medical costs) are among the major economic consequences of injury (*7, 8*). The indirect costs represent the economic consequences of injuries beyond the health care sector, resulting from absence from work, disability, and death. It has been shown that on average these represent more than 50% of the total disease costs or total costs saved by health care interventions (*9*). This means that novel information on these economic production losses could be very important to policy makers in the area of injury control. Injuries through accidents are the cause of a relatively high number of days lost due to absenteeism. Furthermore, population studies have shown that absenteeism is relatively common in the case of occupational accidents but less so in the case of sport injuries.
International variation in productivity costs will be influenced by differences in epidemiology, social security systems, population characteristics, economic circumstances, and registration practices.
This chapter describes approaches to measuring and valuing productivity costs, arising as a result of injuries. A set of minimum data requirements necessary to generate estimates of these costs is provided (using the friction costs and human capital approach). Because data for calculating productivity costs may not be available from existing sources in many countries, a systematic process is described for calculating productivity costs from a sample of relevant facilities.

4.2 What are productivity costs?

Productivity costs can be defined as the costs associated with production loss and replacement, due to illness, disability and premature death (*10*).
Productivity costs are part of the indirect costs as these have a less direct relationship with the treatment of a disease and its resources consumed, such as the direct medical costs. Nevertheless, production losses due to illness and production gains due to health care influence the wealth of society and these costs should therefore be included in economic evaluations using a societal perspective.
Productivity costs and so called ‘human costs’ are sometimes confused. Human costs are defined here as the monetary value attributed to human life (see the literature on the statistical value of a human life). Productivity costs do not represent a valuation of human life as such, they only represent the economic value of a person’s productivity for society. Productivity costs and human costs should therefore be carefully distinguished.

As for all cost categories, estimation of productivity costs normally involves 3 steps:

1. Identification of cost categories;
2. Measurement of utilization;
3. Valuation, i.e. determining the monetary costs per unit of utilisation.

Identification

Productivity costs resulting from illness or its treatment may arise in the following situations:

- Absence from paid work;
- Reduced productivity at work (without absence), for paid or unpaid work. This is often called "presenteeism";
- Permanent disability;
- Mortality.

In this chapter, we will mainly focus on the productivity costs related to the paid work of the sick individual. We will not deal with reduced unpaid production due to the individual's disease and indirect costs accrued by the family and/or friends (which can occur both during paid or unpaid production time) for taking care of the individual due to his or her disease.

Measurement

Analogous to medical costs, where it is important to have a valid measurement of the number of health care services consumed (for example the number of hospital days or GP visits), we need valid estimates of the amount of presenteeism, the number of absence days etc. to be able to calculate productivity costs. Paragraph 4.3 deals with the data requirements and these measurement issues in detail.

Valuation

When data are available on the amount of presenteeism, absenteeism, disability and mortality, these should be valued in monetary terms.

There is no consensus yet on the most appropriate method to value productivity costs. Currently, there are three internationally known methods for valuation: the human capital method, the friction cost method and the US panel method.

First of all, we will give a description of both the human capital method and the friction cost method for calculating indirect costs. The US panel method will be discussed briefly. For more details on the debate concerning the valuation of productivity costs, see Koopmanschap (*11*); Brouwer (*12*); Drummond (*13*).

The Human Capital method

Productivity costs, as defined by the human capital cost approach, are estimated as the reduced future gross income due to mortality and/or morbidity (*14*).

Traditionally, the human capital method has been used for measuring productivity costs. It is a simple and straightforward method in which lost production is measured using gross income on the individual level. Neo-classical economic theory suggests that the productive value of a worker equals his wage, at the margin.

Regardless of the length of the period of absence/disability, the gross wage that a person would have earned during the entire period of absence is taken as an approximation of lost production. For example, if a person would suddenly die or become permanently disabled at age 28 earning €35,000 per year at that time, the human capital method would calculate his wage [sometimes a prediction of average wage (since wages tend to increase during one's career) is used to make the lost income estimation more realistic] of €35,000 multiplied by the number of years that he would have performed

paid work if he was still alive. Aggregation of these individual figures yields the productivity costs at the national level.
A major textbook assumption used here is that of full employment. Because continuous full employment is assumed here, absence from work will always lead entirely to productivity costs and productivity costs may continue until the retirement age of a worker. Hence, cost estimates for disability and death according to the human capital approach yield very high results.

The Friction Cost method
The proponents of the friction cost method view the human capital method as an estimate of the potential theoretical productivity costs in case of permanent full employment. They observe that in many societies full employment is not always prevalent and try to estimate the actual productivity costs.
If the unemployment rate in an economy is higher than the frictional unemployment (an unavoidable part of unemployment, due to the fact that labour demand and will not always instantaneously match), then it will often be possible to replace a sick person (after a while).
The essence of the friction cost method is that in case of unemployment absent workers will be replaced after an adaptation period (the friction period) and in this way further productivity costs may subsequently be prevented (*11*).

The friction cost method distinguishes between a friction period, in which productivity loss occurs and a further period in which a sick worker has been replaced. From a societal point of view, only the value of production, that is lost until the return of the absentee or until someone replaces the absentee, plus the possible replacement costs may be counted as productivity costs. If, for instance, a person becomes disabled and his employer finds replacement for him after 6 months by hiring a qualified unemployed person, from a societal point of view, production then returns to its initial level and no additional productivity costs after replacement are incurred.
The period that productivity costs may occur is within the *friction period*, that is the period between the absenteeism and replacement. Within this period replacement costs are incurred and/or production losses are suffered, incurring societal productivity costs.
The friction period is assumed to be equal to the average vacation period, the period it takes to find a suitable replacement of an absent worker, plus some additional training time.

However, it seems highly unlikely that all workers can be replaced by someone currently unemployed. Koopmanschap handles this issue by segmenting the labour market by age, gender and education, which means that the friction period could have different durations in these segments. In the extreme, this duration could be close to the time period necessary to educate new workers (*15*).

After recovery or replacement, the lost production of the disabled person is being compensated by the production of himself or the formerly unemployed person. The short term productivity costs on the level of society will be zero then. In the medium term however, absence from work and disability may have some macro-economic consequences (by means of their impact on labour productivity and competitiveness on the world market), which may be estimated through a macro-econometric model (see Koopmanschap (*11*)).

With respect to *short term sick leave* the proponents of the friction cost method also stated that the actual productivity costs could be somewhat lower than according to the human capital method.

After sick leave, workers may partly make up for the loss of production when they return to work, or that this can be taken care of by internal labour reserves, or that non-urgent jobs can be cancelled. Obviously, this approach may generally result in a lower estimate of the productivity costs as compared to the human capital approach, although the differences are smaller than for long term disability and death (see Koopmanschap (*11*)).

Koopmanschap and Rutten (*3*) state that the indirect costs due to short term sick leave should be lower than estimated by the human capital approach due to the following: (i) diminishing marginal returns to labour (i.e. that the individual's marginal productivity is decreasing); (ii) the loss of production due to short term sick leave can be taken care of by internal labour reserves; (iii) the individual can make up for part of the loss of production when he or she returns to work; and (iv) non-urgent jobs can be cancelled. Taking all these circumstances into account, Koopmanschap et al. (*11*) proposed to use an elasticity of 0.8 between labour time and productivity, which means that for short term absence 80% of labour time lost results in productivity costs. Later research of Severens (*16*) and Jacob-Tacken (*17*) points to even lower elasticities of about 50%, but Nicholson and colleagues (*18*) argue that in case of team work, the absence of a team member may also harm the productivity of colleagues, which may in some cases result in an elasticity higher than 1.

US panel approach

The US panel on cost-effectiveness in health and medicine proposed (most) productivity costs to be calculated in terms of quality of life and not in monetary terms (as in the other two methods). The Panel felt that when quality of life measurement methods are silent concerning income, respondents will incorporate income changes related to productivity changes into their health state valuations. Therefore, to also capture them in monetary terms would result in a double count.

Most researchers however feel that this method has two main shortcomings: first, the relationship between productivity and income in many countries is quite weak, which makes calculating productivity costs by means of Qaly's unreliable (*12*). Second, Krol (*19*) demonstrated that neither spontaneous differences in incorporation of effects of health on income, nor explicit instructions on incorporating income yielded different health-state valuations. This suggests that QALY measures are insensitive to concerns regarding effects on income even when these are (explicitly) incorporated.

A low degree of consensus

Part of the health economists prefer the friction cost method over the human capital method since it allows for disequilibria in economies, such as unemployment (*12*). However, other health economists are not convinced that the friction cost method is a good alternative for the human capital approach. Therefore, in the coming paragraphs, we will present a practical guide for estimating productivity costs according to both the 'friction cost method' and the 'Human capital method'.

Since the manual is intended to be applicable in all European countries, data availability is a key concern. The friction-cost method might be less appropriate for some countries, as it requires more data.

4.3 How to calculate productivity costs?

Comparability of results of economic evaluations between countries may be hampered due to variation in methodology, data sources, valuation of production losses and social security arrangements. If these aspects are comparable, it is possible to analyse the contribution of differences in epidemiology, demography and economic environment to the level of indirect costs and the distribution by diagnosis. Hence, to improve international comparability of productivity costs of injuries, we will provide some advises on methodology and data.

This section outlines the basic data requirements and calculations necessary to generate an estimate of loss of productivity (indirect costs) due to injuries, according to both the 'Friction cost method' and the 'Human capital method'. Based on the degree of specificity of the available data, however, researchers may wish to refine their cost estimates. The minimal data requirements outlined below should therefore be used as a 'flexible framework' allowing for further investigation and analysis wherever the data permit.

Guideline toward calculating productivity costs

The estimation of productivity costs involves three steps, namely identification, measurement and valuation. Based on these three steps we will present a guideline. Figure 4.1 gives an schematic overview of how to calculate productivity costs.

Step 1 Identification of cost categories

For both the friction cost method as the human capital approach it is necessary to obtain data on absence from paid work, reduced productivity at work without absence (presenteeism), the incidence of disability and mortality. In this chapter, we will mainly focus on the productivity costs related to the paid work of the sick individual.

Step 2 Measurement of utilization

- When does a period of absence from work occur?

A sound calculation of productivity costs requires valid measurement of its components. In order to estimate the number of *absence* periods, it is necessary to obtain data on reduced productivity and absence spells, and the incidence of disability and mortality, correcting for the number of deaths among the disabled. The possible transitions between being healthy, absent from work, disabled or dead, which may depend on the specific social security arrangements (with the exception of being dead), determine when friction periods occur. In case of permanent disability and death maximally one friction period per person can occur.

With respect to absence from work, many questionnaires are being used allover the world. Some of these (e.g. PRODISQ and HLQ) ask respondents about compensation by themselves or by others that may reduce the productivity costs related to short term absence from work.

- How long does a absence period last?

The length of the absence period is based on the average vacancy duration by education level, which has proved to be an important determinant of the level of employment as a position held by a more educated person be harder to fill. As a rule, the friction period is longer than the vacancy duration, since time may elapse between the emergence of production loss and the decision to create a

vacancy. In addition, time passes between filling a vacancy and the first working day of the new employee. One should take both circumstances into account in estimating the length of the friction period.
The friction period should preferably be estimated by education level, because in the labour market unemployment levels often differ by education level. It is necessary to obtain statistics on completed vacancy durations, or estimates of completed vacancy durations, based on data on uncompleted vacancy durations and the number of vacancies. The estimated time between the start of the production loss and the creation of the vacancy should be added to this vacancy duration, together with the time between filling the vacancy and the first working day. Selection and training costs for the new employee may be relevant and should ideally be estimated, for example, by interviewing employers on these types of costs.

