Acta Orthop. Belg., 2020, **86**, 320-326

ORIGINAL STUDY

Health care and productivity costs for isolated tibia shaft fracture admissions in The Netherlands

Mandala S. Leliveld, Suzanne Polinder, Martien J.M. Panneman, Michael H.J. Verhofstad, Esther M.M. van Lieshout

From the Erasmus MC, University Medical Center Rotterdam, Trauma Research Unit Department of Surgery, Rotterdam, The Netherlands

The aim of this study was to provide a detailed overview of age and gender specific health care costs and costs due to lost productivity for hospital admitted patients with an isolated tibia shaft fracture in The Netherlands between 2008 and 2012. Injury cases and length of hospital stay were extracted from the National Medical Registration. Information on extramural health care and work absence were retrieved from a patient follow-up survey on health care use. Medical costs included ambulance care, in-hospital care, general practitioner care, home care, physical therapy, and rehabilitation/nursing care. An incidence-based cost model was applied to calculate direct health care costs and lost productivity in 2012. Total direct health care costs for all patients admitted with a tibia shaft fracture (n = 1,635) were €13.6 million. Costs for productivity loss were € 23.0 million. Total costs (direct health care and lost productivity) per patient were highest for men aged 40-49 years mainly due to lost productivity, and for women aged > 80 years, due to high direct medical costs.

Keywords : Tibia fractures ; healthcare costs ; productivity loss ; age ; gender.

INTRODUCTION

Fractures of the lower leg are one of the leading injuries that come with high health care costs *(4,6,7,11,13,15)*. As a consequence, these injuries may impose a considerable economic burden to society. Several studies assessed the costs of direct health care *(4,6,7,11,13,15)*, short-term disability *(4)* and absenteeism *(4)* for lower leg fractures, including tibia shaft fractures. However, most studies do not focus on tibia shaft fractures as separate entity *(6,11,15)*, and if they do, only specific age groups are accounted for *(7,13)*. Furthermore, health care consumption and lost productivity are age and gender dependent *(5,9,14)* and detailed evaluations of direct health care costs for tibia shaft fractures are lacking.

Population based information about parameters that contribute most to the overall costs of tibia shaft

- Mandala S. Leliveld[1],
- Suzanne Polinder[2],
- Martien J.M. Panneman[3],
- Michael H.J. Verhofstad[1],
- Esther M.M. van Lieshout[1]

[1] *Trauma Research Unit Department of Surgery, Erasmus MC, University Medical Center Rotterdam, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands.*

[2] *Department of Public Health, Erasmus MC, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands.*

[3] *Consumer Safety Institute, P.O. Box 75169, 1070 AD Amsterdam, The Netherlands.*

Correspondence : Esther M.M. Van Lieshout, Erasmus MC, University Medical Center Rotterdam, Trauma Research Unit Department of Surgery, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands. Phone: +31.10.7031050, Fax: +31.10.7032396.

E-mail : e.vanlieshout@erasmusmc.nl

No benefits or funds were received in support of this study. The authors report no conflict of interests.

fractures – such as costs for hospital stay, physical therapy, rehabilitation, nursing care, and economic production losses – are relevant for policy making. Therefore, the aim of this nationwide study was to provide an age and gender specified overview of the associated costs for health care use and lost productivity for patients admitted with a tibia shaft fracture.

PATIENTS AND METHODS

Data were collected for patients with a tibia shaft fracture who were admitted to a hospital in the Netherlands in the period 2008-2012 (population of 16.7 million in 2012 *(3)*). The methods are essentially the same as published before *(5,9,14)*. Injury cases were extracted from the National Medical Registration (LMR) of the Dutch Hospital Database (DHD, Utrecht, the Netherlands). The DHD collects its data in all hospitals nationwide with a uniform classification system (missing values <5%). Extrapolations were made to the national level 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 *(3,18)*. Patients are included in the LMR for their main diagnosis at discharge, which is generally the most severe injury, defined by the International Classification of Diseases (ICD) 9th and (since 2010) 10th revision *(2)*. Tibia shaft fractures are encoded in ICD-9 as 823.2 ('Fracture of shaft of tibia and fibula closed') and 823.3 ('Fracture of shaft of tibia and fibula open'), and in ICD-10 as S82.2 ('Fracture of shaft of tibia').

