Time intervals in the treatment of fractured femurs as indicators of the quality of trauma systems

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Objective To investigate the use of time intervals in the treatment of fractured femurs as indicators of the quality of trauma systems.
Methods Time intervals from injury to admission, admission to surgery and surgery to discharge for patients with isolated femur fractures in four low- and middle-income countries were compared with the corresponding values from one German hospital, an Israeli hospital and the National Trauma Data Bank of the United States of America by means of Student's *t*-tests. The correlations between the time intervals recorded in a country and that country's expenditure on health and gross domestic product (GDP) were also evaluated using Pearson's product moment correlation coefficient.
Findings Relative to patients from high-income countries, those from low- and middle-income countries were significantly more likely to be male and to have been treated by open femoral nailing, and their intervals from injury to admission, admission to surgery and surgery to discharge were significantly longer. Strong negative correlations were detected between the interval from injury to admission and government expenditure on health, and between the interval from admission to surgery and the per capita values for total expenditure on health, government expenditure on health and GDP. Strong positive correlations were detected between the interval from surgery to discharge and general government expenditure on health.
Conclusion The time intervals for the treatment of femur fractures are relatively long in low- and middle-income countries, can easily be measured, and are highly correlated with accessible and quantifiable country data on health and economics.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

According to the global burden of disease study of 2010, injury accounted for 10% of deaths worldwide and 11.2% of all disability-adjusted life years (DALYs).[1,2] Rising awareness among policy-makers of the burden of injury[3] has led to an increased need for easily quantifiable metrics to improve the allocation of resources for the treatment of injuries.[4–11] The intervals involved in the treatment of femur fractures – injury to admission, admission to surgery and surgery to discharge – are easily measurable and may be useful in evaluating the efficiency with which a trauma system treats an injured patient.

Since the poorest third of the world's population accounts for only 3.5% of all of the surgical procedures performed, there is clearly a large disparity in access to surgical care.[12,13] The annual incidence of injury-related deaths is also substantially higher in low- and middle-income countries than in high-income countries: 89 versus 51 per 100 000 inhabitants, respectively.[3] Injuries caused by motorized vehicles are currently the tenth leading cause of DALYs, are projected to be the third highest cause of DALYs by 2020[14–19] and are the leading cause of death among individuals aged 15–29 years.[1] In low- and middle-income countries, the rapid increase in industrialization – without concomitant improvements in infrastructure – is likely to lead to a rise in the incidence of injuries caused by motorized vehicles.

Resource allocation for the care of skeletal traumas differs both between and within countries.[20] The consequences of these differences are difficult to quantify because there is a general lack of access to the many parameters that would be needed to make a detailed assessment of patient care within trauma systems. New metrics to evaluate the efficiency and efficacy of trauma systems are required as aids in decisions on resource allocation.[4–9] A good indicator of the quality of care in a clinical environment must have relevancy, validity, reliability and feasibility.[21] The relevancy of an indicator depends on how well it measures the problems that are experienced in the provision of care. Validity is demonstrated via strong correlations with other measures of the current quality of care. Reliability and feasibility refer to the variation in measurements – both inter- and intra-observer – and the ease with which the indicator can be measured, respectively.

Femur fractures are typically high-velocity injuries that are associated with high rates of both short- and long-term disability (Table 1).[2,22,23] Unlike other fractures of the upper and lower extremities, which could occasionally be treated acceptably with splinting in non-hospital centres, operative management or traction is required for a good functional outcome after a femur fracture.[22–24] Skeletal traction, which typically involves having the patient lie in bed for up to 3 months, prevents most patients from working and places a large burden on the patient's family. In contrast, a patient may be ambulatory within a week of the operative management of a fractured femur by intramedullary nailing. Compared with traction, such nailing – which is now the standard treatment in high-income countries – allows a much faster return to normal functioning.[23–25] The intramedullary nailing of femur fractures has been shown to be cost-effective in low- and middle-income

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Table 1. **Femoral fractures and their disability weights**

Type of fracture	Disability weight[a] (95% CI)
Of neck of femur	
Short-term disability, with or without treatment	0.308 (0.205–0.439)
Long-term disability, with treatment	0.072 (0.047–0.105)
Long-term disability, without treatment	0.388 (0.261–0.532)
Of femur but not of neck of femur	
Short-term disability, with or without treatment	0.192 (0.121–0.280)
Long-term disability, without treatment	0.053 (0.035–0.079)

CI, confidence interval.
[a] Used to calculate disability-adjusted life years.[2]

countries and results in better patient outcomes than those seen with skeletal traction.[24] Unlike more lethal forms of trauma, most isolated femur fractures are seen and recorded by some form of care provider.