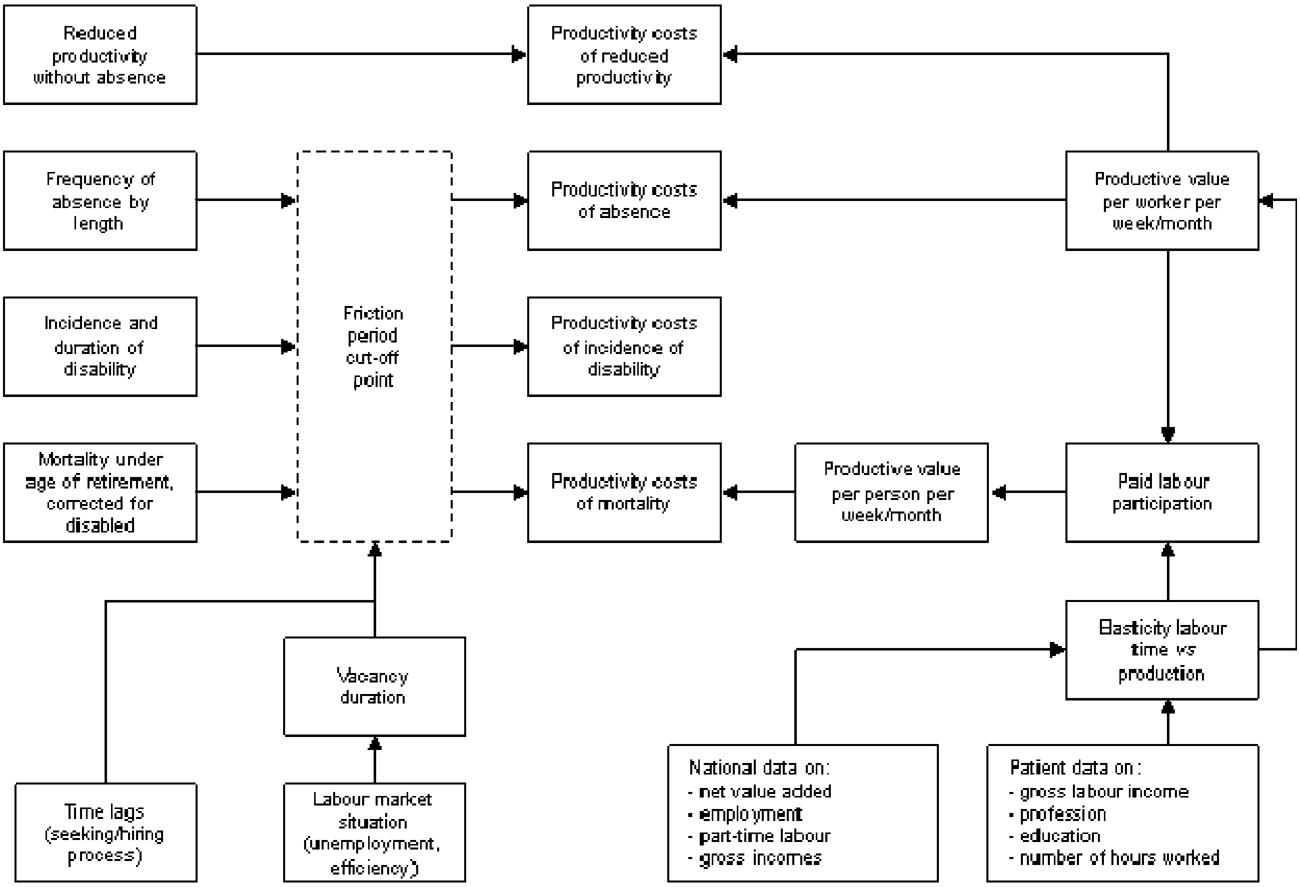
- What is the amount of presenteeism

Presenteeism (ill people who go to work, but are less productive) can be measured in several ways, for example the PRODISQ questionnaire uses two Vas scales, one for the quantity and one for the quality of paid work (*8*). Other questionnaires such as the HLQ (van Roijen 1996, (*20*)) apply other methods to measure presenteeism.

Step 3 Valuation

When data are available on the amount of presenteeism, absenteeism, disability and mortality, these should be valued in monetary terms. Depending on preference and data availability the ‘friction cost method’ or ‘human capital method’ can be used for valuing productivity costs.

Figure 4.1 Schematic overview of calculating indirect costs of injury



Source: Koopmanschap 1996 (*3*)

Friction cost method

- What are the costs during a friction period?

Generally speaking, absence from work reduces the effective labour time less than proportionally. Therefore, an estimate is required for the elasticity of annual labour time versus labour productivity. For the Netherlands, this elasticity was estimated to be 0.8 (*3*). In most countries an appropriate estimate for this elasticity, relevant for that country, or preferably for specific economic sectors or occupations should be available.

The friction cost method assumes that the production level is restored after (a part of) the friction period. The actual indirect costs of disease consist of the value of production lost and/or the extra costs to maintain production, and – if an employee is to be replaced permanently – the costs of filling a vacancy and training new personnel.

The average value of production per labour-year can be approximated by the quotient of the net national product (as the most direct measure of aggregate net value added) and the employment in labour years. This production value can be made age-, sex- and education level-specific by using data on gross labour incomes per labour-year according to age, sex and education level (assuming a linear relationship between gross income and value added per labour year). Age-, sex- and education level-specific data on participation in full-time and part-time labour can be used to calculate the average production value per employee (for absence and disability), and per person (for mortality).

- How can the medium term economic consequences of illness that extend beyond the friction period be estimated?

Absence from work and disability may have some macro-economic consequences (by means of their impact on labour productivity and competitiveness on the world market), which may be estimated through a macro-econometric model (see Koopmanschap (*11*)) in which the decrease of productive labour time per year per worker can be calculated.

Sensitivity analysis

The most uncertain parameters to be used in the friction cost method are the amount of lost production for short absence spells and the length of the friction period. Hence, it is recommended that a sensitivity analysis should be performed, particularly on these parameters. The alternative assumptions should be based on economic research or on knowledge of the statistical distribution of these parameters in the available data.

If these parameters are not available, it is acceptable to choose quite radical assumptions, such as:

- A lower or higher elasticity of labour time versus production, for example 0.9 vs 0.6, as a result of internal labour reserves, again providing a lower bound estimate;
- A long friction period of, for example 6 months, to be used as an upper bound estimate of indirect costs, which may apply in case of a tight labour market.

<u>Human capital method</u>

The average number of life-years lost is calculated from the average age at death from violence related injury (data to be obtained from hospital and mortuary records) and the average age at which a person ceases to work.

For non-fatal injuries due to violence, time lost is measured in days. Information on inactive days caused by slight or serious injuries can be obtained from hospital records, employers' records, insurance company records and case studies. For calculating the average value of lost days and years, researchers should attempt to determine the age/sex-specific wage rates and multiply these by the time lost. In the absence of age/sex-specific wage data, the value of lost days can be calculated on the basis of national wage rates before tax, as published by national governments. Although average national wage rates may equally value the time and lives of individuals in different occupational and earning categories, this method may not account for lost market productivity in the presence of non-random distributions of injury burden in the population. Information on the employment status and occupation of injury victims is also valuable in adjusting estimates of lost productivity costs.

After the identification of cost categories, measurement of utilization and valuation the relevant information can be collected and cost calculations can be made.

4.4 Basic data requirements for estimating lost productivity

When performing an analysis of injuries among individual patients and/or workers, it is most straightforward to collect data on absence from work and disability by means of general statistics or employers registrations. Data on presenteeism (and possibly absence from work) is normally collected by means of patient questionnaires.

The basic data requirements for estimating lost productivity are as follows:

- National data of incidence of disability and mortality, according to age, sex and, if possible, educational level (Inc);
- average age at death from injury (D1);
- average age at retirement/at which a person ceases to work (D2);
- the average number of days an injury patient is unable to resume her/his normal activities (at the hospital and recovering at home) (D3), collected by general statistics/ employer registrations and/or patient questionnaires;
- average wage rate per capita per day (D4), derived from available age/sex-specific wage data or national wage rates;
- The average value of production per person per day, by age and gender (D5);
- Costs of reduced production, measured by hours reduced productivity (presenteeism) (Pr), collected by means of patient questionnaires (e.g. PRODISQ or HLQ);
- a discounting factor, Dr (see below), based on a discount rate of 3%, which should be applied to discount future costs on the principle that people value income in the present more than they do an equivalent amount in the future;
- Friction period (FP): the length of the friction period is based on the average vacancy duration, preferably by education level. It is necessary to obtain statistics on completed vacancy durations, or estimates of completed vacancy durations, based on data on uncompleted vacancy durations and the number of vacancies;
- Elasticity (El) of annual labour time versus labour productivity, which is 0.8.

Source: part of the basic data requirements are from Butchart and colleagues (*21*).

If no national data is available or productivity costs of specific injury groups will be studies desaggregated data can be collected by detailed registries and patient questionnaires on frequency, sequence and length of absence (and reduced productivity) spells, and incidence of disability by age, sex, education level, profession, wage and number of hours worked.

4.5 Calculations

The table below provides the basic equation for calculating loss of production, both for the human cost as the friction cost method.

Table 4.1 Loss of productivity: required data and basic cost equations (Human cost and Friction cost method)

Severity of injury[1]	Required data	Basic costing equation
HUMAN CAPITAL METHOD		
Fatal	Inc, D1, D2, D4, Dr[2]	Inc × 365 × D4 × Dr × (D1 – D2)
Non-fatal injury	Inc, D3, D4	Inc × aD3 × D4
FRICTION COST METHOD		
Fatal	Inc, D5, FP, Pr[4], Dr[2], El3	Inc × FP × (D5*Pr) × Dr × 0.8
Non-fatal injury	Inc, D3, D5, FP, Pr[4], El[3]	Inc × MAX(D3,FP) × (D5*Pr) × 0.8

Inc = incidence of morbidity and mortality of injury patients.

[1] A fatal injury is one in which the patient dies as a result of the incident within 30 days.

[2] $Dr = 1 / 0.03 – 1 / [0.03 × (1.03)^{p2 – p1 + 1}]$.

[3] Elasticity = 0.8.

[4] Presenteeism can be established by means of the quality- and quantity method. The respondents give their marks for the quality and the quantity of their work on the last working day on a visual analogue scale. Pr = (1 – (quality/10) x (quantitiy/10)) x working hours per day (*22*)

4.6 Inventory of available data sources on indirect costs of injury in Europe

<u>Inventory of available literature on indirect costs of injury in Europe</u>

In this paragraph we will give a short description of the published literature about indirect costs due to injuries. There are only very few articles published about the indirect costs or economic production loss due to injuries. In the area of injury control, most attention has been given to the calculation of direct medical costs, although some studies included estimates of the indirect costs as well. Most of these studies are performed in the United States (*23, 24*). The only study with general information about indirect costs of injuries comes from the Netherlands (*7*). Furthermore, there are some economic evaluation studies about injury interventions or specific injury groups which included indirect costs (e.g. (*25*)).

The study of van Beeck (*7*) has shown that injuries are an important source of economic production losses (8% of the indirect costs resulting from all diseases) in the Netherlands.

The indirect costs of injuries are characterized by completely different patterns in terms of subcategory, age, and sex. Contrary to the direct medical costs, more than 80% of the indirect costs are the result of injuries of males. This result is produced independent of the valuation method used. In calculating the potential production losses for society (human-capital approach), traffic injuries are a major source of indirect costs, whereas occupational injuries are by far the largest subcategory when the actual production losses are computed (friction-costs method).

Inventory of available data sources on indirect costs of injury in Europe

It is most straightforward to collect data on absence from work and disability by means of general statistics or employers registrations. Data on presenteeism (and possibly absence from work) should normally be collected by means of patient questionnaires.

Countries around the world are at very different stages with regard to their capacity for data collection and, even when available, the quality of the data may not be suitable for research. Agencies and institutions keep records for their own purposes, following their own internal procedures, which means that their data may be incomplete or lack the information necessary for a proper understanding of indirect costs.

