A surveillance based assessment of medical costs of injury in Europe: Phase 2

Final Report

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Summary

Background

Across the world injuries are a major public health problem, which is expected to increase in the 21st century. They are an important cause of death and disability in the population and also involve high costs to society. The economic and human impact of injuries, however, can be reduced by injury prevention and trauma care policies.
To support policy making, injury surveillance systems are extremely important. 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). Surveillance systems may guide policy makers in their process of priority setting in order to address those problems with the most urgent need to implement interventions at a specific moment. Priority setting is preferably based on a set of reliable indicators of population health, including information on incidence, mortality, disability, and costs. Information about costs is an important supplement to epidemiological data, as recorded by surveillance systems. The high cost involved in certain injury categories and/or age groups is an argument for policy makers to put extra effort into injury prevention addressing particular problems.

The EUROCOST project aimed to enhance the effective use of current European and national injury surveillance systems for policy decision-making, by adding information on the medical costs of injury. The objectives were to harmonise the available data on injury incidence and related health care consumption in all participating countries, to estimate medical costs of injury with a uniform method in those countries, and to explore the causes of international differences. Furthermore, we obtained an estimate of the medical costs of injury at EU level.

The project was conducted as a collaborative effort of experts from Austria, Denmark, Greece, Ireland, Italy, the Netherlands (project leader), Norway, Spain, UK/England, and UK/Wales.

Methods

The development and application of a uniform method to estimate the medical costs of injury in the participating European countries was a major objective of the EUROCOST project.
Before the start of the project, several countries had made their own calculations on medical costs of injury, but all making their own choices on inclusion criteria and methods used. This led to confusing and incomparable information. Within the framework of the EUROCOST project, we reached consensus on a uniform method for the calculation of medical costs of injury with the following major characteristics.

Incidence-based approach
First of all, we adopted an incidence-based approach, calculating the medical costs of injury occurring in a specific year. All countries delivered data for the year 1999, since at the beginning of the project this was the most recent data available for all countries.
The incidence-based approach multiplies the incidence of specific patient groups (defined by injury type and severity level, age and sex) with the average costs of that patient group. Subsequently, the costs of all patient groups are aggregated.

Hospital costs only

We decided to use two primary data sources 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 countries.

Harmonisation of incidence data

We put much effort in the harmonisation of the incidence data: ED incidence and clinical incidence (HDR). Before delivery of data, consensus was reached on the inclusion criteria, and definitions and classifications 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.

Modular approach

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 deliver 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 delivered ED-based information on specific selections of external causes (traffic injury, occupational injury, all injury, intentional injury).

Harmonisation of cost calculations

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'. 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. Finally, all cost calculations were made with a model originally developed in the Netherlands.

Baseline model and variants

In a baseline model, cost calculations were made based on the surveillance and cost data delivered by the countries. The baseline model used the uniform methodology as described above. The baseline model is comprehensive (no prior exclusions of specific injury types are made) and the principal means to make calculations of the medical costs of injury at the country level.
In addition, several variants were constructed in order to allow meaningful international comparisons of the findings. Two variants aim to minimise international variation based on surveillance system bias (due to differences in registration and health care practices). They focus on selections of the more severe injuries: 'selective radiological verifiable fractures' and 'frequently admitted injuries' respectively. One variant aims to minimise international variation due to incomparability of delivered unit costs per country (cost model bias). In this final variant, adjustments are also made for differences in price levels between countries.

Results

Availability of uniform method to calculate hospital costs of injury

First of all, a major result of the EUROCOST project is the availability of a uniform method to calculate hospital costs of injury. This method is based on consensus of international experts in injury epidemiology, traumatology and health economics from 10 European countries. The method is applicable in all countries with ED-based and or HDR-based injury surveillance systems.

Calculations at three levels

The EUROCOST model can be used at the following three levels:

1) Describing hospital costs of injury at country level (baseline model),
2) International comparisons (variants),
3) Describing hospital costs of injury at EU-level.

Hospital costs of injury at country level

The EUROCOST project has demonstrated that, although incidence and cost levels largely differ per country, similar patterns by age, sex, injury type and external cause are observed anywhere.
We observed in all countries that:

- injury is a major source of total hospital costs;
- home and leisure injury accounts for about 65% of the hospital costs of injury patients;
- older people (65+) account for about one-third or more of the costs for home and leisure injury and for almost half of the costs of total hospital admissions resulting from all injuries combined;
- the major sources of hospital costs are hip fractures (33%) fractures of the knee/lower leg (9%), superficial injuries (including contusions and open wounds) (7%), and skull-brain injuries (4%);
- the most expensive types of injury (costs per patient) are spinal cord injuries (€ 6500), fractures of the femoral shaft (€ 6100), hip fractures (€ 5100), pelvic fractures (€ 4700), and burns (€ 4200);
- ED-treated (not-admitted) patients account for about one-third of the hospital costs of injury.

International comparison of injury incidence and costs

The EUROCOST project has shown that meaningful international comparisons of injury incidence and costs can only be made after adjusting for surveillance system bias (ED based data systems) and cost model bias (ED based and HDR based data systems). Therefore in this summary the figures shown are all based on variants that reduce the surveillance system bias (variant 2) and cost model bias (variant 6).

Figure 1 presents data on the ED incidence and costs of radiological verifiable fractures due to home and leisure injury by country and adjusted for differences in unit costs. Fractures are assumed to have medical need for ED treatment, and the incidence of these fractures can therefore be well internationally compared with ED surveillance data.

Figure 1 *ED injury incidence (per 1,000), mean costs per patient (*€100), and costs per capita (€) of home and leisure injuries for radiological verifiable fractures, adjusted for differences in unit costs*

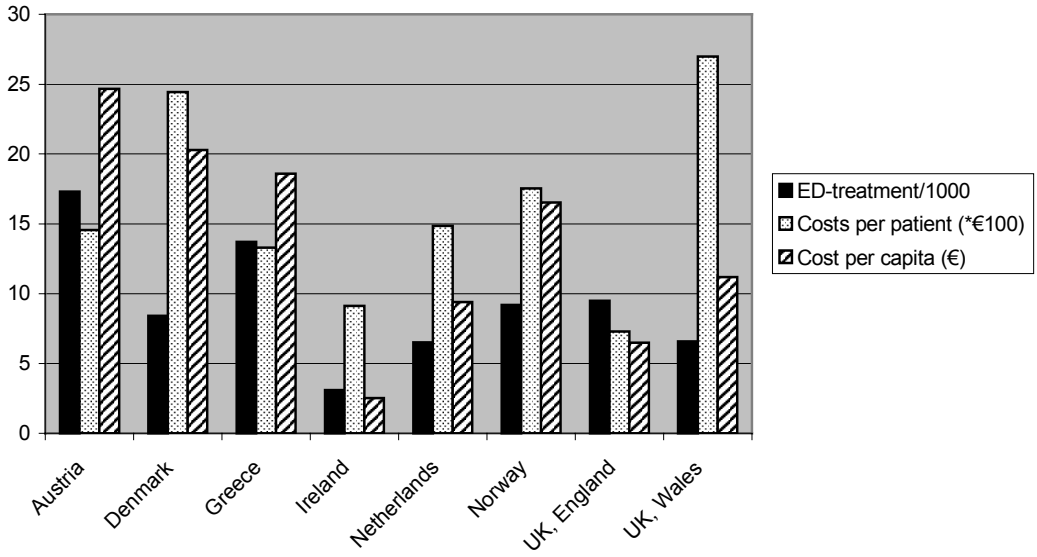
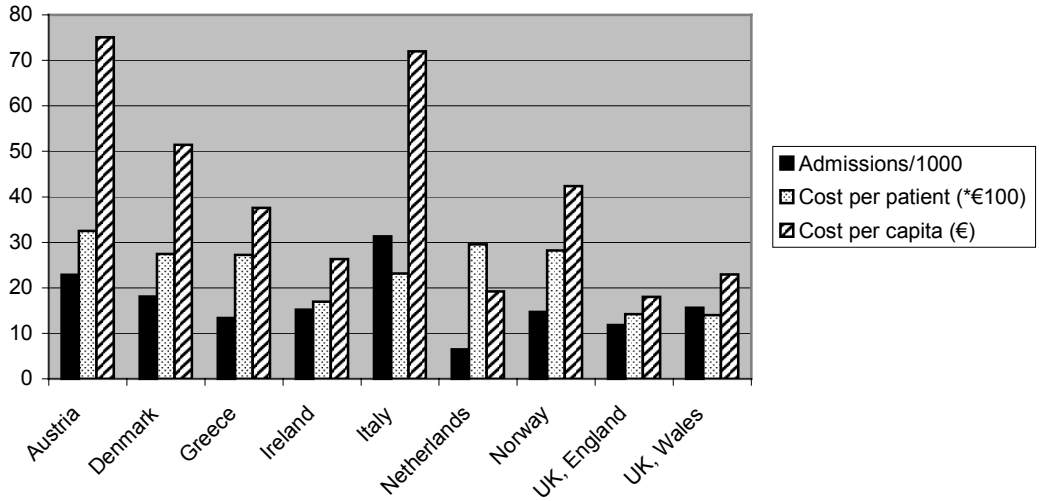


Figure 2 presents data on the hospital inpatient incidence and costs of all injuries combined by country, adjusted for differences in unit costs.

Figure 2 *Hospital inpatient incidence (per 1,000), mean costs per patient (*€100), and costs per capita (€) for all admitted patients, adjusted for differences in unit costs*



The variation in costs per capita between the countries becomes smaller after adjusting for surveillance system bias and cost model bias. The figures show, however, that after adjusting for these biases, large variations in injury costs between countries still exist. Both figures give the same pattern of international differences, with relatively high costs per capita in Austria, Denmark, Greece, Norway, and Italy (only admitted patients) and relatively low costs per capita in England, Wales, the Netherlands, Ireland (particularly home and leisure injuries), and Spain (only admitted patients).
In the EUROCOST project, an important step was made towards further harmonisation of injury incidence data by making selections of the more severe injuries: frequently admitted injuries and/or

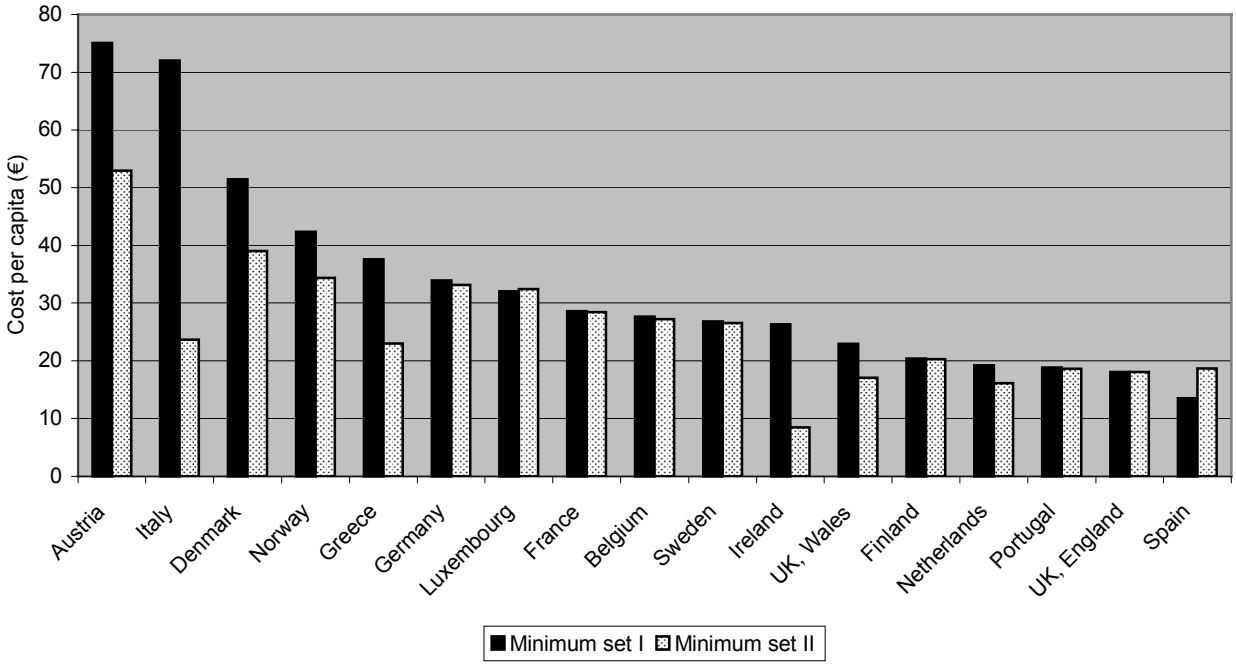
radiological verifiable fractures. Thanks to a uniform methodology the cost estimates can be effectively compared between the participating EUROCOST countries.

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. It allows distinctions to be made according to country, age, sex, accident category, and type of injury. Exploring the reasons behind still existing variation in incidence rates (such as observed among older people) and medical costs could be very interesting for health policy makers.

Hospital costs of injury at EU-level

Calculations on the hospital costs of injury at EU level are preliminary (figure 3). They refer to the 15 EU countries before the recent expansion of the union. They are based on the average hospital costs of injury per capita by age and sex, observed in the participating EUROCOST countries. For each non-participating country of the EU-15, the injury costs were calculated by multiplying the population numbers with the costs per capita by age and sex as found in the EUROCOST countries (thereby assuming similar injury epidemiology and health care consumption). Adjustments were made for total health expenditure per capita by country.
Although the results are preliminary, they already provide important clues for priority setting in injury prevention.

Figure 3 *Cost per capita (€) for all EU-15 countries for home and leisure injuries and for total admitted patients*



Note: the countries are ranged by cost per capita for all admitted injuries

Observations for hospital costs of injury at EU level were made:

- The hospital costs of home and leisure injuries at EU level are € 10 billion (i.e. 5.2% of total inpatient health expenditure).
- Home and leisure injuries make a major contribution (65%) to the hospital costs of injury in the EU.
- The mean costs per ED patient are the highest for traffic injuries and are the lowest for occupational injuries: home and leisure € 250, traffic € 597, occupational € 127, and violence € 280.
- The costs per capita for the not-participating countries (€ 30.1) are higher than for the participating countries (€ 23.4). This can be explained by a higher percentage of older people for the not-participating countries and higher health expenditures per capita.
- Though women sustained only 45% of the total number of injuries for home and leisure injuries, they account for 59% of the costs. This is mainly because many of the injuries suffered by older women require a high level of care.
- The costs per capita of home and leisure injuries are high in children and adolescents (high incidence), and beyond age 65 (high costs per patient).
- For hospital inpatients peaks in costs per capita are observed among children of 0-4 years old, and among 15-24 year old males, where they increase exponentially in older age groups (age 65+).

Conclusions and recommendations

Conclusions

We conclude that:

- 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.

- Injuries among older people (65+) generate high costs and should be a priority area in public health policy in all European countries.

- The major sources of hospital costs of injury in Europe are hip fractures, fractures of the knee/lower leg, superficial injuries and open wounds. The causes and possible interventions of these injury types should therefore –by priority- be further investigated.

- 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 model marks the first step towards calculating the direct medical costs of injury for countries in the European Union following a uniform method.

Recommendations

We recommend to:

- Transfer the uniform method to calculate hospital costs of injury from the coordinating centre in the Netherlands to the member states themselves.

- For all EU-countries, including the new member states, it would be worthwhile to expand the application of the uniform cost model. 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.

- Expand the model with other indicators (indirect costs, Disability Adjusted Life Years).

- Address the following problems as priority areas in public health policy, both at European an national levels: home and leisure injury, injury among older people (65+), hip and pelvic fractures, fractures of the femoral shaft and knee/lower leg, superficial injuries and open wounds, spinal cord injuries, and burns.

- The large share of older victims, reflecting high incidence and consumption rates of hip fractures and fractures of knee/lower leg, is rather impressive. As the European population is ageing, this problem is expected to increase in the future. Research into determinants of injury incidence and consumption rates among older people, should therefore get priority at EU level.

- Validate the extrapolation of local sample data on injury incidence to national level.

- Expand the model to injuries treated by primary care providers and self-treatment.

1 Introduction

1.1 Background

Across the world injuries are a major public health problem, and one, which is expected to increase in the 21st century (Murray, 1997). They are an important cause of death and disability in the population and also involve high costs to society.
Information about costs is an important supplement to epidemiological data on mortality and the incidence of injuries as recorded by surveillance systems. High costs involved in a certain injury categories may be an argument for policy makers to put extra effort into injury prevention. Moreover, information about costs can be used as a first step in assessing the cost effectiveness of possible intervention strategies that will reduce the burden of injury (Mulder, 1999).
So far, national studies on the medical costs of injury have been performed for several European countries (Lindqvist and Brodin, 1996; Kopjar at al, 1996; Kopjar, 1997; Bauer, 1995; van Beeck et al, 1997; Kidholm and Soegaard, 1997). However, due to the use of a variety of methodologies the results are difficult to compare. In particular, comparison of specific injury categories is hardly possible. First of all, because different methods are used, like the inclusion of different cost categories (direct, indirect, human). Secondly, the scope of the studies often differs. Sometimes, studies are limited to (subsets of) road injuries or home and leisure injuries (Mulder, 1999) or hospital costs.
An incidence based injury costing model has been developed by the Consumer Safety Institute and the Erasmus Medical Center, Rotterdam, Department of Public Health in collaboration with a ECOSA European Working Group on the costs of injury (Meerding et al, 2000; Mulder et al, 1999; Mulder et al, 2002).
With the help of this model that is linked to the Dutch EHLASS system, continuous monitoring of medical costs of injury is already possible in the Netherlands (Meerding et al, 2000). The model is primarily based on EHLASS data. Application of this methodology to other European countries might enhance the effective use of EHLASS and facilitate a better international comparability of national cost of injury estimates, compared to studies that have been performed so far.

1.2 Aims and objectives of the EUROCOST project

The aim of the overall project is to enhance the effective use of current European (EHLASS) and national injury surveillance systems for policy decision-making, by adding monitoring information on the medical costs of injury in the European Union. The project gives insight into the international variation in the medical costs of injury, and explores to what extent this variation can be interpreted in relation to the underlying variation in demography, injury epidemiology, and organisation and efficiency of healthcare services.

The objectives of the overall project are:
1 To collect, analyse and harmonise data on injury incidence and related healthcare consumption and costs;
2 To estimate the medical costs of injury in each participating country using a uniform methodology;
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.

1.3 Scope of the EUROCOST model

The model for calculating the costs of acute injuries had to be conducive to supporting priority setting and the continuous delivery of policy information. Hence, it had to meet the following requirements:

- The model must, at all events, be able to calculate the direct medical costs.
- The information it provides must be sufficiently detailed to enable calculations to be made not only for injuries as a whole but also for specific injury scenarios (e.g. senior citizens with hip fracture, facial injuries due to violence).

In principle, policy should be more informed by a model, which incorporates a broad spectrum of costs. However, to prevent the project from becoming overcomplicated, the scope of the model was defined as follows:

- It is directed primarily at the *economic costs* of injury. Hence it does not include the 'human costs', i.e. the monetary equivalent of damage to health, such as a reduced expectancy of healthy life.
- It is directed primarily at the *direct medical costs* (costs within the health sector). The direct medical costs, which are calculated in the EUROCOST model, consist of the costs of emergency department treatment and inpatient costs in hospital. It does not cover direct non-medical costs (e.g. informal care, travel expenses) and indirect costs (e.g. productivity loss).
- The basic model concentrates on *emergency department registered injuries.*
- The project maps the *costs of injuries* and not the costs of injury incidents. Hence, it does not include material damage, police and court costs, administrative costs etc. (Beeck van, 1996).

The strength of this project is that we made detailed cost calculations, instead of rough estimates based on assumptions. The main benefit is that we can calculate the direct medical costs for specific subgroups for each country; not admitted/admitted to hospital, accident group, type of injury, age and gender.

1.4 Project-team and reference group

The project activities are performed in joined collaboration with experts from Austria, Denmark, Greece, Ireland, Italy, The Netherlands (co-ordinator), Norway, Spain, UK, England and UK, Wales (see Annex 7). All experts have experience in the use of routinely available data sources for injury monitoring and surveillance, medical expertise and/or expertise in health economics. All participants have direct or indirect access to the relevant data sources.
The participants represent a substantial number of member states. The intensive international collaboration was vital because it (1) combined knowledge, experiences and opinions from local situations, (2) maximised the exploitation and harmonisation of national data sources on injury epidemiology and healthcare utilisation, and the identification of information gaps and causes for data incomparability, (3) provided the opportunity to exchange and combine knowledge on the international variation of injury related healthcare consumption and costs, and (4) stimulated the dissemination of the results across Europe.

1.5 Reading guide

Chapter 2 gives an overview of the availability of data for the calculation of injury incidence, health care consumption and country specific health care costs. A description of the baseline model that is used for the analysis in this report is given, which include an overview of the selections, classifications and definitions of accidents, injury groups and health care consumption. Furthermore, the uniform costing methodology that was applied in all countries is described. Chapter 3 shows the main results of the injury incidence, health care consumption and injury related costs in Europe. The observed incidence rates per country are a primary source of international variation in costs. Incidence data from hospital-based surveillance systems, however, are extremely sensitive to artificial international variation due to 'surveillance system bias'. Therefore, in chapter 4 we have analysed differences in the country specific incidence data, exploring possible sources of surveillance systems bias. Based on these analyses, several variants of the baseline model have been developed aiming to minimise the influence of surveillance system bias. The potential influences of other major elements of our costing model were tested as well. Chapter 5 gives an overview of the calculation of the injury related medical costs for the baseline model and selected variants that enable a better cross-national comparison. Chapter 6 shows the costs of injury for all 15 European Union countries. In chapter 7 we discuss the limitations of the data to calculate medical costs of injury at country level, making international comparisons of injury costs between EU countries, and describing injury costs at EU level with the EUROCOST model.

2 Data and methods

2.1 Introduction

The EUROCOST project aims to make comparable calculations of the medical costs of injury by country. In this chapter we will start with a description of the cost of injury model (§ 2.2). In this model, costs of injury are estimated by a bottom-up approach by multiplying the incidence of injuries by the average medical costs per patient. The costs per patient are estimated by means of three parameters: transition probability (e.g. probability of hospitalisation), volumes of health care (e.g. average length of stay) and unit costs (e.g. costs of one hospital day). The costs of injury are estimated by patient group, with each group having a more or less homogeneous health care consumption. For the cost model information is needed on injury incidence (§ 2.3), health care consumption (§ 2.4) and unit costs (§ 2.5) from the participating European countries: Austria, Denmark, Greece, Ireland, Italy, the Netherlands, Norway, Spain, UK, England and UK, Wales. For these three elements of the cost model data selections, classifications, and availability of the data are described separately. Each paragraph will end with a short description of the data that were used for the baseline calculations of injury incidence, health care consumption and costs.

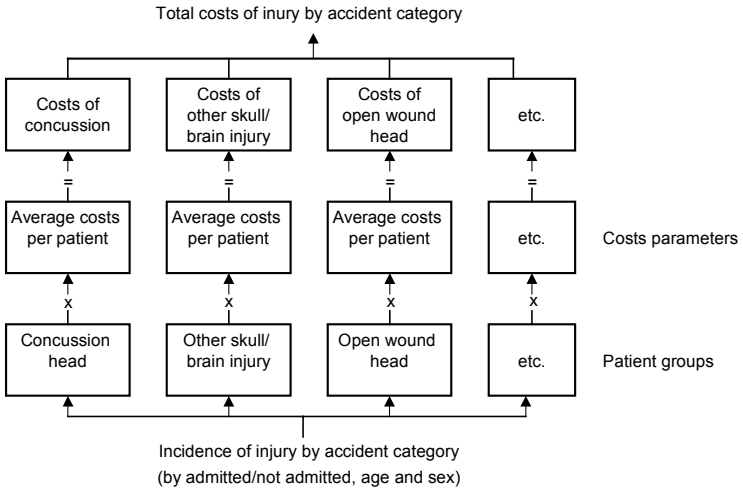
The term **baseline model** is used in this report as follows: in the baseline method uniform selections, classifications and definitions of accident and injury groups and health care selections were used and a uniform costing methodology was applied in all countries. The baseline model is the starting point for the international comparisons of the data in chapter 3. After this procedure, international variation may still exist due to (methodological) differences, not yet adjusted for (e.g. different health care systems). In chapter 4 several **variants** on the baseline model will be explored to increase the comparability of the data among countries.

2.2 Cost of injury model description

2.2.1 EUROCOST model

The EUROCOST model is based on an existing injury cost model, originally developed for the Netherlands (Meerding et al, 2000; Mulder et al, 2002). The general structure of the EUROCOST model is set out in figure 2.1.

Figure 2.1 Diagram of EUROCOST model



Incidence based approach

In epidemiology distinction is made between incidence and prevalence of a disease. Disease incidence is related to the new cases of the disease in a time period, for instance a certain year. Disease prevalence regards all cases of the disease at a particular time irrespective whether the patients got the disease in that particular year or earlier. The original Dutch cost model follows an *'incidence-based approach'*, which estimates the lifetime costs of all injuries that occur within a specific year (1999). In other words, it starts from the 'bottom up', i.e. at the micro level of individual injury patients and works towards estimates of healthcare use at a more aggregated level of injury groups and accident categories. These are the costs that are incurred between the occurrence of injury and the point of recovery or death. The EUROCOST project follows a similar approach and uses data on the incidence of injuries as recorded in the available (emergency department (ED) and hospital based) surveillance systems from the participating European countries.

2.2.2 Patient groups

The model calculates the costs of accident-related injuries by multiplying the incidence by the average medical costs per patient (see figure 2.1). All injury patients are allocated to patient groups, which are defined in such a way that they are more or less homogeneous in terms of healthcare use. Furthermore, it obviates registration differences. The patient groups are defined according to characteristics that are predictive for healthcare use. These characteristics are the result of a systematic literature review on factors that determine healthcare use among injury patients (van Beeck, 1996).

Many determinants of healthcare consumption at the individual level are known from expert opinion and the literature. These determinants were discussed at the Swansea meeting (July 2001) in order to select those determinants to be tested as criteria for the composition of patient groups for the EUROCOST project. Table 2.1 indicates which of these determinants have been selected for the EUROCOST project. These were included in the data set definition of all data sets that were collected in the EUROCOST project.

Age is known as a major determinant of health care consumption, both in general and in relation to injury patients. Sex may have an influence on the costs of injury too, in particular at advanced ages. Among older people, sex becomes a proxy for household composition. Older women live more often alone than older men, which may lead to variation in medical costs by sex. Previous studies have shown that the costs of injuries are highly dependent on the body region involved in combination with

the type of injury. However, it is not only the type of injury that determines the use of medical care but severity as well. This criterion may be operationalized in different ways. Preferably, injury severity scoring systems are used (e.g. AIS, ISS, RTS, TRISS) but other indicators (that are included more often in available data systems) can be used as well: e.g. involvement of a motor vehicle, number of injuries, hospital admission, ICU admission, and medical operations.
Important potential determinants of (extra) costs are complications and comorbidity, Unfortunately, however, these variables are seldom recorded. Finally, several socio-demographic variables (e.g. socio-economic status, ethnicity, type of insurance,) can be relevant, but their role in relation to injury-related health care consumption is ambiguous.
Table 2.1 indicates which determinants have been selected for the EUROCOST project. Determinants were selected if information was available from all countries. Age, sex, injury group, and hospitalisation are the selected determinants that are used in the cost model for all countries. There were also determinants of which only a few countries (<4) delivered information: ICU, operations, and motor vehicle involved and number of injuries. For reasons of uniformity, these were excluded from the cost model. In future research these determinants could be tested. The table also shows which determinants could not be included at all in the cost model.

Table 2.1 Determinants of individual healthcare consumption in the EUROCOST model

Selected determinants	Excluded determinants	Not recorded
Age	ICU [2]	Complications [2, 3]
Sex [1]	Operations [2]	AIS / ISS [2, 3]
Injury group	Motor vehicle involved (yes/no) [2]	Comorbidity [3]
Hospitalised [2]	Number of injuries [2]	Type of insurance [3]
		Ethnicity [3]
		Household composition [3]
		Marital status [3]

[1] As proxy for household composition (living alone).
[2] Indicator for injury severity.
[3] This information is not recorded.

2.3 Injury incidence

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.
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, traffic accidents, and occupational accidents. In addition, they may be caused by medical procedures, but these were not considered.

2.3.1 Selection of injury patients

In the EUROCOST model injury incidence concerns injury patients that attend an ED or are hospitalized, and includes all external causes (both unintentional and intentional). International

differences, caused by varying classification and registration practices, should in principle be minimised by using comparable case selections. We made the following choices:

Level of severity

For the purpose of making international comparisons and the design of indicators of injury incidence, some argue that incidence data derived from ED- and HDR-surveillance systems should preferably only contain cases with an objective need for medical treatment (Cryer, 1999; Langley, 2002; Lyons, 2000a). This topic was intensively discussed in this project. We decided to make no prior exclusions from our ED and HDR surveillance data in the baseline model. But we also defined several variants with different case selections (see chapter 4).

Injury due to medical adverse events

Injury due to 'misadventures to patients during surgical and medical care' (ICD-9 E870-876), '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 E878-879), and 'drugs, medicaments and biological substances causing adverse effects in therapeutic use' (ICD-9 E930-E949), traditionally have not been considered the domain of injury prevention (Langley, 2002). So, the cases with the following codes were removed in the HDR-data: medical procedures (ICD-9 E870-879, E930-949, ICD-10 Y40-Y88). The percentage of injuries due to medical procedures that were removed from the data was 5% on average. The inclusion or exclusion of these events has significant implications for the estimation of the incidence of injury. However, not all countries delivered ICD-9 or ICD-10 codes, and it was not possible to exclude injuries due to medical procedures for Italy and Norway. This will probably result in a slight overestimation of the injury incidence for both countries. This should be recognized when interpreting the data.

Late consequences of injury

Late consequences of injury (ICD-9 E929, and ICD-10 Y850, Y859 and Y86) were excluded from HDR data.

Day patients

Patients whose stay in hospital was less than a day (i.e. did not stay overnight) have been described as day patients. In the literature (Langley, 2002) it is mentioned that for comparative purposes it would be worthwhile to exclude day patients from the analyses. Day patients were often difficult to identify, because not all countries used the same definition for a day case and/or used the same coding practice, and not all HDR systems included day cases. We classified day cases and inpatients with length of stay=0 both as day patients. Separate analyses were made for day cases (< 1 day length of stay) and inpatients (≥1 day length of stay). In the baseline model day patients were classified as non-admitted patients.

Readmissions

Because patients can be admitted to hospital for the treatment of injury in both the acute and rehabilitative phases, it is important to differentiate the two. Failure to do so could produce an overestimation of injury incidence if the dataset being examined contains individuals who have a series of readmissions for ongoing treatment and or rehabilitation (Langley, 2002). However, data about re-admissions could only be distinguished for three countries (Austria, the Netherlands, and Norway), whereas these data may not be reliable. Therefore, readmissions are included in all analyses as first admissions, which should be recognized when interpreting the data.

2.3.2 Classification of accident groups

The report uses the term 'accident group' to distinguish between home and leisure, traffic, sport, and occupational accidents as well as violence and self-mutilation (including suicide), even though violence and self-mutilation do not, strictly speaking, fall within the concept of 'accident'.

A modular approach towards estimating injury incidence (see table 2.2) and health care consumption by external cause has 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, and hospital admitted unintentional and intentional injuries. In addition, modules were defined for specific accident groups that were only available in a minority of the participating countries (see table 2.2). We used the following definitions of accident categories:

- Sport injury: any incident taking place while participating in sports and exercise-related activities and resulting in injury. A sport-accident at school is considered a sport-accident.
- Traffic injury: any land transport vehicle incident occurring on the public highway and resulting in injury. A one-side bicycle-accident is considered a traffic-accident.
- Occupational injury: any incident taking place during the exercise of professional and paid activity and resulting in injury. Traffic accidents during occupational activity are considered traffic accidents.
- All other unintentional injuries are considered home injuries.
- Violence: a deliberate incident with the intent to cause harm, injury or death, where physical or other force was used (or threatened to be used) against oneself or another person which can lead to injury).
- Self-mutilation: deliberate use of physical or other force against oneself, with the intent to cause harm, injury or death.

Table 2.2 Minimum sets and modules for injury incidence

	Injury incidence
Minimum set I	ED incidence of home and leisure injury
Minimum set II	Hospital admissions of unintentional and intentional injury
Module I	ED incidence of traffic injury
Module II	ED incidence of occupational injury
Module III	ED incidence of unintentional and intentional injury
Module IV	ED incidence of intentional injury (violence and self mutilation)

2.3.3 Classification of injury groups

In the EUROCOST project, all injury patients are allocated to injury groups that are defined in such a way, that they are more or less homogeneous in terms of healthcare use. Previous studies have shown that the costs of injuries are highly dependent on the body region involved in combination with the type of injury (see also § 2.2.2). Injuries were classified according to 39 injury groups the participating countries agreed upon (see table 2.3), using conversion tables developed by the project team: ICD-9, ICD-10, EHLASS 1986, EHLASS 1991 and EHLASS 2000 classifications (see Report EUROCOST phase 1 Annex 8 'Injury group classifications and hierarchical key').