In the overall management of femur fractures, the time from injury to hospital discharge can be segmented into three main treatment intervals: injury to admission, admission to surgery and surgery to discharge. The initial injury to admission interval is representative of the presence and efficacy of pre-hospital emergency medical systems, such as ambulance services. Pre-hospital time has been reported as a valid quality indicator in other research articles but not specifically for patients with fractured femurs.[5,26] The admission to surgery interval is affected by in-hospital variables such as the availability of human resources and essential equipment and the hospital infrastructure.[27] The final surgery to discharge interval may be affected by medication availability, nursing care, rehabilitation and the post-operative availability of social services.[28,29]

This study proposes that the intervals from injury to admission, admission to surgery and/or surgery to discharge in the care of traumatic, isolated fractures of the femoral shaft can be good indicators of the general quality of musculoskeletal trauma services and can be validated as indicators against national economic and health system parameters, which are the best available data for such validation.

Methods

We reviewed the medical records of patients with isolated femur fractures who had received operative treatment in six tertiary trauma hospitals outside the United States of America. The hospitals were the Medicine Horschule Hannover (Hannover, Germany), the Komfo Anokye Teaching Hospital (Kumasi, Ghana), the Hadassah Medical Center (Jerusalem, Israel), the Moi Teaching and Referral Hospital (Eldoret, Kenya), the Bedford Orthopaedic Hospital (Mthata, South Africa) and the Muhumbili Orthopaedic Institute (Dar es Salaam, United Republic of Tanzania). These hospitals were chosen because each of them had a long-standing partnership with the University of California's Institute for Global Orthopaedics and Traumatology. The years investigated at each hospital depended on the records available.

Corresponding data for the United States – for the years 2002–2006 – were gathered from the United States National Trauma Data Bank.[30] Only data from patients with isolated closed femur fractures, an injury severity score of < 10 and an age of more than 18 years were included. An injury severity score is calculated as the sum of the squares of the three highest measurements on the abbreviated injury scale. We used an injury severity score of < 10 as an inclusion criterion because – as an isolated femur fracture is assigned a value of 3 on the abbreviated injury scale – any patient with an isolated femur fracture and no additional injury would be given an injury severity score of 9. Any additional injury would increase this score to at least 10.[31]

Each country providing data was categorized as low-, middle- or high-income according to the criteria of the World Bank.[32]

Data gathering from the hospitals

Information was gathered from patient charts, patient interviews or the hospital trauma registry – when available. The study protocol was approved by the institutional review boards at the University of California in San Francisco and at the study hospitals with such boards.

Data variables collected for each patient

The data collected for each patient were age, sex, mechanism of injury, type of pre-hospital transportation, type of initial management, duration of initial management, type of definitive management, whether surgery had been open or percutaneous, length of surgery, type of anaesthesia, implants used, implant source, surgical complications, mean time to the performance of the definitive surgical intervention and the time intervals between injury and hospital admission, admission and surgery and surgery and discharge.

Hospital, resource and country data

For each study hospital, the hospital administrative teams helped enumerate inpatient and emergency department beds, hospital beds dedicated to orthopaedic patients, hospital admissions per year, orthopaedic admissions per year, functioning operating rooms, fluoroscopy machines in use, functioning computed tomography and magnetic resonance imaging scanners available for use, orthopaedic procedures per year, qualified orthopaedic surgeons, qualified general surgeons, qualified anaesthesiologists, orthopaedic officers and physical therapists. The extent of each hospital's orthopaedic coverage – that is, whether such coverage was available 24 hours per day – was also recorded.

Statistical analysis

Student's *t*-tests were used to compare the mean intervals from injury to admission, admission to surgery and surgery to discharge that were recorded in low- and middle-income countries with those that were recorded in high-income countries. In these tests, the means for each study site were weighted according to the number of study patients from the site.

Attempts were made to validate the time interval data – as indicators of the quality of the trauma system – by measuring how well the intervals correlated with various development parameters of the country involved. The parameters investigated were: population; adult literacy; life expectancy; mortalities among infants and children aged less than 5 years; the modelled number of road traffic deaths; estimated mortality from road traffic accidents; per capita values for total and general government

expenditures on health; per capita and national values for the gross domestic product (GDP); the human development index; the Gini coefficient; the corruption index; out-of-pocket expenditure and money spent on private prepaid plans – as percentages of private expenditure on health; general government and private expenditures on health – as percentages of the total expenditure on health; and social security expenditure on health – as a percentage of general government expenditure on health.

Levels of correlation were evaluated by using the Excel software package (Microsoft, Redmond, USA) to calculate Pearson's product moment correlation coefficients.