If no national general data statistics are available there are also some international websites that give information about (country specific) statistics. At the EUROSTAT website (http://epp.eurostat.ec.europa.eu) country specific information is given on for instance employment (employment rate by age/sex, average exit age, unemployment rate), labour market. Furthermore, the OECD website (www.oecd.org) gives information regarding employment and salaries.

Overview of data availability in the Netherlands

As an example we will give an overview of the available data in the Netherlands for calculating indirect costs due to injuries. In the Netherlands, the information on absenteeism of injury patients originates from the LIS-patient survey. Patients in paid employment before the accident are asked a number of questions designed to provide insight into the likelihood of absenteeism, the duration of absenteeism measured in working days and the likelihood of resuming work.

National registration data can be used on mortality (Statistics Netherlands), long-term work disability (Mutual Medical Service), and short-term absenteeism (Statistics Netherlands). Table 4.2 gives an overview of the available data in the Netherlands for calculating indirect costs.

Table 4.2 Overview of data in the Netherlands for calculating indirect costs of injury

Cost element	**Data**	**Source**
Absence paid labor	National registry	CBS
Absence non-paid labor	Population survey	CBS
Long-term work disability	National registry	GMD
Mortality	National registry	CBS
Value production loss because of fatal injuries	Lifetime earnings per person by age and sex	CBS
Value market production loss because of non-fatal injuries	Average earning per worker by age and sex	CBS

CBS, Centraal Bureau voor de Statistiek (Statistics Netherlands); GMD, Gemeentelijke Medische Dienst (Mutual Medical Service).

Conclusions and recommendations

In the EUROCOST project, a model has been developed for the calculation of injury costs in Europe. In a baseline model, in all countries similar selections of accidents and injuries were used (according to a modular approach), similar cost elements were included (ED visits and hospital admissions) and a uniform costing methodology was applied (application of a cost model, originally developed in the Netherlands). In the APOLLO project this model was subsequently tested and applied in seven European countries: Austria, Denmark, Latvia, Netherlands, Portugal, Slovenia, and UK, Wales.

The EUROCOST methodology (including data codes and software) has been made available to all 27 EU countries: http://www.eurosafe.eu.com/csi/eurosafe2006.nsf/wwwVwContent/l4module2economicconsequencesofinjury.htm. This allows the individual member states to calculate the medical costs of injury (with the help of a standard method) for every possible selection of injuries in their own surveillance system. With the EUROCOST baseline model, country-specific descriptions can be made of injury costs by age, sex, injury type and external cause. These descriptions inform policy makers about the size of specific problems, which may support priority setting. As far as policy-making is concerned, the added value of this cost model rests primarily in the opportunities it provides for ongoing and detailed monitoring of accident related injuries. Policy can be supported by detailed estimates of incidence, healthcare use and the direct medical costs of specific accident scenarios.

The EUROCOST model may in principle be used at the following three levels:

1. Describing injury costs by age, sex, injury type, and external cause at country level
2. Making international comparisons of injury costs between EU countries
3. Describing injury costs by age, sex, injury type, and external cause at EU level (EU-27)

In the APOLLO project we experiences again that the validity of results of the EUROCOST model at country level seems primarily dependent on the quality of the surveillance data. Individual countries were identified, where efforts may be needed to install surveillance systems that are representative for the national injury population.

The EUROCOST model has so far been restricted to calculations on the costs of injury of rather broad accident categories. In principal, more detailed descriptions are possible if the national surveillance system includes information on specific external causes. In order to support priority setting in injury prevention, those more detailed descriptions would be necessary. For some countries more detailed information is still available.

The EUROCOST baseline model is sufficient for making international comparisons of injury costs, but differences in surveillance systems and unit costs do obstruct the interpretation of results.
In addition, for the EUROCOST model several variants were constructed, aiming to minimize residing international variation based on surveillance system bias (due to differences in registration and health care practices) or cost model bias (due to incomparability of available unit costs per country).

Only direct medical costs are included in the EUROCOST model (costs borne by the health care sector). Direct non-medical costs (costs of patient help services, which are not borne by the healthcare sector) and indirect non-medical costs (productivity costs) have not yet been included in the cost calculations. The future development of the cost model concerning the inclusion of more cost items is mainly determined by the availability of good quality data. Therefore, in chapter 4 a guideline is developed for calculating indirect, productivity, costs which can be used to calculate the productivity costs due to injuries.

The main conclusions and recommendations of this research were:

- A uniform methodology can be applied in all countries with ED and/or HDR based surveillance systems. It enables the cost estimates to be compared between countries of the European Union.

- We have expanded the application of the uniform cost model to other EU-countries, including the new member states. After the 'hands on training' participating countries can manage the developed model. Participating countries are able to use the developed model. The EUROCOST model can now be used by all EU countries.

- The developed guidelines and tools are sufficient in guiding EU countries into the development of a method to calculate country specific direct medical costs of injury. Countries need to be aware that adjustments of the method and tools maybe necessary related to country specific available data or instruments.

- The validity of results of the EUROCOST model at country level seems primarily dependent on the validity of the surveillance data. Before applying the EUROCOST model to country specific data efforts may be needed to install surveillance systems that are representative for the national population.

- Particularly inadequate extrapolation of ED data towards national level is still a possible source of variation in injury incidence and costs. Therfore, the extrapolation of local sample data on injury incidence to national level should be validated and harmonized. A common procedure of extrapolation is available for the IDB data (https://webgate.ec.europa.eu/idb/).

- Guidelines towards calculating productivity costs due to injuries are developed and basic data requirements for estimating lost productivity are described. The guidelines involve three steps, namely identification of cost categories, measurement of utilization, and valuation in monetary terms.

- A next step for the future will be to complete the EUROCOST model, in which only medical costs of injury can be calculated, with indirect costs of injuries. The expanded method then allows the calculation of direct medical costs and productivity costs of injury by age, sex, external cause and type of injury at country level and EU level.

- For all European countries it would be worthwhile to use the tools for the calculation of costs of injury developed under APOLLO, since policymakers in the European Union need uniform data, allowing the straightforward comparison of the economic impact of injuries. This information is essential for purposes of priority setting in prevention.

References

1. **Polinder, S. et al.** A surveillance based assessment of medical costs of injury in Europe: phase 2. http:/www.euroipn.org/grd/attachments/80/final%20report.pdf, ErasmusMC and Consumer Safety Institute, 2004.
2. **Polinder, S. et al.** Cost estimation of injury related hospital admissions in ten European countries. *Journal of Trauma. 59* (6): 1283-1291 (2005).
3. **Koopmanschap, M.A. & Rutten, F.H.** A practical guide for calculating indirect costs of disease. *Pharmacoeconomics. 10* (5): 460-466 (1996).
4. **Mulder, S. et al.** Setting priorities in injury prevention: the application of an incidence based cost model. *Inj Prev. 8* (1): 74-8 (2002).
5. **Polinder, S. et al.** International variation in clinical injury incidence in ten European countries: performance of indicators based on health care, anatomical and outcome criteria. *AAP. 40*: 182-191 (2008).
6. **Lyons, R.A. et al.** Methodological issues in comparing injury incidence across countries. *International Journal of Injury control and Safety Promotion. 13* (2): 63-70 (2006).
7. **van Beeck, E.F. et al.** Medical costs and economic production losses due to injuries in the Netherlands. *J Trauma. 42* (6): 1116-23 (1997).
8. **Koopmanschap, M.** PRODISQ: a modular questionnaire on productivity and disease for economic evaluation studies. *Expert Rev Pharmacoeconomics Outcomes Res. 5* (1): 23-28 (2005).
9. **Koopmanschap, M. & Rutten, F.F.H.** Indirect costs in economic studies: confronting the confusion. *PharmacoEconomics. 4*: 446 (1993).
10. **Brouwer, W. et al.** Patient and informal caregiver time in cost-effectiveness analysis; a response to the recommendations of the Washington Panel. *Int J of Technology Assessment in Health Care 14*: 505-13 (1998).
11. **Koopmanschap, M. et al.** The friction cost method for estimating the indirect costs of disease. *Journal of Health Economics. 14*: 171-189 (1995).
12. **Brouwer, W.B.F. et al.** Productivity costs in cost-effectiveness analysis: numerator or denominator: a further discussion.Health Econ. 1997 Sep-Oct;6(5):511-4. *Health Econ. 6* (5): 511-4 (1997).
13. **Drummond, M. et al.** *Methods for the economic evaluation of health care programmes. Third edition*. Oxford, 2005.
14. **Liljas, B.** How to calculate indirect costs in economic evaluations. *Pharmacoeconomics. 13*: 1-7 (1998).
15. **Koopmanschap, M. et al.** Reply to Johanneson's and Karlsson's comment. *Journal of Health Economics. 16*: 257-259 (1997).
16. **Severens, R.J.F. et al.** Estimating the cost of lost productivity in dyspepsia. *Aliment Pharmacol Ther. 12*: 919-923 (1998).
17. **Jacob-Tacken, K. et al.** Correcting for compensating mechanisms related to productivity costs in economic evaluations of health care programs. *Health Econ. 14*: 435-43 (2005).
18. **Nicholson, S. et al.** Measuring the effects of work loss on productivity with team production. *Health Econ. 15* (2): 111-123 (2006).
19. **Krol M et al.** Productivity costs in health-state valuations: does explicit instruction matter? *24* (401-414) (2006).

20. **Roijen L van et al.** Labour and health status in economic evaluation of health care: the health and labour questionnaire. *Int J Technology Assessment in Health Care. 12* (3): 405-15 (1996).
21. **Butchart, A. et al.** Manual for estimating the economic costs of injuries due to interpersonal and self-directed violence. In: (U.S.), W.H.O.a.C.f.D.C.a.P., ed. *World Health Organization and Centers for Disease Control and Prevention (U.S.)*, 2008.
22. **Hoeijenbos, M. et al.** Cost-effectiveness of an active implementation strategy for the Dutch physiotherapy guideline for low back pain. *Health Policy. 75*: 85-98 (2005).
23. **Hartunian, N.S. et al.** The incidence and economic costs of cancer, motor vehicle injuries, coronary heart disease, and stroke: a comparative analysis. *Am J Public Health. 70*: 1249 (1980).
24. **Max, W. et al.** The lifetime cost of injury. *Inquiry. 27*: 332 (1990).
25. **Bastida, J.L. et al.** The economic costs of traffic accidents in Spain. *J Trauma. 56* (4): 883-889 (2004).

Annexes

Annex A Checklist for inventory of all available injury surveillance and health care consumption data systems

This annex is meant as a support by making an inventory of all available injury surveillance and health care consumption data systems in your country.

In this project 'injury' refers to all unintentional (home and leisure, transport, occupational) and intentional injuries. 'Injury surveillance system' refers to all more or less permanent systems that gather injury incidence data.

The overview will contain only existing injury surveillance and health care consumption systems of which data can be accessed and retrieved for research purposes.

Try to make an overview per data system:

1. **What is the name of this injury surveillance / health care consumption data system?**
2. **Who is the responsible organisation for this system?**
3. **Since when is this system operational?**
4. **What is the unit of registration in this system?**
   How is a record in the data system defined, e.g. a patient, a consultation, an admission (patients can be admitted more than once), a disease episode.
5. **Which category of patients are included in this system?**
   Define the patient group of whom data are collected. E.g. injury patients attending emergency departments, admitted patients, etc.
6. **What is the procedure of data collection for this system?**
   Describe how data are collected, what information sources are used (e.g. patient records, police notification), who registers and codifies information, and who checks the data.
7. **What is the frequency of data collection for this system?**
   Is it a continuous data system, or are data collected on a specified interval.
8. **Which are the recorded variables in this system?**
   Describe which items (variables) are registered:
   a. Of the victim/patient: e.g. age, date of birth, sex, destination at discharge. Try to be as precise as possible.
   b. Of the accident: e.g. mechanism, activity, location, products involved, type of sport, economic sector, vehicle type victim, vehicle type other actor. Also indicate whether specific classifications are used (e.g. ICD-9 E-codification, IDB, ISS(EHLASS), NOMESCO, ICE). Try to be as precise as possible.
   c. Of the diagnosis: type of injury, part of body injured, comorbidity. Also indicate whether specific classifications are used (e.g. IDB, ISS V2000, ICD-9, ICD-9-CM, ICD-10, ICIDH). Try to be as precise as possible.
   d. Of the treatment: e.g. mode of transportation to the hospital, date of admission, date of discharge, length of stay, type of admission (first admission vs. readmission), follow-up treatment, time of death. Also indicate whether specific classifications are used (e.g. International Classification of Medical Procedures). Try to be as precise as possible.