Table 2.3 Injury groups in the EUROCOST model

Injury group name	Injury group number
Head	
Concussion	1
Other skull-brain injury	2
Open wound head	3
Face	
Eye injury	4
Fracture facial bones	5
Open wound face	6
Vertebrae/Spine	
Fractures/dislocations/ sprain/strain	7
Whiplash/neck sprain/distortion cervical spine	8
Spinal cord injury	9
Abdomen/Thorax	
Internal organ injuries	10
Fracture rib/sternum	11
Upper extremity	
Fracture of clavicle/scapula	12
Fracture of upper arm	13
Fracture of elbow/forearm	14
Fracture of wrist (incl. carpal bones)	15
Fracture of hand/fingers	16
Dislocation/sprain/strain shoulder/elbow	17
Dislocation/sprain/strain wrist/hand/fingers	18
Injury of nerves	19
Complex soft tissue injury	20
Lower extremity	
Fracture of pelvis	21
Fracture of hip	22
Fracture of femur shaft	23
Fracture of knee/lower leg	24
Fracture of ankle	25
Fracture of foot (exc. Ankle)	26
Dislocation/sprain/strain knee	27
Dislocation/sprain/strain ankle/foot	28
Dislocation/sprain/strain hip	29
Injury of nerves	30
Complex soft tissue injury	31
Minor external	
Superficial injury (incl. contusions)	32
Open wounds	33
Burns	34
Poisoning	35
Multi trauma	36
Other injuries	
Foreign body	37
No injury after examination	38
Other and unspecified injury	39

These 39 injury groups were also clustered on three levels. Level 1 (29 groups), level 2 (15 groups), and level 3 (10 groups, see table 2.4) (see Annex 1). At all levels, injury groups 32.0 'superficial injury' and 32.1 ‘contusions’ have been combined into one injury group 'superficial injury (incl. contusions)'.

Table 2.4 Injury groups on level 3 in the EUROCOST model

Injury group name	Injury group number
Head and facial injury (excl. eye injuries)	1
Eye injury	2
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	3
Upper extremity injury (excl. nerves)	4
Lower extremity injury	5
Superficial injury, including contusions and open wounds	6
Burns	7
Poisoning	8
Foreign body	9
Other and unspecified injury	10

The aim of using injury groups on cluster level is to minimise the problems resulting from:

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.

Unknown and unspecified injuries, accidents and external causes

In some ED and HDR data systems a substantial proportion of injuries, accidents and external causes remains unspecified. This may be due to a 'conservative' coding practice, and will underestimate the incidence of specific injury diagnoses. We investigated whether we may assume that the coding of unspecified injuries and external causes is independent from the underlying real type of injury, by comparing the incidence by type of injury/external cause before and after proportional distribution of unspecified cases to known cases (see Annex 2). For the countries with a high proportion of unknown/unspecified injuries and external causes, the distribution of accident or injury groups after proportional distribution of unknown/unspecified accident or injury groups was reasonably comparable to the countries without unknown/unspecified accident or injury groups. In the baseline model we therefore included unknown and unspecified injuries in all analyses, and proportionally distributed the unknown/unspecified cases to the known cases.

2.3.4 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, except for Greece (no HDR) and Italy (no ED). As a substitute for the ED data of Italy a data system on occupational injuries was included. For Spain, ED data for the Barcelona region were used, because nation-wide ED-data were not available.

Annex 3 gives an overview of the necessary variables to participate in the minimum sets and modules. In table 2.5 an overview is given of the countries that participate in the minimum sets and modules for injury incidence.

Table 2.5 Availability of injury incidence data for minimum sets and modules

		Minimum set I ED incidence of home and leisure injury	**Minimum set II** Hospital admissions of unintentional and intentional injury	**Module I** ED incidence of traffic injury	**Module II** ED incidence of occupational injury	**Module III** ED incidence of unintentional and intentional injury	**Module IV** ED incidence of intentional injury
Austria	ED-system	+					
	HDR		+				
Denmark	ED-system	+		+	+		
	HDR		+				
Greece	ED-system	+	+	+	+	+	+
Ireland	ED-system	+					
	HDR		+				
Italy	Occup. injury register				+		
	HDR		+				
Netherlands	ED-system	+		+	+	+	+
	HDR		+				
Norway	ED-system	+		+	+	+	+
	HDR		+				
Spain	ED-Barcelona			+			
	HDR		+				
UK, England	ED-system	+					
	HDR		+				
UK, Wales	ED-system	+		+	+	+	+
	HDR		+				

+ = available

Eight countries delivered data on ED home and leisure injuries (Minimum set I). All countries had HDR data (Minimum set II) available of unintentional and intentional injuries, except Greece. For Greece, we used the EDISS-data for estimating the number of hospitalisations.
Data on ED incidence of traffic injuries (Module I) and occupational injuries (Module II) are available in six countries. Four countries have also injury incidence data available of both unintentional and intentional injuries presenting at an ED (Modules III and IV).
In Annex 4 an overview is given of the availability of specific variables in the ED and HDR-systems. The data of the HDR-systems were almost in accordance with the data set definitions. The type of injury was available in all data systems. Some countries delivered data about more than one injury for patients with multiple injuries. External cause codes were included in some but not all HDR systems. In countries that register this information, there is often considerable underreporting of external causes. Data in the ED-systems were less comprehensive. In some ED-systems only patients from one accident group are included.

2.3.5 Baseline model

Because ED-systems do not have nation-wide coverage, the country-specific ED-incidence data were extrapolated towards national level. For this aim, we used extrapolation factors, as delivered by the countries. To adjust for differences in the demographic composition of the countries, age (18 groups)- and sex- standardised incidence rates were calculated for the year 1999 using the direct method of standardisation. This was done for both ED-data and HDR-data. The total population of the participating countries was used as the reference population. In chapter 3 we will only present

standardized incidence data of injury incidence, according to international epidemiological standard practice. We will also show our results in Comparative Morbidity Figures (CMF). The CMF is calculated by dividing the incidence rate of the country by the incidence rate of the standard (reference) population. In the box below an example is given of the calculation of the direct method of standardization and the CMF.

Calculation example direct method of standardization and CMF

Population A

Age	Person years	Deaths	Mortality rate (per 1,000)
0-14	4000	8	2
15-44	3000	15	5
45-64	2000	20	10
65+	1000	25	25
Total	10000	68	6.8

Reference population Z

Age	Person years	Deaths	Mortality rate (per 1,000)
0-14	25000	100	4
15-44	25000	250	10
45-64	25000	500	20
65+	25000	1250	50
Total	100000	2100	21

Standardization population A

Age	Person years Z	Mortality rate A	Expected deaths Z
0-14	25000	2	50
15-44	25000	5	125
45-64	25000	10	250
65+	25000	25	625
Total	100000	na	1050

Standardized mortality rate = 1050 / 100000 = 10.5

Comparititve morbidity (mortality) figure (CMF) of A =
expected in Z / observed in Z = 1050 / 2100 = 0.50

Baseline model for analysing injury incidence:

- Grouping of accident groups by minimum sets and modules (ED + HDR)
- Grouping of 39 injury groups and clustering of these injury groups on 3 levels (ED + HDR)
- Proportional distribution of unknown/unspecified injuries and external causes (ED + HDR)
- Exclusion of medical procedures (HDR)
- Exclusion of late consequences of injury (HDR)
- Exclusion of day patients (HDR)
- Readmissions interpreted as first admissions (HDR)
- No selection of specific more severe injuries (ED + HDR)
- Extrapolating data towards national level with delivered extrapolation factor (ED-incidence)
- Standardized data by age and sex (ED and HDR)

2.4 Health care consumption

2.4.1 Selection of health care sectors

The EUROCOST model is designed to calculate the direct medical costs of injuries. The aim is to include those health care sectors that are relevant for injury patients. The original Dutch model contains both institutionalised care (hospital care, inpatient rehabilitation, nursing home care) and non-institutionalised care (general practitioner, ambulance transport, outpatient physiotherapy, home care, pharmaceuticals, and aids and appliances). The data on non-institutional care were derived from a patient survey (Mulder et al, 2002; Meerding et al, 2004). Injury-specific data on hospital outpatient care, non-institutional care, nursing homes and rehabilitation institutions were not available in other European countries and were therefore excluded from the EUROCOST model. Therefore, costs only include ED costs and inpatient hospital costs.

Minimum sets and modules were also defined for health care consumption (see table 2.6). All countries should at least provide information about ED visits (Minimum set I) and hospital admissions and length of stay in hospital (Minimum set II). Modules were defined for specific health care sectors of which countries had information available. In Annex 3 an overview is given of the necessary variables, which should be available to participate in the minimum sets and modules for health care consumption.

Table 2.6 Minimum sets and Modules for healthcare consumption

	Healthcare consumption
Minimum set I	ED attendances
Minimum set II	Hospital admissions, admission rates and length of stay
Module I	Inpatient medical procedures
Module II	Hospital outpatient visits
Module III	Ambulance transport
Module IV	ED materials and radiology

2.4.2 Availability of health care consumption data

Table 2.7 gives an overview of the countries that participate in the Minimum sets I and II and Module I for health care consumption. We determined that modules would be analysed when data were available for at least three countries. Information about the healthcare use of injury patients (hospital admissions and inpatient days in hospital) is given both in HDR and ED-systems. Nine ED-systems included information about hospital admissions and six countries delivered information about length of stay (LOS). All countries delivered data about the LOS of the patients in the HDR.
Information about admission to ICU is available in two HDR systems and two ED-systems, but these data will be analyzed in future research.
Data about inpatient medical procedures (Module I) was available for five countries. However, different classifications of inpatient medical procedures were used, which were not comparable between the countries. Information on outpatient treatment (Module II) was available in one HDR system, information about ambulance transport towards the ED (Module III) was available in two ED-systems and radiology use during treatment at the ED (Module IV) was included in one ED-system. Therefore, the modules were not analysed. As a result, all costs refer to ED costs and inpatient hospital costs only.

Table 2.7 Availability of health care consumption data for minimum sets

		Minimum set I ED attendances	**Minimum set II** Hospital admissions, length of stay[1]
Austria	ED-system	+	+
	HDR		+
Denmark	ED-system	+	+
	HDR		+
Greece	ED-system	+	+
Ireland	ED-system	+	+
	HDR		+
Italy	Occup. Injury register	+	
	HDR		+
Netherlands	ED system	+	+
	HDR		+
Norway	ED system	+	+
	HDR		+
Spain	ED-Barcelona	+	
	HDR		+
UK, England	ED-system	+	+
	HDR		+
UK, Wales	ED-system	+	+
	HDR		+

+ = available

[1] Minimum set II: available information of hospital admission and length of stay.

For the availability of health care consumption data we can conclude that all countries have data available for the analyses of ED attendances (Minimum set I), hospital admissions and length of stay (Minimum set II). Note that during our analyses we will not refer to minimum sets and modules for health care consumption, but to hospital costs only.

2.5 Costs

2.5.1 Availability of unit 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.

Due to absence of sufficiently detailed data we were unable to calculate total health care costs. The costs of ambulance transport, rehabilitation, nursing home care, outpatient care and home care were not taken into consideration. For these health care sectors most countries had no information available of the incidence and the unit costs.

The term **'delivered unit cost per hospital inpatient day'** is used for the price that we received from the countries themselves for one inpatient day in hospital for medium care (costs for ICU are not included), including hospital costs for all patients (not only injury patients) for general and university hospitals, public and private hospitals, excluding rehabilitation clinics.

The unit costs are estimated using country-specific information gathered by a questionnaire and by the literature. In table 2.8 and 2.9 an overview is given of the source of the information and the available unit costs for each country, and the source of information for hospital inpatient days.

Table 2.8 Availability of unit costs (€) per country

Country	Inpatient days in hospital	ED visits	ICU-days	ambulance service	DRG/HRG
Austria	273/410 [1]	53 (incl. therapy/plastering)			
Denmark					
Greece	142 [2]	51			
Ireland					Price list DRG's
Italy	362/437 [3]				Total costs
Netherlands	356/486 [4]	99/180 (outpatient/ED visits)	1486	373 (emergency)	Yes
		Incl. diagnostics and overhead		143 (no emergency)	
Norway	555	122 (ED visit, incl. X-ray)			DRG, also price list of DRG's
Spain	353	82 (ED visit, excl. X-ray)		cost components	
		71 (outpatient visit)		available	
England	227	103 (Netten, 2002)		298 (Netten, 2002)	HRG and costs (HRG per patient)
Wales	227	103 (Netten, 2002)		298 (Netten, 2002)	HRG and costs (HRG per patient)

[1] € 273 is nursing only and € 410 is nursing, operation room and other therapy.

[2] € 142 are only nursing department costs.

[3] € 362 is medical inpatients (DRG) and € 437 is surgical inpatients (DRG). For further analyses we have used € 362, since in the unit cost for surgical patients also operation costs are included.

[4] € 356 are the costs for inpatient days in a general hospital and € 486 for an academic hospital.

Table 2.9 Source of cost information for hospital inpatient days

Country	Source
Austria	Based on information from one injury-specific institution, AUVA-hospital
Denmark	No information
Greece	Based on prices paid in one private hospital
Ireland	DRG
Italy	DRG
Netherlands	CTG, CBS, Nzi (based on national estimations of unit costs)
Norway	Detailed cost calculation of the country themselves
Spain	Based on information from one general hospital
England	Econometric estimation of UK hospital costs (Adam, 2003 and Netten, 2002)
Wales	Econometric estimation of UK hospital costs (Adam, 2003 and Netten, 2002)

Eight countries delivered unit costs of inpatient days in hospital, and seven countries had information available about costs of Emergency Department visits. Both cost categories will be used for the cost model. Cost information of diagnosis related groups (DRG) or hospital related groups (HRG) were available for six countries.

2.5.2 Calculation of comprehensive unit costs per country

International comparisons of the costs of injury can only be made, when comparable unit costs of each country are available. Table 2.9 showed that almost all countries delivered unit costs per inpatient day in hospital for their country. These unit costs cannot directly be used for international comparisons, because different cost categories (e.g. nursing, therapy, etc) are included/excluded in different countries. In order to make calculations with the EUROCOST model the delivered 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'.

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).

Because costs for ICU are not included in the comprehensive unit cost per hospital inpatient day, the results are an underestimate of the actual costs. The comprehensive unit cost per hospital inpatient day is calculated in several steps, which are described below. Table 2.10 gives an overview of the calculated comprehensive unit cost of hospital inpatient days. The marks (bold figures) in this table are used in the calculation examples for the explanation of the steps below.

- Step 1: Delivered unit costs of a hospital inpatient day were broken down into location costs of the nursing department (including overhead), clinical staff costs (all health care practitioners), diagnostics, therapy and medication, research and education.
- Step 2: Not all countries delivered unit costs of the year 1999. For Spain (2002), Greece (1996) and UK, England and Wales (2000) the unit costs were re-calculated for the year 1999, based on country-specific inflation rates.
- Step 3: 'Research & education costs' were excluded.
- Step 4: In case data on specific cost categories were absent, these were estimated (italic figures) based on the mean costs of these categories in other countries, adjusted for differences in price

level among countries. We used information on purchasing power parities from the OECD (see box).

> 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.

All costs were converted to the average price level in the EU (see Annex 5). Example: delivered nursing department costs for Austria was € 280. After correction for PPP these costs are € 267 (€ 280 * 0.95). These costs are shown in the grey columns.

- Step 5: For each cost category we calculated the mean, based on the delivered cost data converted to the average EU price level. The mean costs per category are shown in table 2.10 in the last column.
- Step 6: When for a country a specific cost category is missing, the mean cost (calculated in step 5) of that category cost element is used for the calculations, converted back to the national price level. Example: For Austria there is no information available of diagnostics and medication. The mean cost for diagnostics is € 32 (European price level). After correction for PPP, the costs for diagnostics were € 33 (€ 32/0.95; Austrian price level).
- Step 7: Now we have calculated the costs per cost category for each country, the comprehensive unit costs are known. The mean total cost for all participating countries is € 381 (total of the mean costs per cost category in table 2.10).

Table 2.10 Delivered unit cost (€) and calculated comprehensive unit cost (€) of one inpatient day in hospital per country

	AU		**GR**		**NL**		**NO**		**IT**		**SP**		**UK**		**Mean costs**
	Nat. Price level	EU price level	Nat. Price level	EU price level	Nat. Price level	EU price level	Nat. Price level	EU price level	Nat. Price level	EU price level	Nat. Price level	EU price level	Nat. Price level	EU price level	EU price level
Nursing department costs	280	267	142	180	192	195					158	191			208
Clinical staff costs	*122*	*116*	*91*	*116*	114	116					*96*	*116*			116
Diagnostics & medication	*59*	*57*	*44*	*57*	*59*	*60*					*44*	*53*			57
Total	**461**	439	**277**	353	**365**	371	**555**	450	**362**	409	**298**	359	**227**	208	**381**
EU price level / national price level	0.95		1.27		1.02		0.81		1.13		1.21		0.92		1.00

- Step 8: For Denmark and Ireland the comprehensive unit cost of hospital days is calculated by adjusting the mean costs in the EU (€ 381) to the national price levels (Denmark € 465, Ireland € 389).

In table 2.11 an overview is given of the delivered unit cost per ED visit for each country. For Denmark, Ireland and Italy no information was available about the costs per ED visit. The handling of missing data was similar as for cost of hospital inpatient days.

In the baseline model the comprehensive unit cost (national price level) will be used for the calculations of health care costs.

Table 2.11 Delivered unit cost (€) and comprehensive unit cost (€) per ED visit by country

Country	Unit cost	PPP	Unit cost corrected PPP
Austria	*97*	0.95	*92*
Denmark	*113*	0.82	*92*
Greece	**51**	1.27	65
Ireland	*94*	0.98	*92*
Italy	*81*	1.13	*92*
Netherlands	**99**	1.02	101
Norway	**122**	0.81	99
Spain	**82**	1.21	99
UK, England	**103**	0.92	95
UK, Wales	**103**	0.92	95
Mean costs			92

2.5.3 Calculation method EUROCOST model

Costs are the product of incidence, transition probabilities, care volumes and comprehensive unit costs. A patient's health care route is determined by transition ratios, such as the probability of hospitalisation. The probability of hospitalisation 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.

Calculation of transition ratio of hospitalisation

Transition ratio is the probability that an injury patient will use a certain form of healthcare (e.g. the probability of being admitted to a hospital).

For each specific patient group (divided by age/sex/injury and country) the number of admitted patients are compared for ED and HDR.

Example

1000 ED registered patients

- 50 admitted patients registered in ED
- 60 patients registered in HDR

Transition ratio of this specific patient group = 60 / 50 = 1.2

Some ED patients will be admitted later (delayed admission), or will be readmitted. The hospitalisation of these patients is not registered in ED systems, but is registered in the HDR. For the costs calculations we made the assumption that neither of these patients visited the ED. Also, 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 is

the starting point of the hospital inpatient rate. The registered admitted ED patients are corrected for HDR admissions by a transition ratio. The transition ratio is calculated by matching the HDR patients with the ED-admitted patients, based on country, injury groups, age (7 age groups), and sex. This approach was also used in the original Dutch model. 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. The transition ratio of Austria, Ireland and England is based on the comparison of only home and leisure (and occupational for HDR) patients, since the ED data systems of these countries only consisted of patients with injuries caused by home and leisure accidents. For the calculation of the transition ratio of hospitalisation, information about the HDR system is needed. For Greece, no HDR system was available and the ED data of Spain only covered Barcelona. For both countries the admitted ED patients were starting point of the analyses (transition ratio = 1).

Calculation of mean length of stay

For each specific patient group in the ED (divided by country, age, sex and injury) the mean length of stay was calculated in the HDR. We 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) could be calculated. For 5.8% of all patient groups the length of stay was missing. For these groups the mean length of stay by injury group was used. For Greece we used information of the mean length of stay of admitted ED patients, since HDR is not available.

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. generally more severe head injuries are recorded in HDR compared to ED systems). In the cost calculations, using transition probabilities, these patients were not taken into account. This resulted 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 are added to the hospital inpatient rate.

Our hypothesis was that admitted patients without ED registration are relatively severe injuries. The percentage of specific patient groups registered at HDR, but without ED registration varies between 7 and 34 percent. We analysed this patients by injury group. Hip fractures were the most occurring injury.

Calculation method - example

With the help of the cost 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 2.12 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
Transition ratio	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 = € 132150	
Mean costs per patient = € 132150 / (91 * 2.4) = € 606	

Calculation method Italy and Spain

For Italy it is not possible to calculate the hospital costs based on the EUROCOST model. The HDR is an aggregated database, so we have no information available of individual patients.
However, in the HDR there is information available about the total cost per aggregated patient group. These cost calculations are not only based on the length of stay, but on reimbursement costs (diagnosis related hospital costs). The total costs for Italy based on the HDR data system are € 2,147,060,990. The mean costs per patient are € 2313.
The comprehensive unit costs for Italy are € 362 for one inpatient day in hospital and € 81 for ED visit. The total calculated costs are (total patients registered in HDR * € 81) + (total days in hospital * € 362) = € 2,124,377,000. The mean costs per patient registered in HDR = € 2288. (This is comparable with € 2313). The costs per capita for Italy are € 72. The mean costs per patient are comparable with the other countries. The total hospital costs per capita for injuries are higher than the other participating countries.
For Italy and Spain it was not possible to calculate the hospital costs. For Minimum set I we have calculated the total costs and costs per capita for Spain and Italy following the same method as for the countries that did not participate in the EUROCOST project (see chapter 6).

2.5.4 Baseline model

Baseline model for analysing costs:

- Comprehensive unit costs per country (for ED visits and hospital days) are used for calculations
- Registered admitted patients in ED were corrected by transition ratio (correction with HDR admissions)
- Mean length of stay per injury group of the HDR data system was used
- HDR cases without corresponding ED cases by patient group were added
- Extrapolated data is presented

3 Injury incidence, health care consumption and costs in Europe

3.1 Introduction

In chapter 2 an overview is given of the uniform methodology that has been used for analysing the injury incidence, health care consumption and costs. This uniform methodology, or baseline model (see table 3.1), is the starting point for the international comparisons of the data shown in this chapter.

Table 3.1 Baseline model

	Selection external causes: exclusion medical procedures (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 delivered extrapolation factor (ED-incidence)
	Standardised data by age and sex are presented (ED and HDR)
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

3.2 Injury incidence

It appears that large international differences exist in injury incidence on the aggregated level of accident categories (see tables 3.2 and 3.3). Standardised ED incidence rates for home and leisure injury (Minimum set I) vary substantially between the participating countries (27 to 111 per 1,000 person years). The hospital inpatient rate (Minimum set II) ranges from 5 to 23 per 1,000 person years (when Italy is not taken into account).

Table 3.2 Standardised ED-injury incidence rates (per 1,000 person years) by accident group and country

Country	Home and leisure Min.set I (CMF [a])	Sports	Home	Traffic (Mod. I)	Occup. (Mod. II)	Violence	Selfmut.
Austria	59.0 (0.8)	18.3	40.7				
Denmark	89.8 (1.2)	18.2	71.6	12.7	20.5		
Greece	104.3 (1.4)	9.1	95.2	24.1	17.7	4.2	
Ireland	26.6 (0.3)						
Italy					23.3 [b]		
Netherlands	48.4 (0.6)	11.8	36.7	10.3	7.1	2.4	0.9
Norway	70.5 (0.9)	15.9	54.7	7.3	8.1	3.5	1.5
Spain, Barcelona				12.3			
UK, England	110.6 (1.5)	17.8	92.8				
UK, Wales	79.4 (1.1)	11.2	68.3	5.6	12.4	5.7	4.8

[a] CMF = Comparative Morbidity Figure.

[b] Injury incidence rate for Italy is not standardised.

Note: proportional distribution of unknown/unspecified injuries.

Table 3.3 Standardised HDR-injury incidence rates (per 1,000) by accident group and country

Country	HSO [a]	Traffic	Violence	Selfmut.	Total Min.set II (CMF [b)]
Austria	18.8	2.4	0.3	0.2	21.7 (1.7)
Denmark					15.4 (1.3)
Ireland	8.9	1.9	0.6	0.8	12.5 (1.1)
Italy					16.1 [c]
Netherlands	3.7	1.1	0.1	0.3	5.2 (0.5)
Norway					12.9 (1.2)
Spain	2.6	1.8	0.2	0.1	4.8 (0.4)
UK, England	6.4	1.1	0.5	1.1	9.1 (0.9)
UK, Wales	8.4	1.3	0.6	1.7	12.3 (1.1)

[a] HSO = home, sports and occupational.

[b] CMF = Comparative Morbidity Figure.

[c] Injury incidence rate for Italy is not standardised.

Note: proportional distribution of unknown/unspecified injuries.

Table 3.4 Distribution (%) of ED Home and leisure injury (Minimum set I) by injury group (level 3) and country

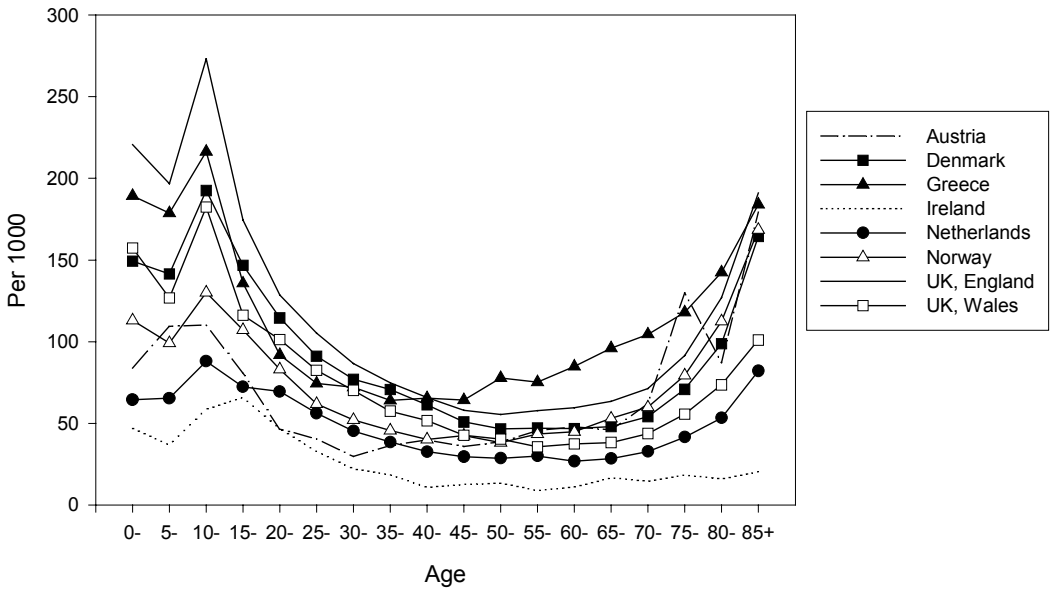
	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Head and facial injury (excl. eye injuries)	8.6	10.3	12.4	5.9	7.8	10.6	9.3	8.8
Eye injury	0.0	5.0	1.3	1.5	3.1	0.9	2.5	0.9
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	1.6	0.6	1.3	0.7	1.1	3.6	1.1	1.5
Upper extremity injury (excl. nerves)	32.3	19.5	16.5	27.8	20.1	22.8	14.2	17.5
Lower extremity injury	31.2	18.8	18.8	16.6	17.9	19.7	11.2	13.8
Superficial injury, including contusions and open wounds	19.5	38.2	43.9	33.7	44.9	34.6	26.5	35.5
Burns	2.3	1.3	2.1	0.0	1.6	1.5	1.9	1.8
Poisoning	0.1	2.0	0.6	1.8	0.7	0.3	0.5	1.6
Foreign body	0.0	0.0	2.8	0.0	0.4	2.9	0.0	2.7
Other and unspecified injury	4.5	4.2	0.3	12.0	2.5	3.1	32.8	16.1
Total	100	100	100	100	100	100	100	100

Note: proportional distribution of unknown/unspecified injuries

Although there exist large differences in the injury incidence rates between the countries, the distribution of frequencies by injury groups is quite similar. For home and leisure patients (ED), the most frequently registered injuries were superficial injuries including contusions, open wounds, and dislocation/sprain/strain injuries (table 3.4). Only Austria has a different pattern with very high incidences for upper and lower extremity injuries and a lower incidence rate for superficial injuries, compared to the other countries. For admitted patients, registered in the HDR, the most frequently registered injuries were hip fractures, knee/lower leg fractures and superficial injuries.

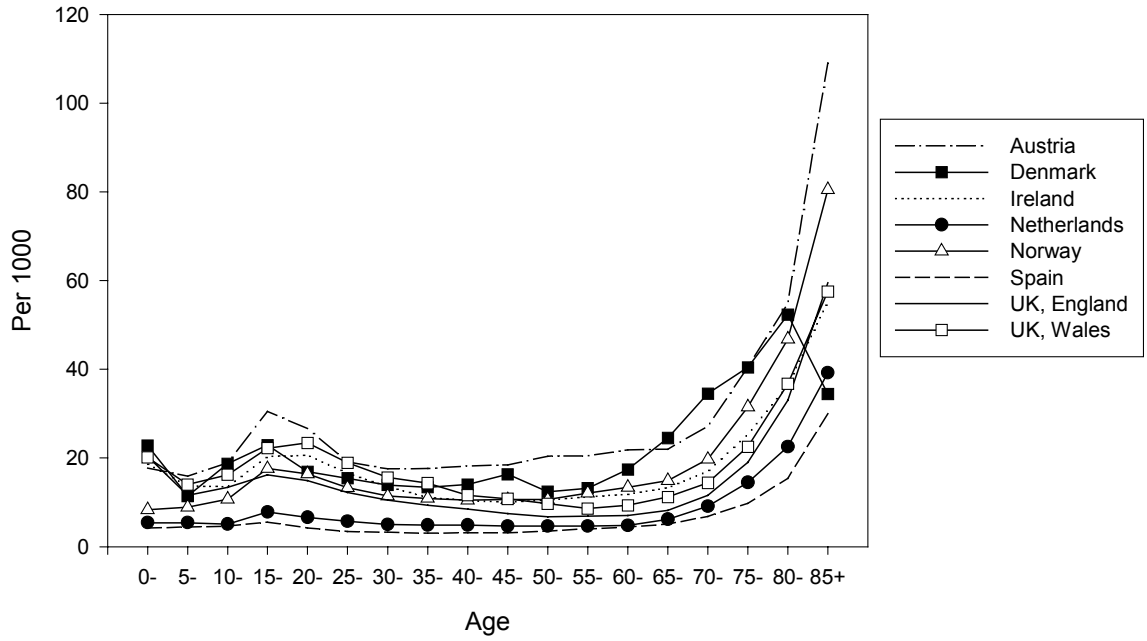
In figures 3.1 to 3.6 the injury incidence (per 1,000 person years) by age groups are shown, for the minimum sets and modules.

Figure 3.1 ED home and leisure injury (Minimum set I) incidence rates (per 1,000) by age and country



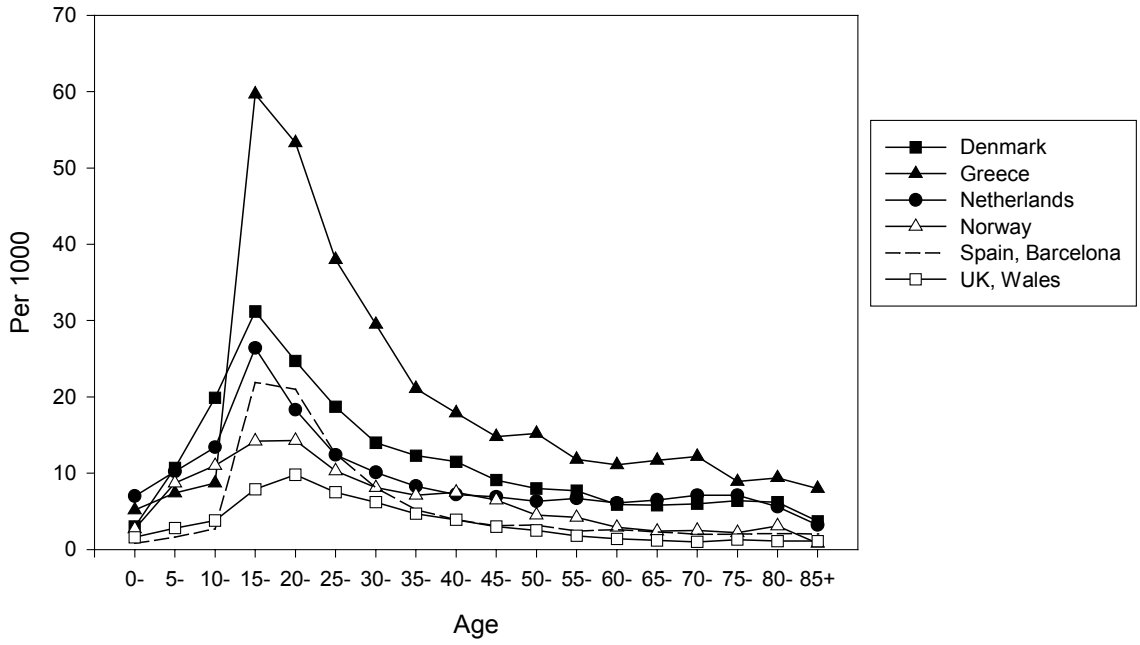
General pattern: The ED incidence for home and leisure injuries is high for children with the age of 0-4 years, with a peak at 10-15 years (see figure 3.1). After the age of 65 years, the incidence rate rapidly increases again.