The study was exempted by the local Medical Research Ethics Committee Erasmus MC (No. MEC-205-218).

Data regarding hospital length of stay (HLOS) were extracted from the LMR database for 10-year age categories. In order to estimate the direct health care costs of injury and productivity costs due to work absenteeism the incidence-based Dutch Burden of Injury Model was used *(6,11,14,15)*. Patient numbers, health care consumption, and related costs were calculated using the LMR database and a patient follow-up survey on health care use *(16)*. Medical costs included ambulance care, in-hospital care, general practitioner (G.P.) care, home care, physical therapy, and rehabilitation/nursing care. Patients were followed until two years after trauma. Health care costs were calculated by multiplying incidence and health care volumes with unit costs (*e.g.*, costs per day in hospital). National guidelines for health care costing were used in order to estimate unit costs *(1)*. Data for were averaged over the 5-year interval (2008-2012).

Productivity costs were determined as described elsewhere *(6)*. Costs for lost productivity were defined as the costs associated with production loss and replacement due to illness, disability, and premature death *(8)*. Data were retrieved from the LMR database and a patient follow-up survey with questions relating to work absence, absence duration, and return to work *(10)*. The absenteeism model was used in order to estimate costs for productivity loss for all patients aged 15-65 years. The friction cost method was used because health-care needs are most substantial in the first year after injury for the majority of injuries *(17)*.

RESULTS

HLOS for patients with a tibia shaft fracture increased with age similarly for men and women (Figure 1). Mean HLOS for men was 5.1 (± 8.9) days, for women 6.0 (± 8.0) days.

The mean cost per case for direct health care costs were higher for women (€ 10,687) than for men (€ 7,073 ; Table I). Cost per case in men increased with age, which was mainly attributable to the rise in costs for revalidation and nursing care (Figure 2A). Hospital related costs predominated in younger ages. Cost per case in women also increased with age (Figure 2B). From the age of 70 years and older, costs for rehabilitation and nursing care were higher than for hospitalization in women. For men, the annual direct health care costs (calculated by multiplying cost per case with incidence) were € 7.5 million (Table I). These costs were lowest in the youngest age group (0-9 years ; € 309,311) and in the highest age group (€ 134,258 ; Figure 2C). Costs were highest between the age of 10 and 19

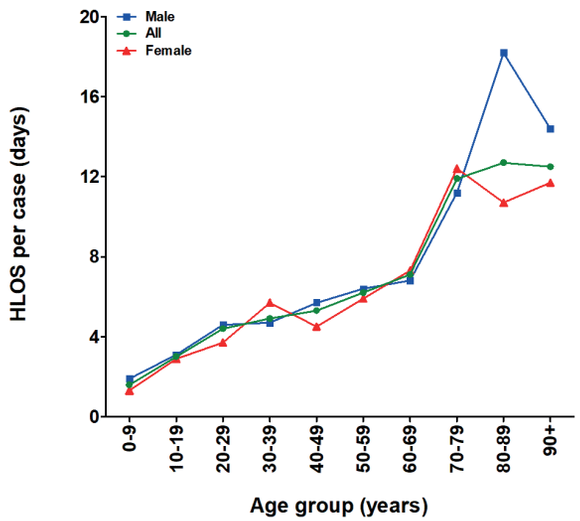

Figure 1. — Age and gender related hospital length of stay due to a tibia shaft fracture. Hospital length of stay increased with age for both genders equally.

years (€ 1.25 million) and gradually decreased with age.

For women, the annual direct health care costs were € 6.0 million (Table I). The lowest costs were seen in the youngest age group (0-9 years ; € 149,065). Annual costs were not as age dependent in women as in men, which is attributable to the incidence peak in elderly women. Highest costs were seen for women aged 80-89 years (€ 1.45 million ; Figure 2D).