9. What are the methodological characteristics of this system?

This question concerns a number of key characteristics of any data system.

a. Coverage: The requested key parameters are: a) the percentage of the patient population under question 5. that is covered by the data system, b) the number of participating A&E departments, hospitals, physicians, etc. (depending on where the data system is based).

b. Representativity: Describe whether the data system is representative for the population under 5, or whether specific patient groups, regions, etc. are under- or overrepresented.

c. Validity/reliability: Describe to what extent the validity of the information in the data system is checked, e.g. by use of reference sources, specific procedures, experienced registration personnel.

10. How many months after a year of registration will data be checked and released?

11. How is the data availability of this system?

Indicate whether or not data are available electronically and whether they are collected locally and/or centrally.

12. Are there publications/reports available in which the (quality of the) data systems are described?

13. Which extrapolation factor is used in the ED data system, and how is it calculated?

Annex B Framework for assessment of content and quality of data systems

Make an assessment of the contents and quality of all the identified data sources.
All HDR and ED data systems have to be checked on:

- coverage,
- representativeness, and
- validity.

<u>Coverage</u>
The coverage of the data system can be calculated as follows:
Operationalisation 1: population in catchment area / total national population.
Population in the catchment area: population that is covered by the participating hospitals.

If no information is available about the population in the catchment area, coverage can be calculated as follows:
Operationalisation 2: admitted injury patients in participating hospitals / national total admitted injury patients.

<u>Representativeness</u>

- General operationalisation: under- and overrepresentativeness of specific characteristics; age, sex, urbanization, accident distribution, injury severity, type of injury. The information can partly be gathered by information of the organization of your data system and partly by analysis by yourself).
- Urbanization: the geographical description of the catchment area, e.g. which municipalities does the catchment area comprise. Source: contact person organization of your data system.
- Analyses of the representativeness of ED-data: Comparison of the characteristics of admitted injury patients in ED-systems with data of all admitted injury patients for the entire country (HDR) (for detailed information: see Validity). Source: analyses. For getting insight into the distribution of the patients by age, sex, injury group and admissions calculations have to be performed. Afterwards the project team will compare the outcomes of all participating countries, to search for deviations (e.g. for daycases, age-groups, sex) compared to the other participating countries.

<u>Validity</u>
The following analyses have to be performed to give insight into the validity of the data systems:

- Comparison of the admitted injury patients in ED with the HDR data (= 'gold standard'). Are ED-data of admitted patients comparable to the 'gold standard' (HDR) according to the breakdown of age, sex, accidents, injuries, and length of stay (LOS) between the patients? Differences can be tested by Chi-square tests (age, sex, injury groups, LOS in categories). The significance level is set at 0.05.
- Percentage of missing values of the most important variables (age, sex, injury, accident, hospital admission and length of stay). When the percentage of missings is below 5.0, it will not be mentioned.

Annex C Manual for the calculation of direct medical costs of injury

Manual for the calculation of direct medical costs of injury

The collection, harmonisation and analysis of data on injury incidence and related healthcare consumption and costs.

September 2008

Introduction

The aim of the project is to support EU countries in calculating the economic consequences of injury for purposes of priority setting in prevention.

The objective of this project and manual is:

- Exploration of methods and data to support EU countries in assessing indirect costs of injury with a uniform methodology. Within this manual indirect costs of injury will not be incorporated.
- Making electronical tools available to support EU countries in assessing direct medical costs of injury with a uniform methodology.

The injury field is very dynamic (specific problems may almost instantaneously rise or return) and heterogeneous (several causes may lead to a wide variety of injury types, ranging from minor to life-threatening). There fore, priority setting (i.e. addressing those problems with the most urgent need to implement interventions at a specific moment) is extremely important for policy makers within this area to efficiently reduce the national burden of injuries. Priority setting is preferably based on a set of reliable indicators of population health, including information on the medical costs of injury. Information about costs is an important supplement to epidemiological data, such as the incidence and mortality rates. High costs involved in a certain injury category and/or age group are an argument for policy makers to put extra effort in injury prevention addressing this problem. Recently, within the framework of the EUROCOST project, a uniform method to calculate medical costs of injury was developed and applied in 10 European countries (Polinder et al 2004). This method allows the calculation of medical costs of injury by age, sex, external cause and type of injury at country level and EU level. Moreover, due to several harmonization procedures, meaningful international comparisons of injury incidence and costs can be made.

In this guideline a description will be given about the collection, harmonisation and analysis of data on injury incidence and related healthcare consumption and costs. The steps are described that should be taken to calculate the direct medical costs of injury for your country.

Steps to be taken to calculate direct medical cost of injury:

1 Selection of data sources on injury incidence and health care consumption
1.1 Inventory of data availability and quality
1.2 Selection of data sources for the cost calculations

2 Adaptation of selected ED and HDR data to structure of EUROCOST model
2.1 Definition of injury; inclusion and exclusion of patients
2.2 Classification of injury groups
2.3 Classification of accident groups
2.4 Health care information
2.5 Extrapolation of ED data
2.6 Linkage of ED and HDR data

3 Calculation of unit costs

4 Cost calculations with EUROCOST model

1 Selection of data sources on injury incidence and health care consumption

For the EUROCOST-project data sets for the calculation of direct medical costs are based on the following injury incidence and health care consumption data systems:

- Emergency Department register (ED-system) or related surveillance systems; records of patients treated at an Emergency Department.
  -> preferably based on EU Injury Data Base (IDB), but any other system which can be transformed to the ED-data set description will do.
- Hospital Discharge Register (HDR-system); records of patients admitted to hospital.
  -> preferably based on ICD-9 or ICD-10, but any other system which can be transformed to the HDR-data set description will do.

Step 1.1 Inventory of data availability and quality

a. Preferably use an HDR and ED data system of the same year, and the most recent year available. Use the checklist in Annex A to make an inventory of the HDR and ED data system of your country. 'Injury surveillance system' refers to all systems that gather injury incidence data on a continuous base.
b. Make an assessment of the contents and quality of all the identified data sources. All data systems have to be checked on coverage, representativeness and validity. Use the framework in Annex B to make this assessment.

Step 1.2 Selection criteria of data sources

The following criteria for the selection (inclusion) of injury surveillance / health care consumption data systems must be followed:

a. The data system should contain accident information (transport, home and leisure (incl. sports), occupational, intentional).
b. The HDR data system should include unintentional and intentional injuries. The ED data systems should at least include home and leisure injuries. Preferably, the ED data system also includes transport, occupational, and intentional injuries (step 2.3).
c. The data system should contain the variables age, sex, part of body injured, type of injury and hospitalized (yes/no) as criteria for the composition of patient groups.
d. The data system should contain the ED attendances or hospital admissions (yes/no and length of stay) information.
e. The data system should be representative for a country/region (derived from step 1.1b).
f. If the data system is a sample an extrapolation factor(s) and its calculation method should be available.
g. The information in the data system should be valid (derived from step 1.1b).
h. If a data source meets criteria a-c, the project team will judge criteria d-f (based on information delivered by the data processor of the country). After this judgement a data source is removed or selected for the cost calculations. Get in touch with the project team.

2 Adaptation of selected ED and HDR data to structure of EUROCOST model

Two data systems, one based on ED-data and another based on HDR-data, have to be transformed into two separate datasets. See Annex D for the exact data set descriptions.

In the EUROCOST model (see figure 1) cost of injury will be estimated by multiplying the incidence of injuries by the average medical costs per patient. The average medical costs per patient are estimated by means of three parameters: health care use (e.g. average length of stay), costs (e.g. costs of one inpatient day in hospital), and transition probability (e.g. probability of hospitalization).

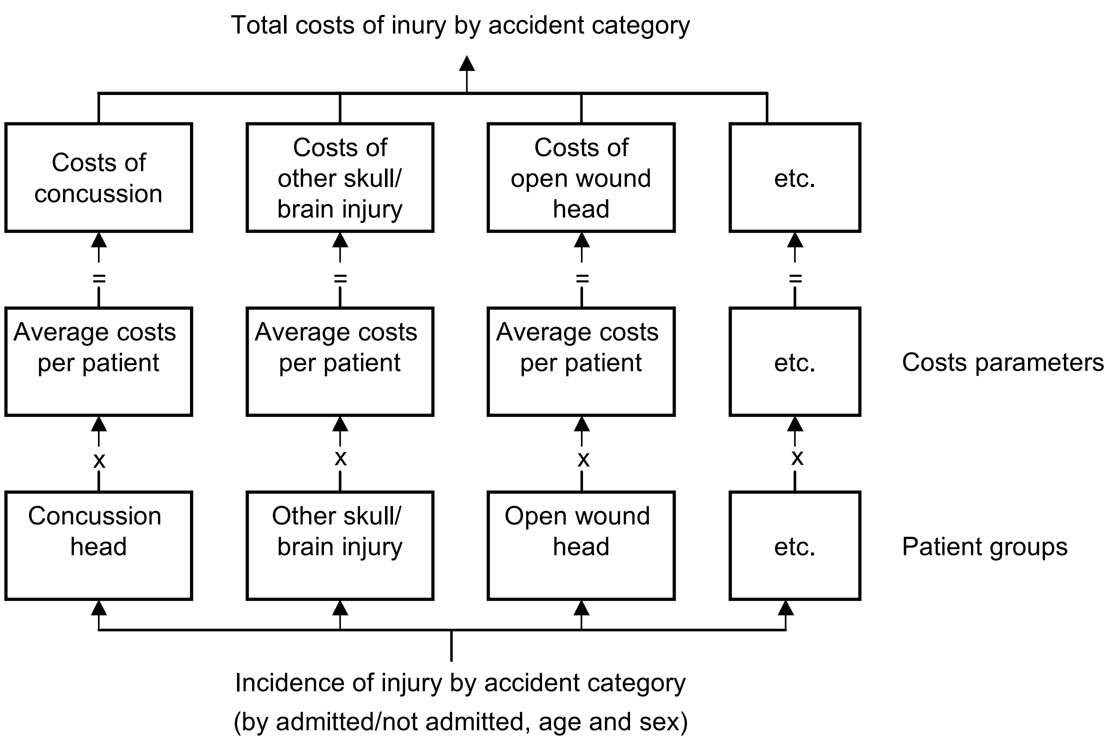


Figure 1 Diagram of EUROCOST-model

Step 2.1 Definition of injury; inclusion and exclusion of patients

The theoretical definition of **injury** is problematic since there is no scientific basis for a distinction between disease and injury. Traditionally, however, the term has been used to refer to damage to the body produced by energy exchanges that have relatively sudden discernible effects (Langley, 2002). Injuries can be distinguished in unintentional and intentional injuries. **Unintentional injuries** are those sustained by the victims of an accident. They are caused by sudden events, which were not intended to happen. **Intentional injuries** are either self-inflicted (suicide and attempted suicide) or the result of interpersonal violence (homicide and assault) (van Beeck, 1998). Both unintentional and intentional injuries are the result of a wide range of specific external causes, including accidents.