Results

Overall, 4967 femur fractures – 4644 from the United States and 323 from other countries – met the inclusion criteria (Table 2). The included patients from the United States had a mean age of 38 years and 59% of them were male. Most (57%) of the included patients were the victims of road traffic accidents. In terms of mechanism of injury, mean age, use of intramedullary nailing and type of anaesthesia, the patients from high-income countries – Germany, Israel and the United States – were similar to those from low- and middle-income countries – Ghana, Kenya, South Africa and the United Republic of Tanzania. However, compared with a patient from a high-income country, a patient from a low- or middle-income country was significantly more likely to be male ($P = 0.019$) and to have undergone open nailing – rather than a percutaneous reduction ($P = 0.001$). The demographics, catchment areas and resource availability of the six study hospitals are summarized in Table 3. The internal resources of each hospital included in the study – taken as indicators of preparedness for surgery – are summarized in Table 4.

Time intervals

The intervals from injury to admission, admission to surgery and surgery to discharge were all longer in the low- and middle-income countries than in the high-income countries (Table 5). The relationships between each of the three types of intervals investigated and the corresponding country development parameters are summarized in Table 6.

There were strong inverse correlations ($P < 0.05$ for each) between the interval from injury to admission recorded in a country and that country's general government expenditure on health – as a percentage of total expenditure on health; social security expenditure on health – as a percentage of general government expenditure on health; out-of-pocket expenditure – as a percentage of private expenditure on health; and life expectancy. There were strong positive correlations ($P < 0.05$ for each) between the same time interval and private expenditure on health – as a percentage of total expenditure on health; the estimated annual number of road traffic deaths per 100 000 inhabitants; and the Gini coefficient.

There were strong inverse correlations ($P < 0.05$ for each) between the interval from admission to surgery and adult literacy, life expectancy, total expenditure on health per capita, government expenditure on health per capita, the human development index and GDP per capita. There were strong positive correlations ($P < 0.05$ for each) between the same time interval and the numbers of infant deaths per 1000 live births; deaths among children aged less than 5 years per 1000 live births; and the estimated annual number of road traffic deaths per 100 000 inhabitants.

There were strong inverse correlations ($P < 0.05$ for each) between the surgery–discharge interval, the number of infant deaths per 1000 live births, the number of deaths among children aged less than 5 years per 1000 live births, private expenditure on health – as a percentage of total expenditure on health, the modelled number of road traffic deaths, and the Gini coefficient. There were strong positive correlations ($P < 0.05$ for each) between the same interval and life expectancy, general

Table 2. **Patient characteristics, treatment and transport in the study hospitals**

Characteristic	Hospital					
	BOH[a]	MTRH[b]	MOI[c]	KATH[d]	HMC[e]	MHH[f]
Mean age, years (IQR)	37 (24–49)	43 (30–52)	34 (26–37)	39 (26–45)	40 (23–55)	44 (24–51)
Patients investigated, no.	46	61	65	67	40	44
Males, %	88	83	88	70	69	61
With open fractures, %	29	7	2	6	23	19
Injured in road traffic accident, %	54	67	91	88	74	61
Treated by intramedullary nailing, %	84	100	100	50	87	94
With open reduction and internal fixation with nail, %	100	100	97	96	34	8
Most common						
Anaesthesia for surgical procedure (%)	Regional (59)	General (100)	General (56)	Regular (70)	General (100)	General (100)
Implant type (%)	IM nail (97)	SIGN nail (100)	SIGN nail (100)	Plate (66)	IM nail (87)	IM nail (94)
Implant source	Government	Donation	Donation	Patient	Government	Government
Transport to hospital (%)	MEMS (61)	Private (50)	Private (94)	NA	MEMS (100)	MEMS (100)

BOH, Bedford Orthopaedic Hospital; HMC, Hadassah Medical Center; IM, intramedullary; IQR, interquartile range; KATH, Komfo Anokye Teaching Hospital; MEMS, mobile emergency medical service; MHH, Medicine Horschule Hannover; MOI, Muhumbili Orthopaedic Institute; MTRH, Moi Teaching and Referral Hospital; NA, not available; SIGN, Surgical Implant Generation Network.

[a] Mthata, South Africa.
[b] Eldoret, Kenya.
[c] Dar es Salaam, United Republic of Tanzania.
[d] Kumasi, Ghana.
[e] Jerusalem, Israel.
[f] Hannover, Germany.

government expenditure on health – as a percentage of total expenditure on health – and social security expenditure on health – as a percentage of general government expenditure on health.

Discussion

This study evaluated whether the intervals between the main stages in the treatment of an isolated femur fracture could be used as indicators of the quality of the clinical process in trauma systems. Indicators of clinical quality need to be well defined, related to optimal patient care, feasibly measured, and able to show improvement.[21] The time intervals that we investigated met all of these criteria. There were significant differences – in the timing of the treatment of femur fractures – between the trauma systems in high-income countries and those in low- or middle-income countries. The three types of time interval studied appeared to be valid quality indicators – since each type correlated with several variables related to the allocation of health-care resources. They could be reliably and easily measured – with the minimal use of resources – even in low-income countries.