Between the age of 15 and 65 years 73% was unable to work due to their sustained tibia fracture. Mean work absence was 89±5 days, which was unrelated to gender and age (Figure 3A). Mean costs per case due to productivity loss were € 16,523 for men and € 9,326 for women and showed a comparable increase in both genders until the age

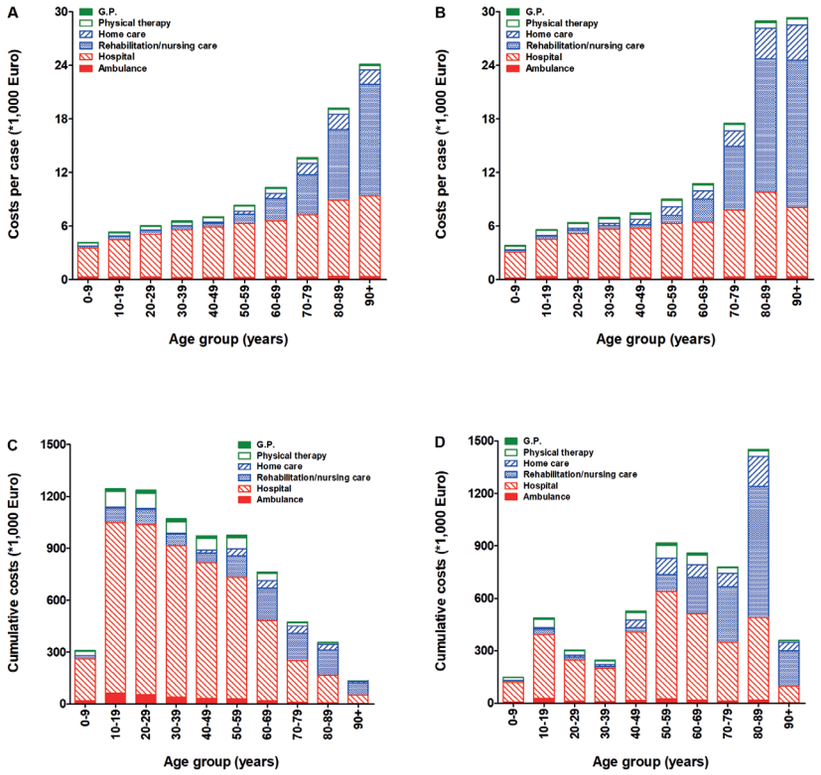

Figure 2. — Age-related cost per case (A, B) and total costs (C, D) due to tibia shaft fractures in males (A, C) and females (B, D). A : Cost per case in men increased with age, which was mainly attributable to the rise in costs for revalidation and nursing care. Hospital related costs predominated in younger ages. B : Cost per case in women also increased with age. From the age of 70 years and older, costs for revalidation and nursing care out were higher than for hospitalization. C : Total costs (cost per case*incidence) in men were lowest in the youngest age group (0-9 years). From the age of 10 years and onwards total costs gradually decreased. Hospital related costs were the major component of the overall total costs in men. D : Total costs (cost per case*incidence) in women were lowest in the youngest age group (0-9 years). Although not as apparent as in men, costs seem to increase with age in women too.

Table I. — Direct and indirect costs per case and total costs by gender

	Cost determinant	Male (n=1,066)	Female (n=569)	Total (n=1,635)
Direct costs	**Ambulance care**			
	Cost/case (€)	264	277	268
	Total cost (€)	280,941	157,553	438,493
	Hospital care			
	Cost/case (€)	5,142	5,788	5,367
	Total cost (€)	5,478,606	3,295,916	8,774,522
	Rehabilitation/Nursing care			
	Cost/case (€)	940	2,944	1,638
	Total cost (€)	1,001,444	1,676,696	2,678,140
	Home care			
	Cost/case (€)	187	932	446
	Total cost (€)	199,224	530,602	729,826
	G.P. care			
	Cost/case (€)	97	116	104
	Total cost (€)	103,759	66,061	169,820
	Physical therapy			
	Cost/case (€)	443	630	508
	Total cost (€)	472,537	358,667	831,204
	Subtotal direct costs			
	Cost/case (€)	7,073	10,687	8,332
	Total cost (€)	7,536,511	6,085,495	13,622,006
Indirect costs	**Productivity loss**			
	Cost/case (€)	16,523	9,326	14,017
	Total cost (€)	17,605,893	5,310,662	22,916,555
Total costs	**Total costs**			
	Cost/case (€)	23,596	20,013	22,348
	Total cost (€)	25,142,404	11,396,157	36,538,561