In the EUROCOST-model injury incidence concerns injury patients that attend an ED and/or are hospitalized. It includes all external causes (both unintentional and intentional). Differences, caused by varying classification and registration practices, should in principle be minimised by using comparable case selections.

a. Inclusion: All levels of severity
Include injuries of all severity levels in ED-data and/or HDR-data. No prior exclusions based on anatomical severity are allowed.

b. Exclusion: Injury due to medical adverse events
Cases with the following codes are to be removed from the HDR-data: medical procedures (ICD-9: E870-E879 and E930-E949 or ICD-10: Y40-Y84 and Y88). Injury due to 'misadventures to patients during surgical and medical care' (ICD-9: E870-E876 or ICD-10: Y60-Y69), 'surgical and medical procedures as the cause of abnormal reaction of patients or later complication, without mention of misadventure at the time of procedure' (ICD-9: E878-E879 or ICD-10: Y83-Y84), and 'drugs, medicaments and biological substances causing adverse effects in therapeutic use' (ICD-9: E930-E949 or ICD-10: Y40-Y59 and Y70-Y82), traditionally have not been considered the domain of injury prevention.

c. Separate category:Late consequences of injury
Late consequences of injury (ICD-9: E929 or ICD-10: Y85-Y87 and Y89) from the HDR-data have to be described in a separate category.

d. Separate category: Day patients
Patients whose stay in hospital was less than a day (i.e. did not stay overnight) have to be described as day patients. Day patients are often difficult to identify, because not all countries use the same definition for a day case and/or used the same coding practice, and not all HDR-systems included day cases. Classify day cases and inpatients with a zero length of stay both as the separate category ‘day patients’ in HDR-data. Day patients are to be classified as a separate category.

e. Separate category: Readmissions
Hospital readmissions have - if possible - to be distinguished from first admissions and should be classified as a separate category. Readmissions are to be classified as a separate category in HDR-data.

Step 2.2 Classification of injury groups

Injuries will be classified according to 39 injury groups. Use conversion tables for EU Injury Data Base (IDB or ISS V2000), ICD-9 or ICD-10 classifications (see Annex E).

In case patients have more than one injury, the primary injury can be determined using a hierarchical key for admitted patients or non-admitted patients (see Annex F).

The 39 injury groups (Base level) can be clustered into 10 groups. The aim of using injury groups on cluster level is to minimize the problems of differences in classification and registration practices between countries. Problems of classification and registration are:

a. Misclassification of injuries: injuries may be wrongly coded.
b. Differences in injury classifications: in some countries ED-systems provide more detail than others, or use slightly different categories.
c. Very low incidence, and therefore uncertainty in country-specific estimates.
d. Incomplete registration of multiple injuries (underreporting).

Clustering of the 39 injury groups can solve some of these problems (see Annex G).

Step 2.3 Classification of accident groups

An **accident** is defined as 'an unexpected and unintended event caused by external forces, resulting in acute physical injury' (van Beeck, 1998). Unintentional injuries are caused by three types of accidents; home and leisure accidents, transport accidents, and occupational accidents. In addition, they may be caused by medical procedures, but these were not considered.

We use the term 'accident group' to distinguish between home and leisure (incl. sports), transport and occupational accidents as well as violence and intentional self-harm (including suicide), even though violence and intentional self-harm do not, strictly speaking, fall within the concept of 'accident'.

A modular approach towards estimating injury incidence and health care consumption by external cause will be used, because not all countries have similar data available for all external causes. The minimum datasets have to be available to participate in the EUROCOST project. The additional datasets are optional.

Two minimum datasets of injury incidence data are defined:

- Minimum set 1: ED incidence of home and leisure injury (home and leisure and sports)
- Minimum set 2: Hospital admissions of unintentional and intentional injury

Beside these minimum datasets four additional (optional) modules of injury incidence can be defined:

- ED incidence of transport injury (Module 1)
- ED incidence of occupational injury (Module 2)
- ED incidence of unintentional and intentional injury (home and sport and transport and occupational and violence and intentional self-harm) (Module 3)
- ED incidence of intentional injury (violence and intentional self-harm) (Module 4)

Make an assessment of your data sources and define the minimum sets and/or modules that can be implemented in your country. Document for each of the selected minimum sets and modules which classification system (ICD-9, ICD-10, IDB, other) and level of detail is used.

See Annex H for recodes from ED-/HDR-datasets to EUROCOST type of accident.

Step 2.4 Health care information

Within the EUROCOST-model calculations can be performed with injury information on ED-treatments, hospital admissions and the length of stay during a hospital admission.

Provide information in the datasets about ED attendances and/or Hospital admissions and Length of stay (LOS) in hospital (see Annex D data set description).

Step 2.5 Extrapolation of ED-data

Because ED-systems do not have nation-wide coverage, the country-specific ED-incidence data have to be extrapolated towards national level. For this aim, use extrapolation factors, as available for your country.

Nation-wide estimates of the incidence of injury can be arrived at using an extrapolation factor that is the inverse of the coverage.

An extrapolation factor (age and sex specific) should preferably be attained from the responsible organization of the data system (method A).

If no extrapolation factor is available, the extrapolation factor can be calculated following two methods. The method used depends on the available information. The calculations are described in order of preference:

1. The whole population of the country divided by the population covered by the catchment area, distinguished by age and sex. (method B).
2. The total admitted injury patients of all hospitals together in the whole country divided by total of the admitted injury patients of the participating hospitals of the data system, distinguished by age and sex (method C).

Step 2.6 Linkage of ED and HDR data

The ED and HDR data systems will be linked to each other in an aggregated file.
Some ED patients will be admitted later (delayed admission), or will be readmitted. The hospitalization of these patients is not registered in ED systems, but is registered in the HDR. For the costs calculations it is assumed that neither of these patients visited the ED. The basic assumption that the extra patients are directly admitted to the hospital with no treatment in the emergency department is not always congruent with clinical practice. However, the cost calculations are based on the best available data systems.

Calculation of correction factor of hospitalization

ED surveillance systems contain a sample, which means that the estimated hospital inpatient rate does not perfectly match the reality, in particular if the ED sample is small. For these reasons, the HDR will be the starting point of the hospital inpatient rate. The registered admitted ED patients have to be corrected for HDR admissions by a correction factor. The correction factor is the probability that an injury patient will use a certain form of healthcare (e.g. the probability of being admitted to a hospital). To calculate the correction factor of hospitalization, for each specific patient group (divided by age/sex/injury) the number of admitted patients have to be compared for ED and HDR.
A patient's health care route is determined by correction factors, such as the probability of hospitalization. The probability of hospitalization multiplied by the average period of nursing (= care volume) results in the average duration of hospitalization for a patient group per country.

<u>Example</u>

1000 ED registered patients
- 50 of these patients registered as admitted in ED
- 60 of these patients registered as admitted in HDR

Correction factor of this specific patient group = 60 / 50 = 1.2

Calculation of mean length of stay

For each specific patient group in the ED (divided by age, sex and injury group) the mean length of stay can be calculated in the HDR. It is assumed that the HDR gives more valid information about mean length of stay per patient group than ED-systems. Not for all specific patient groups the mean length of stay (by injury group, age and sex) can be calculated. For some patient groups the length of stay is missing. For these groups the mean length of stay by injury group can be used.

Specific patient groups without ED registration

A problem with linking HDR to ED surveillance system data is that for some specific patients groups no ED registrations are available, while there are patients recorded in the HDR (e.g. patients with whiplash are recorded in HDR and not in ED systems). In the cost calculations, using transition probabilities, these patients are not taken into account. This results in an underestimation of the transition probability. For these specific patient groups of which no ED registration was available, the numbers of patients registered in the HDR are starting point of the analyses. These patients have to be added to the hospital inpatient rate.

3 Calculation of unit costs

The calculation of the direct medical costs (costs within the healthcare sector) of injury is restricted to hospital costs of inpatients, consisting of costs per inpatient day in hospital and ED costs preceding the hospitalization and ED visits only.
The total costs are the sum of the number of ED visits multiplied by the unit costs per ED visit and the number of hospital admissions multiplied by length of stay and unit costs per inpatient day.

The term **'unit cost per hospital inpatient day'** is used for the unit cost for one inpatient day in hospital for medium care (costs for ICU are not included).
The term **'unit cost per Emergency Department visit'** is used for the unit cost for one ED visit in hospital,

Both unit costs should be the average costs for all patients (not only injury patients) for general and university hospitals, public and private hospitals. The unit costs include costs for staff, costs for diagnostics, therapy and medication, and overhead costs (e.g. hotel costs and management costs). Research and education costs are not included in the unit costs of the EUROCOST project.
International comparisons of the costs of injury can only be made, when comparable unit costs of each country are available. In order to make calculations with the EUROCOST model the available unit costs will be adjusted in such a way that in all countries similar cost categories will be included.
Unit costs should be based on the same year of the data systems.

The unit cost per hospital inpatient day is calculated in several steps, which are described below:

- Step 1: Collect the relevant cost information by standard data source(s).
- Step 2: Complete the excel workbook 'unit costs per inpatient day'. Unit costs were broken down into nursing department costs, diagnostics, medication, and location costs.
- Step 3: If data on specific cost categories are absent, these can be estimated based on the mean costs of these categories of the EUROCOST countries, adjusted for differences in price level among countries. We used information on purchasing power parities from the OECD (see box) to convert the mean EUROCOST unit cost back to the national price level.
- Step 4: If the cost information is of an earlier year than 2005, re-calculate the unit costs for the year 2005, based on country-specific inflation rates.
- Step 5: Indicate the data sources from which data were extracted.

The same can be done for the ED unit cost. For the ED unit costs it is not necessary to collect data from separate cost categories.

The **purchasing power parity** (PPP) can adjust unit costs for differences in price levels among countries. The purchasing-power parity theory states that the exchange rate between one currency and another is in equilibrium when their domestic purchasing powers at that rate of exchange are equivalent. An international dollar has the same purchasing power as the U.S. dollar has in the United States. Costs in local currency units are converted to international dollars using PPP exchange rates. A PPP exchange rate is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States. An international dollar is therefore a hypothetical currency that is used as a means of translating and comparing costs from one country to the other using a common reference point, the U.S. dollar. We used the PPP exchange rates from the OECD Health Data.

4 Cost calculations with EUROCOST model

Costs are the product of incidence, transition probabilities, health care use and unit costs. A patient's health care route is determined by correction factors, such as the probability of hospitalization. The probability of hospitalizations multiplied by the average period of nursing (= care volume) and the comprehensive unit costs per country results in the average costs of hospital nursing for a patient group per country. The care volume is expressed in the units normally applied to health care use, namely ED visits and inpatient days in hospital.

Baseline model

The baseline model gives an overview of the uniform methodology that has been used for analysing the injury incidence, health care consumption and costs in the EUROCOST project. This uniform methodology, or baseline model (see table underneath), is the starting point for the international comparisons of the data that have to be conducted.

Table Baseline model

Incidence	Selection external causes: exclusion medical procedures (HDR) Exclusion of day cases (HDR) No exclusion of readmissions (HDR) No selection of specific more severe injuries (ED + HDR) Extrapolating data with extrapolation factor (ED-incidence)
Healthcare Consumption	Selection of ED attendances, hospital inpatient admissions (length of stay), and day cases Registered admitted patients in ED will be corrected by transition probability (correction with HDR admissions) Mean length of stay per injury group of the HDR data system was used
Costs	Comprehensive unit costs per country (for ED visits and hospital stay) are used for calculations

Calculation method - example

With the help of the EUROCOST model the mean medical costs can be calculated by patient group in which a patient is classified based on country, age, sex and injury group. As an example we have calculated the costs of a 9-year-old girl from Denmark with a concussion.