The interval from injury to admission is a useful tool for examining one of the major defining variables in trauma survival: the time it takes to reach a hospital. In trauma, the general goal is to have the patient assessed within the first hour post-injury – the so-called "golden hour".[34] Pre-hospital time has been examined in various forms for other traumatic injuries in previous studies.[5,7,10,26] It has been shown that – for high-velocity trauma – the earlier a patient receives initial treatment, the better the outcome.[34–36]

The longest times from injury to admission occurred in hospital systems in low-income countries that did not have adequate resources available for the initiation of emergency medical services in the field. In Kenya and the United Republic of Tanzania, for example, patients were more likely to be transported to the hospital via a privately owned car or taxi (50% of Kenyan patients and 94% of the Tanzanian) than by emergency medical services. In a previous study in Kenya, it was reported that trauma patients were transported to the hospital by individuals who had witnessed their injury – so-called "good Samaritans" (76%), family or

Table 3. **Demographics, catchment areas and funding sources pertaining to the study hospitals**

Characteristic	Hospital					
	BOH[a]	MTRH[b]	MOI[c]	KATH[d]	HMC[e]	MHH[f]
Population of city of location	120 000	193 830	4 000 000	1 468 609	750 000	520 966
Population of city and any suburbs	700 000	2 000 000	4 000 000	3 612 950	1 000 000	1 128 543
Estimated population of catchment area	4 000 000	13 000 000	4 000 000	3 612 950	1 000 000	1 128 543
Source of hospital funding	Government	Government	Government	Government	Charity	Government
Source of MEMS funding	Government	None	None	None	Government	Government
Study year or years	2010	2010	2010	2010–2011	2005–2010	2004–2010

BOH, Bedford Orthopaedic Hospital; HMC, Hadassah Medical Center; KATH, Komfo Anokye Teaching Hospital; MEMS, mobile emergency medical service; MHH, Medicine Horschule Hannover; MOI, Muhumbili Orthopaedic Institute; MTRH, Moi Teaching and Referral Hospital.
[a] Mthata, South Africa.
[b] Eldoret, Kenya.
[c] Dar es Salaam, United Republic of Tanzania.
[d] Kumasi, Ghana.
[e] Jerusalem, Israel.
[f] Hannover, Germany.

Table 4. **Internal resources of the study hospitals, indicative of preparedness for surgery**

Characteristic	Hospital					
	BOH[a]	MTRH[b]	MOI[c]	KATH[d]	HMC[e]	MHH[f]
Annual no. of admissions	3250	34 582	6681	29 590	84 372	54 628
No. of C-arm fluoroscopes	1	1	3	2	4	4
Other imaging available	None	CT	CT and MRI	CT and MRI	CT and MRI	CT and MRI
Annual no. of surgeries	NA	3000	2181	4888	NA	3000
Estimated mean travel distance for a patient, km	40	100	600	100	20	25
No. of full-time, certified or qualified staff						
Orthopaedic surgeons	2	5	12	5	34	11
Anaesthesiologists	2	6	5	NA	74	35
Orthopaedic emergency department active 24 h per day?	Yes	Yes	Yes	Yes	Yes	Yes
Orthopaedic theatre available 24 h per day?	No	No	Yes	Yes	Yes	Yes
Average annual salary of orthopaedic surgeon (US$)[g]	NA	24 000	12 000	25 000	80 000	60 507

BOH, Bedford Orthopaedic Hospital; CT, computed tomography; HMC, Hadassah Medical Center; KATH, Komfo Anokye Teaching Hospital; MHH, Medicine Horschule Hannover; MOI, Muhumbili Orthopaedic Institute; MRI, magnetic resonance imaging; MTRH, Moi Teaching and Referral Hospital; NA, not available; US$, United States dollars.
[a] Mthata, South Africa.
[b] Eldoret, Kenya.
[c] Dar es Salaam, United Republic of Tanzania.
[d] Kumasi, Ghana.
[e] Jerusalem, Israel.
[f] Hannover, Germany.
[g] Estimated for the surgeon's first year after training.

friends (16%) or the police (6%).[37] Private expenditure on health as a percentage of total expenditure on health – which was significantly positively correlated with the interval from injury to admission – is a measure of the private sector contribution to total spending on health care. If private expenditure on health as a percentage of total expenditure on health is high, the government funding available for mobile emergency medical services is likely to be lower and the interval be-

Table 5. **Time intervals involved in the treatment of femur fractures, by hospital/databank**