Figure 3.2 HDR incidence rates (Minimum set II) (per 1,000) by age and country



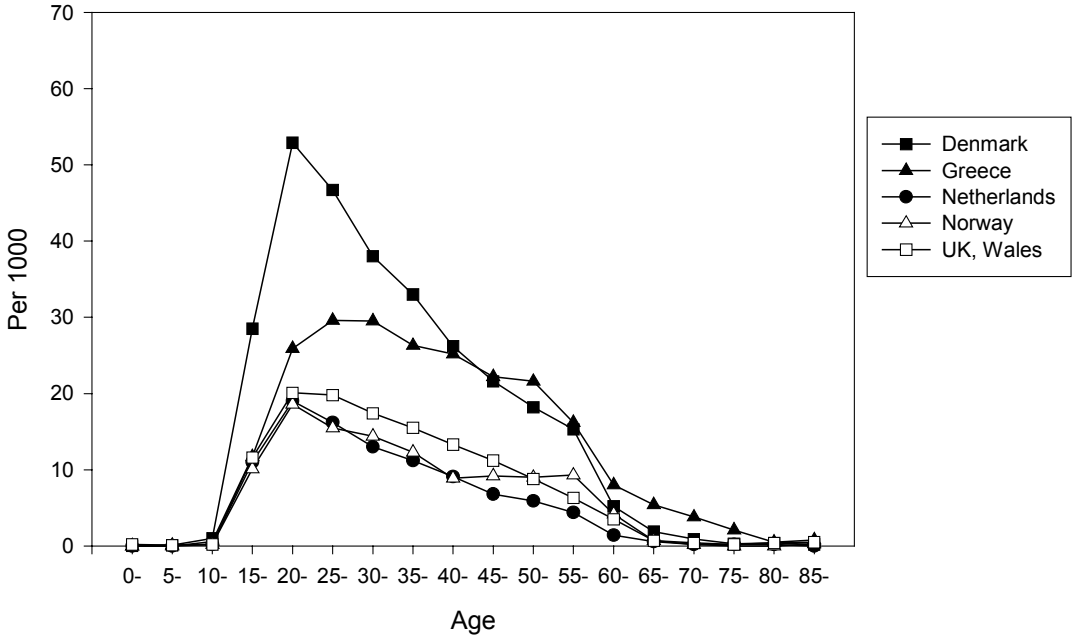
General pattern: The hospital inpatient rate (HDR) is quite stable up to age 65 for all countries, with a small peak among 15-29 year old and a strong increase after age 65 (see figure 3.2).

Figure 3.3 ED traffic injury (Module I) incidence rates (per 1,000) by age and country



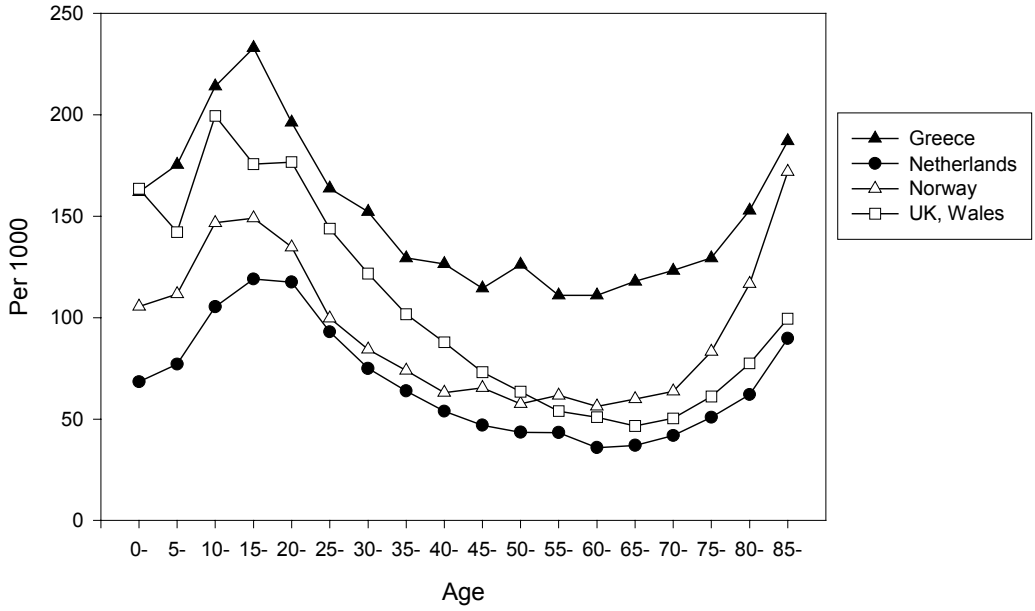
General pattern: The injury incidence for traffic injuries is the highest for young adults in the age of 15-24 years.

Figure 3.4 ED occupational injury (Module II) incidence rates (per 1,000) by age and country



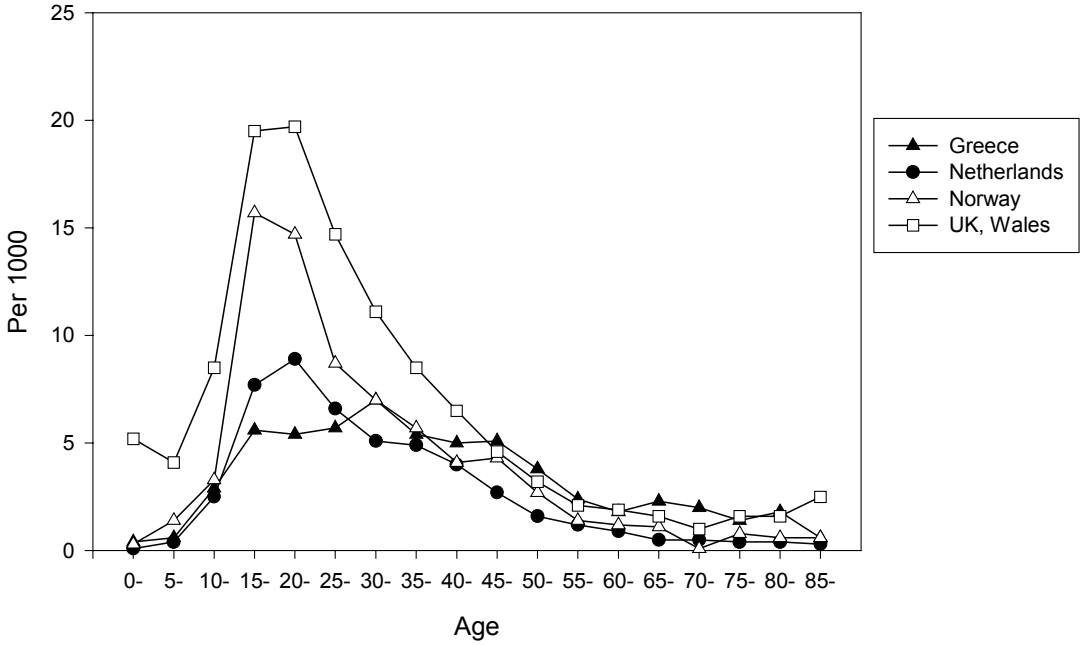
General pattern: In most countries the injury incidence for occupational injuries is highest for persons aged 20-24 years, and decreases thereafter (see figure 3.4). Please notify that the presented figures are not adjusted for differences in labour participation by age or country.

Figure 3.5 ED intentional and unintentional injury (Module III) incidence rates (per 1,000) by age and country



General pattern: Among countries with information of all accident groups available the age pattern of the injury incidence rate is quite similar, with a peak at the age of 10-24 years, and an increase after the age of 65 (see figure 3.5).

Figure 3.6 ED intentional injury (Module IV) incidence rates (per 1,000) by age and country



General pattern: The incidence rate of intentional injuries is far the highest among young adults (see figure 3.6).

3.3 Health care consumption

Similar to the ED incidence, also the hospital inpatient rate shows large variation among countries, e.g. from 2.9 to 19.3 per 1,000 for home and leisure accidents (see table 3.5).

Table 3.5 ED incidence rates admitted injuries (per 1,000) by accident group and country

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Home and leisure	19.3	5.6	7.6	2.9	3.2	7.9	5.4	7.1
Traffic		1.6	4.3		1.5	1.2		0.5
Occupational		0.5	1.1		0.2	0.3		0.8
Violence			0.4		0.2	0.4		0.6
Selfmutilation					0.5	1.3		1.5
Total	**19.3**	**7.7**	**13.4**	**2.9**	**5.7**	**11.1**	**5.4**	**10.6**
% of total ED patients [a]	32.7	6.2	8.9	11.0	8.3	12.5	4.9	9.9

[a] Admitted patients / Total registered ED patients (see table 3.2).

The presented data in tables 3.5 and 3.6 are from ED and HDR systems, respectively. Remarkably, the total hospital inpatient rate is higher in general when calculated from HDR data, and even much higher for Denmark, Ireland, and England. Also the international differences are smaller in table 3.6 compared to table 3.5, and the ranking is different. Countries with the lowest hospital inpatient rates (Netherlands, Spain) have the highest proportions of patients with a high length of stay (LOS).

Table 3.6 Hospital inpatient rates of admitted injuries (per 1,000) and distribution (%) by LOS and country (Minimum set II)

	AU HDR	DK NDR	IR HIPE	NL LMR	NO HDR	SP HDR	UK, England HDR	UK, Wales HDR
1-3	10.2 (47.1)	8.5 (55.2)	7.6 (62.7)	2.2 (42.5)	7.7 (60.0)	1.7 (36.1)	5.7 (62.6)	7.5 (64.4)
4-6	4.6 (21.1)	2.3 (15.0)	1.7 (14.0)	0.8 (14.9)	2.0 (15.9)	0.9 (18.8)	1.0 (11.5)	1.4 (11.5)
7+	6.9 (31.8)	4.6 (30.0)	2.8 (23.3)	2.1 (42.7)	3.1 (23.8)	2.1 (45.5)	2.4 (26.1)	2.9 (23.9)
Total	21.7	15.4	12.5	5.2	12.9	4.6	9.1	12.3

Figure 3.7 HDR mean LOS by age and country

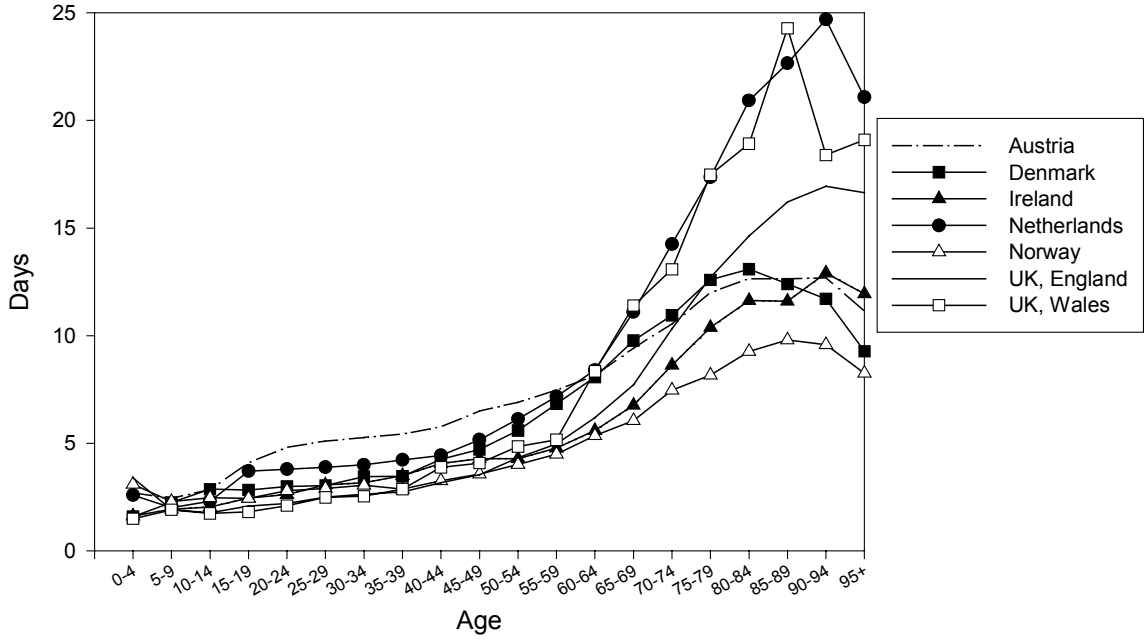


Figure 3.7 shows an increase in length of stay in hospital by age in all countries. There are large international differences in length of stay of admitted injury patients among older age groups. Particularly in the Netherlands and Wales there is an exponential increase in length of stay after the age of 65.

Table 3.7a HDR mean LOS of admitted injuries by injury group (level 3) and country

	AU	DK	IR	NL	NO	SP	UK, England	UK, Wales
Head and facial injury (excl. eye injuries)	5	4	5	7	3	8	5	6
Eye injury	6	4	5	3	4	6	4	4
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	9	8	8	11	6	12	10	9
Upper extremity injury (excl. nerves)	5	4	3	5	4	5	4	5
Lower extremity injury	13	12	11	17	9	13	14	19
Superficial injury, including contusions and open wounds	4	6	4	6	4	5	5	5
Burns	9	11	11	12	9	14	8	10
Poisoning	3	3	3	4	2	11	2	3
Foreign body	2	2	2	3	2	4	2	4
Other and unspecified injury	9	4	3	8	4	8	8	5

Table 3.7a shows that lower extremity injuries, burns and injuries of the vertebral column/spine/internal organ have a relatively long length of stay (primarily elderly) (means in table 3.7a, medians in table 3.7b (next page). In particular Wales and Netherlands have a very high length of stay for lower extremity injuries that are predominantly occurring in older people. The length of stay for poisoning for Spain (406 patients) is striking compared to the other countries.

Table 3.7b HDR median LOS of admitted injuries by injury group (level 3) and country

	AU	DK	IR	NL	NO	SP	UK, England	UK, Wales
Head and facial injury (excl. eye injuries)	2	1	2	2	1	3	2	2
Eye injury	4	2	4	2	3	5	2	2
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	5	5	5	6	4	7	4	4
Upper extremity injury (excl. nerves)	3	2	2	2	2	3	2	1
Lower extremity injury	9	7	6	10	5	10	9	10
Superficial injury, including contusions and open wounds	2	2	2	2	2	3	2	2
Burns	5	7	6	6	3	9	3	3
Poisoning	1	1	2	1	1	6	1	1
Foreign body	1	1	1	1	1	2	1	1
Other and unspecified injury	5	1	1	3	2	4	1	1

3.4 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.

First of all, an impression is given of the share of the total hospital costs of injured patients as percentage of gross domestic product (GDP). GDP is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production. The sum of the final uses of goods and services measured in purchasers' prices, less the value of imports of goods and services, or the sum of primary incomes distributed by resident producer units. Also, total hospital costs are measured as percentage of total health expenditure per country.

Table 3.8 *Total hospital costs and total hospital costs as percentage of GDP and total health expenditure for home and leisure patients (Minimum set I) and all admitted injury patients (Minimum set II) per country*

	Home and leisure patients (Minimum set I)			**Admitted injury patients (Minimum set II)**		
	Total hospital costs (* mln €)	Costs as % of GDP	Costs as % of total health expenditure	Total hospital costs (* mln €)	Costs as % of GDP	Costs as % of total health expenditure
Austria	429	0.07	3.11	609	0.10	4.42
Denmark	207	0.13	1.96	273	0.17	2.59
Greece	242	0.21	1.78	316	0.28	2.33
Ireland	32	0.04	0.62	98	0.11	1.90
Italy				2147	0.19	2.41
Netherlands	255	0.07	0.83	304	0.08	0.98
Norway	253	0.02	2.63	189	0.02	1.96
Spain				540	0.10	1.12
United Kingdom	948	0.07	1.25	965	0.07	1.27

Table 3.9 and figure 3.8 give an overview of incidence, the total costs, costs per patients and costs per capita for the minimum sets and modules for each country. Costs per capita are the multiplication of the incidence rate and costs per patient. For example, costs per capita of home and leisure injuries (Minimum set I) are highest in Austria, because of relatively high costs per patient. Although England has the highest incidence rate of home and leisure injuries, costs per capita are low because of low costs per patient.

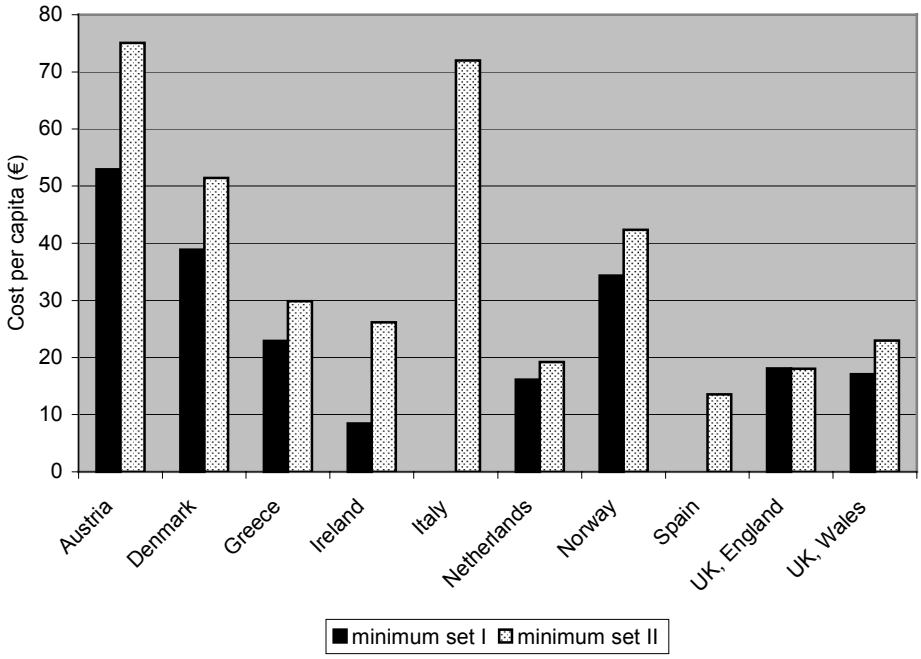
Minimum sets and modules

Table 3.9 Injury incidence rate (per 1,000), cost per ED patient, cost per capita, and total costs (million €) by minimum sets and modules and country

	Minimum set I HLA	Minimum set II Only-admitted	Module I Traffic	Module II Occupational	Module III Intentional	Module IV Int. and unint.
Austria						
incidence rate	59	22.9				
cost per patient	888	3252				
cost per capita	53	75				
total costs	429	609				
Denmark						
incidence rate	89.8	18.1	12.7	20.5		
cost per patient	431	2745	1103	238		
cost per capita	39	51	14	5		
total costs	207	273	72	25		
Greece						
incidence rate	104.3	13.4	24.1	17.7	4.2	150.3
cost per patient	243	2166	523	177	155	282
cost per capita	23	30	12	3	1	43
total costs	242	316	123	29	6	456
Ireland						
incidence rate	26.6	15.2				
cost per patient	273	1690				
cost per capita	8	26				
total costs	32	98				
Italy						
incidence rate		31.3				
cost per patient		2313				
cost per capita		72				
total costs		2147				
Netherlands						
incidence rate	48.4	6.5	10.3	7.1	3.3	69.1
cost per patient	335	2954	649	181	537	426
cost per capita	16	19	6	1	1	30
total costs	255	304	103	20	20	469
Norway						
incidence rate	70.5	14.7	7.3	8.1	5	86.4
cost per patient	480	2819	1080	332	900	593
cost per capita	34	42	8	3	3	56
total costs	153	189	34	11	13	248
Spain, Barcelona						
incidence rate		4.8	12.3			
cost per patient		2771	424			
cost per capita		14	5			
total costs		540	8			
UK, England						
incidence rate	110.6	11.8				
cost per patient	156	1418				
cost per capita	18	18				
total costs	898	897				
UK, Wales						
incidence rate	79.4	15.6	5.6	12.4	10.5	108.5
cost per patient	327	1399	475	252	529	279
cost per capita	17	23	2	2	2	31
total costs	50	68	5	6	6	90

Table 3.9 also shows that the hospital costs for injury incidence are for the largest part caused by home and leisure injuries. Home and leisure injuries account for about 75% of the injury costs. Costs per patient are highest for traffic injuries, and lowest for occupational injuries.

Figure 3.8 Cost per capita (€) for home and leisure injuries (Minimum set I) and for total admitted patients (Minimum set II) per country



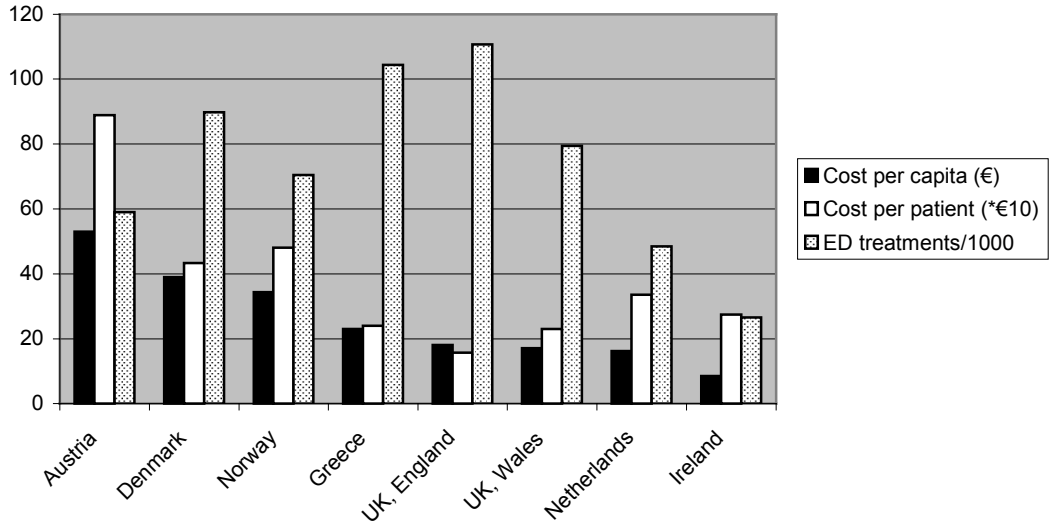
Costs for ED home and leisure injuries (Minimum set I)

Table 3.10 Calculation of injury-related hospital costs for home and leisure injuries (Minimum set I)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Registered patients ED, only HLA (a)	483400	479479	998167	115710	760133	319140	5755936	153728
Admitted HLA patients (b)	159154	30998	82490	12586	48677	36439	293847	14747
Total adm. pat. after correction transition probability (c)	100767	58038	82490	18632	55328	40343	255105	17828
Transition probability (mean)	0.6	1.9	1.0	1.5	1.1	1.1	0.9	1.2
Mean length of stay (d)	8.4	5.8	9.1	3.0	8.9	5.6	5.6	6.7
Total admission days (c * d) (e)	850352	337586	754372	56806	494513	226752	1440554	119489
Cost price inpatient day in hospital (f)	461	465	277	389	365	555	227	227
Cost price ED visit (g)	97	113	51	94	99	122	103	103
Total costs (a * g) + (c * f) (h) (*1,000,000)	429	207	242	32	255	153	898	50
Mean costs per patient (h/a) (i)	888	431	243	273	335	480	156	327
Total costs per capita/year	53	39	23	8	16	34	18	17
Total admitted patients per capita (per 1,000)	12	11	8	5	4	9	5	6

The next figure shows the international differences of the injury incidence, costs per capita and the mean costs per patient for all participating EUROCOST countries for home and leisure injuries.

Figure 3.9 Costs per capita (€), mean costs per patient (€10), and ED injury incidence (per 1,000) for home and leisure injuries (Minimum set 1)*

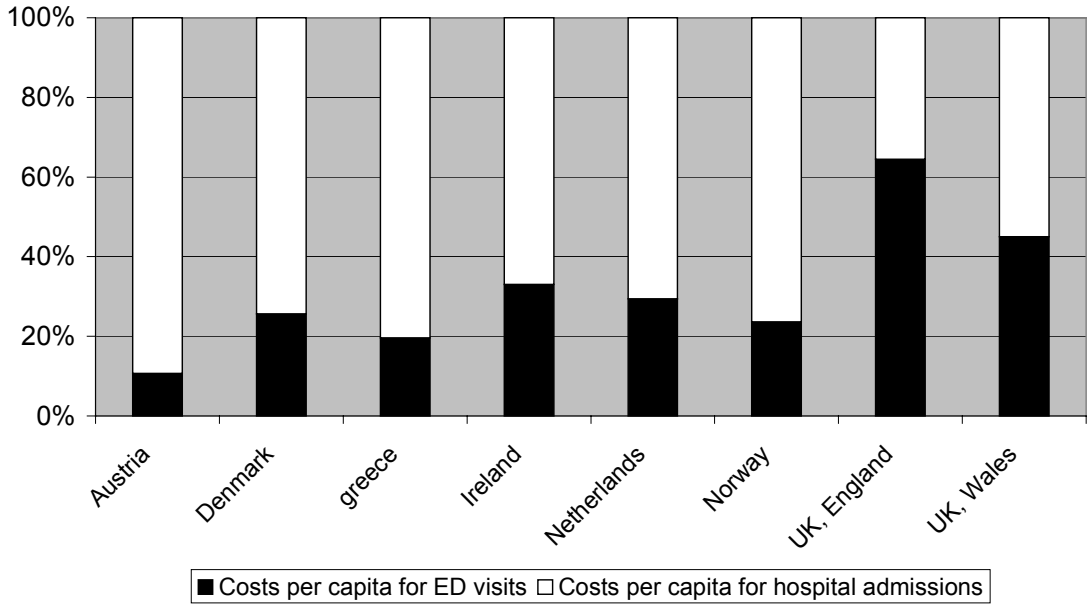


Note: Standard deviation cost per capita for all EUROCOST-countries = 14.7

The figure shows that large international differences exist in injury incidence, mean costs per patient and costs per capita for home and leisure injuries.

Figure 3.10 gives an overview of the distribution of the costs of ED visits and hospital admissions in the total costs of HLA injuries (Minimum set I) for all countries.

Figure 3.10 Cost distribution of HLA injuries (Minimum set I) by ED visits and hospital admissions



For most countries the costs of ED visits account for more than a quarter of the total hospital costs of HLA injuries. For Austria the costs of ED visits are relatively low, which can be explained by their high inpatient admission rate. The very high percentage in the distribution of the total costs for ED visits for

England is a reflection of their high ED injury incidence and their low inpatient admission rate for HLA injuries compared to the other participating countries.

We now present the distribution of hospital costs by sex (see figure 3.11), age (see figure 3.12) and injury groups (level 3) (see table 3.11).

Figure 3.11 Mean costs (€) per patient by sex and country (Minimum set I)

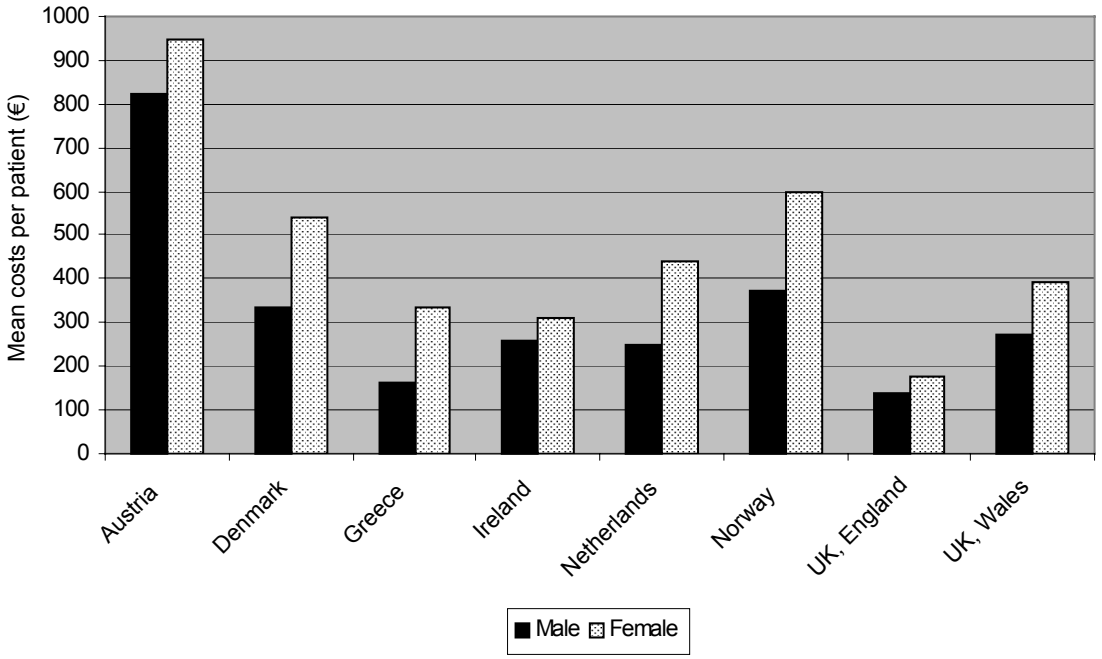
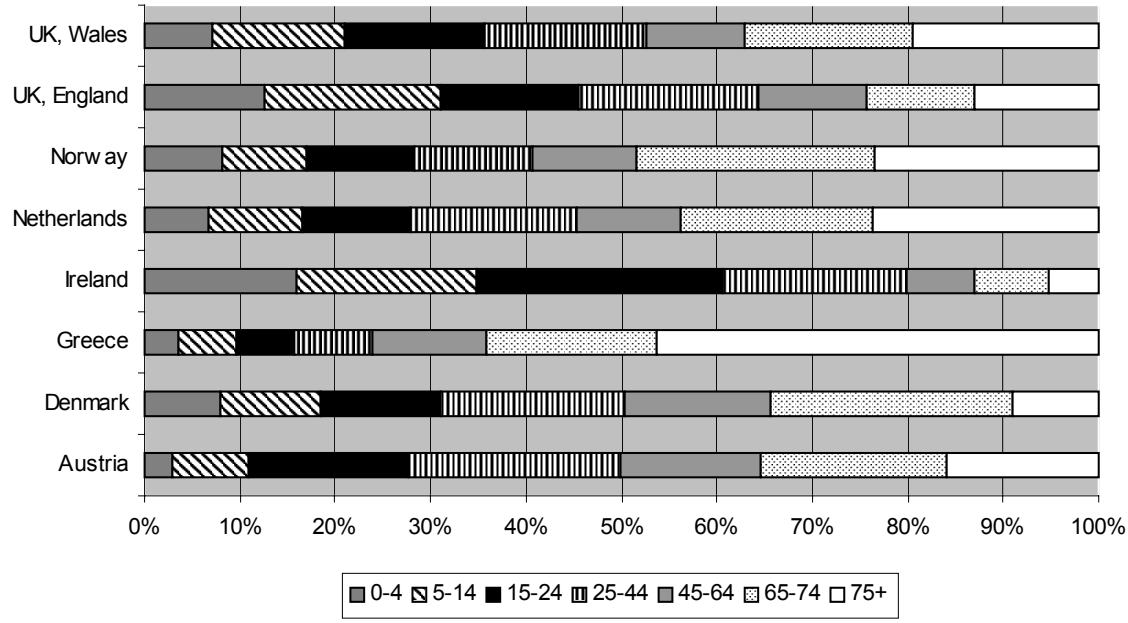


Figure 3.12 Cost distribution for home and leisure injuries by age per country (Minimum set I)



The table shows that the total costs of HLA injuries are dominated by persons of 65 years and older. In Norway, the Netherlands and Greece people above the age of 65 generate around 50% of the total costs for home and leisure injuries.
In Ireland and England the share of persons above the age of 65 in total costs is the lowest.