Table Calculation example: 9-year-old girl, admitted for concussion

Classification criteria	
Country	Denmark
Injury group	Concussion
Age	5 to 14
Sex	Women
Cost calculations	
Admitted patients ED	91 patients
Correction factor hospitalization	2.4
Mean length of stay	1.2 days
Cost per inpatient day in hospital	€ 465
Cost per ED visit	€ 113
Total costs = (91 * € 113) + (91 * 2.4 * 1.2 * € 465) = € 132,150	
Mean costs per patient = € 132,150 / (91 * 2.4) = € 606	

References

Polinder S, Meerding WJ, Toet H, van Baar, ME, Mulder S, van Beeck EF, and the Eurocost reference group. A surveillance based assessment of medical costs of injury in Europe: final report. 2004, ErasmusMC, Department of Public health: Rotterdam.

Langley, J., S. Stephenson, C. Cryer, and B. Borman. Traps for the unwary in estimating person based injury incidence using hospital discharge data. Inj Prev, 2002. 8(4): p.332-7

Van Beeck EF: Injuries: a continuous challenge for public health. Rotterdam, Thesis Erasmus University: 1998

Other recommended references

Polinder S, Meerding WJ, van Baar ME, Toet H, Mulder S, van Beeck EF, and the Eurocost reference group. Cost estimation of injury related hospital admissions in ten European countries. Journal of Trauma. 2005; 59: 1283-1291.

Lyons RA, Polinder S, Larsen CF,et al. Methodological issues in comparing injury incidence across countries. International Journal of Injury Prevention and Safety Promotion 2006;13:63-70.

Polinder S, Meerding WJ, Mulder S, Petridou E, van Beeck E and Eurocost reference group. Assessing the burden of injury in six European countries. Bull WHO 2007; 85(1): 27-34.

Annex D Data set descriptions

In this document an indication is given of the data sets that are required for this project. There are two separate data set definitions: one for ED data systems (IDB/ISS V2000) (Table 1), and one for HDR data systems (Hospital Discharge Register systems) (Table 2).

Table 1 Data set description for ED data systems (IDB/ISS V2000), primary and additional variables

Variable name	Variable definition use and instructions	Values and labels	Value of missings	Position	Length	Variable type
Primary variables						
Year	The most recent year available.	Year	--	1	4	N (numeric)
Age	The most detailed available level.	Years	999	5	3	N
Sex		1 = male, 2 = female	9	8	1	N
Extrap	Extrapolation factor by which incidence should be multiplied in order to arrive at national estimates.		999999	9	6	N
Hospadm	Whether the patient is admitted to a hospital for treatment.	1 = admitted, 2 = not admitted	9	15	1	N
LOS	Number of days a patient spends in hospital. Length of stay (LOS) is calculated as the date of discharge minus the date of admission. In case a patient is discharged at the day of admission, the LOS is zero.	Exact number	999	16	3	N
Intent	Selection of injury events (according to IDB-classification). For ISS data systems code all cases as Intent = 1	Use original codes 1 = unintentional, 2 = intentional self-harm, 3 = assault, 4 = other violence, 5 = undetermined intent, 8 = other specified intent, 9 = unspecified intent	9	19	1	N
Transp	Transport injury event (according to IDB-classification). For ISS data systems code all cases as Transp = 9.	Use original codes 1 = yes, 2 = no, 9 = unknown	9	20	1	N

Activity	Activity when injured (according to IDB-classification). For ISS data systems code sports cases = 5 (50-59), other cases = 99	Use original codes	999	21	4	N if ISS, T (text) if IDB
Injtype1	Type of injury nr. 1. Use original IDB/ISS-coding.	Use original codes	99	25	2	N
Injtype2	Type of injury nr. 2. Use original IDB/ISS-coding.	Use original codes	99	27	2	N
Injpart1	Part of the body injured nr 1. Use original IDB/ISS-coding.	Use original codes	9999	29	4	N if ISS, T if IDB
Injpart2	Part of the body injured nr 2. Use original IDB/ISS-coding.	Use original codes	9999	33	4	N if ISS, T if IDB
Additional (new to create) variables						
Injury	Primary injury defined and labelled according to injury group definitions in Annex E.	1 = brain injury, 2 = other skull-brain injury, etc.	99	37	2	N
Injuryl1	Injury groups clustered (cluster 1) according to Annex G.	1 = skull-brain injury, 2 = open wound head and face, etc.	99	39	2	N
Injuryl3	Injury groups clustered (cluster 3) according to Annex G.	1 = head and facial injury, 2 = eye injury, etc.	99	41	2	N
Accident	Type of accident. Accident defined and labelled according to type of accident definitions in Annex H.	1 = home and leisure, 2 = sports, 3 = transport, 4 = occupational, 5 = violence, 6 = intentional self-harm	9	43	1	N
Age7	Age defined into 7 groups.	1 = 0-14, 2 = 15-24, etc.	9	44	1	N
Age20	Age defined into 20 groups.	1 = 0-4, 2 = 5-9, etc.	99	45	2	N
LOS4	Length of stay (LOS) in 4 categories.	0 = 0, 1 = 1-3, 2 = 4-6, 3 = 7+	9	47	1	N

Source: EUROCOST-project

Table 2 Data set description for HDR data systems (Hospital Discharge systems), primary and additional variables

Variable name	Variable definition use and instructions	Values and labels	Value of missings	Position	Length	Variable type
Primary variables						
Year	The most recent year available.	Year	--	1	4	N (numeric)
Age	The most detailed available level.	Years	999	5	3	N
Sex		1 = male, 2 = female	9	8	1	N
LOS	Number of days a patient spends in hospital. Length of stay (LOS) is calculated as the date of discharge minus the date of admission. In case a patient is discharged at the day of admission, the LOS is zero.	Exact number	999	9	3	N
Extcause	Type of accident (External cause). Use original external-cause-of-injury coding: E800-E999-codes for ICD-9 or V01-Y98-codes for ICD-10.	Use original codes Example preferred ICD-9 coding: E880 Example preferred ICD-10 coding: W10	9999	12	4	T (text)
Primdiag	Primary diagnosis nr 1. Primary diagnosis is the main cause of the hospitalization as indicated by the physician. Use original injury coding: 800-999 codes for ICD-9 or S00-T98-codes for ICD-10	Use original codes Example preferred ICD-9 coding: 88020 Example preferred ICD-10 coding: S45.0	999999	16	6	N if ICD-9, T if ICD-10
Primdiag2	Primary diagnosis nr 2 (additional)– depends of your data system. Use original injury coding: 800-999 codes for ICD-9 or S00-T98-codes for ICD-10	Use original codes Example preferred ICD-9 coding: 88020 Example preferred ICD-10 coding: S45.0	999999	22	6	N if ICD-9, T if ICD-10
Primdiag3	Primary diagnosis nr 3 (additional)– depends of your data system. Use original injury coding: 800-999 codes for ICD-9 or S00-T98-codes for ICD-10	Use original codes Example preferred ICD-9 coding: 88020 Example preferred ICD-10 coding: S45.0	999999	28	6	N if ICD-9, T if ICD-10
Clinic	Type of clinic	1 = hospital, 2 = rehabilitation clinic	9	34	1	N

Admtype1	Admission type 1: Whether the admitted patient is day patient (did not stay overnight) or not.	1 = day patient, 2 = no day patient	9	35	1	N
Admtype2	Admission type 2: A readmission is defined as a second, third, etc, admission for the same injury in the same or another hospital.	1 = first admission, 2 = readmission	9	36	1	N
Latecons	Late consequences of injury. Whether the patient is admitted due to late consequences. ICD-9: E929 or ICD-10: Y85-Y87 and Y89	1 = yes, 2 = no, 9 = unknown	9	37	1	N
Additional (new to create) variables						
Injury	Primary injury defined and labelled according to injury group definitions in Annex E.	1 = brain injury, 2 = other skull-brain injury, etc.	99	38	2	N
Injuryl1	Injury groups clustered (cluster 1) according to Annex G.	1 = skull-brain injury, 2 = open wound head and face, etc.	99	40	2	N
Injuryl3	Injury groups clustered (cluster 3) according to Annex G.	1 = head and facial injury, 2 = eye injury, etc.	99	42	2	N
Accident	Type of accident. Accident defined and labelled according to type of accident definitions in Annex H.	3 = transport, 5 = violence, 6 = intentional self-harm, 7 = home and leisure (incl. sports) + occupational, 8 = all other injuries	9	44	1	N
Age7	Age defined into 7 groups.	1 = 0-14, 2 = 15-24, etc.	9	45	1	N
Age20	Age defined into 20 groups.	1 = 0-4, 2 = 5-9, etc.	99	46	2	N
LOS4	Length of stay (LOS) in 4 categories.	0 = 0, 1 = 1-3, 2 = 4-6, 3 = 7+	9	48	1	N

Source: EUROCOST-project

Annex E Injury group classifications

Table 1 Data set definition of injury groups IDB and ISS V2000

Injury group	IDB [1]		ISS V2000 [2]	
	Type of injury [a]	**Part of body injured [b]**	**Type of injury [c]**	**Part of body injured [d]**
Head				
1. brain injury	10	1.30	1	10
2. other skull-brain injury	2, 5, 8, 11, 19-20	1.30-1.40	2, 5, 8-9, 11	10, 11
3. soft tissue head injuries	4	1.21, 1.40	4	11, 12
Face				
4. eye injury	2-22, 24-99	1.10	1-99	13
5. fracture facial bones	5	1.22-1.24	5	14-16
6. open wound face	4	1.22, 1.24, 1.28-1.29	4	14, 16, 18, 19
Vertebrae/Spine				
7. fractures/dislocations/ sprain/strain	5-7	2.10, 3.10, 3.42	5-7	23, 32, 42
8. whiplash/neck sprain/distorsion cerval spine	99	2.99	99	29
9. spinal cord injury	19	2.10, 3.10, 3.42	8	23, 32, 42
Abdomen/Thorax				
10. internal organ injuries	2-11, 13-99	3.20 (3.21-3.29)	1-99	33, 34, 41
11. fracture rib/sternum	5	3.32, 3.38-3.39	5	31, 38-39
Upper extremity				
12. fracture of clavicle/scapula	5	4.10-4.20	5	50-51
13. fracture of upper arm	5	4.30	5	52
14. fracture of elbow/forearm	5	4.40-4.50	5	53-54
15. fracture of wrist (incl. carpal bones)	5	4.60	5	55
16. fracture of hand/fingers	5	4.70 (4.71-4.72)	5	56-57
17. dislocation/sprain/strain shoulder/elbow	6-7	4.20, 4.40	6-7	51, 53
18. dislocation/sprain/strain wrist/hand/fingers	6-7	4.60-4.70 (4.71-4.72)	6-7	55-57
19. injury of nerves	19	4.10-4.99	8	50-59
20. complex soft tissue injury	8-9, 20-21	4.10-4.99	9-12	50-59
Lower extremity				
21. fracture of pelvis	5	3.44	5	44
22. fracture of hip	5	5.10	5	60
23. fracture of femur shaft	5	5.20	5	61
24. fracture of knee/lower leg	5	5.30-5.40	5	62-63
25. fracture of ankle	5	5.50	5	64
26. fracture of foot (exc. Ankle)	5	5.60 (5.61-5.62)	5	65-66
27. dislocation/sprain/strain knee	6-7	5.30	6-7	62
28. dislocation/sprain/strain ankle/foot	6-7	5.50-5.60 (5.61-5.62)	6-7	64-66
29. dislocation/sprain/strain hip	6-7	5.10	6-7	60
30. injury of nerves	19	5.10-5.99	8	60-69
31. complex soft tissue injury	8-9, 20-21	5.10-5.99	9-12	60-69

Minor external				
32. superficial injury (incl. contusions)	2-3	1.20 (1.21-1.29), 1.98-1.99, 2.98-2.99, 3.30 (3.31-3.39), 3.41, 3.43-3.49, 4.10-9.99	2-3	12-20,28-31, 38-40,43-99
33. open wounds	4	2.98-2.99, 3.30 (3.31-3.39), 3.41, 3.43-3.49, 4.10-9.99	4	28-31, 38-40, 43-99
34. **Burns**	14	1.20 (1.21-1.29), 1.98-1.99, 2.98-2.99, 3.30 (3.31-3.39), 3.41, 3.43-3.49, 4.10-9.99	14	12-20,28-31, 38-40,43-99
35. **Poisoning**	23	1.10-9.99	13	10-99
36. **Multitrauma**	Not operational	Not operational	Not operational	Not operational
Other injuries				
37. foreign body	12	1.10-9.99	--	--
38. no injury after examination	1	1.10-9.99	97	10-99
39. other and unspecified injury	All other combinations		All other combinations	
Not included				

[1] IDB, version 1.1 (2005).
[2] Coding manual V2000 for HLA, ISS Database version august 2002 (2002).