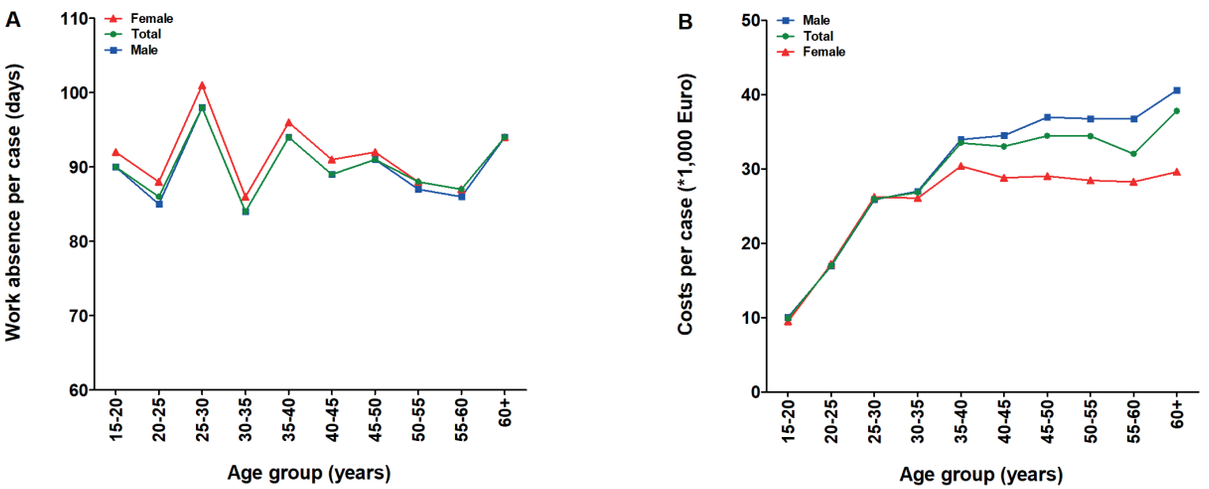

Figure 3. — Age-related work absence (A) and associated costs (B) for lost productivity in males and females. A : Work absence per case showed no evident correlation with age or gender. B : Costs per case for associated costs increased in men and women until the age of 40 years. Hereafter costs only increase for men.

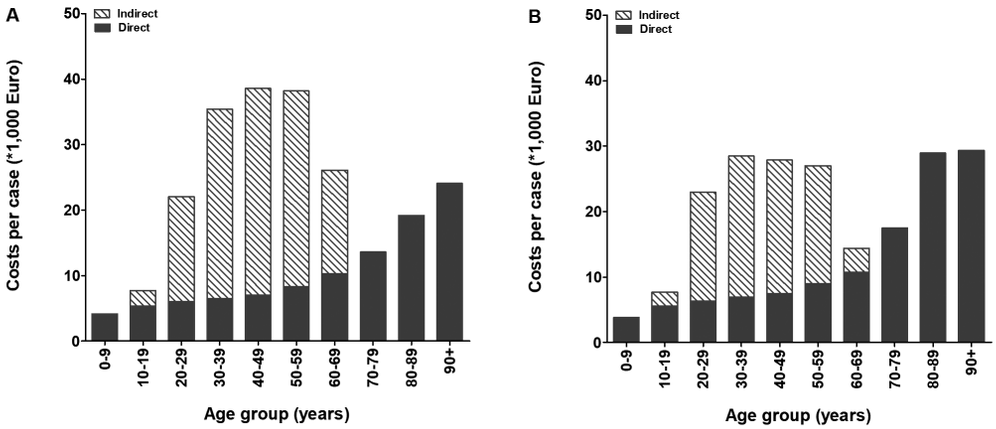

Figure 4. — Age-related direct and indirect costs in males (A) and females (B). A : Direct and indirect costs per case combined were highest for men aged 40-49 years. B : Direct and indirect costs per case combined were highest for women aged 30-39 years.

of 40 years. Hereafter these costs only increased in men (Figure 3B). Total costs due to productivity loss were € 17.6 million for men and € 5.3 million for women (Table I).

