

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.

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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 electronic 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). 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 EUROCCOST 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 EUROCCOST 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 EUROCCOST 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 (see [Annex C](#)).

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).

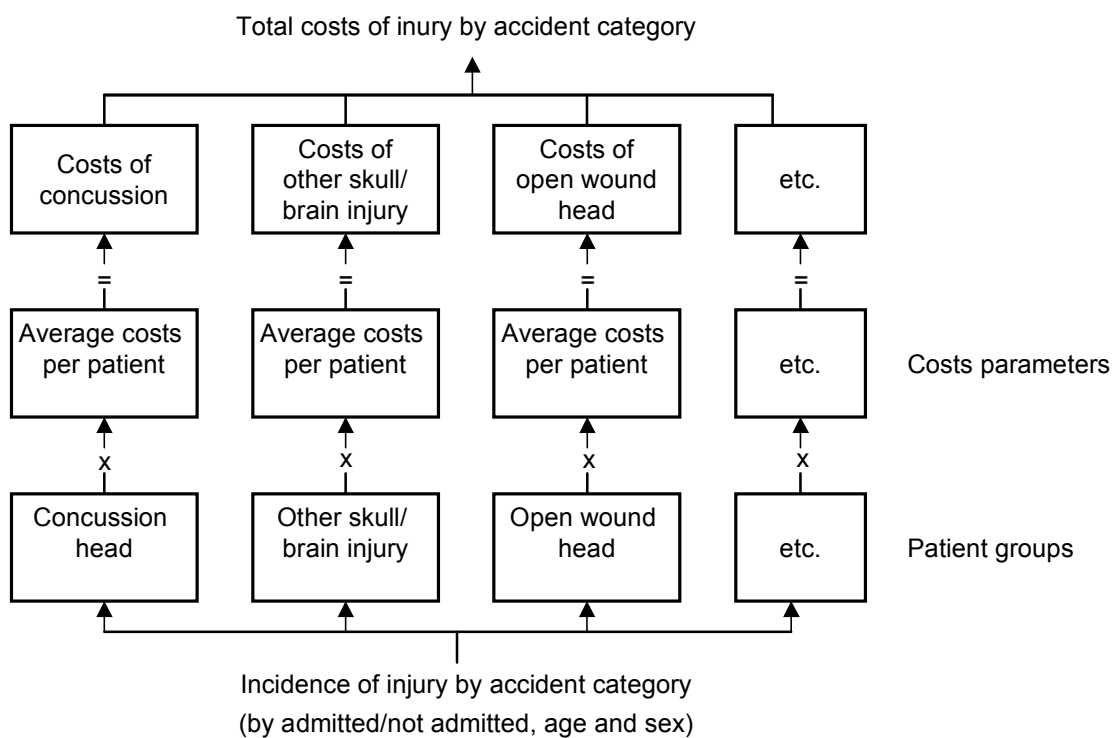


Figure 1 Diagram of EUROCOST-model

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 EUROCCOST 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 EUROCCOST 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.

Example

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 EUROCCOST 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 EUROCCOST 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 EUROCCOST 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 EUROCCOST 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) |
| Costs | Mean length of stay per injury group of the HDR data system was used 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 = $€ 132,150 / (91 * 2.4) = € 606$ | |

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