Table 3.11 Costs per capita (€) per injury group (level 3) per country (Minimum set I)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Head and facial injury (excl. eye injuries)	5.0	3.5	1.0	0.8	1.0	3.2	1.6	1.2
Eye injury	0.1	0.8	0.1	0.0	0.2	0.2	0.3	0.1
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	2.6	1.3	0.8	0.1	0.7	2.0	0.6	0.6
Upper extremity injury (excl. nerves)	12.9	6.2	1.3	2.2	1.8	5.1	3.1	2.4
Lower extremity injury	25.9	19.2	16.6	2.3	9.0	18.2	3.9	6.6
Superficial injury, including contusions and open wounds	3.4	4.5	2.1	1.5	2.5	2.8	3.8	3.4
Burns	0.6	0.7	0.1	0.0	0.4	1.1	0.4	0.3
Poisoning	0.1	1.7	0.5	0.4	0.2	0.2	0.3	0.6
Foreign body	0.0	0.0	0.2	0.0	0.1	0.3	0.0	0.2
Other and unspecified injury	2.3	1.1	0.1	1.0	0.3	1.3	4.1	1.8

The types of injury with the highest total costs are hip fractures and knee/lower leg fractures (lower extremity injury), and superficial injuries (including contusions and open wounds) (see table 3.11).

Costs for admitted patients (Minimum set II)

Table 3.12 Calculation of the injury-related hospital costs for admitted patients (Minimum set II)

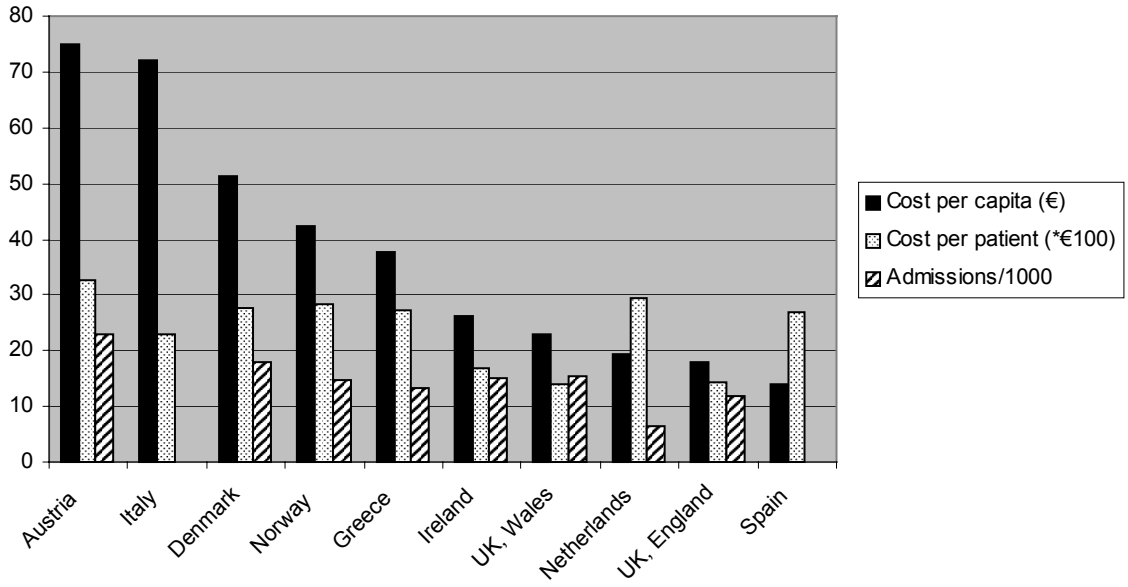
	AU	DK	GR [a]	IR	IT [b]	NL	NO	SP [b]	UK, England	UK, Wales
Admitted patients ED (a)	159154	41776	145850	12586		88001	52040		293847	31896
Adm. pat. ED after correction transition probability (b)	123074	79941	145850	38430		95135	62229		545512	39978
HDR patients without ED registration (c)	64151	19677	0	19766		7633	4733		86667	8288
Total admitted patients (b + c) (d)	187225	99618	145850	58196	928317	102768	66962	194859	632179	48266
Mean length of stay (e)	6.9	6.1	7.6	4.2	4.2	8.4	5.0	9.3	5.9	6.5
Total admission days (d * e) (f)	1295015	603442	1113586	243527	3868468	866977	333332	1812189	3702823	311532
Cost price inpatient day in hospital (g)	461	465	277	389	362	365	555	298	227	227
Cost price ED visit (h)	97	113	51	94	81	99	122	82	103	103
Total costs (f * g) + (b * h) (i) (*1,000,000)	609	273	316	98	2147	304	189	540	897	68
Mean costs per patient (i/d) (j)	3252	2745	2166	1690	2313	2954	2819	2771	1418	1399
Total costs per capita/year	**75**	**51**	**30**	**26**	**72**	**19**	**42**	**14**	**18**	**23**
Total admitted patients per capita (per 1,000)	23	19	14	16	17	7	15	5	13	16

[a] For Greece, admitted patients were derived from ED data, because HDR data were not available.

[b] Minimum set II for Italy and Spain is based on admitted patients in the HDR.

Figure 3.13 presents data on the standardised hospital inpatient incidence, costs per capita and the mean costs per patient for all participating EUROCOST countries.

Figure 3.13 Costs per capita (€), mean costs per patient (€100), and Hospital inpatient incidence (per 1,000) for total admitted patients (Minimum set II)*



Note: Standard deviation cost per capita for all EUROCOST-countries = 22.2

The mean hospital costs per admitted patient (inpatients only, exclusive day cases) vary between € 1400 and € 3200. Costs per capita of admitted patients range from € 5 (Spain) to € 23 (Austria) The costs per capita are highest for Denmark and Austria Costs per capita in the Netherlands and Spain are low because of their low hospital inpatient rate.

We compared the LOS and inpatient admission rate of injuries and all patients (including non-injury) together (OECD Health Data). The discharge rates of injuries in table 3.13 are comparable to the inpatient admission rates of table 3.12 (for most countries the same data sources have been used). Also injury specific and all cause discharge rates show a strong correlation.

Table 3.13 Hospital discharges (per 1,000) (1999) and LOS (1998), all diagnoses and injury-specific by country

	AU	DK	GR	IR	NL	NO	SP	UK
Discharge rates, all causes	280.6	20.5	15.4[a]	12.4	9.6	15.6	11.4	14.8[a]
Discharge rates, injury specific	2.9	18.7	1.5[a]	1.4	7.6	1.7	0.9	-
LOS inpatient acute care, all causes	6.8	5.3	6.3	6.5	9.5	6.2	7.6[b]	6.1
LOS inpatient acute care, injury specific	8.1	6.1	6.0[b]	5.8	10.9	6.0	9.6	-

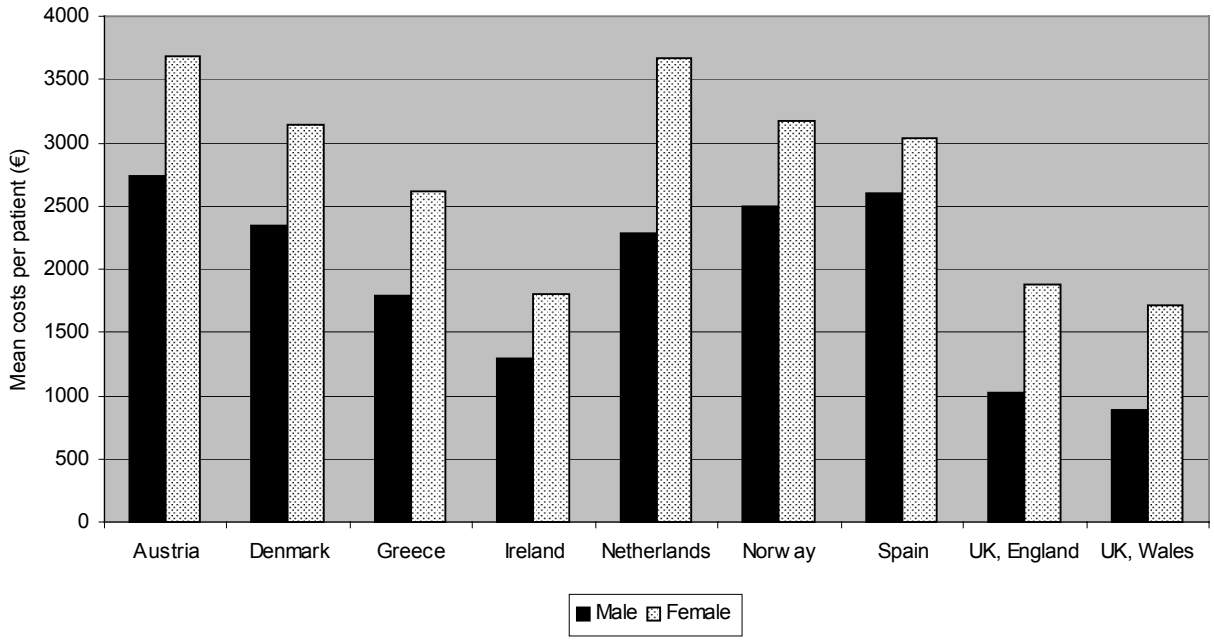
Source: OECD Health Data

[a] Data are of 1998.

[b] Data are of 1997.

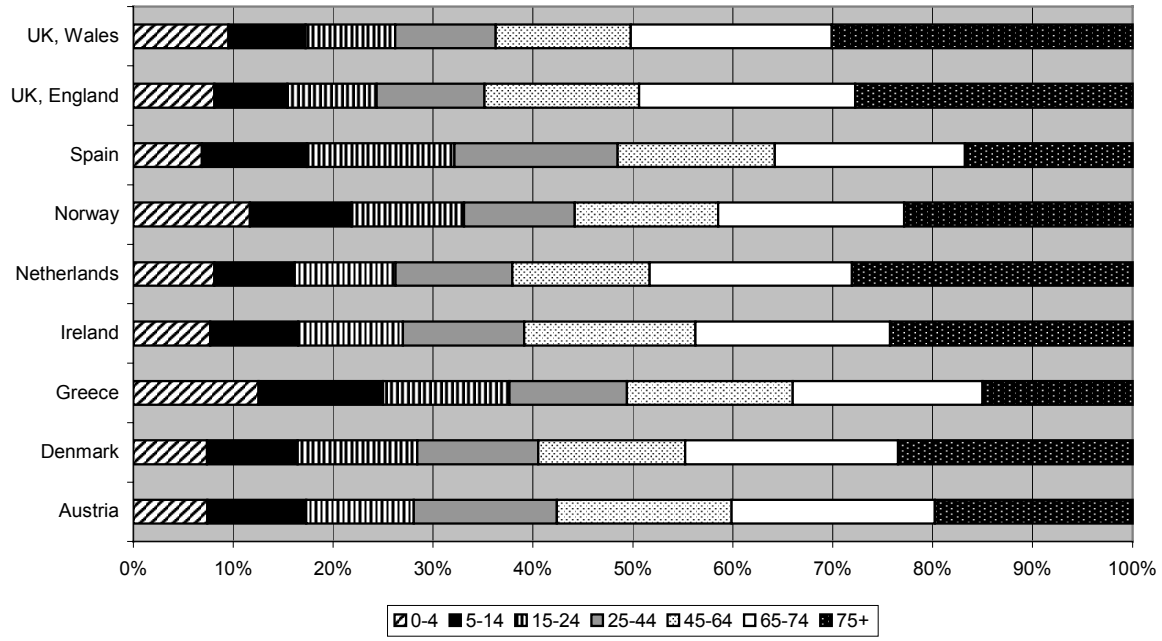
We now present the hospital costs of hospital inpatients (Minimum set II) by sex (see figure 3.13), age (see figure 3.14) and injury groups (level 3) (see table 3.12).

Figure 3.14 Mean costs (€) per admitted patient by sex and country (Minimum set II)



In each participating country the total costs of hospital inpatients are higher for women than for men, mainly because of high costs in elderly females.

Figure 3.15 Cost distribution (%) by age per country (Minimum set II)



The table shows that in most countries almost 50% of total costs are due to persons of 65 years and older. The contribution of patients above the age of 65 is for Greece relatively low (whereas the contribution in costs for the elderly of Minimum set I in figure 3.12 were very high).

Table 3.14a Mean hospital costs (€) per injury group (level 3) per country (Minimum set II)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Head and facial injury (excl. eye injuries)	2606	2710	768	1247	2313	2280	837	1508
Eye injury	2138	1646	956	1350	1286	2457	893	832
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	4085	3734	1762	2752	3609	3037	2088	1891
Upper extremity injury (excl. nerves)	2122	1902	1066	893	1658	1918	850	1267
Lower extremity injury	5229	4310	2835	3184	4950	3924	2242	2459
Superficial injury, including contusions and open wounds	3617	3106	1208	2634	3304	2921	1374	1863
Burns	4779	5503	2277	4196	5566	5401	1873	2423
Poisoning	1502	1586	463	1090	1911	1514	730	878
Foreign body	792	473	611	585	1298	1376	255	951
Other and unspecified injury	4415	1919	3005	1548	2914	2543	1582	1724
Mean costs of total admitted patients	3877	2871	1991	1962	2985	2673	1619	1625

Table 3.14b Costs per capita (€) per injury group (level 3) per country (Minimum set II)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Head and facial injury (excl. eye injuries)	7.1	5.5	1.7	1.1	1.8	4.7	0.5	1.1
Eye injury	0.3	0.1	0.1	0.1	0.0	0.3	0.0	0.1
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	5.7	3.0	1.9	0.8	1.6	3.5	0.5	0.9
Upper extremity injury (excl. nerves)	11.9	5.9	1.6	2.1	1.5	5.3	1.6	2.1
Lower extremity injury	29.0	24.0	21.7	6.2	11.4	21.5	7.4	9.4
Superficial injury, including contusions and open wounds	6.6	2.7	0.5	1.0	0.8	2.1	0.7	1.4
Burns	1.1	0.8	0.5	0.7	0.4	1.5	0.2	0.4
Poisoning	0.3	1.8	0.2	0.5	0.8	1.4	0.2	1.9
Foreign body	0.1	0.2	0.0	0.1	0.1	0.2	0.0	0.2
Other and unspecified injury	2.4	1.1	0.4	0.9	0.5	1.9	0.4	1.2

Costs per patient are highest for lower extremity injuries and burns (see table 3.14a). The mean costs per capita were the highest for injuries of the vertebral column, spine and internal organs and for lower extremity injuries. The costs per capita are by far the highest for lower extremity injuries (includes hip fracture) for all countries, because of the high costs per patient (long hospital stay) for this injury group.

Traffic, occupational and intentional injury

Not all countries had information available about traffic, occupational and intentional injuries. In this section we will show the international differences in injury incidence and costs for selections of the EUROCOST countries.

Figure 3.16 ED injury incidence (per 1,000), mean costs per patient (€100), and costs per capita (€) for traffic injuries (Module I)*

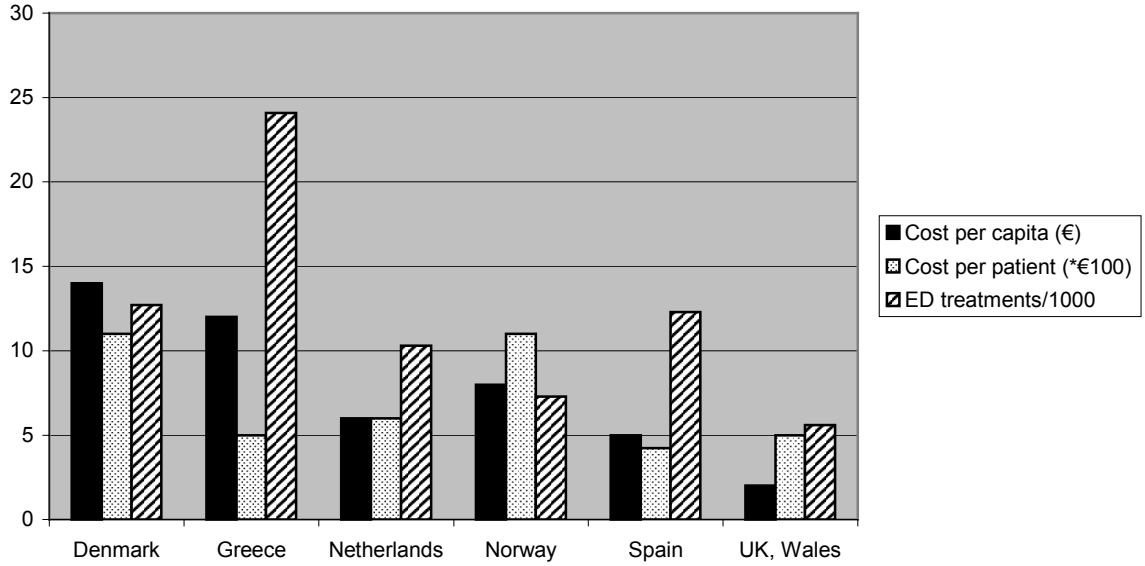


Figure 3.17 ED injury incidence (per 1,000), mean costs per patient (€10), and costs per capita (€) for occupational injuries (Module II)*

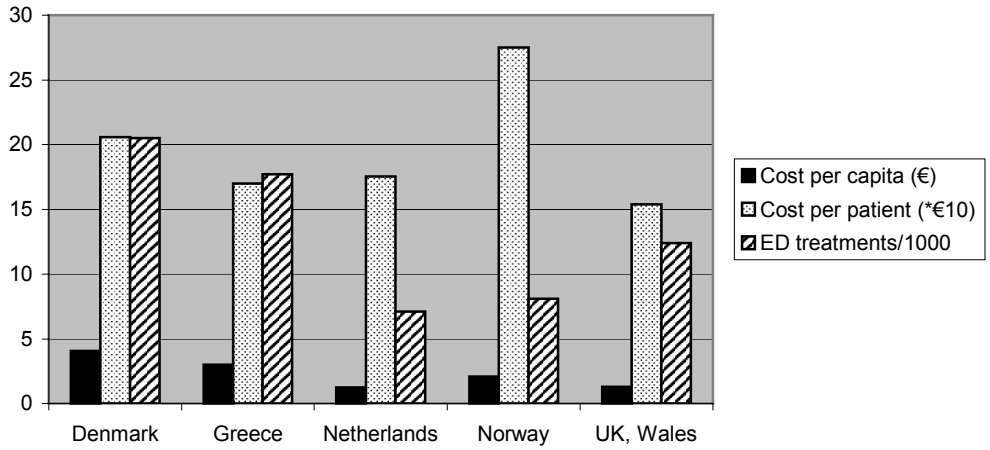


Figure 3.18 ED injury incidence (per 1,000), mean costs per patient (€100), and costs per capita (€) for intentional injuries (Module III)*

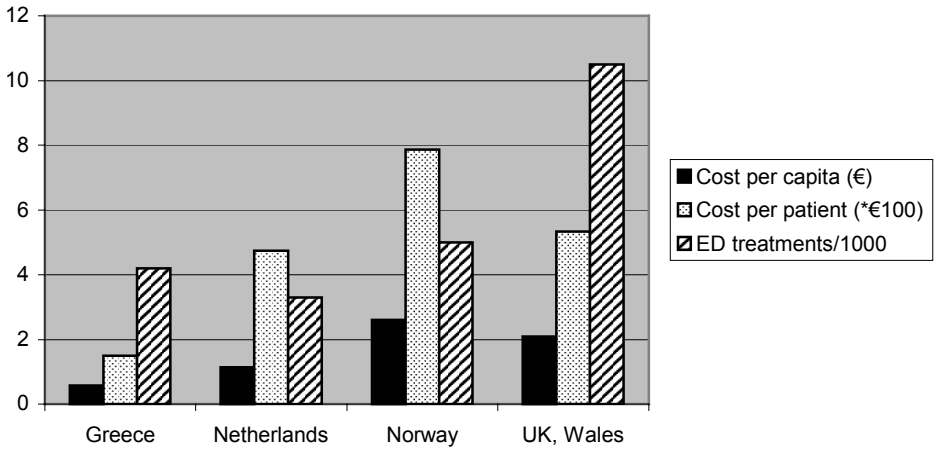
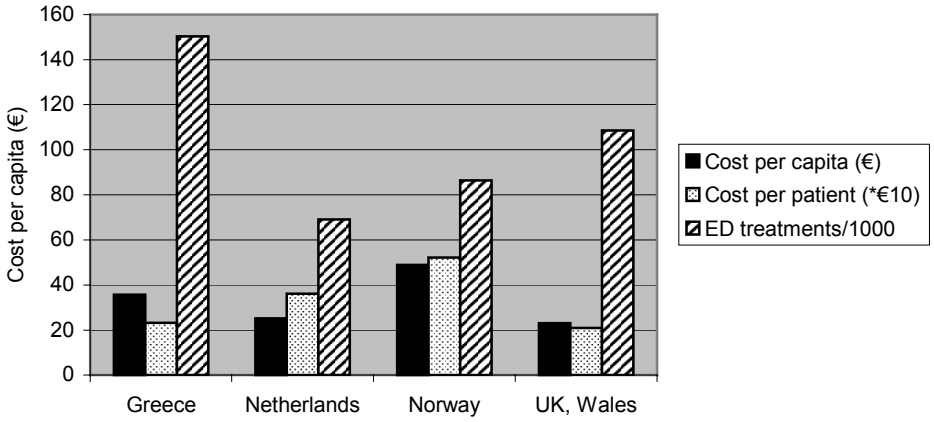


Figure 3.19 ED injury incidence (per 1,000), mean costs per patient (€10), and costs per capita (€) for intentional and unintentional injuries (Module IV)*



Total cost calculations for European countries participating in EUROCOST

In the last part of the chapter an overview is given of the costs of injury for all participating European countries together, except Italy (EUROCOST countries). The costs for Italy are not included because the aggregated data have a different age classification. The total costs of the European countries participating in the EUROCOST project are the sum of the costs of all countries combined. The tables below show the costs of injury in all participating countries.

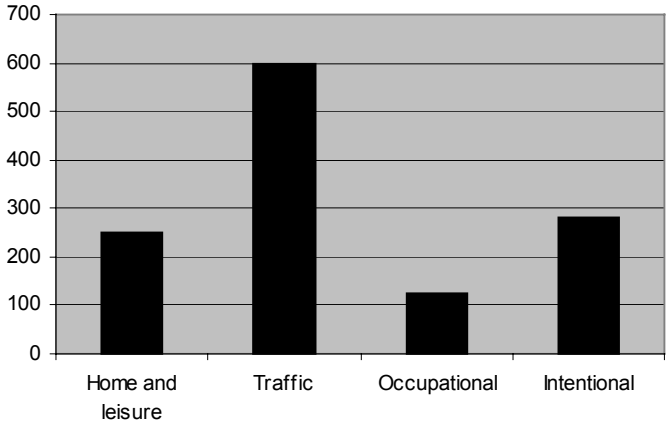
Table 3.15 Hospital costs (€) per capita for the EUROCOST countries by sex, age, injury group (level 3) for home and leisure injuries (Minimum set I) and total admitted patients (Minimum set II)

		Costs per capita			
		Minimum set I		Minimum set II	
Total		**22.5**		**22.6**	
Sex					
Male		20.5		18.9	
Female		24.4		26.1	
Age					
0-4		31.2		26.6	
5-14		22.8		10.7	
15-24		24.5		24.2	
25-44		13.2		11.1	
45-64		11.7		12.4	
65-74		45.6		62.4	
75+		60.5		73.6	
Age	**Sex**	**Male**	**Female**	**Male**	**Female**
0-4		36.0	26.1	29.7	23.4
5-14		28.9	16.4	15.2	5.8
15-24		33.7	14.9	34.3	13.6
25-44		15.1	11.2	12.7	9.4
45-64		8.8	14.6	9.3	15.5
65-74		23.7	64.4	33.8	86.9
75+		30.7	77.2	36.7	94.2

For the year 1999 the cost per capita for the participating EUROCOST countries were € 23 for Minimum set I and Minimum set II. Though women sustained only 45% of the total number of injuries (Minimum set II), they account for 59% of the costs. This is mainly because many of the injuries suffered by older women require a high level of care.

The mean costs per capita for injuries are € 35 for the participating countries together. The figure shows a subdivision of these costs per capita by accident group (home and leisure, traffic, occupational and intentional) (see figure 3.20).

Figure 3.20 Mean costs per capita (€) by accident group for the EUROCOST countries



Note: costs per capita per accident group are calculated based on available data of (a subgroup of) participating countries.

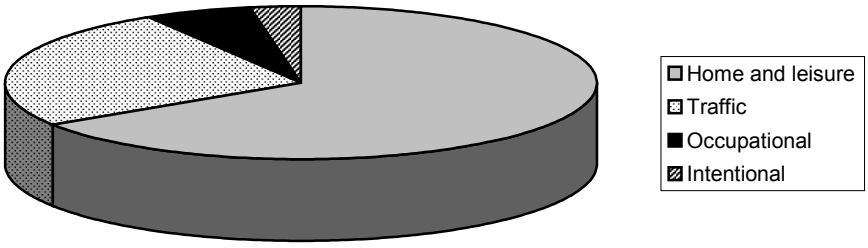
Home and leisure injuries make a major contribution of the hospital costs of injury in Europe. The costs per capita are € 23 for only admitted patients.

Table 3.16 Mean costs per patient (€) for the EUROCOST countries by minimum sets and modules.

	Mean costs
Minimum set I (HLA)	250
Minimum set II (admitted patients only)	2,351
Module I (traffic)	597
Module II (occupational)	127
Module III (intentional)	280

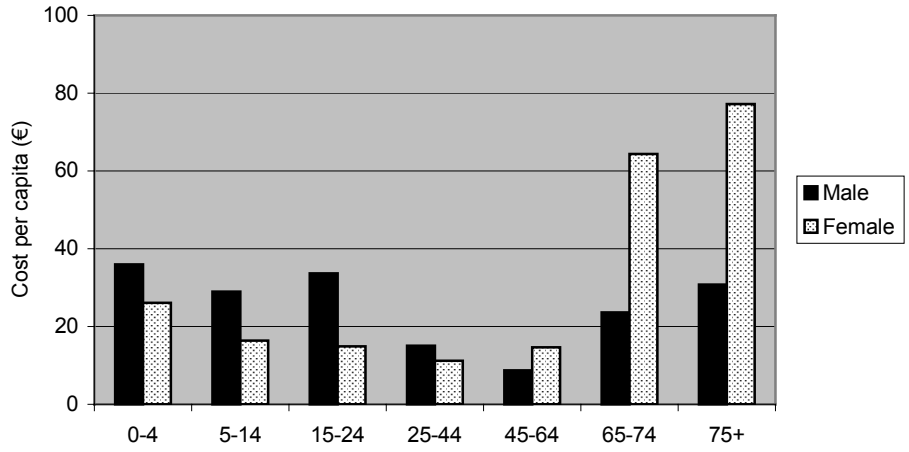
Note: not all countries can participate in all minimum sets and modules.

Figure 3.21 Cost per capita (€) for the EUROCOST countries for home and leisure injuries (Minimum set I) by age and sex



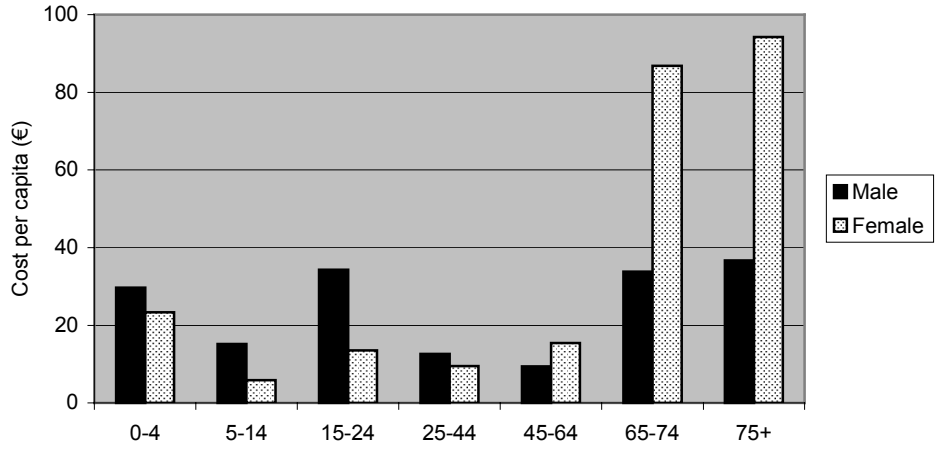
The mean costs for ED patients are the highest for traffic injuries and are the lowest for occupational injuries.

Figure 3.22 Cost per capita (€) for the EUROCOST countries for hospital inpatient incidence



(Minimum set II) by age and sex

Figure 3.23 Cost per capita (€) for the EUROCOST countries for hospital inpatient incidence (minimum set II) by age and sex



The costs per capita of HLA injuries (Minimum set I) are high in children and adolescents (high incidence), and beyond age 65 (high costs per patient). For hospital inpatients (Minimum set II) peaks in costs per capita are observed among children of 0-4 years old, and among 15-24 year old males. Also among these patients, costs per capita increase exponential in older age groups (age 65+). Women above the age of 65 have far the highest cost per capita for home and leisure injuries and total admitted injuries.

The next tables give an overview of the ten injury groups with the highest cost per capita (see table 3.17) and the ten injury groups with the highest mean costs per patient (see table 3.18) for total admitted patients (Minimum set II).

Table 3.17 Top 10 total costs per capita by injury group (39 groups, Minimum set II)

Injury group	Total costs (*€ mln)	Cost per capita (€)
Fracture hip	766.8	5.45
Fracture knee/lower leg	208.4	1.48
Other skull-brain injury	89.3	0.63
Fracture ankle	87.7	0.62
Fracture pelvis	81.4	0.58
Fracture femur shaft	78.1	0.56
Fracture/dislocation/strain/sprain vertebrae/spine	71.4	0.51
Contusions	70.9	0.50
Open wounds	57.2	0.41
Poisoning	51.5	0.37

Table 3.18 Top 10 mean costs per patient by injury group (Minimum set II)

Injury group	Mean costs per patient (€)
Spinal cord injury	6484
Fracture femur shaft	5937
Fracture hip	5014
Fracture pelvis	4584
Other skull-brain injury	4124
Burns	4095
Fracture knee/lower leg	3351
Fracture/dislocation/strain/sprain vertebrae/spine	3215
Complex soft tissue injury lower extremities	3146
Dislocation/sprain/strain hip	3093

Injury patients admitted with a hip fracture have far the highest share in total costs, followed by fractures of the knee and lower leg. Spinal cord injury ('low frequency, high impact') and fractures cause very high costs per admitted patient.

4 International harmonization of data

4.1 Introduction

Chapter 3 showed that, when our baseline model is used, large international differences in injury incidence, health care consumption and costs are observed. In the baseline model, in all participating European countries uniform selections and classifications of accidents and injuries are used. Similar cost elements are also included, and a uniform costing methodology is applied. Nevertheless, part of the observed differences could still be artificial.
Our baseline model uses an incidence-based approach. For that reason, the observed incidence rates per country (ED based and HDR based) are a primary source of international variation in costs. Incidence data from hospital-based surveillance systems, however, are sensitive to artificial international variation due to 'surveillance system bias". The frequency ("incidence") and nature ("severity") of injuries recorded per country-specific surveillance system may vary due to differences in registration practice, diagnostics, availability of alternatives for ED-treatment or hospital admission, payment systems, and socio-demographic factors.
Therefore, in the EUROCOST project we have analysed differences in the country specific incidence data (ED based and HDR based), exploring possible sources of surveillance system bias (§ 4.2). Based on this analysis, we have developed several variants of the baseline model aiming to minimise the influence of surveillance system bias. The potential influence of other major elements of our costing methodology was tested as well (§ 4.3).

4.2 International comparability of surveillance systems

4.2.1 Methods

This paragraph summarises the comparability of the surveillance systems of the participating countries, by assessing the coverage, representativeness and validity of the ED- and HDR-systems. Some qualifications of the data originate from the countries themselves and others are the result of data analyses by the EUROCOST project team. Before a description of the comparability of the data is given, we will explain how these different aspects were operationalized and/or analysed.

Coverage
Operationalisation 1: population in catchment area / total national population. Population in the catchment area: population that is covered by the participating hospitals.
Operationalisation 2: admitted injury patients in participating hospitals / national total admitted injury patients.
In all participating countries, ED-systems are based on samples of hospitals of different sizes. 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). Source: contact person country.
2) The total number of ED attendances (or admitted injury patients) nation-wide divided by total number of ED attendances (or admitted injury patients) of the participating hospitals. This extrapolation may be age, sex and accident-specific. Source: contact person country.

Representativeness

The persons in the registration system are assumed to be a random sample of injury patients in a country.

From international comparisons of the data and information provided by the contact persons of the countries, we tried to identify under- and overrepresentativeness of specific groups by age, sex, urbanization, accident or type of injury.

Validity

The registration system is valid when it measures what it intends to measure. In the EUROCOST project, only broad indications of validity could be identified, since testing against a 'gold standard' was neither possible for the ED systems nor the HDR systems.