Annual direct health care costs for all patients admitted with a tibia shaft fracture in the Netherlands were € 13.6 million. Costs due to lost productivity for men and women were € 22.9 million. For men (all ages combined), mean costs per case for combined direct health care costs and costs due to lost productivity, were € 23,596. Of these costs, 70% was due to productivity loss (Table I). The highest costs per cases were for men between the age of 40 and 49 years (€ 38,569 ; Figure 4A). In women, the highest costs per case were seen between the ages 30 and 39 years (€ 28,473 ; mean € 20,013 for all ages combined) and 47% were due to lost productivity (Figure 4B). Noteworthy is that direct health care costs per case in women in the oldest age categories (80+ years) exceed the highest combined direct health care and lost productivity costs.

DISCUSSION

The aim of this study was to provide a detailed overview of age and gender related health care costs and costs due to lost productivity for patients with a tibia shaft fracture admitted to a hospital in The Netherlands. Productivity loss in middle aged men and health care consumption in elderly women accounted for a substantial share of health care costs for tibia shaft fracture admissions. These high costs are either due to a high incidence (men) or high costs per patient (women).

Previous studies showed that productivity costs due to work absenteeism generally are larger than health care costs *(12)*, as is the case in the current study. Mean costs per case due to productivity loss were € 16,523 versus € 7,073 for health care consumption in men. In women mean lost productivity costs were € 10,687 and mean health care costs € 9,326. A large American claims-based study analyzed both direct medical costs and utilization, as well as work absenteeism and short term disability in patients with long bone fractures between 2001 and 2008 *(4)*. The costs per case presented for absenteeism and short term disability were $ 5,166 (~ € 4,000) *(4)*, which is more than half of the amount we report. This discrepancy can be explained by the fact that the study by Bonafede *et al.* did not include presentism (i.e. the degree to which employees are present at work but not fully engaged or productive). They only captured lost productivity from absenteeism or short-term disability, resulting in a lower cost burden. Furthermore, the analysis in the American study was limited to 6 months post-fracture, whereas the population based study from Meerding *et al*. showed that hospitalized patients with a lower extremity fracture (excluding hip fracture) had a return-to-work rate of 64% at 5

months *(10)*. Lost productivity costs were therefore underestimated in the study from Bonafede *et al*. Finally, sociodemographic characteristics and educational level might differ from the Dutch study population.

The costs per case for direct health care for patients admitted with a tibia shaft fracture were € 8,332 in our study. These expenditures were comparable to the direct health care costs found by Bonafede *et al*. ($ 10,070 [~ € 7,750]). Likewise, health care consumption in the claims-based study from Ohsfeldt *et al.* in patients aged 45 years and older was valued $ 10,224 (~ (€ 7,900).

A major strength of the present study is that it is based on population based data on the costs of tibia shaft fractures. Health care resources that are most important for these fractures, such as hospital inpatient care and rehabilitation/nursing home care are analyzed. Also it provides age and gender specific costs which is important for potential allocation of health care resources. Furthermore, this study presents a comprehensive incidence-based cost model in which both health care and productivity costs were included *(15, 17)*.

An inherent limitation of a population-based survey is the lack of available clinical details of the patient and the injury – for example, comorbidities, the severity of the fracture or whether the fracture was open or closed. Overall, patients with tibia shaft fractures are relatively healthy *(4)* and therefore no major variation is expected in the current study population.

Patients are included in the LMR for their main diagnosis at discharge only, which is generally the most severe injury. This implies that both patients that sustained at least one more severe injury than a tibia shaft fracture and those treated in an outpatient clinic only, are missing. It cannot be appraised whether this shortcoming influences ratios between men and women and/or the young and elderly.

Clinical research on surgical and rehabilitation interventions for tibia shaft fractures that aim to lower the time off from work, such as minimally invasive surgical techniques or early active mobilization therapy, may have large economic potential, especially in middle aged men and women. For the elderly, where costs for rehabilitation and nursing care are highest, focus should be on (fall) prevention. Quicker discharge from hospital or nursing home will lower costs for those facilities, but likely put increased pressure on other health care sectors (and their costs). Due to a shift in health care use and associated costs, the efficiency of the health care system may not improve for the elderly.

