Injury, Int. J. Care Injured 46 (2015) 1930–1937

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Trends in incidence rate, health care consumption, and costs for patients admitted with a humeral fracture in The Netherlands between 1986 and 2012

Kiran C. Mahabier [a], Dennis Den Hartog [a], Joyce Van Veldhuizen [a], Martien J.M. Panneman [b], Suzanne Polinder [c], Michael H.J. Verhofstad [a], Esther M.M. Van Lieshout [a,*]

[a] Trauma Research Unit Department of Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands
[b] Consumer Safety Institute, Amsterdam, The Netherlands
[c] Department of Public Health, Erasmus MC, Rotterdam, The Netherlands

ARTICLE INFO

Article history:
Received 17 March 2015
Received in revised form 22 May 2015
Accepted 12 July 2015

Keywords:
Epidemiology
Incidence rate
Health care costs
Hospital costs
Productivity loss
Humeral fractures
Shoulder fractures
Proximal humerus
Humeral shaft
Distal humerus

ABSTRACT

Introduction: This study aimed to examine long-term population-based trends in the incidence rate of patients with a humeral fracture admitted to a hospital in the Netherlands from 1986 to 2012 and to give a detailed overview of the health care consumption and productivity loss with associated costs.
Materials and methods: Age and gender-standardised incidence rates of hospital admissions for patients with a proximal, shaft, or distal humeral fracture were calculated for each year (1986–2012). Injury cases, length of hospital stay (LOS), trauma mechanism, and operation rate were extracted from the National Medical Registration. An incidence-based cost model was applied to calculate costs for direct health care and lost productivity in 2012.
Results: Between 1986 and 2012 112,910 patients were admitted for a humeral fracture. The incidence rate increased from 17.8 in 1986 to 40.0 per 100,000 person years in 2012. Incidence rates of proximal fractures increased the most, especially in elderly women. Operation rates decreased in patients aged 70 years or older. The mean LOS decreased from nine days in 1997 to five days in 2012. The cumulative LOS of all patients in 2012 was 28,880 days of which 73% were caused by women and 81% were caused by patients aged 50 years or older. Cumulative medical costs in 2012 were M€55.4, of which M€43.4 was spent on women. Costs increased with age. Costs for hospital care contributed most to the overall costs per case until 70 years of age. From 70 years onwards, the main cost determinants were hospital care, rehabilitation/nursing care, and home care. Cumulative costs due to lost productivity were M€23.5 in 2012. Costs per case increased with age in all anatomic regions.
Conclusions: The crude number of patients admitted for a humeral fracture increased 124% in 27 years, and was associated with age and gender. Proximal fractures in elderly women accounted most significantly for this increase and most of the costs. The main cost determinants were hospital care and productivity loss.

Introduction

Between 1986 and 2008, over 3.7 million persons presented to an Emergency Department (ED) of a Dutch hospital with an upper extremity injury; this comprised 42% of all ED visits in The Netherlands [1]. The incidence rate of upper extremity injuries overall increased by 13%, from 970 in 1986 to 1,098 per 100,000 person years in 2008, showing these injuries put an increasing pressure to resources. Incidence rates and health care use were related both to age and gender. In 2007, the total health care costs of upper extremity injuries in The Netherlands amounted €290 million. Fractures were the most expensive injuries to treat among upper extremity injuries, as 76% of the overall costs of the treatment were spent on the treatment of fracture patients [1].

Given the sometimes permanent, disabling effect of humeral fractures, the societal burden associated with these injuries can be high [2–4]. Trauma affects persons of all ages and fractures in employed patients cause high costs for health care and lost

* Corresponding author at: Erasmus MC, University Medical Center Rotterdam, Trauma Research Unit Department of Surgery, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands. Tel.: +31 10 7031050; fax: +31 10 7032396.
E-mail address: e.vanlieshout@erasmusmc.nl (Esther M.M. Van Lieshout).

http://dx.doi.org/10.1016/j.injury.2015.07.025
0020–1383/

productivity [5,6]. In current economic distress, insight into trends in incidence and costs of individual patient groups is highly relevant. Population-based knowledge of trends in incidence gives directions for the allocation of health care services and for preventive measures. Age and gender dependency of humeral fractures at the proximal end versus the shaft versus the distal end have not been described in detail yet. Likewise, detailed evaluations of costs, gaining insight in the parameters that contribute most to the overall costs, such as costs for hospital stay, physical therapy and rehabilitation, nursing care and costs due to productivity loss are not available. Due to budgetary restraints and increasing health care costs, such economic analyses are gaining importance.

Therefore, this study aimed to examine long-term population-based trends in the incidence rate of patients with a humeral fracture admitted to a hospital in the Netherlands from 1986 to 2012 and to give a detailed overview of the associated costs for health care and lost productivity.