Analyses:

1) Comparisons were made between the standardized hospital inpatient rate of ED and HDR data systems (= external test criterion) per country. Are ED-data of admitted patients comparable to HDR data when broken down by age, sex, accidents, injuries, and length of stay (LOS)? Differences were tested by Chi-square tests (age, sex, injury groups, LOS in categories) and Mann-Whitney U test (median LOS by injury groups). The significance level was set at 0.05. Our hypothesis was, that ED data systems are of good quality when there are no significant differences with similar data from HDR systems.
2) Injury mortality rates were compared with the hospital inpatient rate of ED and HDR. Standardized injury incidence rates and standardized mortality rates by cause were calculated. The mortality data are based on the World Health Organization Statistics and refer to 1999, except Austria (2000) and Denmark, Italy and Spain (1998). Data from England and Wales are combined. The following accident categories were analysed:

Table 4.1 Overview of accident categories by ICD-9 and ICD-10

Category	**ICD-9 BTL**	**ICD-10**
Traffic injuries	E470-E474, E479	V01-V06, V9-V99
Unintentional injuries	E47-E53	V01-X59, Y85,Y86, Y88
Suicide and self-inflicted injury	E54	X60-X84
Homicide and injury purposely inflicted by other persons	E55	X85-Y09
Intentional injuries	E54-E56	X60-Y09
All injuries	E47-E55	V01-X59, Y10—Y36, Y40-89

BTL = basic tabulation list (standard classification of causes of death)

To analyse the comparability of the data systems, case fatality rates (CFR) were calculated. The CFR is calculated as the number of deaths divided by the number of cases (injury patients registered in the HDR) expressed as a percentage. Comparable CFR's underscore the validity of these incidence rates. The assumption was made, that when the CFR's are equal among countries, the incidence for HDR should be clearly associated with mortality.

3) Percentage of missing values of the most important variables (age, sex, injury, accident, hospital admission and length of stay).

4.2.2 Results

The coverage, representativeness and the validity of the data were analysed. Table 4.2 and 4.3 give an overview of the data systems.

Table 4.2 shows, that the coverage of ED samples varies between 2 and 61% for those countries providing data on Home and Leisure Accidents (Minimum set I) and that striking differences in extrapolation methods could possibly influence our results. The ED systems show large variation in the frequency and nature of injuries, pointing to possible differences in 'registration thresholds'. Austria, for example, has a low frequency combined with a very high admission rate. This indicates a high registration threshold in comparison to other countries. England, on the other hand shows the opposite: a high frequency with a low admission rate. These differences in 'registration threshold' (which is in fact the combined influence of differences in registration and health care systems) are a major source of 'surveillance system bias' and must be taken into account, when international comparisons are made. Table 4.2 further shows important international differences in the age distribution of the injury victims. It seems that older persons (50+), accounting for more than half of all victims in most countries, are underrepresented in Ireland.

Table 4.3 shows that the coverage of HDR samples is (almost) nation-wide in all participating countries. For this reason, they are the preferred source for making cost calculations for hospital-admitted patients (the national estimates of hospital-admitted patients based on ED surveillance are based on different sample sizes and extrapolation methods). But the HDR systems also show large variation in the frequency and nature of injuries between countries. This indicates, that the hospital inpatient rate might be influenced by surveillance system bias as well. For example, the proportion of long-stay cases (more than 7 days) in Spain, the Netherlands and Austria is much higher than elsewhere. This points towards restrictive admission policies (in the sense of higher severity thresholds) in those countries. Table 4.3 further shows, that among admitted patients the breakdown of injuries by type of injury is quite different between countries. Some injury types are shown, where variation in health care practice could highly influence whether patients are admitted (and/or registered as such) or not. Concussion, for example, ranges from a very low proportion in Italy and England to a rather high proportion in Norway. Poisoning ranges from almost being absent in Spain to almost a quarter of admitted patients in Wales. Finally, as in the ED systems, differences in the age distribution are observed with a relatively low proportion of older victims (50+) in Ireland.

Table 4.2 Comparability of ED-systems (Minimum set I)

	Austria	Denmark	Greece	Ireland	Italy	Netherlands	Norway	Spain, Barcelona	UK, England	UK, Wales
Coverage										
Total number of injury patients registered	9,437	95,160	51,234	7,980	692,694	140,007	20,913	17,746	197,598	324,153
Coverage (% national population)	2	15	14	7	100	12	4	95 (city of Barcelona)	5	61
Extrapolation factor (Source)	Age / Sex – specific (national population / catchment area)	Age / Sex-specific (National population / catchment area)	Age / Hospital-specific (HDR/ Inpatients ED	One factor (= 14,5) (total attendances ED / attendances ED participating hospitals)	-	One factor (= 7,86) (HDR / inpatients ED)	Age / Sex-specific (National population / catchment area)	One factor (= 1,05) (region Barcelona)	One factor (= 18,29) (Number of all attendances / number of new attendances)	One factor (= 1,6377) (total attendances ED / attendances ED participating hospitals)
Representativeness										
Incidence rates[1] (per 1,000)	59.0	89.8	104.3	26.6	na	48.4	70.5	na	110.6	79.4
Superficial injury incl. Contusions / open wounds[2] incidence rates (% of total)	18.3	37.8	38.8	33.8	na	43.4	33.6	na	26.1	22.8
Admissions[2] (%)	32.7	6.2	8.9	11.0	na	8.3	12.5	7.0	4.9	9.9
Age distribution[3] (% 50+)	35 (52)	22 (60)	34 (67)	14 (26)	31[4]	22 (56)	29 (64)	16 (14)[4]	23 (56)	21 (43)
Sex distribution[3] (% male)	50.8	54.1	57.3	68.5	54.8[4]	55.1	52.6	62.2[4]	54.5	54.8
Injury distribution	See table 3.4 chapter 3									
Validity										
Unspecified or unknown injury (%)	4.9	5.7	0.9	11.7	16.8	2.8	4.0	14.0	32.6	16.4
Unknown accident category (%)	0	0	11.1	0	0	1.8	2.7	0	0	34.7

na = not available, ED-system Italy is restricted to ED attendances occupational injuries and the Ed system for Spain is restricted to traffic injuries.

[1] standardized incidence rates, with proportional distribution of unknown/unspecified injuries per accident group.

[2] standardized percentages.

[3] extrapolated data. For age is the distribution of admitted patients older than 50 years shown between brackets.

[4] For Italy and Spain respectively occupational injuries and traffic injuries are included.

Table 4.3 Comparability of HDR-systems (Minimum set II)

	Austria	Denmark	Greece[1]	Ireland	Italy	Netherlands	Norway	Spain	UK, England	UK, Wales
Coverage										
Coverage (% hospitals)	100%	100%		95%	<100%	100	100%	90/30%[2]	100%	100%
Representativeness										
Hospital inpatient rate[3] (per 1,000)	22.9	18.1		15.2	16.1	6.5	14.7	4.8	11.8	15.6
Long stay cases[5] (% LOS ≥ 7 days)	6.9 (30.2)	4.6 (25.5)		2.8 (18.8)	[4]	2.1 (33.6)	3.1 (20.9)	2.1 (43.6)	2.4 (19.9)	2.9 (18.4)
Intracranial injury (%)										
- Concussion	9.6	9.6		1.3	0.6	6.4	12.2	5.5	0.5	4.0
- Other skull-brain injury	3.4	2.7		5.1	8.5	4.3	3.1	7.6	2.5	3.7
Superficial injury, incl. Contusions / open wounds[3] (%)	18.4	7.2		9.0	13.4	6.9	6.9	6.0	10.8	12.1
Age distribution[3] (% 50+)	42.0	42.0		27.4		41.8	46.2	47.3	34.9	34.6
Sex distribution[3] (% male)	56.2	50.1		61.3	53.9	51.6	51.9	56.5	53.9	55.5
Poisonings[3] (%)	1.9	8.3		10.3	11.5	9.9	8.2	0.2	16.3	22.6
Validity										
Other and unspecified injury[3] (%)	3.3	3.3		12.7	9.7	2.9	5.5	3.2	9.9	8.5
Unknown accident categories[3] (%)	0	100		12.7	100	0	68.0	54.1	9.3	15.8

[1] na = not available.

[2] (90% of public and 30% of private hospitals).

[3] All accident categories are included, only admitted patients (Minimum set II).

[4] For Italy there is only aggregated information about length of stay available.

[5] Incidence rate and percentage between brackets.

To test the validity of the ED-and HDR systems, data from admitted injury patients in ED-systems are compared to HDR-data. Comparison is restricted to non-traffic accidents ((E850-E928). This comparison was possible with data from 5 countries. For Austria both crude (I) and extrapolated data (II) are presented.

Table 4.4 Comparison admitted patients in ED versus HDR systems: non-traffic injuries

	AU			IR		NL		UK, England		UK, Wales	
	ED I	**ED II**	**HDR**	**ED**	**HDR**	**ED**	**HDR**	**ED**	**HDR**	**ED**	**HDR**
Age (%)											
0-14	11.2	18.5	15.4	**47.5**	**27.7**	17.2	17.7	25.6	26.7	23.7	21.6
15-24	11.3	8.9	11.4	17.6	18.2	7.5	9.2	6.5	10.4	11.8	13.4
25-44	21.0	**15.9**	**21.0**	**13.8**	**19.9**	18.2	19.6	**10.8**	**17.7**	19.8	20.0
45-64	24.4	19.0	19.9	7.6	14.6	15.6	16.4	11.2	12.5	14.1	13.9
65-74	12.5	11.4	10.6	5.1	7.0	10.9	9.8	10.0	7.6	7.9	7.8
75-84	13.1	16.4	12.1	5.4	8.3	17.2	15.7	18.7	13.1	13.1	13.1
85+	6.6	9.8	9.7	3.0	4.4	13.3	11.7	**17.2**	**12.0**	9.5	10.2
Sex											
% male	48.9	**45.5**	**51.8**	59.9	60.6	47.9	49.9	**44.9**	**51.5**	52.9	52.7
Injury (%)											
Head and facial injury (excl. eye)	15.9	17.8	18.3	10.5	12.1	10.1	12.1	9.0	9.7	9.0	6.9
Upper extremity injury (excl. nerves)	21.3	21.6	25.2	29.5	30.7	**16.0**	**23.0**	**18.1**	**24.8**	**14.5**	**20.8**
Lower extremity injury	**41.3**	**39.4**	**25.8**	19.1	20.1	45.5	41.7	29.6	29.3	**16.7**	**22.1**
Superficial injury, incl. contusions	7.5	7.7	12.1	4.1	2.7	6.5	3.9	6.6	4.7	10.2	6.7
Other and unspecified injury	4.3	4.1	3.4	**23.5**	**11.9**	5.4	3.1	**23.9**	**9.3**	**22.7**	**11.0**

In general, the observed patterns by age, sex and (broad classes) of injury are comparable in the two systems. Nevertheless, in each country differences of more than 5% are noted. In Austria, the most striking difference is found regarding the share of lower extremity injury, being far more prevalent in ED than HDR data. This could be due to the high registration threshold in the ED system of Austria, as already noticed. In Ireland, children (0-14) seem highly over represented in the ED system. Both the international comparison of ED data (see table 4.2) and this international comparison of ED and HDR data (see table 4.4) indicate, that the ED system of Ireland (based on one hospital) is probably not representative for the national population and underestimates the incidence of injury (in particular among older persons).

In Wales the age and sex distribution is quite similar in the ED system and the HDR system. Wales has some differences in the breakdown by type of injury, but this seems mainly due to a conservative coding policy in the ED system, where almost a quarter of the victims are in the 'other/unspecified' category. In the international comparison (see table 4.2) Wales shows a relatively low proportion of older victims. However, given the consistency of findings in both the ED and HDR data, and the high coverage rate of the ED system of Wales, we may assume that the ED data from Wales are representative for the national population.

In England, the most striking difference concerns the larger proportions of older victims in the ED system (and 85+ in particular) than in the HDR system (which has an age distribution comparable to Wales). Vice versa, the proportion of 15-44 year-old is much lower in the ED system. The ED system of England is characterized by a low proportion of admitted patients (see table 4.2). Underregistration among (the more severely injured) 15-44 year olds could be a contributing factor.

In the Netherlands, the ED and HDR systems show comparable patterns by age, sex and injury type. Maybe, older victims (and lower extremity injuries) are slightly overrepresented in favour of 15-44 year-olds (and upper extremity injuries) in the ED system.

Table 4.5 Standardized mortality rate, and hospital inpatient rate (HDR and ED) (per 1,000) by external cause and country

		AU [a]	DK [b]	GR [a]	IR [a]	IT [a]	NL [b]	NO [b]	UK [a]
Unintentional	Mort.	0.33	0.43	0.37	0.34	0.34	0.23	0.39	0.2
	HDR	22.2			13.3		5.9		21.5
	ED	19.3	7.7	13.0	2.9		4.9	9.1	11.0
	CFR	**0.015**			**0.026**		**0.039**		**0.009**
Traffic	Mort.	0.11	0.1	0.18	0.12	0.12	0.07	0.09	0.06
	HDR	3.0			2.3		1.3		2.7
	ED		1.6	4.3			1.5	1.2	
	CFR	**0.037**			**0.052**		**0.054**		**0.022**
Intentional [c]	Mort.	0.43	0.3	0.1	0.27	0.18	0.22	0.3	0.19
	HDR	0.7			1.9		0.6		5.8
	ED			0.4			0.7	1.6	
	CFR	**0.614**			**0.142**		**0.367**		**0.033**
All injuries	Mort.	0.54	0.63	0.42	0.48	0.44	0.34	0.54	0.31
	HDR	22.9	18.1		15.2		6.5	14.7	27.4
	ED		7.7	13.4	2.9		5.7	11.1	16.0
	CFR	**0.024**	**0.035**		**0.032**		**0.052**	**0.037**	**0.011**

[a] Classification external cause ICD-9.

[b] ICD-10.

[c] Intentional injuries ICD-9 classification: intentional injuries = suicide + homicides + other violence. ICD-10 classification: intentional injuries = suicide + homicides.

Note: no distinction possible between the mortality rate of UK, England and Wales. England and Wales combined in table.

Finally, comparisons are made of injury mortality data with the hospital inpatient rates per country (see figure 4.1 and 4.2). In this analysis the mortality data are used as an indicator of injury incidence. Injury mortality rates (both all injuries and unintentional injuries) are relatively high in Denmark and low in the Netherlands and the UK. The high mortality rate in Denmark is due to the high fall-related mortality in this country.

The comparison with hospital inpatient rates is only partly possible due to the limited availability of incidence data by external cause. For example, for Denmark only cause-specific ED-data are available. The low mortality rate in the Netherlands is combined with low hospital inpatient rate rates, but the low mortality rate in the UK is not. Norway, Ireland, and Austria have similar mortality rates, but the hospital inpatient rate is much higher in Austria. Denmark has a higher hospital inpatient rate than Norway and Ireland, but also the mortality rate is higher in Denmark. The mortality rate due to intentional injuries is relatively high in Austria, and relatively low in Greece. Data on hospital inpatient rate of intentional injuries are hardly available. Therefore, no comparison is possible.

The CFR for unintentional injuries is low for Austria and UK, what could be explained by a low admission threshold for these countries. There are much more injury patients admitted to hospital, whereas the injury mortality rate is comparable with the other countries.

The CFR for all injuries ranges from 0.011 to 0.052 between the countries. This could indicate that the UK has a low admission threshold and the Netherlands has a high admission threshold.

Figure 4.1 Comparison of the standardized mortality rate and the hospital inpatient rate for all injuries per country

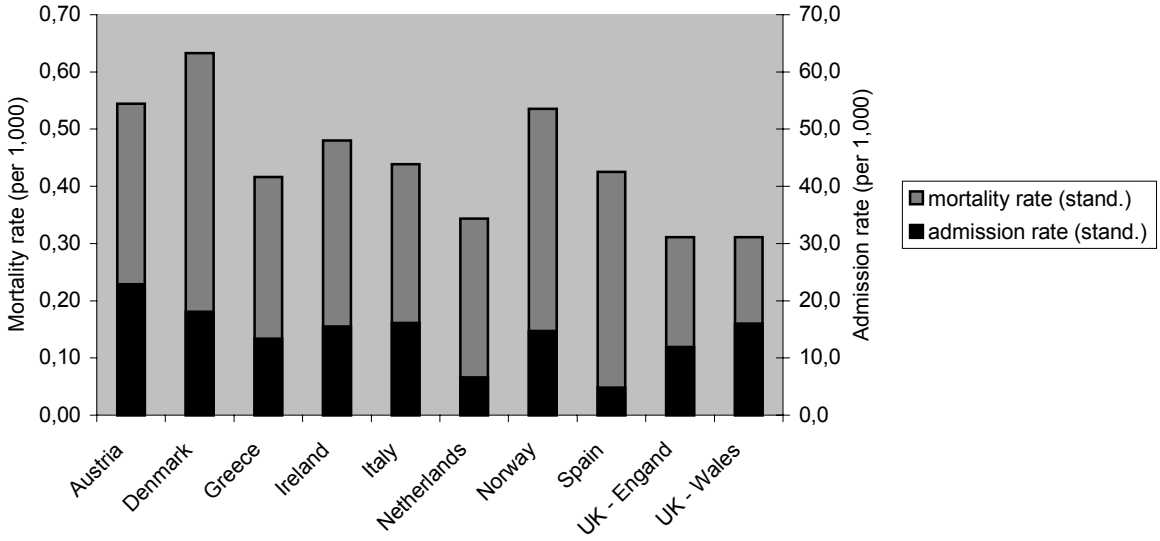
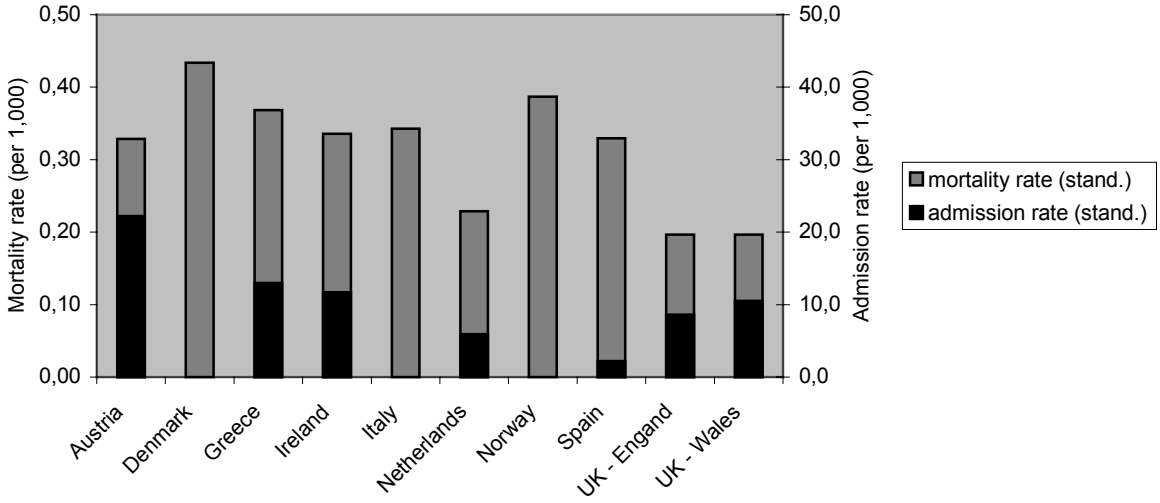


Figure 4.2 Comparison of the standardized mortality rate and the hospital inpatient rate for unintentional injuries per country



4.2.3 Conclusion

This chapter has shown important differences between the surveillance systems of the participating countries:

- In coverage and extrapolation methods
- In registration thresholds (influenced by registration practices and health care systems)

A next step is to analyse whether these differences influence the results of the baseline model: injury incidence and health care consumption and costs that were shown in chapter 3. International variation may exist due to (methodological) differences, not yet adjusted for (e.g. different health care systems). In the next paragraph several variants of the baseline model will be explored.

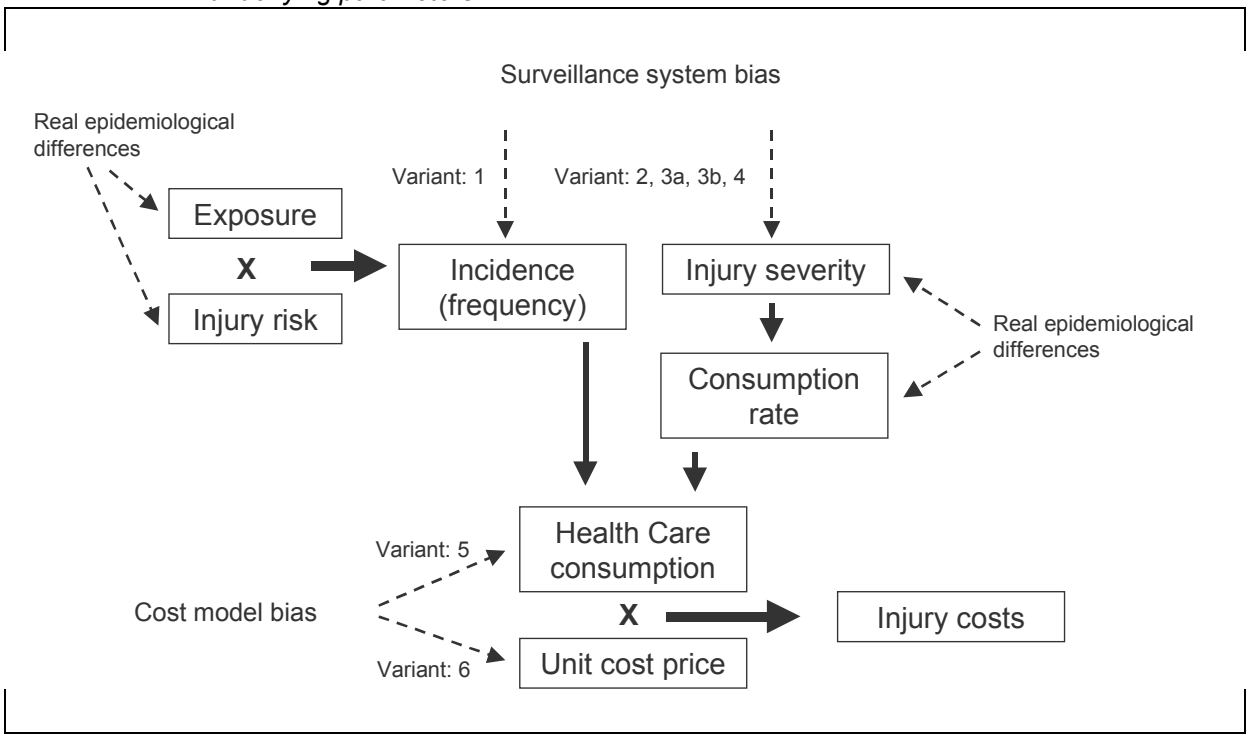
4.3 Variants of the baseline model

4.3.1 Introduction

Our baseline model produces large variation in injury costs (see chapter 3). It is difficult to determine whether observed variations in injury costs between countries are due to real or artificial differences. Injury costs are the result of several parameters (e.g. injury incidence and severity, unit costs). In turn, those parameters are influenced by various factors (e.g. socio-cultural factors, surveillance system bias).

Figure 4.3 provides a conceptual model for the explanation of international variation in injury costs and its underlying parameters. It shows the complexity of the topic.

Figure 4.3 Conceptual model for the explanation of international variation in injury costs and its underlying parameters



Incidence = the product of exposure (number of exposure units, e.g. possession of cars, per 1000 person-years) and injury risk (frequency of injuries per unit of exposure).
Health care consumption = the product of incidence (frequency of injuries per 1000 person-years) and consumption rates (number of volume units, e.g. hospital days, per injury patient). Consumption rates are highly dependent on injury severity (distribution of injuries by type of injury).
Injury costs = are the product of health care consumption (volume units, e.g. hospital days, per 1000 person-years) and unit costs (Euros per volume unit, e.g. Euros per hospital day).

The major parameters of our cost model are incidence, injury severity, consumption rate, and unit costs. International variation in these parameters is due to real underlying differences at societal level on the one hand (e.g. socio-cultural factors, injury prevention, organisation of health care), and to methodological bias on the other. In the EUROCOST project, we have tried to minimise the influence of methodological bias, which can be distinguished into:

- Surveillance system bias, artificial differences in incidence due to variation in surveillance systems (see § 4.2) and
- Cost model bias, artificial differences in health care costs due to effects of our costing methodology per country.

We have compared the results of our baseline model with six variants, each containing some adjustments to the baseline model. In a first variant (1), the influence of differences in coverage and extrapolation methods between countries on injury incidence was assessed. A set of variants (2, 3a, 3b, 4) was subsequently developed aiming to select the more severe injuries (those with an objective need for ED treatment or hospital admission). By making these selections, artificial differences in incidence and injury severity were (partially) adjusted for. The Variants 1-4 have assessed the potential influence of surveillance system bias. In Variants 5 and 6, the potential influence of cost model bias was analysed. A major characteristic of the cost model is its calculation of the transition probability of hospital admission (i.e. a consumption rate) by comparing ED and HDR data, and by making the assumption that the HDR data give the real hospital inpatient rate in each country. This assumption could produce artificial variation, since some countries provided HDR data, where others did not. Therefore, in Variant 5 we used the hospital inpatient rates as reported by the ED systems. Finally, in Variant 6 the possible influence of artificial differences in unit costs was investigated by using the mean of all unit costs for each country, only adjusted for differences in general price level. In the baseline model, we tried to harmonize unit costs per country as much as possible, but residual bias could still be possible due to lack of uniform information in a number of countries.

Table 4.6 provides some key results of our baseline model. In table 4.7 an overview is given of the 6 variants, showing their specific differences with the baseline model. These variants will separately be described in the next paragraphs.

Table 4.6 Injury incidence and costs per capita for the baseline model

	AU	DK	GR	IR	IT	NL	NO	SP	UK, England	UK, Wales
Total injuries (Module IV)		123.0				68.3	89.5			106.6
Home and leisure (Minimum set I)	59.0	89.8	104.3	26.6		48.4	70.5		110.6	79.4
Admitted home and leisure	19.3	5.6	7.6	2.9		3.2	7.9		5.4	7.1
Cost per capita (€)										
Minimum set I	53	39	23	8		16	34		18	17
Minimum set II	75	51	30	26	72	19	42	13	18	23

Table 4.7 Baseline model and the variants

	Baseline model	Variants
Incidence	Selection accident groups: minimum sets and modules	
	Selection 39 injury groups (+clustering)	
	All external causes, exclusive medical injuries	
	Proportional distribution of unknown/unspecified injuries	
	No selection of specific severe injuries	Variants 2-4
	Extrapolation with delivered extrapolation factor	Variant 1
	Standardized data by age and sex	
Healthcare consumption	Hospital ED and inpatient care, exclusive outpatient care	
	Registered admitted patients in ED systems were corrected by data from HDR systems (using transition ratios)	Variant 5
	Mean length of stay per injury group as reported by HDR system	
Costs	Comprehensive unit costs per country	Variant 6

4.3.2 Uniform extrapolation method (Variant 1)

Injury surveillance systems are seldom population based. They are often biased by age, sex, ethnic origin, socio-economic position, health insurance state, and geographical location (Stone, Morisson, Smith 1999). Particularly ED data systems differ in the size of the background population, and also differ with respect to what is known about the composition of the background population. Of some data systems only the overall coverage rate is known (Ireland, Netherlands, Barcelona, England and Wales), while for Austria, Denmark, Greece and Norway also the age/sex composition of the background population is known or assumed equal to the total population. This leads to the use of different methods to extrapolate surveillance data to the national level (see table 4.2: comparability of ED data systems).

Hypothesis: The differences in extrapolation methods may, in principle, influence the comparability. The data will be better comparable when for each country the same extrapolation method is used.

Analysis

The preferred method would need data on the age/sex composition of the population of the catchments areas of all country-specific ED systems. This information, however, is available in only

three countries. As an alternative we have therefore applied a uniform extrapolation method, based on ED-HDR comparisons of the number and distribution of hospitalised injury patients by age (20 groups) and sex.
We have analysed the changes in the ED-incidence rates if we use age- and sex-specific extrapolation factors in all countries, which are based on ED-HDR comparisons for inpatients. For each age/sex group the extrapolation factor was calculated by dividing the total HDR patients through the total admitted ED patients. The incidence rate corrected by the uniform extrapolation method could only be calculated for Denmark, Netherlands, Norway and Wales, who had the same accident groups registered in ED and HDR (see table 4.8). We made similar calculations for home and leisure accidents (Variant 1-HLA). This analysis was possible for five countries (see table 4.9).

Results

The tables 4.8 and 4.9 give an overview of the standardized ED incidence rates, corrected by the uniform extrapolation method.

Table 4.8 Standardized ED incidence rate (per 1,000) by accident and country (Variant 1)

	DK	NL	NO	UK, Wales
Baseline model	**123.0**	**68.3**	**89.5**	**106.6**
Sport	52.8	13.8	21.4	11.3
Traffic	36.5	11.9	10.2	6.2
Occupational	56.6	8.2	12.0	14.6
Home	186.9	42.4	71.9	63.5
Violence		2.8	5.0	6.6
Selfmutilation		1.0	2.1	5.2
Missing		1.4	3.8	57.0
Total	332.8	81.6	126.5	164.4

Table 4.9 Standardized ED incidence rate (per 1,000) by country (Variant 1-HLA)

	AU	IR	NL	UK, England	UK, Wales
Baseline model	**59.0**	**26.6**	**48.4**	**110.6**	**79.4**
Variant 1	61.4	95.5	78.7	184.9	101.6

Conclusion

Variant 1 results in much higher injury incidence rates for all countries, which can be explained by the higher registered clinical injury incidence rates for HDR compared to the ED. It seems that there exists an underregistration of the admitted patients in the ED for all countries. Additional analyses have shown that this underregistration mainly affects younger victims, in particular 15-44 year olds. This phenomenon was noted already when the ED and HDR data systems were compared per country (see table 4.4). For Denmark and Ireland the incidence rate based on Variant 1 (using a uniform extrapolation method) is more than two times higher than the incidence rate based on the delivered extrapolation factor. Countries with a large underestimation of admitted patients in the ED system (compared to the HDR system) receive a very high extrapolation factor, because this factor also extrapolates the number of non-admitted patients. Probably this is not right, since an underestimation of the admitted patients can result in an overestimation of the non-admitted patients. When this overestimation of non-admitted patients is also extrapolated with the relatively high extrapolation factor, this will result in double counting, which can explain the very high incidence rates for Denmark, Ireland and England.

The influence of Variant 1 was not different for countries that delivered a uniform extrapolation factor compared to countries that delivered age/sex specific extrapolation factors.
The uniform extrapolation method (Variant 1) will not be applied in the cost calculations in the EUROCOST project, since the differences in registration of admitted patients in ED and HDR are too outsized. A recommendation for further research is that all countries acquire insight in the age/sex composition of the catchments areas of their surveillance systems. Working with the delivered extrapolation factors per country, must currently be seen as the best option. This means that we were not able to adjust for surveillance system bias due to differences in coverage and extrapolation methods.

4.3.3 Registration thresholds ED systems (Variant 2, 3a and 3b)

The number of injury patients visiting the ED varies strongly between European countries. These differences may be caused by the differences in design of health care systems, registration practices and access to health care. All countries provide alternatives for treatment apart from the ED (e.g. general practitioners, self treatment) for the vast majority of victims, but this may vary between countries. In order to minimize the influence of international variation in registration and health care practices on the observed variation in injury incidence and costs, it would be wise to exclude those injuries (predominantly less severe injuries) that are highly associated with these factors.

Frequently admitted injuries are injuries with a severity level defined as 'having an objective need for diagnosis, treatment, and registration at the ED. Injuries are defined as more severe when there exists risk of dying and risk of disability, often resulting in high costs. The assumption is made that for this group, visiting the ED and being recorded or being admitted and recorded will hardly be influenced by the design of health care systems, registration practices and access to health care.

Hypothesis: Including only serious injuries, reduces the influence of international variation in registration and health care practices, which improves the comparability of injury incidence data.

Analysis

First of all, an indicator of injury severity was developed based upon the likelihood of hospital admission. The admission rates by type of injury in 7 countries were analyzed (Austria has been excluded, because of its very high total admission rate) (see Annex 6: percentage hospital admissions per injury group). The threshold for serious injury is defined by at least 5 of the 7 counties having an admission rate of >15% for a particular injury diagnosis. This indicates that these injuries are unlikely to be treated outside the ED.

This operationalization results in the following groups of "frequently admitted injuries" (Variant 2) and "frequently admitted fractures" (Variant 3a) respectively. According to our operationalization, group 35 poisoning, should in principle be included as well. We excluded poisoning however, because it is a condition with rather specific properties and treatment needs. The latter might lead to large variations not based on real variations in injury epidemiology.