CONCLUSION

In 2012, direct health care costs were € 13.6 million euro and costs due to lost productivity were € 22.9 million euro for patients admitted with a tibia shaft fracture. Both expenditures were age and gender dependent. Costs per patient were highest for women aged > 80 years, due to high direct medical costs and for men aged 40-49 years mainly due to lost productivity. Further research should focus on interventions to lower costs due to lost productivity in middle aged men and women and (fall) prevention in the elderly, thus reducing the costs of this injury both to the health care system and society.

REFERENCES

1. The Dutch Burden of Injury Model. Amsterdam, The Netherlands : Consumer and Safety Institute. 2010.
2. International Classification of Diseases (ICD). World Health Organization. 2010.
3. Bevolking. CBS Nederland. 2014.
4. **Bonafede M, Espindle D, Bower AG.** The direct and indirect costs of long bone fractures in a working age US population. *J Med Econ*. 2013 ; 16 : 169-78.
5. **De Boer AS, Schepers T, Panneman MJ, et al.** Health care consumption and costs due to foot and ankle injuries in the Netherlands, 1986-2010. *BMC Musculoskelet Disord*. 2014 ; 15 : 128.
6. **de Putter CE, Selles RW, Polinder S, et al.** Economic impact of hand and wrist injuries : health-care costs and productivity costs in a population-based study. *J Bone Joint Surg Am*. 2012 ; 94 : e56.
7. **Kilgore ML, Morrisey MA, Becker DJ, et al.** Health care expenditures associated with skeletal fractures among Medicare beneficiaries, 1999-2005. *J Bone Miner Res*. 2009 ; 24 : 2050-5.
8. **Koopmanschap MA, Rutten FF, van Ineveld BM, et al.** The friction cost method for measuring indirect costs of disease. *J Health Econ*. 1995 ; 14 : 171-89.
9. **Mahabier KC, Hartog DD, Van Veldhuizen J, et al.** Trends in incidence rate, health care consumption, and costs for patients admitted with a humeral fracture in The

Netherlands between 1986 and 2012. *Injury*. 2015 ; 46 : 1930-7.

10. **Meerding WJ, Looman CW, Essink-Bot ML, et al.** Distribution and determinants of health and work status in a comprehensive population of injury patients. *J Trauma*. 2004 ; 56 : 150-61.
11. **Meerding WJ, Mulder S, van Beeck EF.** Incidence and costs of injuries in The Netherlands. *Eur J Public Health*. 2006 ; 16 : 272-8.
12. **Nilsen P, Hudson D, Lindqvist K.** Economic analysis of injury prevention--applying results and methodologies from cost-of-injury studies. *Int J Inj Contr Saf Promot*. 2006 ; 13 : 7-13.
13. **Ohsfeldt RL, Borisov NN, Sheer RL.** Fragility fracture-related direct medical costs in the first year following a nonvertebral fracture in a managed care setting. *Osteoporos Int*. 2006 ; 17 : 252-8.
14. **Polinder S, Iordens GIT, Panneman MJM, et al.** Trends in incidence and costs of injuries to the shoulder, arm and wrist in The Netherlands between 1986 and 2008. *BMC Public Health*. 2013 ; 13 : 531.
15. **Polinder S, Meerding WJ, van Baar ME, et al.** Cost estimation of injury-related hospital admissions in 10 European countries. *J Trauma*. 2005 ; 59 : 1283-90 ; discussion 90-1.
16. **Polinder S, van Beeck EF, Essink-Bot ML, et al.** Functional outcome at 2.5, 5, 9, and 24 months after injury in the Netherlands. *J Trauma*. 2007 ; 62 : 133-41.
17. **van Beeck EF, van Roijen L, Mackenbach JP.** Medical costs and economic production losses due to injuries in the Netherlands. *J Trauma*. 1997 ; 42 : 1116-23.
18. **Van der Stegen R, Ploemacher J.** Discription of methods for statistics by diagnoses in time by using the LMR (1981-2005). The Hague : Statistics Netherlands (CBS). 2009.