Data source	Mean interval in days (IQR)		
	Injury to admission	Admission to surgery	Surgery to discharge
Low- or middle-income country			
BOH[a]	16.71 (4.50–25.00)	15.38 (7.25–22.5)	9.07 (6.00–10.50)
MTRH[b]	5.07 (0.00–0.00)	7.37 (2.75–9.25)	7.95 (4.00–10.00)
MOI[c]	2.63 (0.00–1.25)	3.80 (0.00–4.00)	3.19 (1.00–2.00)
KATH[d]	1.71 (1.00–2.00)	20.30 (11.00–25.00)	11.46 (6.00–12.00)
Mean for four hospitals	6.53 (NA)	11.71 (NA)	7.92 (NA)
High-income country			
HMC[e]	0.01 (0.00–0.00)	2.00 (0.00–2.00)	11.29 (6.00–11.00)
MHH[f]	0.03 (0.00–0.00)	3.89 (0.00–6.00)	18.53 (10.00–20.00)
NTDB	0.22 (0.00–0.00)	0.60 (0.00–1.00)	8.65 (0.00–2.00)
Mean for two hospitals and NTDB	0.09[g] (NA)	2.16[g] (NA)	12.82[h] (NA)

BOH, Bedford Orthopaedic Hospital; CT, computed tomography; HMC, Hadassah Medical Center; IQR, inter-quartile range; KATH, Komfo Anokye Teaching Hospital; MHH, Medicine Horschule Hannover; MOI, Muhumbili Orthopaedic Institute; MTRH, Moi Teaching and Referral Hospital; NA, not applicable; NTDB, United States National Trauma Data Bank.

[a] Mthata, South Africa.
[b] Eldoret, Kenya.
[c] Dar es Salaam, United Republic of Tanzania.
[d] Kumasi, Ghana.
[e] Jerusalem, Israel.
[f] Hannover, Germany.
[g] Significantly less than the corresponding value for the data from low- and middle-income countries ($P < 0.001$).
[h] Significantly less than the corresponding value for the data from low- and middle-income countries ($P = 0.025$).

Table 6. **Coefficients for the correlations between time intervals involved in the treatment of femur fractures and country development indicators**

Indicator	Interval				
	Injury to admission	Admission to surgery	Surgery to discharge	Injury to discharge	Admission to discharge
Adult literacy	−0.08	−0.65*	0.45	−0.20	−0.25
Infant mortality rate	0.41	0.47*	−0.70	0.21	0.01
Child mortality rate	0.38	0.43*	−0.71	0.17	−0.03
Total expenditure on health per capita[a]	−0.43	−0.59	0.39	−0.41	−0.28
Total expenditure on health per capita[b]	−0.44	−0.71	0.18	−0.63	−0.59
Government expenditure on health per capita[a]	−0.53	−0.72	0.50	−0.58	−0.44
Government expenditure on health per capita[b]	−0.51	−0.73*	0.43	−0.59	−0.48
General government expenditure on health[c]	−0.58	−0.30	0.93*	−0.23	0.15
Private expenditure on health[c]	0.57	+0.30	−0.95*	0.21	−0.16
Social security expenditure on health[d]	−0.67	−0.50	0.87*	−0.41	−0.06
Out-of-pocket expenditure[e]	−0.38	0.23	0.13	−0.07	0.23
Private prepaid plans[e]	0.37	−0.25	−0.04	0.08	−0.21
Life expectancy	−0.66	−0.64*	0.60	−0.48*	−0.21
Modelled number of road traffic deaths	0.05	−0.27	−0.49	−0.30	−0.50
Estimated road traffic mortality rate	0.67	0.74*	−0.61	0.64	0.42
GDP	−0.30	−0.46	0.03	−0.41	−0.37
GDP per capita	−0.42	−0.62*	0.50	−0.38	−0.23
Human development index	−0.37	−0.70	0.44	−0.49	−0.44
Gini coefficient	0.82*	0.36	−0.79*	0.45	−0.01
Corruption index	−0.44	−0.56	0.63	−0.39	−0.22

GDP, gross domestic product; *$P < 0.05$.

[a] Calculated in United States dollars, at the average exchange rate.
[b] Calculated in purchasing power parity international dollars.
[c] As a percentage of total expenditure on health.
[d] As a percentage of general government expenditure on health.
[e] As a percentage of private expenditure on health.
Data obtained from the World Health Organization.[33]

tween injury and admission is likely to be relatively long (Table 5).