Frequently admitted injuries (Variant 2)

1. concussion
2. other skull-brain injury
7. fracture/dislocation/sprain/strain vertebrae/spine
9. spinal cord injury
10. internal organ injury
11. rib/sternum fracture
13. upper arm fracture
14. elbow/forearm fracture
19. injury of upper extremity nerves
20. complex soft tissue injury upper extremities
21. pelvis fracture
22. hip fracture
23. femur shaft fracture
24. knee/lower leg fracture
25. ankle fracture
29. dislocation/sprain/strain hip
30. injury of lower extremity nerves
31. complex soft tissue injury lower extremities

Frequently admitted fractures (Variant 3a)

Fractures of:
11. rib/sternum
13. upper arm
14. elbow/forearm
21. pelvis
22. hip
23. femur shaft
24. knee/lower leg
25. ankle

Secondly, a variant was constructed based upon how fractures are diagnosed and treated in emergency departments. This variant (3b) restricts injuries to fractures that are most likely to attend an ED because they should always be x-rayed.

Radiological verifiable fractures (Variant 3b)

Fractures of:
13. upper arm
14. elbow/forearm
15. wrist (incl. carpal bones), except age<5
21. pelvis
22. hip
23. femur shaft
24. knee/lower leg
25. ankle

The following fracture types were excluded from these analyses:

- 5. fracture facial bones; facial bones are mainly nasal fractures and many hospitals do not x-ray these, so they may not be recorded.
- 7. vertebral column fractures/dislocation/sprain/strain; this group contains sprains and strains as well as important and trivial fractures. Given the lengths of stay (median # days) in the matched ED-inpatients analysis carried out in the Netherlands the vast majority of these patients will have fractured transverse processes or osteoporotic wedge fractures and not life threatening spinal fractures requiring immobilization/surgery. There will be considerable variation in the proportions x-rayed in these groups between health care administrations.
- 12. fracture of clavicle/scapula; many places do not x-ray all clavicular fractures.
- The exclusion of wrist fractures (injury group 15) under the age of 5 in Variant 3b reflects the occurrence of greenstick fractures below this age, many of which will not attend for x-ray.

Results

Tables 4.10 and 4.11 and figure 1 give an overview of the influence of Variants 2, 3a and 3b on the incidence rates of HLA injuries. A distinction has been made between total HLA patients registered in ED and only admitted HLA patients.

Table 4.10 Standardized ED injury incidence rates (per 1,000) for Variant 2, 3a and 3b, only HLA

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Home and leisure								
Baseline model	**59.0**	**89.8**	**104.3**	**26.6**	**48.4**	**70.5**	**110.6**	**79.4**
Variant 2	27.0	10.1	13.4	7.0	6.6	12.0	9.2	7.5
Variant 3a	13.8	5.0	9.6	2.6	4.6	7.8	6.6	4.5
Variant 3b	17.3	8.4	13.7	3.1	6.5	9.2	9.5	6.6
Admitted home and leisure								
Baseline model	**19.3**	**5.6**	**7.6**	**2.9**	**3.2**	**7.9**	**5.4**	**7.1**
Variant 2	12.4	3.5	5.6	1.2	2.3	5.0	2.3	1.3
Variant 3a	7.2	2.4	4.6	0.9	1.7	3.6	1.9	1.0
Variant 3b	7.7	2.8	4.6	1.1	1.7	3.9	2.2	1.1

Table 4.11 Standardized ED injury incidence rates (per 1,000), number of cases per variant and percentage of patients compared to baseline model

	AU		DK		GR		IR		NL		NO		UK, England		UK, Wales	
		%		%		%		%		%		%		%		%
Baseline model	**59.0**		**89.8**		**104.3**		**26.6**		**48.4**		**70.5**		**110.6**		**79.4**	
	483400		479479		998167		115710		760133		319140		5755936		153490	
Variant 2	27.0		10.1		13.4		7.0		6.6		12.0		9.2		7.5	
	222223	**46**	54856	**11**	144861	**15**	29237	**25**	104138	**14**	56889	**18**	490337	**9**	15458	**10**
Variant 3a	13.8		5.0		9.6		2.6		4.6		7.8		6.6		4.5	
	115526	**24**	27616	**6**	103239	**10**	10924	**9**	72177	**9**	36453	**11**	349230	**6**	8708	**6**
Variant 3b	17.3		8.4		13.7		3.1		6.5		9.2		9.5		6.6	
	144308	**30**	45925	**10**	148440	**15**	12851	**11**	101685	**13**	42988	**13**	497033	**9**	12796	**8**

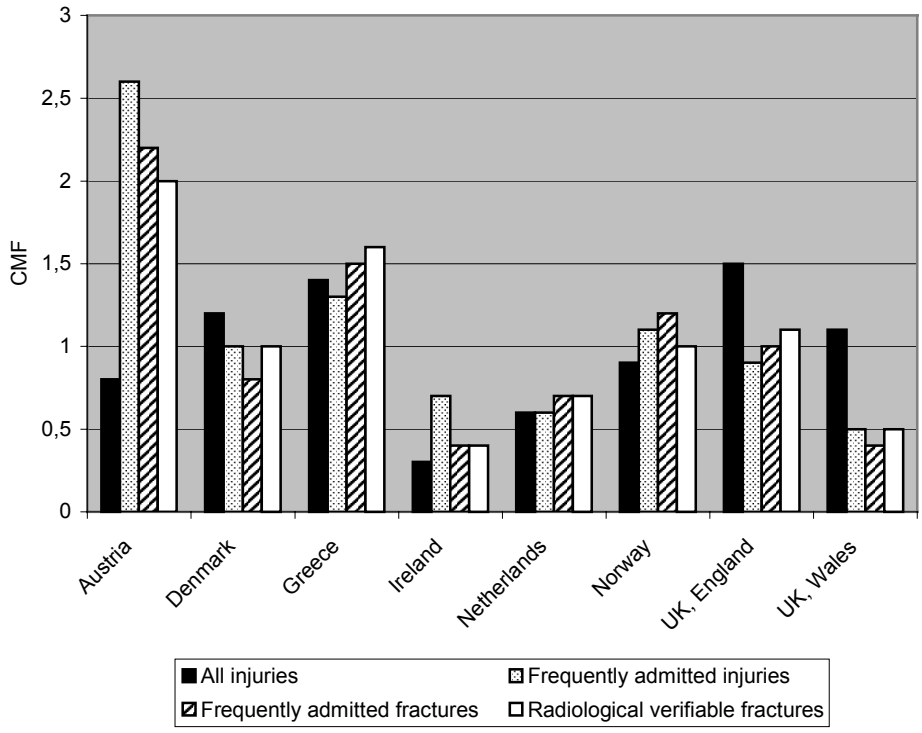
Table 4.12 CMF's for the baseline model, Variant 2, 3a and 3b for HLA and the standard deviation

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales	Stdev [a]	Stdev [b] excl. AU
Baseline model	**0.8**	**1.2**	**1.4**	**0.3**	**0.6**	**0.9**	**1.5**	**1.1**	**0.41**	**0.43**
Variant 2	2.6	1.0	1.3	0.7	0.6	1.1	0.9	0.5	**0.67**	**0.29**
Variant 3a	2.2	0.8	1.5	0.4	0.7	1.2	1.0	0.4	**0.61**	**0.41**
Variant 3b	2.0	1.0	1.6	0.4	0.7	1.0	1.1	0.5	**0.54**	**0.41**

[a] Stdev = standard deviation calculated over the CMF's of all countries.

[b] Standard deviation calculated for all countries except Austria.

Figure 4.4 Influence of Variant 2 and 3a/b on the incidence rates (per 1,000) of HLA patients



In table 4.12 and figure 4.4 we transformed the incidence rates into comparative morbidity figures (CMF). The CMF is calculated by dividing the standard incidence rate per country by the real incidence rate of the standard (reference) population. As can be derived from the standard deviations in table 4.12, the variance in injuries decreases compared to the baseline model, particularly for Variant 2 (Austria excluded). In figures 4.5 to 4.8 we present the incidence by age of ED home and leisure injury (Minimum set I) as for the total and for Variant 2, 3a and 3b.

Figure 4.5 *ED Home and leisure injury (Minimum set I) incidence rates (per 1,000) by age and country*

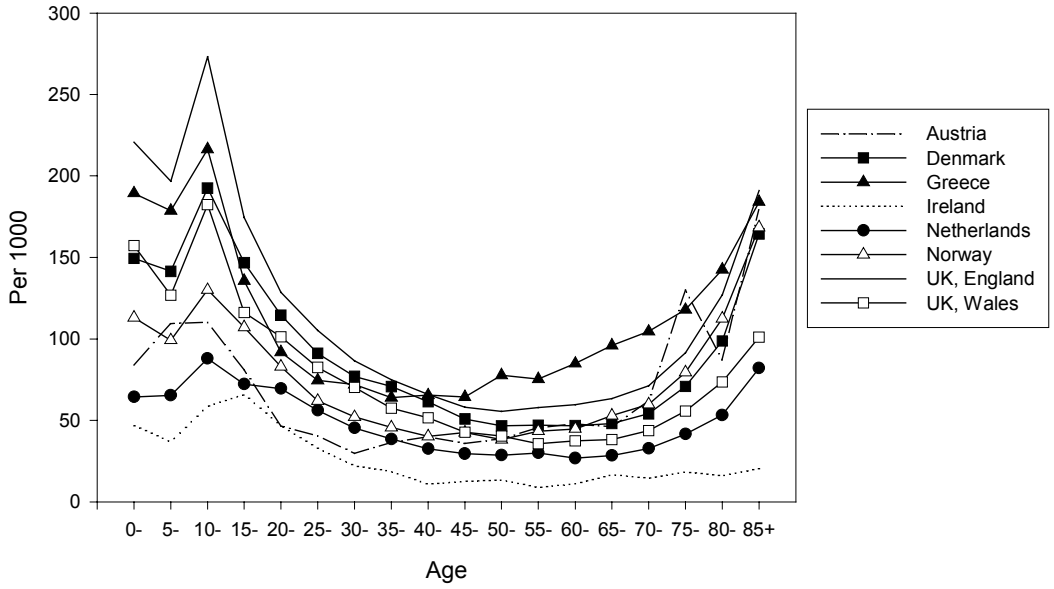


Figure 4.6 *ED Home and leisure incidence rate of commomly admitted injuries by age and country (Variant 2)*

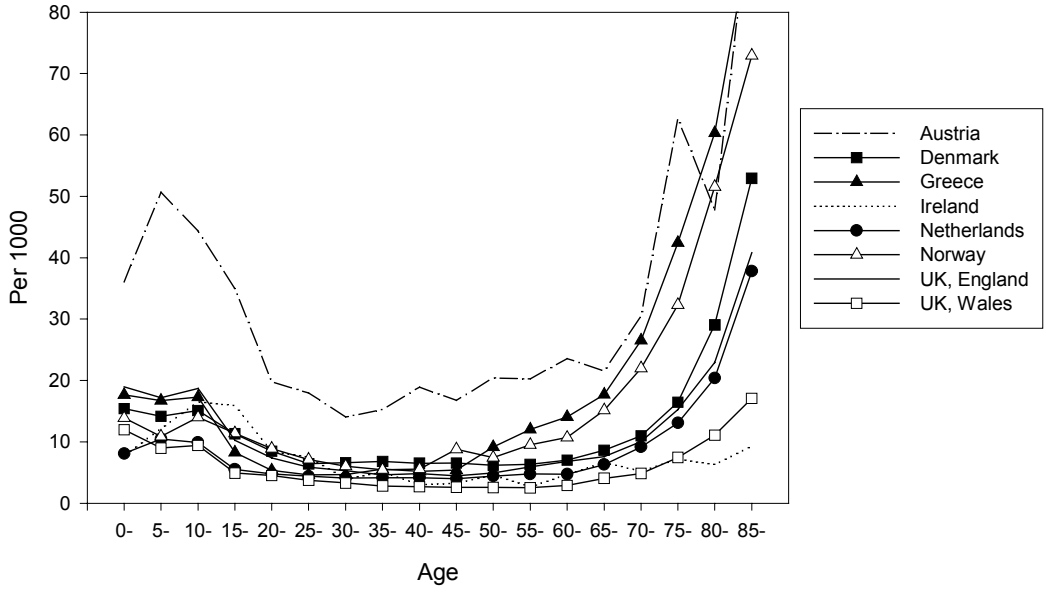


Figure 4.7 ED incidence rate of commomly admitted fracture (HLA) by age and country (Variant 3a)

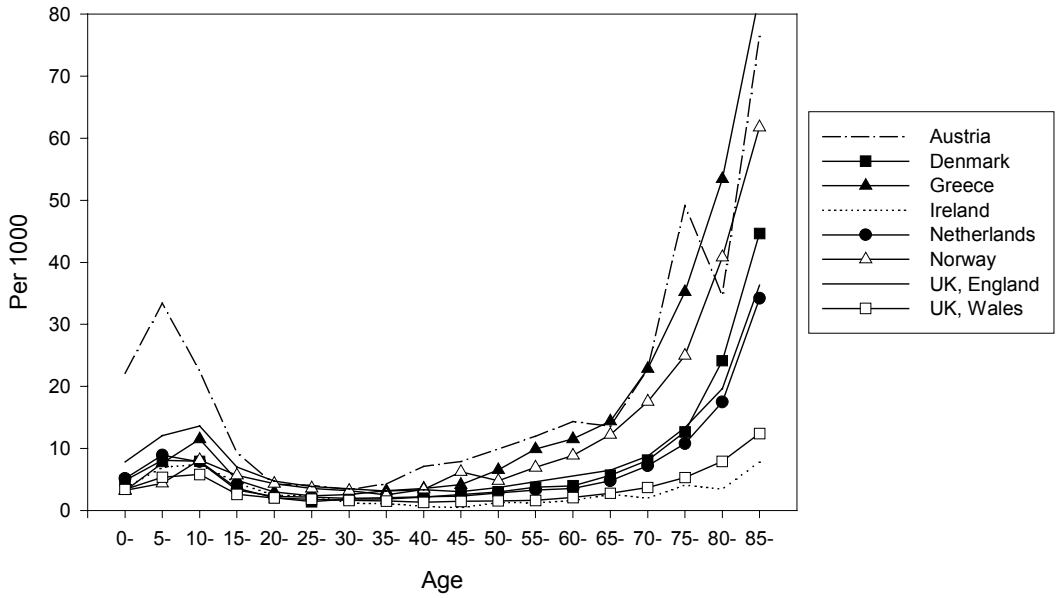
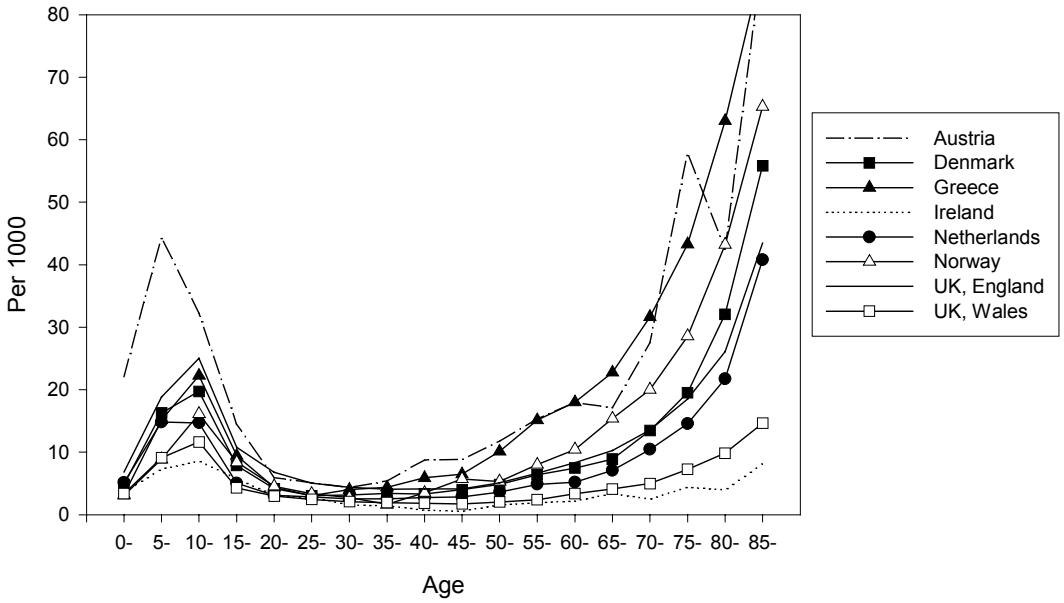


Figure 4.8 ED incidence rate of radiologically verified fractures (HLA injury) by age and country (Variant 3b)



Conclusions

Table 4.11 show that the variants give a shifting of the CMF patterns between the countries. The CMF's for Austria for example change from below the mean for the baseline model to very high for the variants and the CMF's of Wales change the opposite. In spite of our hypothesis that excluding low severity injuries should minimise the international variation, the variance between incidence rates only decreased when Austria was excluded. The consistency of findings, when looking at several selections of the more severe injuries, supports our theory, that adjustments for surveillance system bias are made. The remaining variance can notably be explained by variance in injury incidence for patients older than 50 years (see figures 4.6 to 4.8). It seems that in this age group, even among the more severe injuries (mainly fractures), international differences in health systems could influence the derived incidence rates. Therefore, in chapter 5 some analyses stratified by age (below 50 versus above 50) will be conducted.

During earlier analyses we noticed that Austria has a high hospital inpatient rate, which could possibly be due to a low admission threshold. However, Austria has also by far the highest ED incidence rate for all variants of the registration threshold (for both admitted and not-admitted patients).
The differences in injury incidence for Ireland compared to the other countries become smaller, looking at the more severe injuries. Especially, Variant 2 for all registered patients' results in more or less comparable incidence rates. It seems that there exists an underregistration of the trivial injuries in the ED data system for Ireland.
Opposed to Ireland, the ED data set of England includes a high amount of less severe injuries. The injury incidence for the baseline model is very high compared to the other participating countries, whereas the incidence rates of the variants are comparable.
Comparing the incidence rates of Variant 3a and 3b for total ED patients, Variant 3b gives for all countries higher incidence rates. This can be explained by the inclusion of injury group 15; fracture of wrist (including carpal bones).
We conclude that the Variants 2, 3a and 3b better describe the real international variation in injury incidence than the incidence rates used in our baseline model. The cost consequences of these variants will therefore be calculated in the next chapter, including some analyses stratified by age (chapter 5).

4.3.4 Registration threshold HDR systems (Variant 4)

Differences in hospital inpatient rate of injury patients may also exist due to varying admission policies among countries. In some countries the threshold for admitting patients may be lower than in others, since it is associated with injury severity as well as socio-cultural factors. This will probably apply to all injury diagnoses.

Hypothesis: The variation in hospital inpatient rates becomes smaller using higher LOS thresholds.

Analysis

A possible solution to improve the international comparability of hospital inpatient rate will be to make cut-off point for patient admitted 1+ days, 4+ days, and 7+ days. The analysis could be performed for six countries.

Results

In table 4.12 the standardized hospital inpatient rates of the ED data system are shown for the baseline model and for Variant 4.

Table 4.13 Standardized ED incidence rates (per 1,000) for Variant 4, HLA

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales	Stdev
Baseline model	**59**	**89.8**	**99.6**	**26.6**	**48.1**	**69.6**	**110.6**	**67.3**	
Admissions (%)	32.7	6.2	7.6	11.0	6.5	10.9	4.9	7.0	
Variant 4									
LOS 1+	19.3	5.6	7.5	2.9	3.1	7.6	5.4	4.7	**5.3**
LOS 4+	14.6	2.7	4.7	0.6	1.9		2.7		**5.1**
LOS 7+	8.9	1.6	3.3	0.2	1.4		1.8		**3.1**

Conclusions

The data give no support for our hypothesis that the variation in the injury incidence becomes smaller, using higher length of stay thresholds. The table shows that in the ED systems the opposite happened. The variation of the incidence between the countries decreased comparing total admitted patients and patients admitted for a short period (1-3 days) and increased, comparing only the patients with a length of stay for more than 4 days. This shows that the LOS threshold is not a very adequate indicator of injury severity. Only using a cut-off point of 7+ in the HDR systems seems to somewhat reduce the variation. Because of the inconsistent findings, the cost consequences of Variant 4 will not be assessed.

4.3.5 Transition ratio (Variant 5)

In the baseline model the HDR systems are the preferred source of hospital inpatient data, because they are population based. The HDR patients are matched with the ED-admitted patients, for calculating the transition ratio. However, we can alternatively assume that the ED registration gives the best estimation of the admitted injury patients in the hospital, and that using the transition probability results in an overestimation of the number of admitted patients.

Hypothesis: Using the transition ratio in the cost model gives an overestimation of the admitted injury patients, resulting in an overestimation of the hospital costs.

Analysis

The total costs per capita for Minimum set I (HLA) are measures without a correction for the admitted patients in HDR.

Results

Table 4.14 Cost per capita (€) for Variant 5 (Minimum set I)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales	Stdev
Baseline model	**53**	**39**	**23**	**8**	**16**	**34**	**18**	**17**	**14.7**
Variant 5	92	20	23	5	13	31	11	11	**28.2**

Conclusion

The variation between countries increases when using this variant. For countries with very small sample sizes, not being representative for their national population either extremely high (Austria) or extremely low (Ireland) costs are calculated. Estimating the hospital inpatient rates based on ED data does not lead to better harmonization of data between countries. Differences between ED systems are

too large and probably more pronounced than differences between HDR systems. Because of its tendency to produce extreme over- or underestimations of costs, this variant will not be used in the next chapter.

4.3.6 Similar unit costs adjusted for the monetary conversion rate (Variant 6)

Finally, the possible influence of artificial differences in unit costs was investigated by using the mean of all country-specific unit costs for each country, only adjusted for differences in the general price level (Variant 6). As we described in § 2.5.2 the PPP can be used to adjust unit costs for differences in price levels among countries. In the baseline model, we tried to harmonize unit costs per country as much as possible, but residing bias could still be possible due to lack of valid information in a number of countries.

Hypothesis: Using similar (i.e. the mean) unit costs adjusted for differences in price level among countries, results in better comparable unit costs and therefore better comparable hospital costs between the participating European countries.

Analysis

Hospital costs per capita were calculated for Minimum set I (HLA), using the mean unit cost adjusted with the monetary conversion rate, instead of the comprehensive unit costs per inpatient day and per ED visit. The mean unit cost for an inpatient day in hospital is € 381 (see table 2.10) and the mean unit cost for an ED visit is € 92 (see table 2.11). These mean unit costs were divided by the monetary conversion rate per country. Table 4.15 gives an overview of these cost units for the participating countries.

Table 4.15 Unit costs for an inpatient day in hospital and ED visit adjusted for the monetary conversion rate by country

Country	PPP	Unit cost Inpatient day	Unit cost ED visit (€)
Austria	0.95	400	97
Denmark	0.82	465	113
Greece	1.27	299	72
Ireland	0.98	389	94
Italy	1.13	337	81
Netherlands	1.02	375	91
Norway	0.81	470	113
Spain	1.21	316	76
UK, England	0.92	415	100
UK, Wales	0.92	415	100

Results

Table 4.16 Cost per capita (€) for Variant 6 (Minimum set I)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales	Stdev
Baseline model	**53**	**39**	**23**	**8**	**16**	**34**	**18**	**17**	**14.7**
Variant 6	47	39	25	8	16	30	24	25	**12.1**

Since the unit costs of an inpatient day in hospital based on the monetary conversion rate are more comparable between the countries, the standard deviation decreases.

Conclusion
We can assume that the unit costs based on the mean unit cost adjusted by the monetary conversion rate give a fair description of the real situation, since Variant 6 eliminates the effect of bias in the delivered unit costs due to inadequate or missing information. This variant will be applied in the cost calculations in chapter 5.

4.4 Summarizing

There exist large differences in injury incidence, health care consumption and costs between the participating European countries. We analysed whether variants of the baseline model of analysis resulted in better comparability of data between the countries. The table gives an overview of the variants that were analysed.

Table 4.17 Overview of the variants on the baseline model

		Variations
Incidence	Baseline model	Extrapolation with delivered extrapolation factor
	Variant 1	**Calculated age-/sex specific extrapolation**
	Baseline model	No selection for specific severe injuries
	Variant 2	**frequently admitted injuries**
	Variant 3a +3b	**frequently admitted fractures (2 methods)**
Healthcare consumption	Baseline model	No selection of only hospital admitted patients
	Variant 4	**Injury patients admitted 4+ days**
Costs	Baseline model	Registered admitted patients in ED were corrected by transition ratio (correction with HDR admissions)
	Variant 5	**only registered admissions in ED**
	Baseline model	Comprehensive unit costs
	Variant 6	**Unit cost based on the monetary conversion rate**

One of the hypotheses was that international compatibility could be improved by concentrating on specific selections of injury types, which are less vulnerable to registration thresholds and health care systems and admission thresholds. Comparing these specific patient selections between the participating countries did result in consistent findings.
In the next chapter we will calculate the cost consequences of Variants 2, 3, and 6. These variants might further improve harmonization of the data, resulting in better comparability of the outcome measures.

5 Cost consequences of harmonization strategies

5.1 Introduction

The baseline model produces large variations in health care costs for injury incidence (see chapter 3). In order to explore the potential influence of surveillance system bias and cost model bias, we have analysed the influence of 6 variants in chapter 4. We concluded that Variants 2 and 3 better describe the real international variation in injury incidence, and that Variant 6 give a better description of the real international variation in health care costs than our baseline model. The cost consequences of these variants will therefore be calculated in this chapter. Using these variants might further improve harmonization of the data, resulting in better comparability of the outcome measures. Furthermore, the cost consequences of various combinations of variants are analysed.

Variants on the baseline model:
- Variant 2: registration threshold, frequently admitted injuries
- Variant 3: registration threshold, radiological verifiable fractures
- Variant 6: costs calculations based on differences in prosperity level

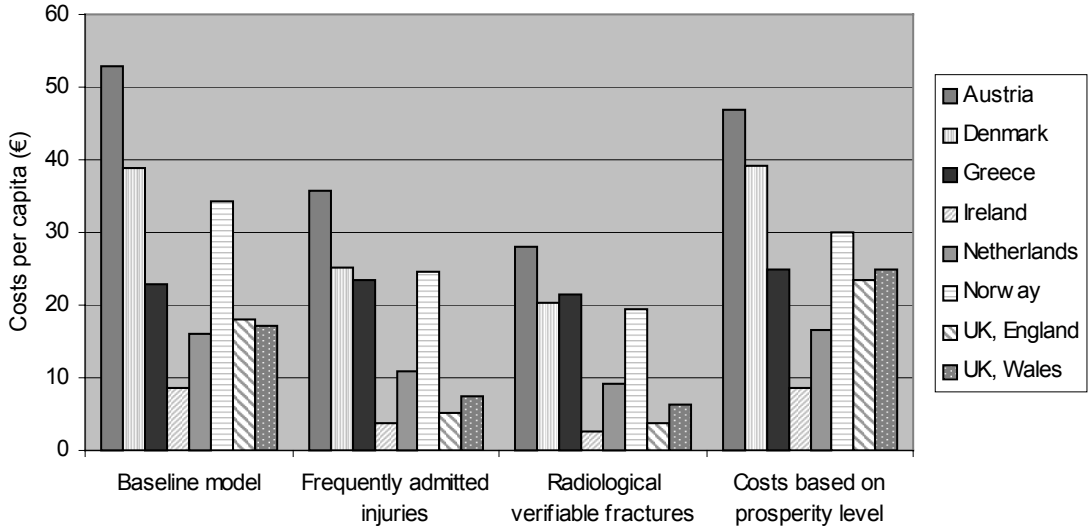
5.2 Cost consequences of the separate variants (Minimum set I)

In table 5.1 an overview is given of the influence of the variants on the hospital costs per capita for home and leisure accidents.

Table 5.1 Overview of influence of variants on costs per capita (€) for Variant 2, 3, and 6 (Minimum set I)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales	Stdev
Baseline model	**53**	**39**	**23**	**8**	**16**	**34**	**18**	**17**	14.7
Variant 2	36	25	23	4	11	25	5	7	11.8
Variant 3	28	20	21	3	9	19	4	6	9.5
Variant 6	47	39	25	8	16	30	24	25	12.1

Figure 5.1 Costs per capita for the baseline model and Variant 2, 3 and 6



The pattern of international variation in costs is broadly similar in the baseline model and the 3 variants. However, some differences are noted. In particular, England and Wales drop to the lower range of international cost estimates, when Variant 2 and 3 are used. Minimising surveillance system bias, therefore, leads to slightly different cost results. We conclude that Variant 6 should preferably be included when analysing international differences in hospital costs of injuries between the countries, since differences due to effects of the use of different costing methods are excluded, which minimises cost model bias. This should preferably be combined with one of the Variants 2 or 3 in order to simultaneously minimise surveillance system bias (see § 5.3).

5.3 Cost consequences of combination of variants (Minimum set I)

In chapter 4 the influence of the separate variants on the basic method was analysed. In this paragraph we present the results of combinations of the variants.

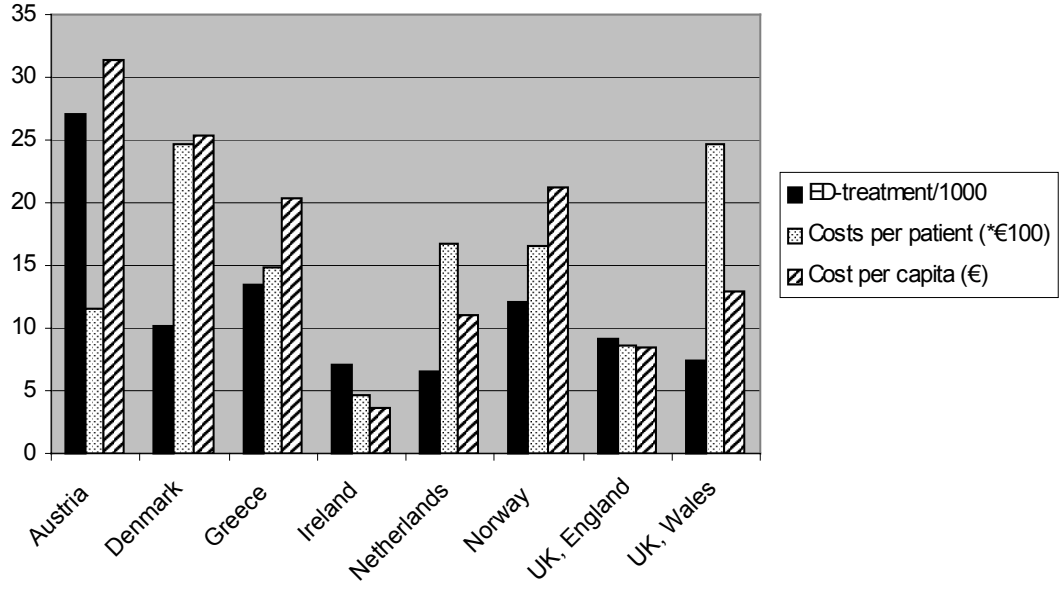
Table 5.2 Overview of influence of combinations of variants on costs per capita (€), (Minimum set I)

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales	Stdev
Baseline model	**53**	**39**	**23**	**8**	**16**	**34**	**18**	**17**	14.7
Variant 2 + 6	31	25	20	4	11	21	8	13	9.3
Variant 3 + 6	26	21	19	3	10	17	7	12	7.6

Table 5.2 shows that after minimising surveillance system bias and cost model bias, a dichotomy can be observed in the international pattern in cost per capita: Austria, Denmark, Norway and Greece have the highest cost per capita; the Netherlands, England, Wales, and Ireland have relatively low costs per capita.

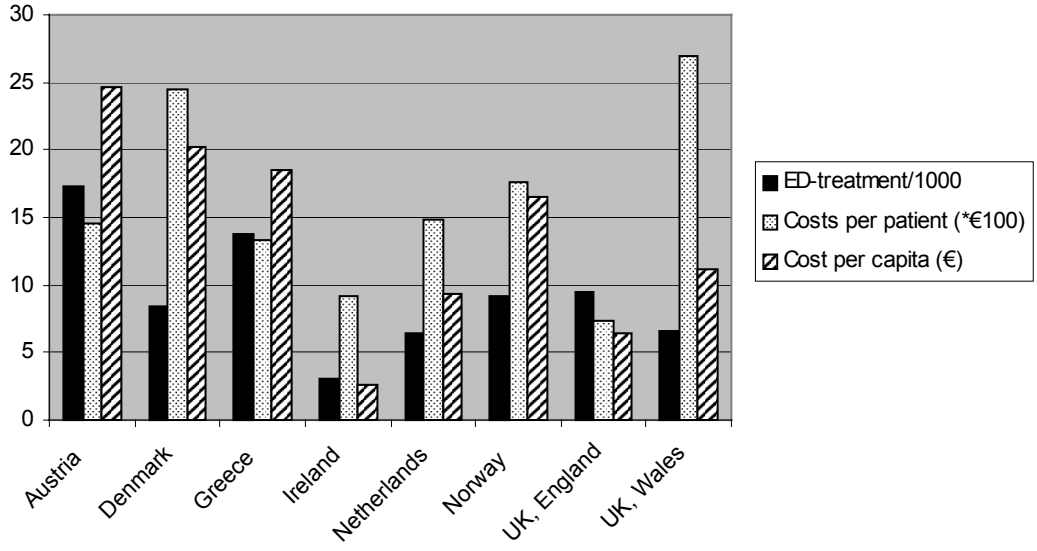
Finally, the next figures give an overview of the influence of the use of the variants (see figure 5.2 and 5.3) compared to the baseline model (see figure 3.9) on the injury incidence, mean costs per patient and the costs per capita for home and leisure injuries (Minimum set I).