Source: EUROCOST-project

[a.]= **Type of injury (IDB, version 1.1, 2005)**:

1 = No injury diagnosed
2 = Contusion, bruise
3 = Abrasion
4 = Open wound
5 = Fracture
6 = Luxation, dislocation
7 = Distorsion, sprain
8 = Crushing injury
9 = Traumatic amputation
10 = Concussion
11 = Other specified brain injury
12 = Consequences of foreign body entering through natural orifice
13 = Suffocation (asphyxia)
14 = Burns, scalds
15 = Corrosion (chemical)
16 = Electrocution
17 = Radiation (sunlight, X•rays)
18 = Frostbite
19 = Injury to nerves and spinal cord
20 = Injury to blood vessels
21 = Injury to muscle and tendon
22 = Injury to internal organs
23 = Poisoning
97 = Multiple injuries
98 = Other specified type of injury
99 = Unspecified type of injury

[b.] = **Part of body injured (IDB, version 1.1, 2005)**:

1.10 = Eye area
1.20 = Face, other and unknown part
1.21 = Ear
1.22 = Nose
1.23 = Teeth
1.24 = Jaw/cheek
1.25 = Lip and oral cavity
1.28 = Face, other specified
1.29 = Face, unspecified
1.30 = Brain
1.40 = Skull
1.98 = Other specified part of the head
1.99 = Unspecified part of the head
2.10 = Cervical spine
2.20 = Organs throat
2.98 = Neck, throat, other specified
2.99 = Neck, throat, unspecified
3.10 = Thoracic spine
3.20 = Organs trunk
3.21 = Lungs, bronchus
3.22 = Heart
3.23 = In- and external genital organs
3.24 = Intra abdominal organs (eg., spleen, colon)
3.25 = Pelvic organs (eg., kidney, bladder)
3.28 = Organs trunk, other specified
3.29 = Organs trunk, unspecified
3.30 = Thorax
3.31 = Chest
3.32 = Ribs and sternum
3.38 = Thorax, other specified
3.39 = Thorax, unspecified

3.40 = Abdomen, lower back, lumbar spine and pelvis
3.41 = Abdomen, external
3.42 = Lower spine (lumbar and sacral)
3.43 = Lower back, buttocks
3.44 = Pelvis
3.48 = Abdomen, other specified
3.49 = Abdomen, unspecified
3.98 = Trunk, other specified
3.99 = Trunk, unspecified
4.10 = Collar bone
4.20 = Shoulder
4.30 = Upper arm, humerus
4.40 = Elbow
4.50 = Forearm, lower arm
4.60 = Wrist
4.70 = Hand, fingers
4.71 = Hand
4.72 = Fingers
4.98 = Upper extremities, other specified
4.99 = Upper extremities, unspecified
5.10 = Hip
5.20 = Upperleg, thigh
5.30 = Knee
5.40 = Lower leg
5.50 = Ankle
5.60 = Foot and toes
5.61 = Foot

5.62 = Toes
5.98 = Lower extremities, other specified
5.99 = Lower extremities, unspecified
7.10 = Multiple body parts affected
7.20 = Whole body affected
9.10 = Organs, level not specified
9.98 = Body part, other specified
9.99 = Body part, unspecified

[c.]= **Type of injury (Coding manual V2000 for HLA, ISS Database version august 2002)**:
1 = Concussion
2 = Contusion, bruise
3 = Abrasion
4 = Open wound
5 = Fracture
6 = Luxation, dislocation
7 = Distorsion, sprain
8 = Injury to nerve(s)
9 = Injury to blood vessels
10 = Injury to tendon(s) and/or muscle(s)
11 = Crushing
12 = Amputation
13 = Poisoning
14 = Burns, scalds
15 = Corrosion
16 = Electrocution
17 = Radiation
18 = Frostbite
19 = Suffocation (asphyxia)
97 = No injury diagnosed
98 = Type of injury, other specified
99 = Type of injury, unspecified

[d.]= **Part of body injured (Coding manual V2000 for HLA, ISS Database version august 2002)**:
10 = Brain
11 = Skull
12 = Ear
13 = Eyeball, eyelid
14 = Nose
15 = Teeth
16 = Jaw/cheek
17 = Lip and oral cavity
18 = Head, other specified
19 = Head, unspecified
20 = Neck
21 = Throat, internal parts
23 = Cervical spine
28 = Neck/throat, other specified
29 = Neck/throat, unspecified
30 = Chest, external
31 = Ribs and sternum
32 = Thoraric spine
33 = Lungs, bronchus
34 = Heart
38 = Thorax, other specified
39 = Thorax unspecified
40 = Abdomen, external
41 = Abdome, internal organs
42 = Lower spine
43 = Lower back, buttocks

44 = Pelvis
45 = Genitals
46 = Abdomen, other specified
49 = Abdomen, unspecified
50 = Collar bone
51 = Shoulder
52 = Upper arm, humerus
53 = Elbow
54 = Forearm, lower arm
55 = Wrist
56 = Hand, excl. fingers
57 = Fingers
58 = Upper extremities, other specified
59 = Upper extremities, unspecified
60 = Hip
61 = Upper leg/thigh
62 = Knee
63 = Lower leg
64 = Ankle
65 = Foot, excl. toes
66 = Toe
68 = Lower extremities, other specified
69 = Lower extremities, unspecified
70 = Multiple body parts affected
75 = Whole body affected
98 = Body part, other specified
99 = Body part, unspecified

Table 2 Data set definition of injury groups ICD-9CM and ICD-10

Injury group base level	ICD-9CM	ICD-10
Head		
1. brain injury	850	S06.0
2. other skull-brain injury	800-801, 803-804, 851-854, 950-951	S02.0-1, S02.7, S02.9, S06.1-9, S04.0-9, S07.1-9, T02.0, T04.0
3. soft tissue head injuries	873.0-1	S01.0, S08.0
Face		
4. eye injury	870-871, 918	S01.1, S05.0-9
5. fracture facial bones	802	S02.2-6, S02.8
6. open wound face	872, 873.2-9	S01.2-9, S08.1-9, S09.2
Vertebrae/Spine		
7. fractures/dislocations/ sprain/strain	805, 839.0-5, 846, 847.1-9	S12.0-7, S12.9, S13.0-3, S13.6, S22.0-1, S23.0-1, S23.3, S29.0, S32.0-2, S33.0-2, S33.5-7, T02.1, T03.0-1, T08, T09.2
8. whiplash/neck sprain/distorsion cerval spine	847.0	S13.4
9. spinal cord injury	806, 952	S14.0-1, S24.0-1, S34.0-1, S34.3, T06.1, T09.3
Abdomen/Thorax		
10. internal organ injuries	860-869, 900-902, 926, 929	S26.0-9, S27.0-9, S29.7, S36.0-9, S37.0-9, S39.6-9, T06.5
11. fracture rib/sternum	807.0-3, 809	S22.2-4, S22.8-9
Upper extremity		
12. fracture of clavicle/scapula	810-811	S42.0-1, S42.7-9
13. fracture of upper arm	812.0-3	S42.2-3
14. fracture of elbow/forearm	812.4-5, 813.0-3, 813.8-9	S42.4, S52.0-4, S52.7-9
15. fracture of wrist (incl. carpal bones)	813.4-5, 814	S52.5-6, S62.0-1
16. fracture of hand/fingers	815-817	S62.2-8
17. dislocation/sprain/strain shoulder/elbow	831-832, 840-841	S43.0-7, S53.0-4
18. dislocation/sprain/strain wrist/hand/fingers	833-834, 842	S63.0-7
19. injury of nerves	953.0-1, 953.4, 955	S14.2-4, S24.2, S44, S54, S64, T11.3
20. complex soft tissue injury	880.2, 881.2, 882.2, 883.2, 884.2, 885-887, 903, 927	S45-S49, S55-S59, S65-S69, T04.2, T05.0-2, T11.4-9
Lower extremity		
21. fracture of pelvis	808	S32.3-8
22. fracture of hip	820	S72.0-2
23. fracture of femur shaft	821.0-1	S72.3, S72.7-9
24. fracture of knee/lower leg	821.2-3, 822, 823	S72.4, S82.0-2, S82.4, S82.7-9
25. fracture of ankle	824	S82.3, S82.5-6
26. fracture of foot (exc. Ankle)	825, 826	S92.0-9
27. dislocation/sprain/strain knee	836, 844	S83.0-7
28. dislocation/sprain/strain ankle/foot	837-838, 845	S93.0-9
29. dislocation/sprain/strain hip	835, 843	S73.0-1
30. injury of nerves	953.2-3, 953.5, 956	S34.2, S34.4-8, S74, S84, S94, T13.3
31. complex soft tissue injury	890.2, 891.2, 892.2, 893.2, 894.2, 895-897, 904, 928	S15.1, S75-S79, S85-S89, S95-S99, T04.3, T05.3-5, T06.3, T13.4-9, T14.5

Minor external		
32. superficial injury (incl. contusions)	910-917, 919-924	S00,S10, S20, S30, S40,S50, S60,S70, S80,S90, T00, T09.0,T11.0, T13.0,T14.0
33. open wounds	874-884 (excl. 880.2, 881.2, 882.2, 883.2, 884.2), 890-894 (excl. 890.2, 891.2, 892.2, 893.2, 894.2)	S11, S21, S31, S41, S51, S61, S71, S81, S91, T01
34. **Burns**	940-949	T20-T32
35. **Poisoning**	960-989	T36-T65
36. **Multi trauma** [1]	Not operational	Not operational
Other injuries		
37. foreign body	930-939	T15-T19
38. no injury after examination	--	--
39. other and unspecified injury	807.4-6, 818-819, 827-829, 830, 839.6-9, 848, 953.8-9, 954, 957, 925, 959, 990-995	All other combinations
Not included	905-909 (late consequences), 958 (early complications), 996-999 (medical complications)	T90-T98 (late consequences), T79 (early complications), T80-T88 (medical complications)

[1] Can not be operationalized.