Methods

Data source

For this retrospective, epidemiological study data were collected for patients admitted to a hospital in The Netherlands with a humeral fracture in the period 1986–2012. In 2012 the Netherlands had 16.7 million inhabitants [7]. Injury cases were extracted from the National Medical Registration (LMR) of the Dutch Hospital Database (DHD), Utrecht, The Netherlands. The DHD collects hospital data of all hospitals in The Netherlands with a uniform classification system and has an almost complete national coverage (missing values <5%, except in 2007 12%). These figures were extrapolated by the Consumer and Safety Institute to full national coverage for each year. An extrapolation factor was estimated by comparing the adherence population of the participating hospitals with the total Dutch population in each year using the population data obtained from Statistics Netherlands [7,8]. Patients are included in the LMR for their main diagnosis at discharge, defined by the International Classification of Diseases (ICD) 9th and (since 2010) 10th revision [9]. Codes for humeral fractures are presented in Table 1. Injuries include both traumatic and pathologic fractures.

The study was exempted by the local Medical Research Ethics Committee Erasmus MC (No. MEC-2014-120).

Calculation of incidence rates

Age- and gender-specific incidence rates were calculated in 5-year age groups for each year of the study. In order to adjust for differences in the demographic composition over time, incidence rates were standardised for age (in 5-year age groups) and gender using a direct standardisation method, as previously described [1]. In short, the age- and gender-specific incidence rates per 100,000 person years were calculated based upon the Dutch mid-year standard population (calculated using the formula $((N_{1986} + N_{2012})/2)$.

Table 1
Humeral fractures classified in ICD-9 and ICD-10.

Fracture region	Fracture closed or open	ICD-9	ICD-10
Proximal	Fracture of upper end of humerus closed	812.0	S42.2
	Fracture of upper end of humerus open	812.1	S42.2
Shaft	Closed fracture of shaft or unspecified part of humerus	812.2	S42.3
	Fracture of shaft or unspecified part of humerus open	812.3	S42.3
Distal	Fracture of lower end of humerus closed	812.4	S42.4
	Fracture of lower end of humerus open	812.5	S42.4

Hospital length of stay, trauma mechanism, and surgical intervention

Data regarding hospital length of stay (LOS), trauma mechanism, and operation rate were extracted from the LMR database for 10-year age categories. In order to assess trends in LOS and trauma mechanism over time, mean LOS and percentage of trauma mechanisms were averaged over 5-year intervals from 1993 to 2012. For operation rates, data were averaged over a 5-year interval 2008–2012, as earlier data were not available.

Direct and indirect health care costs

The incidence-based Dutch Burden of Injury Model was used in order to measure and describe direct and indirect health care costs [1,10–12]. Patient numbers, health care consumption and related costs and costs for lost productivity were calculated using the LMR database and a patient follow-up survey on health care use [13]. Costs were measured from a societal perspective Patients were followed until two years after trauma. Medical costs included ambulance care, in-hospital care, general practitioner (G.P.) care, home care, physical therapy, and rehabilitation/nursing care. Health care costs were calculated by multiplying incidence and health care volumes with unit costs (*e.g.*, costs per day in hospital). Unit costs were estimated according to national guidelines for health care costing [14].

Costs for lost productivity were determined as described before [12]. Productivity costs were defined as the costs associated with production loss and replacement due to illness, disability, and premature death [15]. The absenteeism model was used in order to estimate costs for productivity loss for all patients aged 15–64 years. The friction cost method was used because healthcare needs are most substantial in the first year after injury for the majority of injuries [16].

Age-specific costs are presented in 10-year (medical costs) or 5-year (lost productivity) age groups for men and women separately. Data were averaged over 5-year intervals; 2002–2007 2008–2012, as earlier data were not available. Inflation has been taken into account.

Results

Incidence rates

During the study period 112,910 patients were admitted for a humeral fracture. The crude number of patients per year increased by 124%; from 2,790 in 1986 to 6,250 in 2012. The overall incidence rate increased from 17.8 per 100,000 person years (py) in 1986 to 40.0 per 100,000 py in 2012. The increase in incidence rate was largest for proximal fractures (20.0/100,000 py in 2012; +277%), but was also noted for shaft fractures (7.2/100,000 py in 2012; +132%) and distal fractures (12.8/100,000 py in 2012; +36%; Fig. 1A). The largest increase was seen for proximal fractures in women since the year 2002.

The incidence rates showed a bimodal distribution, with a clear peak at 5–9 years of age for both genders and a gradual increase from 50 years onwards in women and from 65 years onwards in men (Fig. 1B and C). Whereas the peak at 5–9 years has remained fairly stable during the study period (83.0/100,000 py for boys and 97.8/100,000 py for girls in 2012), the increase in the elderly has become more pronounced after the year 2002.

Fig. 1D and E show incidence rates for the different age groups and anatomical regions in 2012 for men and women separately. Until 15 years of age, humeral fractures were mainly located at the