The Gini coefficient is commonly used to measure inequality of wealth within a population. A Gini coefficient of 0 indicates perfect equality – everybody with the same wealth – whereas a value of 1 indicates perfect inequality – a single individual having all the wealth.[38] In our study, the Gini coefficient was found to be positively correlated to the injury–admission interval but negatively correlated with the interval from surgery to discharge. This may be explained by the financial dynamics of the individual trauma and health-care systems. For example, when wealth is concentrated, governments are less likely to allocate resources for pre-hospital care and trauma cases become responsible for their own transport to a hospital. Additionally, when individual expenditure is high within a hospital, relatively impoverished patients are highly motivated to leave a hospital as soon as possible, to minimize the out-of-pocket payments for their hospitalization.

The interval between hospital admission and definitive treatment is typically affected by the personnel and hard goods available as resources, and by the payment system involved. In the present study, this interval was found to be positively correlated with private health expenditure as a percentage of total health expenditure – regardless of the type of health facility. Catastrophic personal expenditures on health care have been shown to cause impoverishment, especially when the patient is one of the main sources of household income. In low- and middle-income countries, the main income earners tend to be young adult males.[39–42] In Kenya and the United Republic of Tanzania, we found that patients and their families and friends had had to sell livestock and assets to pay for implants and hospital care. In a previous study in Kenya, 60% of the patients investigated had had to approach relatives for help in paying hospital bills, and 15% had had to pay "up front" before they had received any care.[37]

The data that we analysed showed a significant inverse correlation between the in-hospital resources that were available and the interval from admission to surgery. In low- and middle-income countries, most patients must pay for resources such as implants before surgery. The acquisition of the necessary implants can be a time-consuming process that delays surgical care. In most hospitals in high-income countries, however, implants and other in-hospital resources are readily available for patient care. In the hospitals in low- and middle-income countries that we investigated – even at the highest level of tertiary care, with 24-hour orthopaedic, emergency and surgical availability – in-hospital resources such as fluoroscopy equipment and anaesthesiologists were relatively scarce. In these hospitals, the absence or scarcity of fluoroscopy machines and other essential equipment meant that femoral nailing was performed as an open procedure much more often than in the study hospitals in high-income countries. Open reduction has become relatively rare in high-income countries because it is associated with higher rates of infection and non-union.[43–47] In Kenya and the United Republic of Tanzania, where most orthopaedic surgeons are concentrated in the large urban referral centres, peripheral hospitals seldom treat femur fractures surgically.

The interval from surgery to discharge represents the time spent in in-hospital recovery after surgical intervention. In the present study, there was a high positive correlation between this interval and both government and social security expenditures on health – as proportions of the total expenditure on health. Trauma patients often need subacute care before they are discharged and such care may not be readily available in areas with minimal resources. There were strong inverse correlations between the interval from surgery to discharge and private expenditure on health – as a percentage of total expenditure on health; the modelled number of road traffic deaths; and the Gini coefficient. It seems likely that a patient who is facing relatively high out-of-pocket expenditure for hospitalization will be particularly eager to be discharged.

Our study had several limitations. It was difficult to distinguish cases of isolated femur fracture from cases with multiple traumas that included femur fracture, and this may have resulted in selection bias and misclassification. We tried to minimize this problem by interviewing patients – when possible – and searching each patient's chart for other injuries or diagnoses. We studied far more patients from the United States than from any low- or middle-income country and the number of patients that we studied in each hospital in a low- or middle-income country was relatively small, although we still detected strong correlations. The hospitals that we investigated were all tertiary-care institutions and in most low- and middle-income countries there are many peripheral hospitals for each such tertiary-care institution. The peripheral rural hospitals are particularly likely to have low resources[27] and patients attending such hospitals with fractured femurs are more likely to be treated with traction than with intramedullary nailing. Our data probably therefore underestimate the mean length of time it would take a patient with a fractured femur to flow through a trauma system in a low- or middle-income country. Patients with femur fractures in peripheral hospitals may be in traction for many weeks, never receive any surgical intervention and have poorer outcomes – at a higher overall cost to the trauma system – than patients treated by intramedullary nailing.[24] In an evaluation of trauma care in a rural setting near Lake Naivasha, Kenya, it was found that half of the patients with fractured femurs were treated with traction or closed treatment.[48] Furthermore, we do not know if the hospital patients that we investigated received care elsewhere before presenting to a tertiary-care institution.

In conclusion, the intervals between injury and admission, admission and surgery, and surgery and discharge for patients with fractured femurs were all easily measurable and highly correlated to known, accessible and quantifiable country data on health and economics. The strengths of the observed correlations suggest that the intervals can be used as valid clinical indicators of the quality of trauma systems and as guides to resource allocation efforts. Further work will include a larger multicentre study as well as a study analysing the rate of capture of different traumatic injuries. ■

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ملخص

الفترات الفاصلة في علاج كسور عظم الفخذ كمؤشرات على جودة أنظمة الرضوح

الغرض تحري استخدام الفترات الفاصلة في علاج كسور عظم الفخذ كمؤشرات على جودة أنظمة الرضوح.