Source: EUROCOST-project

Annex F Hierarchical keys of injury groups

Table 1 Hierarchical key of injury groups of admitted patients, by ranking

Injury group	**Hierarchical key**
	Ranking
Head	
1. brain injury	20
2. other skull-brain injury	2
3. soft tissue head injuries	27
Face	
4. eye injury	33
5. fracture facial bones	26
6. open wound face	32
Vertebrae/Spine	
7. fractures/dislocations/ sprain/strain	14
8. whiplash/neck sprain/distorsion cerval spine	15
9. spinal cord injury	1
Abdomen/Thorax	
10. internal organ injuries	11
11. fracture rib/sternum	16
Upper extremity	
12. fracture of clavicle/scapula	9
13. fracture of upper arm	13
14. fracture of elbow/forearm	17
15. fracture of wrist (incl. carpal bones)	19
16. fracture of hand/fingers	24
17. dislocation/sprain/strain shoulder/elbow	30
18. dislocation/sprain/strain wrist/hand/fingers	31
19. injury of nerves	35
20. complex soft tissue injury	23
Lower extremity	
21. fracture of pelvis	5
22. fracture of hip	7
23. fracture of femur shaft	4
24. fracture of knee/lower leg	6
25. fracture of ankle	12
26. fracture of foot (exc. Ankle)	18
27. dislocation/sprain/strain knee	22
28. dislocation/sprain/strain ankle/foot	21
29. dislocation/sprain/strain hip	8
30. injury of nerves	36
31. complex soft tissue injury	3
Minor external	
32. superficial injury (incl. contusions)	29
33. open wounds	28
34. **Burns**	10
35. **Poisoning**	25
36. **Multi trauma** [1]	--
Other injuries	
37. foreign body	34
38. no injury after examination	38
39. other and unspecified injury	37

[1] Can not be operationalized.
Source: EUROCOST-project

Table 2 Hierarchical key of injury groups of non-admitted patients, by ranking

Injury group	**Hierarchical key**
	Ranking
Head	
1. brain injury	25
2. other skull-brain injury	2
3. soft tissue head injuries	28
Face	
4. eye injury	34
5. fracture facial bones	23
6. open wound face	30
Vertebrae/Spine	
7. fractures/dislocations/ sprain/strain	14
8. whiplash/neck sprain/distorsion cerval spine	15
9. spinal cord injury	1
Abdomen/Thorax	
10. internal organ injuries	20
11. fracture rib/sternum	22
Upper extremity	
12. fracture of clavicle/scapula	10
13. fracture of upper arm	8
14. fracture of elbow/forearm	9
15. fracture of wrist (incl. carpal bones)	11
16. fracture of hand/fingers	13
17. dislocation/sprain/strain shoulder/elbow	17
18. dislocation/sprain/strain wrist/hand/fingers	24
19. injury of nerves	35
20. complex soft tissue injury	16
Lower extremity	
21. fracture of pelvis	4
22. fracture of hip	6
23. fracture of femur shaft	3
24. fracture of knee/lower leg	5
25. fracture of ankle	12
26. fracture of foot (exc. Ankle)	21
27. dislocation/sprain/strain knee	18
28. dislocation/sprain/strain ankle/foot	19
29. dislocation/sprain/strain hip	7
30. injury of nerves	36
31. complex soft tissue injury	26
Minor external	
32. superficial injury (incl. contusions)	27
33. open wounds	29
34. **Burns**	32
35. **Poisoning**	31
36. **Multi trauma** [1]	--
Other injuries	
37. foreign body	33
38. no injury after examination	38
39. other and unspecified injury	37

[1] Can not be operationalized.

Source: EUROCOST-project

Annex G Injury group clustering

Table Injury groups and injury clustering

Injury group base level	Cluster 1	Cluster 2	Cluster 3
Head			
1. brain injury	1. skull-brain injury	1. head injury	1. head and facial injury (excl. eye)
2. other skull-brain injury			
3. soft tissue head injuries	2. open wound head and face		
Face			
4. eye injury	3. eye injury	2. eye injury	2. eye injury
5. fracture facial bones	4. facial fractures	3. facial injury (excl. Eye)	see 1.
6. open wound face	see 2.		
Vertebrae / Spine			
7. vertebral column fractures / dislocations / sprain / strain	5. injuries to vertebral column and spine	4. injuries to vertebral column and spine	3. spinal thorasic and abdominal injuries
8. whiplash, neck sprain, distortion of cerval spine			
9. spinal cord injury			
Abdomen / Thorax			
10. internal organ injury	6. internal organ injury	5. Injury to abdomen /thorax	see 3.
11. fracture rib / sternum	7. fracture rib / sternum		
Upper extremity			
12. fracture of clavicle / scapula	8. fracture of clavicle/scapula	6. upper extremity fractures	4. upper extremity injury (excl. nerves)
13. fracture of upper arm	9. fracture of upper arm		
14. fracture of elbow / forearm	10. fracture of elbow/forearm		
15. fracture of wrist (incl. carpal bones)	11. fracture of wrist (incl. carpal bones)		
16. fracture of hand / fingers	12. fracture of hand / fingers		
17. dislocation / sprain / strain shoulder / elbow	13. dislocation / sprain / strain shoulder / elbow	7. other upper extremity injury (excl. nerves)	
18. dislocation / sprain / strain wrist / hand / fingers	14. dislocation / sprain / strain wrist / hand / fingers		
19. injury of nerves	see 29.	see 15.	see 10.
20. complex soft tissue injury	15. complex soft tissue injury	see 7.	see 4.

Lower extremity			
21. fracture of pelvis	16. fracture of pelvis / hip / femur shaft	8. lower extremity fractures	5. lower extremity injury
22. fracture of hip			
23. fracture of femur shaft			
24. fracture of knee / lower leg	17. fracture of knee / lower leg		
25. fracture of ankle	18. fracture of ankle		
26. fracture of foot	19. fracture of foot		
27. dislocation / sprain / strain of knee	20. dislocation / sprain / strain of knee	9. other lower extremity injury (excl. hip and nerves)	
28. dislocation / sprain / strain of ankle / foot	21. dislocation / sprain / strain of ankle / foot		
29. dislocation / sprain / strain of hip	see 29.	see 15.	see 10.
30. injury of nerves	see 29.	see 15.	see 10.
31. complex soft tissue injury	22. complex soft tissue injury	see 9.	see 5.
Minor external			
32. superficial injury (incl. contusions)	23. superficial injury (incl. contusions)	10. superficial injury (incl. contusions)	6. superficial injury (incl. contusions and open wounds)
33. open wounds	24. other open wounds	11. open wounds	
34. **Burns**	25. burns	12. burns	7. burns
35. **Poisoning**	26. poisoning	13. poisoning	8. poisoning
36. **Multi trauma**	exclude from analysis	exclude from analysis	exclude from analysis
Other injuries			
37. foreign body	27. foreign body	14. foreign body	9. foreign body
38. no injury after examination	28. no injury after examination	n.a.	n.a.
39. other and unspecified injury	29. other and unspecified injury	15. other and unspecified injury	10. other and unspecified injury

n.a. = not available
Source: EURCOST-project

Annex H Accident categories by data systems

Table 1 Recode from accident categories by IDB, ISS V2000 to EUROCOST type of accident

EUROCOST type of accident	Minimum set / Module	IDB	ISS V2000
Home and leisure injuries (HLI)	Minimum set 1	Intent = 1 (excluding Transport injury event = 1 or Activity = 1)	All cases
Transport injuries	Module 1	Transport injury event = 1	n.a.
Occupational injuries	Module 2	Activity = 1 (or 1.1-1.9)	n.a.
Intentional injuries	Module 4	Intent = 2-4	n.a.
All injuries	Module 3	Intent = 1-9	n.a.
Sports injuries	--	Activity = 3.1	Activity = 5 (or 50-59)

n.a. = not available

Source: EUROCOST-project

Table 2 Recode from accident categories by ICD-9 and ICD-10 to EUROCOST type of accident

EUROCOST type of accident	Minimum set / Module	ICD-9-CM	ICD-10
All injuries	Minimum set 2	E800-E869, E880-E928, E950-E969, E970-E999	V01-V99, W00-W19, X01-X99, Y00- Y36, Y85-Y87, Y89

Source: EUROCOST-project

Annex I Evaluation summary of APOLLO project 'The economic consequences of injury' by participating countries

1. Was it clear to you which data you had to bring to the Workshop?

P1: Yes.
P2: Yes, it was clear.
P3: Yes.
P4: Yes.
P5: It was well described.
P6: Yes.

2. Was it clear to you how this data needed to be prepared before the Workshop?

P1: Mostly yes.
P2: No, before the workshop it wasn't clear. The workshop was very useful to learn how to prepare the data.
P3: Yes.
P4: Yes, through a combination of the documents and email contact with the event organisers I had full knowledge of how the data had to be prepared.
P5: Not sufficiently, or I misunderstood what should be done in advance and what should be done at the workshop.
P6: Yes.

3. Where the provided documents (Manual and Annexes) before the Workshop clear?

P1: Mostly yes, just some things were not clear.
P2: Yes, the documents before the workshop were clear.
P3: Yes.
P4: Largely, yes. I had a good idea of what data I needed and what I had to do with it from reading the documentation provided to me. On the few occasions that I was unsure of something my queries were answered via email.
P5: They were quite clear.
P6: Yes.

4. Where the developed tools (Syntax-scripts) clear (or do they need more explanation)?

P1: Yes
P2: The developed tools were clear.
P3: Tools which we used was clear. We used syntax scripts for HDR data on the ED data with small changes, because in both data we have the same ICD 10 coding. In the end we calculated cost by hand, because we do not have appropriate variables to link the both data.
P4: The ability to work on the scripts at the workshop under the guidance of the event organisers helped me greatly to understand the syntax scripts. They would not have been so clear if I had not attended the workshop.
P5: The needed some explanations and corrections, but this was done at the workshop.
P6: The syntax scripts need some explantion. They need to be combined with the provided guidelines and annexes.

5. Did the Workshop help you getting more insight in calculation of direct medical costs of injury?

P1: Yes.
P2: Yes, the Workshop helps me to do the calculations of direct medical costs of injury.
P3: This theme was new for me.
P4: Yes. It proved very interesting. Prior to the workshop I had no experience of calculating medical costs. It was very beneficial to see how this was achieved within the APOLLO project and will help me greatly in my future work.
P5: As there are many different ways this can be done, it showed me at least one way to do the calculations.
P6: Yes.

6. Did the final provided tools (Syntax-scripts) work (run)?

P1: Yes. Although some scripts were updated.
P2: Yes, the syntax-scripts worked.
P3: We do not know if all syntax scripts work (calculating cost), we calculate cost by hand.
P4: The syntax scripts provided to me had to be adjusted slightly so that it was applicable to the country data that I was using. With the help of the event organisers I was able to make the alterations meaning the scripts did work.
P5: Yes, after some corrections, it ran well.
P6: Yes, with some adaptions related to our country specific available data.

7. Is the final Manual (incl. Annexes) a good tool to guide you through the whole work process?

P1: Yes.
P2: The manual and the annexes was a perfect tool to understand the whole work process.
P3: In the manual is missing definition about incidence. We have some problems because of it in the end.
P4: The Manuals and Annexes proved to be very useful and acted as a good reference when I needed some information. However, on their own I don't think the documents would successfully have guided me through the whole process and in my opinion need to be supplemented with the workshop. The documents and the workshop together were definitely good enough to guide me through the whole work process.
P5: I think so.
P6: Yes.

8. Was it difficult to fill in the provided methods and results chapter?

P1: Not much
P2: It wasn't difficult to fill the provided methods and results.
P3: It was no problem, problems was the missing definitions.
P4: No.
P5: It was ok.
P6: No.

9. Was the help you got from the coordinating project group sufficient?

P1: Yes.

P2: Yes, it was sufficient.

P3: I was pleased with the help I get.

P4: Yes. They proved to be a great help during the workshop plus they were able to answer any queries that I had whilst back in my country via email.

P5: It was quite fine, I got the help I needed.

P6: Yes.

10. What did you learn from participating in this project?

P1: How to use data in other way that it is done normally. New possibilities for data analysis.

P2: The participation in this project was important to recognize problems in ED and in HDR coutry data and the need to improve the registrations.

P3: All was new for me.

P4: I gained a valuable insight into how the medical costs of injury are calculated. Plus the APOLLO project has revealed that cross country collaboration is feasible.

P5: As mentioned before, I learned one new way to calculate direct cost.

P6: I gained insight in the way to calculate direct medical costs with available data sources.

11. Do you have other general comments, have we missed things?

P1: Good project that gives insight how to use existing data and what results is possible to get from them.

P2: -

P3: -

P4: I've enjoyed working with you on the APOLLO project. Hopefully we can collaborate again some time in the future.

P5: -

P6: -