Figure 5.2 *ED injury incidence (per 1,000), mean costs per patient (*€10), and costs per capita (€) for home and leisure injuries (Minimum set I) for frequently admitted injuries and costs based on differences in prosperity level (Variant 2 + 6)*



Note: Standard deviation of cost per capita = 9.3

Figure 5.3 *ED injury incidence (per 1,000), mean costs per patient (*€10), and costs per capita (€) for home and leisure injuries (Minimum set I) for radiological verifiable fractures and costs based on differences in prosperity level (Variant 3 + 6)*



Note: Standard deviation cost per capita = 7.5

We can conclude that international comparisons of injury incidence and costs should be made after adjusting for surveillance system bias (Variant 2 or 3) and cost model bias (Variant 6).

5.4 Cost consequences of variants (Minimum set II)

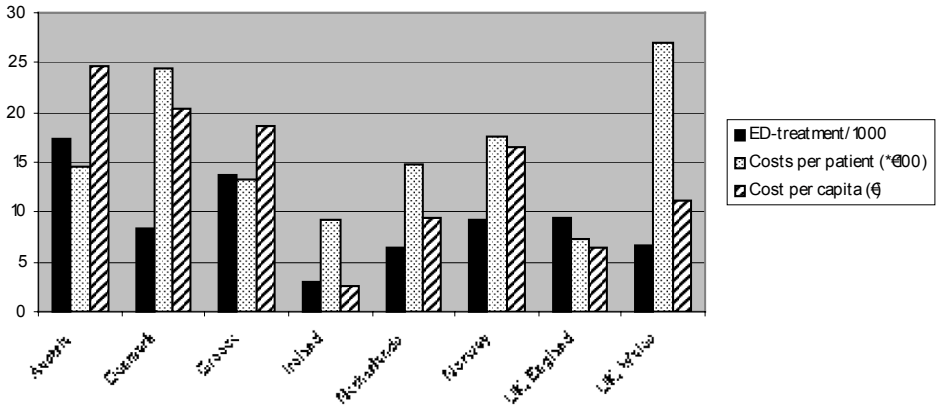
In table 5.3 an overview is given of the influence of cost calculations based on differences in prosperity level (Variant 6) on the hospital costs of admitted patients (Minimum set II).

Table 5.3 Cost per capita (€) for the baseline model and Variant 6 for Minimum set II

Participating EUROCOST countries	Costs per capita	
	Baseline model	Variant 6
Austria	75.1	65.7
Denmark	51.4	55.0
Greece	37.5	32.4
Ireland	26.3	26.2
Italy	72.0	72.0
Netherlands	19.2	21.3
Norway	42.3	37.0
Spain	13.5	14.4
UK, England	18.0	32.2
UK, Wales	22.9	45.5
Total	**27.4**	**36.1**
Standard deviation	**22.4**	**19.0**

Figure 5.4 gives an overview of the hospital inpatient incidence and costs based on differences in prosperity level (Variant 6), compared to the baseline model (see figure 3.13) for Minimum set II.

Figure 5.4 Hospital inpatient incidence (per 1,000), mean costs per patient (€100), and costs per capita (€) for total admitted patients (Minimum set II), costs based on differences in prosperity level (Variant 6)*



Note: Standard deviation cost per capita = 19.0

5.5 Conclusion

The figures show that after adjusting for surveillance system bias and cost model bias, large variations in injury costs between countries still exist. For home and leisure injuries (Minimum set I), the costs of frequently admitted injuries (and radiological verifiable fractures between brackets) range between € 31 (€ 25) and € 4 (€ 3) per capita, respectively. However, the variation in costs per capita between the countries becomes smaller, since the standard deviation decreases. Both minimum sets give the same pattern of international differences, with relatively high costs per capita in Austria, Denmark, Greece, Norway, and Italy (only Minimum set II) and relatively low costs per capita in England, Wales, the Netherlands, Ireland (in special Minimum set I), and Spain (only Minimum set II). It even seems that the dichotomy between the countries with high and low costs per capita increases after correction for surveillance system bias. For all admitted injuries (Minimum set II), similar findings are observed.

6 Costs of injury in the European Union

6.1 Introduction

The European Union (EU) consists of 15 countries (until May 2004). In the EUROCOST project nine countries of the EU participated and Norway. For these countries the costs of injury were described at country level. Furthermore, the data of the 10 participating countries were combined, to give an estimate of the 'mean' costs of injury per capita by age and sex (see chapter 3). In this chapter we extrapolate the incidence and cost estimates to all EU countries, including countries that did not participate in the project. The countries for which cost calculations were made:

Austria	http://europa.eu.int/abc/governments/austria/index_en.htm
Belgium	http://europa.eu.int/abc/governments/belgium/index_en.htm
Denmark	http://europa.eu.int/abc/governments/denmark/index_en.htm
Finland	http://europa.eu.int/abc/governments/finland/index_en.htm
France	http://europa.eu.int/abc/governments/france/index_en.htm
Germany	http://europa.eu.int/abc/governments/germany/index_en.htm
Greece	http://europa.eu.int/abc/governments/greece/index_en.htm
Ireland	http://europa.eu.int/abc/governments/ireland/index_en.htm
Italy	http://europa.eu.int/abc/governments/italy/index_en.htm
Luxembourg	http://europa.eu.int/abc/governments/luxembourg/index_en.htm
Portugal	http://europa.eu.int/abc/governments/portugal/index_en.htm
Spain	http://europa.eu.int/abc/governments/spain/index_en.htm
Sweden	http://europa.eu.int/abc/governments/sweden/index_en.htm
The Netherlands	http://europa.eu.int/abc/governments/netherlands/index_en.htm
United Kingdom	http://europa.eu.int/abc/governments/united_kingdom/index_en.htm

For these countries preliminary estimates of the total hospital costs (ED visits and hospital admissions) of home and leisure accidents (Minimum set I) and hospital admission costs of all injuries (Minimum set II) could be estimated.

6.2 Methods

In chapter 3 (see table 3.14) an overview was given of the costs per capita (by age and sex) for the participating EUROCOST countries for Minimum set I and 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). Note that the costs per capita for the EUROCOST countries are highly influenced by the injury costs of England, since this country has much the largest population of the participating countries. Subsequently, the estimates were adjusted for total health expenditures per capita for each EU country, because we assumed that the percentage of injury costs on the total expenditure of health is comparable for the EU countries. The costs of injuries in the participating countries were 1.5% of the total health expenditure of these countries for both Minimum set I and II. The health expenditures per capita for the participating countries were on average € 1511 and for the not participating countries € 1970.

6.3 Results

6.3.1 Baseline model

The tables 6.1 and 6.2 give an overview of the costs per capita, the total costs, and the health expenditure per capita for all EU countries for Minimum set I and II respectively.

Table 6.1 Injury cost per capita (€), total injury costs (million) and health expenditure per capita (€) for EU countries and Norway , ranked by injury cost per capita (Minimum set I, Home and leisure injuries)

	Minimum set I			
	Hospital costs per capita	**Total costs (million)**	**Health expenditure per capita**	
Participating EUROCOST countries				
Ireland	8.5	32	1347	
Netherlands	16.1	255	1956	
UK, Wales	17.1	50	1443	
UK, England	18.1	898	1443	
Spain [a]	18.9*	746	1207	
Greece	23.0	242	1283	
Italy [a]	24.0*	1321	1594	
Norway	34.4	153	2159	
Denmark	39.0	207	1984	
Austria	53.0	429	1698	
Total	**22.5**	**4333**	**1511**	**(mean)**
Non-participating EU countries				
Portugal	18.6	187	1244	
Finland	20.3	105	1361	
Sweden	26.5	237	1738	
Belgium	27.2	279	1790	
France	28.4	1689	1872	
Luxembourg	32.4	14	2273	
Germany	33.1	2723	2214	
Total	**29.7**	**5233**	**1970**	**(mean)**
Total EU countries	**27.1**	**9567**	**1728**	**(mean)**

[a] Costs per capita for Minimum set I are calculated using the same method as for the non-participating countries.

Table 6.2 Injury cost per capita (€), total injury costs (million) and health expenditure per capita (€) for EU countries and Norway, ranked by injury cost per capita (Minimum set II)

	Minimum set II			
	Hospital costs per capita	**Total costs (million)**	**Health expenditure per capita**	
Participating EUROCOST countries				
Spain	13.5	540	1207	
UK, England	18.0	897	1443	
Netherlands	19.2	304	1956	
UK, Wales	22.9	68	1443	
Ireland	26.3	99	1347	
Greece	37.5	397	1283	
Norway	42.3	189	2159	
Denmark	51.4	273	1984	
Italy	72.0	2147	1594	
Austria	75.1	609	1698	
Total	**23.4**	**5523**	**1511**	**(mean)**
Non-participating EU countries				
Portugal	18.8	189	1244	
Finland	20.4	105	1361	
Sweden	26.8	239	1738	
Belgium	27.7	284	1790	
France	28.6	1699	1872	
Luxembourg	32.1	14	2273	
Germany	33.9	2787	2214	
Total	**30.1**	**5318**	**1970**	**(mean)**
Total EU countries	**27.4**	**10841**	**1728**	**(mean)**

The tables show that the costs per capita for the not participating countries are much more consistent, because differences in injury epidemiology, health care consumption and cost prices are not included. The differences that exist are based on differences in age and sex distribution between the countries and differences in health care expenditure per capita. The costs per capita for the non-participating countries are higher than for the participating countries, both for Minimum set I and II. This can be explained by a higher percentage of elderly people in the non-participating countries and higher health expenditure per capita. Portugal has the lowest health expenditure of total EU countries and also has the lowest cost per capita for injuries.

This extrapolation results in 10 billion Euro spent annually on hospital costs (exclusive outpatient care) of home and leisure injuries. This is 1.5% of the total health expenditure.

Figure 6.1 gives an overview of the costs per capita for all EU countries for both minimum sets.

Figure 6.1 Cost per capita (€) for all EU-15 countries for Minimum set I and Minimum set II

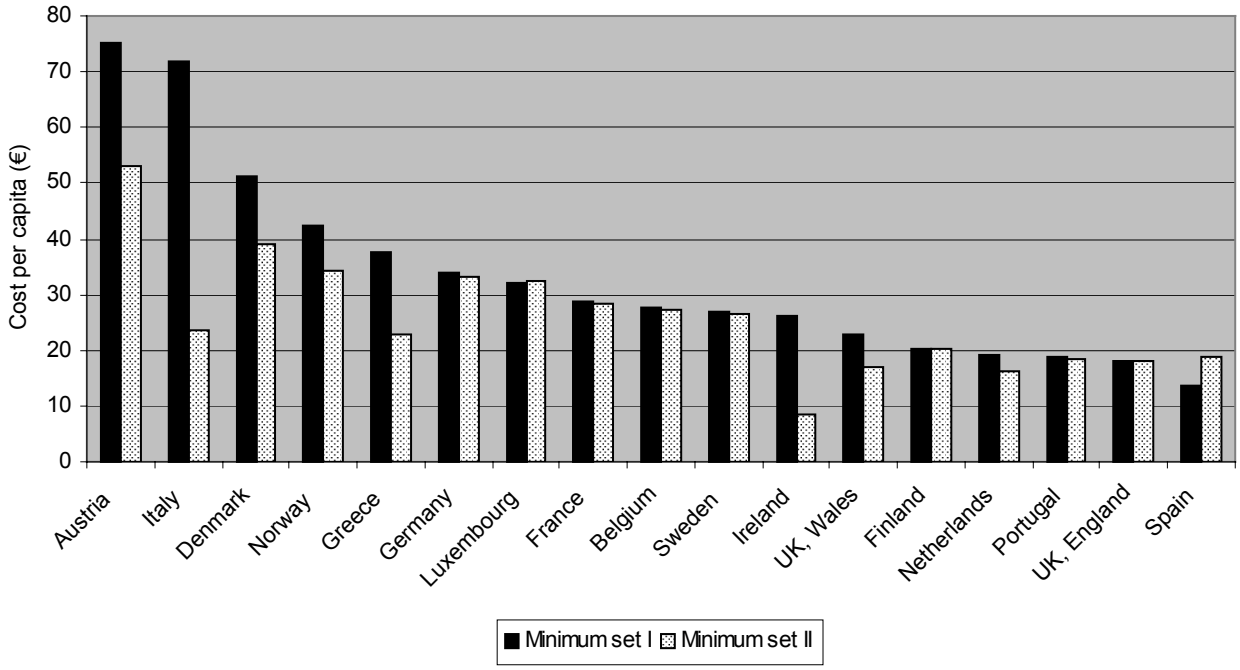


Table 6.3 gives an overview of the costs per capita for injury groups (level 3).

Table 6.3 Cost per capita (€) for the EUROCOST countries, non-participating countries and the EU (15 countries) for injury groups (level 3), Minimum set I

	EUROCOST countries	**Non-participating countries**	**EU-15 countries**
Head and facial injury (excl. eye injuries)	1.9	1.9	**1.8**
Eye injury	0.3	0.3	**0.3**
Injuries to vertebral column, spine, internal organs and rib/sternum fractures	0.9	1.2	**1.1**
Upper extremity injury (excl. nerves)	3.7	4.3	**4.0**
Lower extremity injury	9.7	14.6	**12.9**
Superficial injury, including contusions and open wounds	3.3	3.9	**3.6**
Burns	0.5	0.5	**0.4**
Poisoning	0.3	0.3	**0.3**
Foreign body	0.0	0.1	**0.1**
Other and unspecified injury	2.5	2.7	**2.6**
Total	23.0	29.7	**27.1**

The costs per capita for lower extremity injuries are higher in the non-participating countries, because these injuries predominantly occur in elderly and non-participating countries have a higher proportion of elderly in their population (see table 6.3).

In contrast, head and facial injuries occur frequently in the younger age groups, which result in lower costs per capita for the non-participating countries. After correction for the health expenditure (which are higher for the non-participating countries) the cost per capita are comparable.

6.3.2 Variants

In table 6.4 the costs per capita for all EU countries are shown for the baseline model and Variant 6.

Table 6.4 Cost per capita (€) for all EU countries for the baseline model and Variant 6 for home and leisure injuries (Minimum set I)

	Costs per capita	
	Baseline model	**Variant 6**
Austria	53.0	46.8
Denmark	39.0	39.2
Greece	23.0	24.8
Ireland	8.5	8.4
Italy	23.7	26.1
Netherlands	16.1	16.5
Norway	34.4	30.1
Spain	18.7	20.6
UK, England	18.1	23.5
UK, Wales	17.1	24.7
Belgium	27.2	30.2
Finland	20.3	22.5
France	28.4	31.5
Germany	33.1	36.8
Luxembourg	32.4	35.8
Portugal	18.6	20.6
Sweden	26.5	29.5
Total EU countries	**27.1**	**30.0**

The unit costs based on the monetary conversion rate are a bit higher that the comprehensive unit costs for all not participating countries. This can be explained by the fact that the mean costs per capita by age for the participating countries is highly influences by the costs per capita of England, since the population of England represent a large share of the total population of the participating countries. The unit costs for inpatient days in hospital based on Variant 6 are much higher than the delivered unit costs for England, which also result in higher total costs per capita for the non participating countries.

Table 6.5 Cost per capita (€) for all EU countries for the baseline model and Variant 6 for total admitted patients (Minimum set II)

	Costs per capita	
	Baseline model	**Variant 6**
Austria	75.1	65.7
Denmark	51.4	55.0
Greece	37.5	32.4
Ireland	26.3	26.2
Italy	72.0	72.0
Netherlands	19.2	21.3
Norway	42.3	37.0
Spain	13.5	14.4
England	18.0	32.2
Wales	22.9	45.5
Belgium	27.7	33.1
Finland	20.4	24.4
France	28.6	34.2
Germany	33.9	40.6
Luxembourg	32.1	38.2
Portugal	18.8	22.4
Sweden	26.8	32.2
Total EU countries	**27.4**	**32.9**

7 Discussion

7.1 Introduction

In the EUROCOST project, a model has been developed for the calculation of injury costs in Europe. This model was subsequently tested and applied in 10 European countries: Austria, Denmark, Greece, Ireland, Italy, Netherlands, Norway, Spain, England, and Wales. 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 addition, 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 delivered unit costs per country).

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-15)

In this chapter we discuss the main results and their policy implications for each of the three aforementioned levels.

7.2 Injury costs per country

Injury costs are an important indicator to support priority setting in injury prevention within countries. They reflect the loss of economic resources due to specific types of injury or accident, and combine the effects of frequency (injury incidence) and severity, in terms of health care consumption (costs per patient). This enables the identification of health policy priority areas of both ‘high frequency, low impact injuries’ and ‘low frequency, high impact injuries’. In this way, they add important information to existing injury surveillance systems (ED based and HDR based). Rankings purely based on frequency information may change when cost information is added.

Injury costs per country should, in principle, be calculated with the baseline model. With the 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. The variants of the EUROCOST model are less appropriate for this aim. Prior exclusions of low severity injuries (Variants 2 and 3) could lead to underestimations of specific types of accidents, characterized by ‘high frequency, low impact’ (e.g. sports injuries, with their high proportion of ‘superficial injuries’). Also at country level the adjustment of unit costs for international differences in prosperity is not justified (Variant 6).

The costs per capita of home and leisure accidents account for about 75% of all medical costs due to injury (see chapter 3). The EUROCOST model, therefore, clearly points to home and leisure accidents as a priority area in injury prevention at country level. Within the field of home and leisure accidents, people above the age of 65 years raise a major concern in most countries. In Greece, the Netherlands, and Norway, for example, they account for around 50% **of the costs of home and**

leisure injuries and for all admitted patients combined, including unintentional and intentional injuries (Minimum set II), their share of the costs is even higher.
This partly explains why lower extremity injury (with a high proportion of hip fractures of elderly people) has such a high share in the costs of injury. Other types of injury with a relatively high share in the total costs in most countries are superficial injuries and open wounds. The latter shows, that when costs are used as indicator of the burden of injury at country level, injuries that are often considered minor should be included. This is further supported by the fact that the costs of ED treatment account for almost one-third of the hospital costs of injury.
The most expensive types of injury (costs per patient) are spinal cord injuries (€ 6500), fracture of the femoral shaft (€ 6100), hip fractures (€ 5100), pelvic fractures (€ 4700), and burns (€ 4200).

The validity of results of the EUROCOST model at country level seems primarily dependent on the validity of the surveillance data. Individual countries were identified, where efforts may be needed to install surveillance systems that are representative for the national population. The EUROCOST methodology (baseline model) produces consistent patterns of injury costs by age, sex, injury type and external cause.
The application of the baseline model at country level seems therefore appropriate. This application, however, 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.

We recommend making the EUROCOST methodology (including data codes and software) available to all EU countries, including the 10 new member states. This would allow 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. We also recommend applying the EUROCOST methodology on a more detailed level of specific external causes.

7.3 Variation in injury costs between EU countries

In chapter 3 figures 3.9 and 3.13 show that large international differences exist in injury incidence, mean costs per patient and costs per capita using the baseline model for Minimum set I and II. Despite these differences, similar patterns in incidence and costs divided by age, sex, injury type and external cause were observed.
International comparisons of injury-related incidence, health care consumption and costs should always be made with caution. In chapter 4, we showed the complexity of international variation in injury costs, being influenced by so many parameters including surveillance system bias (artificial differences due to variation in surveillance systems) and cost model bias (artificial differences due to effects of our costing methodology per country) (see paragraph 4.3.1).
The baseline model seems not appropriate for making international comparisons of injury costs, because differences in surveillance systems and unit costs obstruct the interpretation of results. Therefore, we have developed several variants aiming to minimize both types of bias. For purposes of international comparisons of injury costs it is advised to select the more severe injuries (frequently admitted injuries (Variant 2), or radiological verifiable fractures (Variant 3b)) in order to minimize surveillance system bias for Minimum set I and the modules. This should be combined with using the mean of country-specific unit costs (adjusted for differences in the general price level (Variant 6)) in all countries in order to minimize cost model bias. For international comparisons of Minimum set II similar

unit costs (Variant 6) should be used. The figures in chapter 5 show the results of injury incidence, mean costs per patient on costs per capita after adjusting for the variants for Minimum set I and II. The figures show that after adjusting for surveillance system bias and cost model bias, large variations in injury costs between countries still exist. It even seems that the dichotomy between the countries with high and low costs per capita increases after correction for surveillance system bias.
Since the international variation in injury costs can only partly be explained by variation in registration and health care systems (analysis with the variants) we may assume that international variation in costs be explained largely by real differences in price level, health care consumption and injury incidence between the participating countries. However, there are still some important methodological issues that can influence the international differences in injury incidence and costs, particularly differences in extrapolation method (see chapter 4).

In order to reduce heterogeneity, some additional analyses stratified by age may be helpful. Figures 7.1 and 7.2 show the differences in cost per capita for persons above and below the age of 50.

Figure 7.1 ***Cost per capita (€) for home and leisure injuries (Minimum set I) by age for radiological verifiable fractures, based on differences in prosperity level (Variant 3 + 6)***

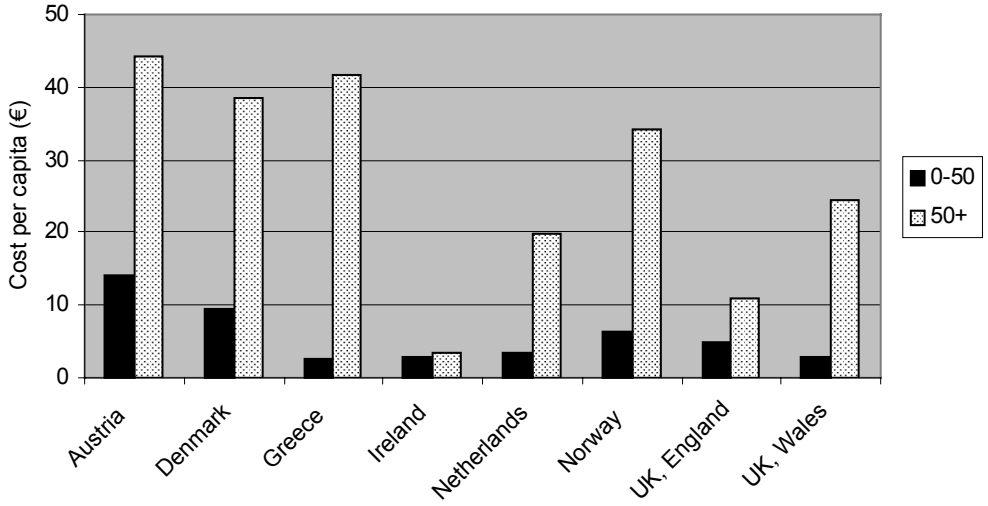
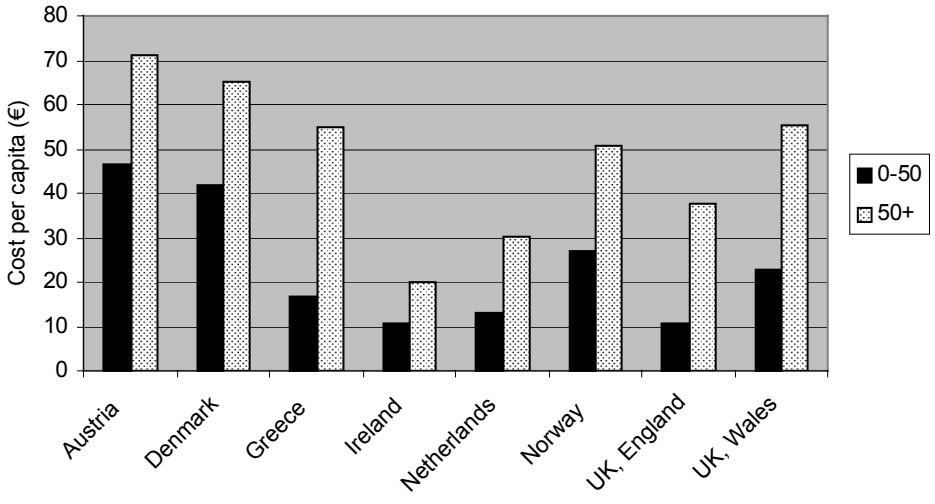


Figure 7.2 *Cost per capita (€) for hospital inpatient incidence (Minimum set II) by age, adjusted for differences in prosperity level (Variant 6)*



Variation in costs per capita is high for persons above the age of 50. 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.
Comparing the younger persons results in more gradual differences in costs per capita between the countries, with the exception of Austria and Denmark.

In the EUROCOST project, an important step was made towards further harmonization of injury incidence data by making selections of the more severe injuries: frequently admitted injuries and/or radiological verifiable fractures. Thanks to a uniform methodology the cost estimates can be effectively compared between the participating EUROCOST countries. Hence, the EUROCOST-model forms a sound basis for the evaluation of the costs and effects of specific preventive measures. 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.

Exploring the reasons behind variation in incidence rates (such as observed among older people) could also be very interesting for health policy makers. In particular, knowing why some countries have relatively low incidence rates and low costs per capita could give important information for developing prevention programs. A low incidence of home and leisure injury among older people in Ireland, for example, could be due to several factors. Possible explanations could be related to a low prevalence of (modifiable) determinants (e.g. determinants of falls), but also to (modifiable) health system factors, such as mean distance to the ED. Figure 7.3 (see last page of this paragraph) shows that there are several alternatives for ED treatment, which could be more prevalent in some countries than in others, which could lead to a reduction of the hospital costs.

It is likely that the data for Ireland are not representative as they were provided for a single hospital.

A next step would consist of formal analyses of international variation in the incidence of the more severe injuries and/or the more severe fractures in relation to several determinants at population level (such as prosperity, level of education, degree of urbanization, index of inequality, availability and dispersal of health care). Preferably, the number of participating countries in this type of analysis would increase up to 15-20 countries. For all European countries it would be worthwhile to participate in the EUROCOST project, 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.

7.4 Injury costs at EU level (EU-15)

Chapter 6 has shown that, according to the applied method, home and leisure accidents in the EU-15 annually result in € 10 billion for hospital costs (i.e. 5.2% of total inpatient health expenditure). This indicates that home and leisure accidents probably make a major contribution to the economic burden of injury in the EU. The large share of older victims, reflecting high incidence and consumption rates of hip fractures and fractures of knee/lower leg, is rather impressive. As the European population is ageing, this problem is expected to increase in the future. Prevention programs for older people should receive priority! Therefore, research into determinants of injury incidence and consumption rates among older people is important at EU level. Other priority areas are superficial injuries and open wounds that are known as ‘high frequency, low impact’ types of injury .On the other hand, spinal

cord injuries, femur shaft fractures, pelvis fractures, hip fractures and burns deserve special attention as being the most important 'low frequency, high impact' types of injury in all countries.

It should be noted that the EU estimates should be seen as preliminary estimates, based on the available information of a selection of countries that are not representative for the whole EU. Large countries like Germany and France were not included, and they represent almost half of the total EU population. The application of the EUROCOST methodology in all EU countries, including the 10 new member states, is therefore recommended. This will allow the definite estimation of medical costs of injury at EU-25 level.

7.5 Methodological and data limitations

When the results are being interpreted certain allowances should be made for the methodological and data limitations with respect to:

- patient group classification, and
- cost elements, volume units and cost prices.

Patient-group classification

The model classifies patients according to the nature of the care (hospital admission/non-admission), injury group (combination of the location and type of injury), age, sex, and country. When a patient sustains multiple injuries, a primary diagnosis is formed on the basis of a hierarchical classification. These criteria are used to identify medically recognisable patient groups, which are largely homogeneous in terms of the range, intensity and duration of the healthcare ('economically homogeneous').

It was not possible to operationalize severity with the Abbreviated Injury Scale (AIS). As a result, we might have insufficiently discriminated among severe and less severe injuries, especially among patients with very severe injuries (e.g. patient admitted to hospital due to 'skull/brain' injuries). Also, multi-trauma patients (seriously injured patients, usually with multiple injuries) could not be distinguished. The availability of adequate data on injury severity (e.g. AIS) would make the model more supportive for policy making, especially with regard to severe injuries.

Cost elements, volume units and cost prices

This study covers not all healthcare segments that are important to injury patients. It only used data of emergency department registers and hospital discharge registers. There was no information available on outpatient care, rehabilitation, nursing homes and primary care.

Only direct medical costs are included in the cost estimates (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 (sick leave and/or occupational invalidity) 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.

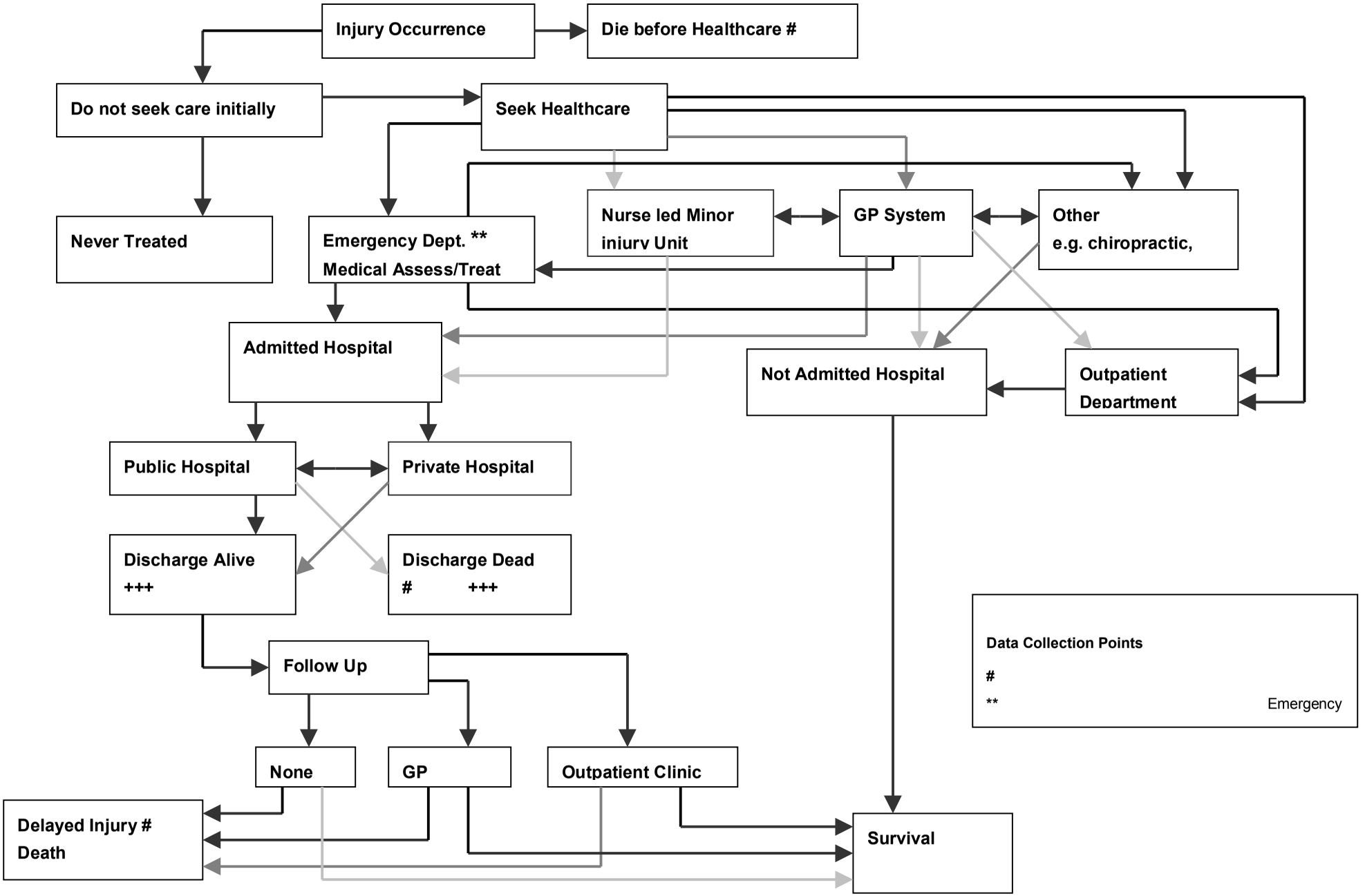


Figure 7.3 Acute injury / healthcare flow diagram

8 Conclusions and recommendations

Conclusions

We conclude that:

- The added value of the costs model for policy purposes lies mainly in the opportunities that it provided for continuous and detailed monitoring of the costs of injuries. For the benefit of policy development, detailed estimated can be compiled of the incidence, the healthcare use and the medical costs of specific accident groups. 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.