الطريقة تم مقارنة الفترات الفاصلة بين الإصابة إلى دخول المستشفى، وبين دخول المستشفى إلى الجراحة وبين الجراحة إلى الخروج من المستشفى، لمرضى كسور عظم الفخذ المعزولين في أربعة بلدان منخفضة ومتوسطة الدخل، بالقيم المقابلة من إحدى المستشفيات الألمانية وإحدى المستشفيات الإسرائيلية وبنك البيانات الوطني الأمريكي للرضوح بواسطة اختبارات ستيودنت الافتراضية الإحصائية. وتم كذلك تقييم الارتباطات بين الفترات الفاصلة التي تم تسجيلها في أحد البلدان وإنفاق هذا البلد على الصحة وإجمالي الناتج المحلي باستخدام معامل ارتباط بيرسون للنتاج الزمني.

النتائج بالنسبة للمرضى من البلدان المرتفعة الدخل، من الأرجح إلى حد كبير أن يكون المرضى من البلدان المنخفضة والمتوسطة الدخل من الذكور وأنه تم علاجهم بتسمير كسور عظم الفخذ المفتوحة وأن الفترات الفاصلة من الإصابة إلى الدخول إلى المستشفى، ومن الدخول إلى المستشفى إلى الجراحة، ومن الجراحة إلى الخروج من المستشفى لهؤلاء المرضى كانت أطول على نحو كبير. وتم اكتشاف ارتباطات سلبية قوية بين الفترة الفاصلة من الإصابة إلى دخول المستشفى والإنفاق الحكومي على الصحة، وبين الفترة الفاصلة من الدخول إلى المستشفى إلى الجراحة، وقيم إجمالي الإنفاق على الصحة للفرد والإنفاق الحكومي على الصحة وإجمالي الناتج المحلي. وتم اكتشاف ارتباطات إيجابية قوية بين الفترة الفاصلة من الجراحة إلى الخروج من المستشفى والإنفاق الحكومي العام على الصحة.

الاستنتاج الفترات الفاصلة لعلاج كسور الفخذ طويلة نسبياً في البلدان المنخفضة والمتوسطة الدخل، ويمكن قياسها بسهولة، كما أنها ترتبط بشكل كبير بالبيانات القطرية المتاحة والقابلة للتحديد الكمي عن الصحة والاقتصاديات.

摘要

股骨骨折治疗中将时间间隔作为创伤系统质量指标

目的 调查时间间隔在股骨骨折治疗中作为创伤系统质量指标的使用。

方法 通过学生氏 t 检验，将四个中低收入国家分离的股骨骨折患者从受伤到入院、从入院到手术、从手术到出院的时间间隔和一所德国医院、一所以色列医院和美国国家创伤数据库的相应值进行比较。还使用皮尔逊积差相关系数评价一个国家记录的时间间隔与该国卫生开支和国内生产总值 (GDP) 之间的相关性。

结果 相对于高收入国家，中低收入国家的患者是男性以及接受开放髓内钉治疗的可能性大得多，他们从受伤到入院、入院到手术和手术到出院的间隔也长得多。在从受伤到入院的时间间隔和政府卫生支出，以及入院到手术的时间间隔和总卫生支出人均值、政府卫生支出和国内生产总值之间发现显著的负相关性。从手术到出院的时间间隔和一般政府卫生支出之间发现显著的正相关性。

结论 在中低收入国家，股骨骨折治疗时间间隔相对较长，易于测量，并且与卫生和经济方面可用和可量化的国家数据具有高度相关性。

Résumé

Intervalles de temps dans le traitement des fémurs fracturés comme indicateurs de la qualité des systèmes de prise en charge des traumatismes

Objectif Examiner l'utilisation des intervalles de temps dans le traitement des fémurs fracturés comme indicateurs de la qualité des systèmes de prise en charge des traumatismes

Méthodes Les intervalles de temps de la blessure à l'admission, de l'admission à la chirurgie et de la chirurgie à la sortie des patients présentant des fractures du fémur isolées dans quatre pays à revenu faible et intermédiaire ont été comparés aux valeurs correspondantes d'un hôpital allemand, d'un hôpital israélien et de la Banque nationale des Données des Traumatismes des États-Unis d'Amérique à l'aide de tests *t* de Student. Les corrélations entre les intervalles de temps enregistrés dans un pays et les dépenses de santé et le produit intérieur brut (PIB) de ce pays ont également été évaluées à l'aide du coefficient de corrélation de Pearson.

Résultats Par rapport aux patients des pays à revenu élevé, les patients des pays à revenu faible et intermédiaire étaient significativement plus susceptibles d'être des hommes et d'avoir été traités par enclouage ouvert du fémur, et leurs intervalles de temps entre la blessure et l'admission, l'admission et la chirurgie et la chirurgie et la sortie étaient considérablement plus longs. De fortes corrélations négatives ont été détectées entre l'intervalle de temps entre la blessure et l'admission et les dépenses publiques de santé, et entre l'intervalle de temps entre l'admission et la chirurgie et les valeurs par habitant pour les dépenses totales de santé, les dépenses publiques de santé et le PIB. De fortes corrélations positives ont été détectées entre l'intervalle de temps entre la chirurgie et la sortie et les dépenses publiques générales de santé.

Conclusion Les intervalles de temps pour le traitement des fractures du fémur sont relativement longs dans les pays à revenu faible et intermédiaire. Ils peuvent être facilement mesurés et sont fortement corrélés aux données nationales accessibles et quantifiables sur la santé et l'économie.

Резюме

Временной интервал, необходимый для лечения перелома бедренной кости, как индикатор качества травматологических служб

Цель Исследовать применение временного интервала, необходимого для лечения перелома бедренной кости, как индикатора качества травматологических служб.

Методы Было произведено сравнение следующих временных интервалов: от получения травмы до приема пациента с изолированным переломом бедра врачом, от приема до проведения операции и от операции до выписки пациента в четырех странах с низким и средним уровнем дохода с соответствующими показателями немецкой больницы, израильской больницы и Национальной базы данных по травмам США с использованием критерия Стьюдента. Также оценивалось соотношение между зарегистрированными в определенной стране временными интервалами и расходами в этой стране на здравоохранение, а также валовым внутренним продуктом (ВВП), используя коэффициент корреляции смешанных моментов Пирсона.

Результаты По сравнению с пациентами из стран с высоким уровнем дохода, пациенты из стран с низким и средним уровнем дохода с намного большей вероятностью являлись мужчинами, лечение проводилось путем введения стержня в бедренный сустав, а временные интервалы от получения травмы до приема врачом, от приема до проведения операции и от операции до выписки были значительно более продолжительными. Значительная обратная корреляция была обнаружена между временным интервалом от получения травмы до приема пациента врачом и государственными расходами на здравоохранение, а также между интервалом от приема у врача до проведения операции и общими расходами на здравоохранение в пересчете на душу населения, государственными расходами на здравоохранение и ВВП. Значительная положительная корреляция была выявлена между временным интервалом от проведения операции до выписки пациента и общими государственными расходами на здравоохранение.

Вывод Временные интервалы при лечении перелома бедренной кости являются более продолжительными в странах с низким и средним уровнем доходов, их можно легко измерить, и они в значительной степени коррелируют с доступными и поддающимися количественному измерению данными в сфере здравоохранения и экономики в стране.

Resumen

Intervalos de tiempo en el tratamiento de la fractura de fémur como indicadores de la calidad de los sistemas traumatológicos

Objetivo Investigar el uso de intervalos de tiempo en el tratamiento de la fractura de fémur como indicadores de la calidad de los sistemas traumatológicos.

Métodos Por medio de pruebas t-Student se compararon los intervalos de tiempo desde la lesión al ingreso, del ingreso a la cirugía y de la cirugía al alta hospitalaria de pacientes con fractura de fémur aislada en cuatro países de ingresos bajos y medianos con los valores correspondientes de un hospital en Alemania, un hospital israelí y el National Trauma Data Bank de Estados Unidos de América. También se evaluaron las correlaciones entre los intervalos de tiempo registrados en un país y el gasto sanitario de ese país y el producto interno bruto (PIB) mediante el coeficiente de correlación del producto-momento de Pearson.

Resultados En comparación con los pacientes de los países de ingresos altos, era mucho más probable que los procedentes de países de ingresos bajos y medianos fueran varones y hubieran recibido tratamiento mediante fijación femoral abierta, y los intervalos desde la lesión al ingreso, del ingreso a la cirugía y de la cirugía al alta hospitalaria fueron mucho más largos. Se detectaron correlaciones negativas fuertes entre el intervalo desde la lesión al ingreso y el gasto público en salud, y entre el intervalo desde el ingreso hasta la cirugía y los valores per cápita de gasto total en salud, el gasto público en salud y el PIB. Se detectaron correlaciones positivas fuertes entre el intervalo desde la cirugía hasta el alta hospitalaria y el gasto público general en salud.

Conclusión Los intervalos de tiempo en el tratamiento de la fractura de fémur son relativamente largos en los países de ingresos bajos y medianos, se miden fácilmente, y tienen una alta correlación con los datos nacionales accesibles y cuantificables sobre salud y economía.

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