- 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 should be made after adjusting 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.

- Injuries among older people (65+) generate high costs and should be a priority area in public health policy in all European countries.

- The major sources of hospital costs of injury in Europe are hip fractures, fractures of the knee/lower leg, superficial injuries and open wounds. The causes and possible interventions of these injury types should therefore -by priority- be further investigated.

- The most important ‘low frequency, high impact’ types of injury in addition to hip fractures are spinal cord injuries, femoral shaft fractures, pelvic fractures, and burns. Research into the causes and possible interventions of these severe types of injury deserve attention as well.

- 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, particularly inadequate extrapolation of ED data towards national level is still a possible source of variation in injury incidence and costs. there are still some important methodological issues that can influence the international differences in injury incidence and costs; differences in extrapolation method and variation in health care systems.

- Finally, this model marks the first step towards calculating the direct medical costs of injury for countries in the European Union following a uniform method.

Recommendations

We recommend to:

- Transfer the uniform method to calculate hospital costs of injury from the coordinating centre in the Netherlands to the member states themselves.

- The EUROCOST model needs to be regularly maintained in order to stay up-to-date. The maintenance plan states when new healthcare and costs price data is entered. It is also the intention to make use of any newly available data, which could help to refine and optimise the cost estimates.

- Expand the application of the uniform cost model to all EU-countries, including the new member states: For all European countries it would be worthwhile to participate in the EUROCOST project, 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.

- Expand the model with other indicators (indirect costs, DALYs): at least as important as quantifying the economic impact of injury, is the estimation of its human impact. For this purpose, summary measures (i.e. DALYs) of population health should be used, looking at the integrated impact of mortality and disability due to injuries.

- Address the following problems as priority areas in public health policy, both at European and national levels: home and leisure injury, injury among older people (65+), hip and pelvic fractures, fractures of the femoral shaft and knee/lower leg, superficial injuries and open wounds, spinal cord injuries, and burns.

- Start explanatory research into international variation in injury costs among older people in particular: observed international variation in costs per capita for home and leisure injuries (Minimum set I) is highly influenced by observed differences among persons older than 50 years. This reflects variation in health care consumption, based on rather large differences in injury incidence rates among this group.

- Validate the extrapolation of local sample data on injury incidence to national level.

- Expand the model to injuries treated by primary care providers and self-treatment.

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Annex 1 Injury clustering EUROCOST

Table Injury clustering for cross-national analysis of incidence rates and hospital LOS

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

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

na = not available.

a = high risk of EHLASS misclassification (observed in admitted patients).

b = differences in injury classifications: in some countries EHLASS systems provide more detail than others, or use slightly different categories.

c = very low incidence, and therefore uncertainty in country-specific estimates.

LOS = length of stay.

Annex 2 Proportional distribution of unknown and unspecified injuries

Table ED Home and Leisure injury incidence rates by injury group (level 3) and country, after proportional distribution of unknown/unspecified injury (including versus excluding cases with unknown and unspecified injuries)

	Austria		Denmark		Greece		Ireland		Netherlands		Norway		UK, England		UK, Wales	
	All	**Excl.[1]**	All	**Excl.[1]**	All	**Excl.[1]**	All	**Excl.[1]**	All	**Excl.[1]**	All	**Excl.[1]**	All	**Excl.[1]**	All	**Excl.[1]**
Head and facial injury (excl. eye)	9.1	**9.6**	10.3	**10.8**	12.2	**12.3**	5.9	**6.7**	7.8	**8.0**	10.6	**11.0**	9.3	**13.9**	8.8	**10.4**
Eye injury	0.0	**0.0**	5.0	**5.2**	2.2	**2.2**	1.5	**1.7**	3.1	**3.2**	0.9	**0.9**	2.5	**3.8**	0.9	**1.0**
Injuries vertebral column / spine / Int. organs + fracture rib / sternum	1.5	**1.6**	0.6	**0.6**	1.1	**1.2**	0.7	**0.8**	1.1	**1.1**	3.6	**3.7**	1.1	**1.6**	1.5	**1.8**
Upper extremity injury (excl. nerves)	30.6	**32.1**	19.5	**20.3**	15.3	**15.5**	27.8	**31.6**	20.1	**20.7**	22.8	**23.5**	14.2	**21.1**	17.5	**20.8**
Lower extremity injury	30.5	**31.9**	18.8	**19.6**	17.4	**17.5**	16.6	**18.9**	17.9	**18.4**	19.7	**20.4**	11.2	**16.7**	13.8	**16.4**
Superficial injury, incl. contusions and open wounds	21.5	**22.6**	38.2	**39.9**	44.1	**44.5**	33.7	**38.3**	44.8	**46.0**	34.6	**35.8**	26.5	**39.5**	35.5	**42.3**
Burns	2.1	**2.2**	1.3	**1.4**	2.2	**2.2**	0.0	**0.0**	1.6	**1.6**	1.5	**1.6**	1.9	**2.8**	1.8	**2.2**
Poisoning	0.1	**0.1**	2.0	**2.1**	0.5	**0.5**	1.8	**2.0**	0.7	**0.7**	0.3	**0.3**	0.5	**0.7**	1.6	**1.9**
Foreign body	-	**-**	-	**-**	4.0	**4.0**	-	**-**	0.4	**0.4**	2.9	**3.0**	-	**-**	2.7	**3.2**
Other and unspecified injury	4.6		4.2		0.5		12.0		2.6		3.1		32.8		16.1	

[1] Excluding cases with unknown and unspecified injuries.

Annex 3 Necessary variables to participate in minimum sets and modules

The table gives an overview of the necessary variables, which have to be available in a data set to be able to participate in a minimum set and/or module.

Table Necessary variables to participate in a minimum set or module

	ED data	HDR
INJURY INCIDENCE		
Minimum set I: ED incidence of home and leisure injury	Accident = home + sport OR HLA	X
Minimum set II: Hospital admission of unintentional and intentional injury	X	Accident = (sport OR occupational OR traffic OR home) AND (Violence OR self mutilation)
Module I: ED incidence of traffic injury	Accident = traffic	X
Module II: ED incidence of occupational injury	Accident = occupational	X
Module III: ED incidence of unintentional and intentional injury	Accident = (sport OR occupational OR traffic OR home) AND (Violence OR self mutilation)	X
HEALTH CARE CONSUMPTION		
Minimum set I: ED attendances	ED data file	X
Minimum set II: Hospital admissions, length of stay (LOS), ICU	Variables: hospital admission AND (los AND/OR ICU)	Variables: los AND/OR ICU
Module I: Inpatient medical procedures	X	Variable: inpatient medical procedure
Module II: Hospital outpatient visits	X	Variable: hospital outpatient visits
Module III: Ambulance transport	Variable: transport	Variable: transport
Module IV: Materials and radiology	X	Variable: materials/radiology

Annex 4 Availability of ED- and HDR-data to EUROCOST-team

Table 1 Availability of data-systems per country

Country	ED data	HDR
Austria	EHLASS	HDR and MEDOK[1]
Denmark	EHLASS	NDR
Greece	EDISS	X
Ireland	EHLASS	HIPE
Italy	Occupational Injury register[2]	
		HDR
Netherlands	LIS	LMR
Spain	Emergency Register[3]	HDR
Norway	Injury Register	HDR
UK, England	HASS en LASS	HDR
UK, Wales	AWISS	HDR

[1] MEDOK hospitals are a subset of hospitals in the hospital discharge system.

[2] The Occupational Injury Register is not an ED based system. Those registered are cases of accident at workplace notified by the employer tot the National Institute for Occupation.

[3] The data of the emergency register of Spain contains only information about hospitals in the region of Barcelona.

Table 2 Availability of ED-data to EUROCOST-team

Variables	**AU**	**DK**	**GR**	**IR**	**IT**	**NL**	**NO**	**SP, Bar.**	**UK, England HASS**	**UK, England LASS**	**UK, Wales**
Sex	+	+	+	+	+	+	+	+	+	+	+
Age[1]	+	+	+	+	+	+	+	+	+	+	+
Accident category	+	+	+		+	+	+	+	+	+	+
Sports	+	+	+			+	+		(+)	+	(+)=missing
Traffic		+	+			+	+	+			+
Occupational		+	+		+	+	+				+
Home	+	+	+			+	+		+	(+)	+
Violence			+			+	+				+
Selfmutilation						+	+				+
HLA[2]				+[3]							
HLA + Occupational[2]											
Injurygroups[4]	+	+	+	+	+	+	+	+	+	+	+ Own class.
			ICD-9[6]			ICD-9		ICD-9			
Number of injuries	2	3	3	1	1	3	1	3	1	1	3
External cause[5]	na	na	E-codes			+	na	+	+	+	na
Hospital admission	+	+	+	+	na	+	+	+	+	+	+
Length of stay	+	+	+	+	na	+			+	+	
ICU			+			+					
ICU length of stay											
Extrapolation	+	+	+	+		+	+	+	+	+	+

+ = available, na = not available to EUROCOST, but registered in data system.

[1] Age is delivered in years (sometimes in combination with 7 categories) by all countries except Italy.

[2] In some systems accidents are coded as HLA (or HLA + Occupational), no further distinction in underlying accident category is possible.

[3] No accident information Ireland is available; information phase I indicates HLA.

[4] Most countries have delivered injury data as defined in 39 injury groups. A few countries have delivered data in a specific classification.

[5] In most countries the classification of external causes is based on own classification system. In a few countries a specified classification is used.

[6] Greece delivered injury data with ICD-9 codes and EHLASS 2000 codes. In the analyses we used the ICD-9 information.

Table 3 Availability of HDR-data to EUROCOST-team

Variables	**AU**	**AU**[1]	**DK**	**IR**	**IT**	**NL**	**NO**	**SP**	**UK, England**	**UK, Wales**
	HDR	**MEDOK**								
Sex	+	+	+	+	+	+	+	+	+	+
Age[2]	+	+	+	+	+	+	+	+	+	+
Accident category	+	+	na[3]	+		+	+[4]	+	+	
Traffic	+	+		+		+		+	+	+
Occupational	+									
Violence	+			+		+		+	+	+
Suicide	+			+		+		+	+	+
HLA[6]	+					+				
HLA + Occupational[6]	+			+				+	+	+
Injurygroups	+	+	+	+	+	+	+	+	+	+
Number of injuries	1	1	1	1	1	1	1	1	1	1
External cause	+	na	na	ICD-9		ICD-9		ICD-9	ICD-10	
Length of stay	+	+	+	+	+	+	+	+	+	+
ICU admission	+	+	+							
ICU length of stay		+	+							
Inpat. Med. Proced.				+		+	+	+		+
Late consequences										
Readmissions										
Inhospital injuries										

+ = available, na = not available to EUROCOST-team but registered in data system.

[1] For the international comparisons, HDR of Austria will be used in stead of MEDOK.

[2] Age is delivered in years (sometimes in combination with 7 categories) by all countries except Italy.

[3] The distinction of unintentional and intentional injuries and suicide can be made for the comparison of the NDR with the injury register of Denmark.

[4] Dinction of accident category is not possible.

[6] In some systems accidents are coded as HLA (or HLA + occupational), no further distinction in underlying accident category is possible.

Annex 5 Monetary conversion rate

Monetary conversion rates GDP purchasing power parity, US$ National currency unit per US$, PPP		Monetary conversion rates US$ exchange rate National currency unit per US$	Calculation national price level --> EU price level 1999 EU = EU Member States + Norway				
Countries	**1999**	**1999**	**NCU**	**$**	**$PPP**	**US price level / national price level**	**EU price level / national price level**
Austria	0.95	0.94	100	106	105	0.99	**0.95**
Belgium	0.93	0.94	100	106	108	1.01	**0.97**
Denmark	8.24	6.98	100	14	12	0.85	**0.82**
Finland	1	0.94	100	106	100	0.94	**0.90**
France	0.97	0.94	100	106	103	0.97	**0.93**
Germany	0.98	0.94	100	106	102	0.96	**0.92**
Greece	0.68	0.9	100	111	147	1.32	**1.27**
Ireland	0.92	0.94	100	106	109	1.02	**0.98**
Italy	0.8	0.94	100	106	125	1.18	**1.13**
Luxembourg	0.98	0.94	100	106	102	0.96	**0.92**
Netherlands	0.89	0.94	100	106	112	1.06	**1.02**
Norway	9.25	7.8	100	13	11	0.84	**0.81**
Portugal	0.64	0.94	100	106	156	1.47	**1.41**
Spain	0.75	0.94	100	106	133	1.25	**1.21**
Sweden	9.64	8.26	100	12	10	0.86	**0.82**
United Kingdom	0.65	0.62	100	161	154	0.95	**0.92**
Average						**1.04**	**1.00**

Source: OECD HEALTH DATA 2002

Annex 6 Percentage hospital admissions per injury group, only HLA

Table Distribution (%) of hospital admitted patients of total registered patients in ED, only HLA

	AU	DK	GR	IR	NL	NO	UK, England	UK, Wales
Concussion	0	44	16		34	34	12	
Other skull-brain injury	85	10	80	68	56	52	28	19
Open wound head	31	5	6	4	4	3	3	8
Eye injury	100	1	2	2	1	17	1	8
Fracture facial bones	83	7	5	21	12	14	5	24
Open wound face	30	1	1	14	1	1	3	6
Fracture/dislocation/strain/sprain vertebrae/spine	85	34	66		48	39	26	12
Whiplash, neck sprain, distorsion cervical spine			4			7	1	6
Spinal cord injury			64	5	33		25	67
Internal organ injury	67	34	63	29	54		21	33
Fracture rib/sternum		29	20		30	8	8	22
Fracture clavicle/scapula	38	12	7	11	5	7	7	11
Fracture upper arm	52	28	13	25	15	32	19	24
Fracture elbow/forearm	23	25	15	25	13	21	16	26
Fracture wrist	14	11	3	30	4	13	10	13
Fracture hand/fingers	7	4	0	14	1	9	2	5
Dislocation/sprain/strain shoulder/elbow	40	4	5	2	3	5	5	6
Dislocation/sprain/strain wrist/hand/fingers	6	0	0	1	1	1	1	2
Injury of upper extremity nerves	77	66			56	72	39	21
Complex soft tissue injury upper extremities	26	14	28	4	9	24	14	21
Fracture pelvis		40	59	92	67	62	85	63
Fracture hip	88	98	96		93	99		96
Fracture femur shaft	96	94	94	95	87	96	84	93
Fracture knee/lower leg	60	45	44	29	34	50	32	47
Fracture ankle	49	24	30	34	23	39	15	25
Fracture foot/toes	8	2	2	6	1	4	2	5
Dislocation/sprain/strain knee	34	1	5	2	1	6	1	2
Dislocation/sprain/strain ankle/foot	3	0	0	1	0	1	1	1
Dislocation/sprain/strain hip	100	60	100		66	22		28
Injury of lower extremity nerves	27			1		72		
Complex soft tissue injury lower extremities	19	12	45	3	13	23	12	22
Superficial injury, abrasions	21	2	2	1	1	4	4	4
Contusions			2				2	
Open wounds	19	1	1	20	2	2	2	9
Burns	12	4	7		1	13	4	11
Poisoning	100	11	70	23	36	70	30	56
Foreign body			2		14	5		13
No injury after examination	36	3	2		3	10	2	
Other injury	29	7	15	25	9	14	4	15
Other medical condition			79					
Late consequences of injury			3					

Note: the injuries with an admission rate >=15% are marked gray

Annex 7 Participants EUROCOST phase 2

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Annex 8 Meeting EUROCOST phase 2 – Athens Workshop, 23-24 June 2003

Attending: Robert Bauer, Claus Falck Larsen, Stellina Kiosse, Nick Dessypris, Alessio Pitidis, Catherine Pérez, Ronan Lyons, Willem Jan Meerding, Suzanne Polinder, Saakje Mulder (chair), Hidde Toet (minutes)

Not attending: Anne Mette Tranberg Johansen, Tim McCarthy, Branko Kopjar, Johannes Wiik, Ed van Beeck

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1. General introduction

- Introduction of participants
- EUROCOST: Saakje gives a brief summary of the project, including a general outline of the European model to calculate the costs of injuries of the project and an explanation of the different phases to be performed during this project.

Note: Remarks by participating countries, which result in defined actions for the project-team or the participant country will be reported in these minutes. Other remarks by participants made during the meeting (for instance explanations of injury incidence, health care consumption or costprices) have been noted by the project-team and will be used in later stages of the project.

2. Availability of data on injury incidence and health care consumption

Objectives:

- To determine the availability of the incidence and health care consumption data;
- To determine the minimum sets and modules to be conducted per country.

Suzanne gives a presentation on the data on injury incidence and health care consumption per country (See attached sheets of presentation).

Decisions on Minimum sets and Modules for injury incidence:

- Extra modules will be created for ED incidence of intentional injury (Module IV) (or) and ED incidence of unintentional injuries (Module V). Data for these modules are available for Denmark, Netherlands, Norway, UK, Wales.
- Austria: A new extrapolation factor for ED-data will be delivered, without deviation for accident groups.
- Denmark: Is the source of the ED-data EHLASS in stead of the Injury Register? In the (Injury Register-data) EHLASS, probably data is available on intentional injury (Mod.III). Do cases in the NDR-datafile represent patients or admissions? Data on Traffic, Occupational, Violence, Selfmutilation and External cause (ICD-10) should be available. Claus and Anne Mette will check.
- Greece: HDR-data for Min.set II is probably available, but difficult to get. Nick will write a concept letter, which the project-team will send to the Greek Statistics Bureau. No separation of intentional or unintentional possible and injury groups are in fewer categories than the defined 39. Alternative: Greece can participate in Min.set II by analysing the admitted patients in EDISS (by extrapolating the EDISS-data).
- Italy: HDR-data for Mod.I is probably available. No external cause registration and only crude estimates of injuries treated in hospitals available. Alessio will check.
- Spain: ED-data for Min.set I and Mod.II probably available. Try to trace Spanish EHLASS-data, which includes occupational injuries. HDR-data from Spain will be more specific on traffic injury if

'FINA'-variable is included. Try to get a new copy of HDR data for 2000, including 'FINA'. Catherine will check.
- UK, England: It is doubted if Sports accidents are registered in HASS. LASS includes some home accidents (leisure which occur in home), but these accidents can also be registered in HASS. Double counting is suspected. Solution: new HASS/LASS data file excluding the doubles, or get separate data files with an identifiable code. The project-team will contact LöGD (EHLASS) if they know about the double counting. ED-data has to be extrapolated to the UK population (not the English population). Furthermore HASS and LASS can't be both extrapolated by the same factor, while LASS contains information of less hospitals than HASS. Ronan will supply UK-coverage population and check extrapolation factors for both systems.
- UK, Wales, The number of cases for AWISS is less than expected, probably because Sports-accidents are not included. Ronan will check the dataset and sent probably a new version.

Decisions on Minimum sets and Modules for health care consumption:
- Modules II and IV will be removed, while less than three countries have data.
- Module III will not be removed. Denmark, Spain and Wales will come up with statistics on total costs and drives of ambulance services (if possible, only for injury patients), in order to generate a common costprice for ambulance transport. These data will be combined with Dutch data on ambulance transport distributed by accident category.
- DRG/HRG should be regarded a separate module, since in most countries these cover inhospital days and medical procedures, but the components cannot be separated. Mind that DRG/HRG may cover different items in different countries. This should be checked. Also, the project team should come up with a definition of medical procedures.
- No separate module on ICU. Only Netherlands and Austria (and maybe Denmark) have information about ICU, but with a lot of missings.
- The EUROCOST model includes short-term medical costs. A document should be prepared on describing the possible treatment pathways (theoretical framework) through the healthcare system, and defining which parts are included in the EUROCOST model. Ronan (in consultation with Claus) will make a schedule of treatment procedures (admitted, follow-up, complications, etc.). Use IPP-study (comprehensive view) by Robert Bauer. Robert Bauer will sent this report.

3. Availability of data on cost prices

Objectives:
- To determine the availability of cost price data;
- To decide upon the potential use of common cost prices.

Willem Jan gives a presentation on availability of data on cost prices per country (See attached sheets of presentation).

Decisions on use of (common) cost prices:
- The volume unit 'Outpatient visits, outpatient days, outpatient DRG/HRG' will be skipped.
- A new volume unit 'Total hospital cost' based on DRG's' will be introduced. Denmark, Norway, Italy, UK, England have this information available. The project-team will investigate how DRG's are used in participating countries (which diagnoses and medical procedures are included and codified, and what is the quality of DRG-coding). The DRG's can be used to refine the total costs.
- The volume unit 'emergency/ambulance transport' stays included (See discussion agenda-item 2.).
- A common cost price will be used for countries not having information on cost prices, especially cost prices on hospital stay and inpatient medical procedures.
- The project-team will make a checklist to verify exactly which costunits are included in the total costs for inpatient days in hospitals, to increase the comparability of the countries. We will also

compare the costprices of the countries by partly be correct(ed)ing by using PPP (parchasing power parity), by which unit costs can be adjusted for differences in price levels among countries. Both outcomes will be compared with each other, to measure the validity of the costprices we have.
- We will once again take contact with EUCOMP/EUROSTAT persons to explore the availability of unit costs or data by which those can be estimated.
- Denmark: Probably information is available about costs for ED-visits and ambulance transport. Claus and Anne Mette will check.
- Greece: Costs for outpatient visits are the same as ED visits. Nick will fax the project-team tables with more specific cost information (already done!).

4. Preliminary results on injury incidence and health care consumption per country

Objectives:
- To show international differences in injury incidence and health care consumption;
- Discussion on observed differences and possible explanations.

Suzanne gives a presentation of the preliminary results on injury incidence and health care consumption per country (See attached sheets of presentation).

Decisions on observed differences and possible explanations:
- Add 'Late consequences of injury' under section Case selection.
- Interpretation of figures is influenced by scale of figures. It has to be taken into account while interpreting the results in figures. Confidence intervals will no be calculated/reported.
- Treatment at burncentres or specialised eyecentres does influence the data for eye injury and burns. Check per participating country. Which countries have eye- or burncentres, which decrease the incidence rates of these injurygroups?
- Exclude the word whiplash from tables with injury groups, because it is a combination of physical and psychological injury.
- Add 'multiple injury' as an explanation of primary diagnosis migration.
- Denmark: ED occupational injury incidence is probably influenced by mandatory reporting (labour inspection?) of occupational accidents. What are definitions? Claus will check this.
- Greece: ED-data on external causes has no information on pedestrians. Stellina will sent new/more detailed data.
- Ireland: the presented ED-data is probably influenced by the fact that one of the EHLASS-hospital is a paediatric hospital. Project-team will check this with Irish representatives. Also check if an agespecific extrapolationfactor is available. The numbers of LOS for Ireland look wrong. Check by project-team.
- Italy: can be included in tables/figures based on Mod.II if agegroups will be presented in seven groups.
- Netherlands: ED-data on other external causes can probably be delivered. Hidde will check this.
- Spain: The injury incidence of ED-data has been calculated with the wrong denominator (must be Barcelona city!). The injury incidence of HDR-data has been calculated with a wrong denominator (must be Spain). Check by project-team. Catherine will send right number of people in Barcelona city. ED-data on external causes can't be right. Catherine will sent new/more detailed data.

5. Enhancing the comparability of the data

Objectives:
- To show the major variations in registration practices between countries;
- To decide upon measures to enhance the comparability of the data used in the cost calculations.

Willem Jan gives a presentation on enhancing the comparability of the data (See attached sheets of presentation).

Decisions on enhancing the comparability of the data:
- A Common indicator of injury incidence should be:
  - Able to lead to comparisons between countries (injury rates or costs) and explain;
  - Extrapolate results to countries you do not have information of (whole of Europe).
- Two methods for the calculation of the costs:
  - Actual costs (for each country, with their own cost data);
  - Standardised cost for all countries, taking into account all differences, using one common health care system. Conclusions can than be drawn without arguments of different health care systems in the countries.
- We will use two indicators for the comparability of data based on type of injury; trivial and non-trivial injuries. These indicators will be used for ED- and HDR-data. Ronan and Claus will design these indicators. It will be studied if an other dimension (age) will be added to the indicators.
- Suggestion: Excluding superficial injuries makes all countries more comparable. The project-team will analyse this.
- Note: Be careful trying to level everything out! It is a fact that health care organisation and use do differs between countries.
- For the comparison of the quality of the extrapolation factors for all countries we will extrapolate the ED-data of all countries with (self made) extrapolation factors based on the deviation of age and sex in the HDR, to see which influence this has. After that, we will discuss which extrapolation factor we will use in final.
- Suggestion: after proportional distribution of cases coded as missing, changes between countries become smaller.
- Suggestion: add-up superficial injuries and open wounds injuries, since these seem to be complementary due to coding practices.
- Look at admitted and non-admitted patients for categories unknown or unspecified. This may give an indication for missing severe injuries.

6. Publications

Objective:
- To get agreement on the publications (including its authors) resulting from the project.

Introduction and explanation by Saakje.

- Authors of the final report: leading project-team + one participant per country most contributed to the project. The participating countries themselves should give input to the countries 'most contributed person'. Other country participants involved with the project (for instance institutes which provided data) will be mentioned in the acknowledgement.
- Send additional ideas for papers and contributions to already listed papers to the project-team before 10th of August 2003.
- Last draft versions of papers/articles will be send to participants who contributed substantially for approval (last review of results and conclusions).
- Collected data for this project can be used for other purposes, but only with a solid project-proposal and permission of all the participating countries. Proposed papers or projects should not interfere.

7. Final remarks and other issues
- In August 2003 an interim (progress) report will be send to the EC. The interim report will include: the presented annexes during this meeting, a brief summary of work in progress and an

accompanying letter. No adjustments in the annexes will be made for the interim report. The annexes in the interim report should only give the EC insight in the workload that has been done so far for this IPP project. Results in the annexes are 'preliminary" and this will be stated in the introduction.

- Every country will receive a mail (also these minutes) with requests for: new data of adjusted data, suggestions for enhancing data or presentation of figures and tables, additional questions and requests for analysis.
- Next Workshop: Spring 2004 in Spain (Barcelona or Madrid).

See ATTACHEMENTS in mail

Sheets presentation Suzanne Polinder (Agenda item 2)
Sheets presentation Willem Jan Meerding (Agenda item 3)
Sheets presentation Suzanne Polinder (Agenda item 4)
Sheets presentation Willem Jan Meerding (Agenda item 5)

Annex 9 Meeting EUROCOST phase 2 – Barcelona Workshop, 19-20 April 2004

Attending: Robert Bauer, Claus Falck Larsen, Stellina Kiosse, Alessio Pitidis, Catherine Pérez, Johannes Wiik, Ronan Lyons, Willem Jan Meerding, Suzanne Polinder, Saakje Mulder (chair), Hidde Toet (minutes)

Not attending: Anne Mette Tranberg Kejs, Tim McCarthy, Ed van Beeck

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1. General introduction

- Introduction of participants
- EUROCOST phase 2: Saakje describes the general objective of this meeting.

2. Injury incidence and the health care consumption: availability of data, methods and results

Objective: To inform the participants on the baseline model.

Suzanne gives a presentation on the availability of data and methods on injury incidence and health care consumption and presents some (See attached sheets).

Remarks:

- Attachment with overview of the day patients (percentage of total, distribution by injury and accident groups). It is not possible to check what percentage of the day cases are deceased patients. Add to text.
- Irish hospitals: one ED in country town with a large rural population and the other in a suburb of a small city with a mixed urban-rural population. Hospital catchment areas ill defined. Add to text.
- For the cost calculations the mean length of stay will be used. For the health care consumption comparison between countries we will also make a table with median LOS. (Use of a mean for average LOS with skew data is not useful. It is useful for the costs, but for the picture use a median).
- Rename “clinical incidence” into “hospital inpatient incidence (rate)”.

3. Costs of injury: availability of data, methods and results

Objective: To get agreement on the method used for calculating the costs of injury.

Suzanne gives a presentation on the availability of unit cost-data, methods of calculation injury costs and presents injury cost results (See attached sheets).

Remarks:

- Direct medical costs: make clear what is and isn’t included. Refer to ECOSA report: ‘Measuring the costs of injury in Europe : a review of the state-of-the-art’. Add to text.
- Describe exact definitions of the cost categories and add these in a paragraph. “Location costs” will -change into “nursing department costs” and “department costs” will change into “clinical staff costs”.
- For publishing we will also calculate the costs for 2004 by using the medical inflation rate (differs from normal inflation).
- Cost per patient: ICU remain excluded! We will mention in the discussion that that the cost per patient are probably underestimated because of .....
- Include transition probability by average per country in overall table of report as an indication.

- Give an example to explain how transition probabilities are calculated. Give an overview of the mean transition probabilities per countries.

4. International harmonisation of data

Objectives:
- To get agreement on the relevant variants of the baseline model;
- To inform the participants on the results of four variants.
- Discussion: other relevant variants available?, which variants are most relevant?

Willem Jan gives a presentation on six variants (See attached sheets).

Remarks:
- Comparison of mortality rate with admission rate is useful as a global check.
- Due to lack of information it is impossible to check all ED- and HDR-data on in- or exclusion of 1st visits and/or recovery visits.
- Change names of variant groups into positive ones. Change name of “non-trivial injuries” into “frequently admitted injuries”, “frequently admitted fractures” and “selective radiological verifiable fractures”.
- Hipfractures can be missed. Check ED-HDR on differences and add references to text. Johannes Wiik will check on Norwegian publication and Willem Jan Meerding will check on Dutch publication.
- Quantify the differences in variation due to variants and add tot text.
- Standard deviations of variants should be added to text.
- Conclusion: Variants 2, 3 en 6 can be used!

5. Results on the medical cost of injury in Europe

Objectives:
- To get agreement on the results to be presented in the final report.
- Discussion: other relevant information to be published?

Willem Jan gives a presentation on variants (See attached sheets).

Remarks:
- Better way of doing the EU average: comparison of country specific admissions rates, or standardised mortality data. Do not make a big effort for it.
- *Add extra tables/information: mean health expenditure per capita for all countries, cost per capita for injury groups and accident groups.*
- Discussion on in- or exclusion of new EU countries (since May 2004) in calculations: do not include, but make a note of it in the discussion section.

6. Discussion section in final report

Objectives:
- To get suggestions on the discussion section in the final report.
- Brainstorm and discussion: which issues should be taken into account?

Introduction and explanation by Saakje.

Remarks:
- Refer to introduction as to what we are suppose to do. Because of the availability of data: outpatient, GP, rehabilitation and ambulance transport costs are not included. Introduction: give a clear description of the setting; direct medical costs of ED’s and inpatient days in hospitals.
- Add that EUROCOST gives a conservative calculation of direct medical costs.

- Mention the gaps (per country) in our calculations.
- Add cost per injury.
- Present general results and discuss these based on country-specific data.
  - Mention that the prevention/treatment for elderly brings high costs. Show patientgroups with potential savings (female, >75 and lower extremity injuries).
- EUROCOST can be used as an indicator for priority setting.
- Investigate if the EUROCOST-model can be extended to EU-25, indirect medical costs or DALY's.
- Discussion: estimation of the total health care costs of injuries? No, this would implicate/suggest that it is very easy to calculate costs. This would seriously harm our work from the past period to present detailed estimations of costs.

7. Dissemination of the results from the project

Objectives:
- To get suggestions on how and what to disseminate by who of the results of EUROCOST phase 2.
- Public relations national and international
- Planned publications

Remarks:
- Press releases have to originate from the EUROCOST-group.
- First a central press release. After this press releases per country are possible.
- Core papers to be presented in order of appearance: a paper on methodological issues of EUROCOST, a paper on incidence results of EUROCOST-model, a paper on health care consumption and cost results of the EUROCOST-model.
- Comments from participating countries will be asked on these core-papers.
- No other papers can be published before these core-papers are published.
- Country contactpersons are responsible for handling request on data and modelresults.

8. Final remarks and other issues
- Last concept of final report to the to all participants at the begin of July 2004.
- Comments on concept of final report before the end of July 2004.
- The final report will be send to the EC at the end of August 2004.

See ATTACHEMENTS in mail

Sheets first presentation Suzanne Polinder (Agenda item 2)
Sheets second presentation Suzanne Polinder (Agenda item 3)
Sheets third presentation Willem Jan Meerding (Agenda item 4)
Sheets fourth presentation Willem Jan Meerding (Agenda item 5)