Predictors determining the duration of hospital stay among patients admitted with single fractures

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ABSTRACT

Introduction: Fractures pose a tremendous burden on the health care systems due to the prolonged duration of admission. Addressing various determinants that prolong hospital stay will help minimize the cost of treatment.

Objective: To study the determinants associated with the duration of hospital stay among patients admitted with fractures.

Methods: This was a retrospective observational study conducted at a private tertiary care hospital in Mangalore. A semi-structured proforma was used for collecting data from the medical records.

Results: The mean age of the 124 patients were 48.3±21.4 years. The majority were males [69(55.6%)] and were from urban areas [86(69.3%)]. Co-morbidities were present among 69(55.6%) patients. Out of the total patients, 8(6.4%) were alcoholics, and 10(8.1%) were tobacco smokers. The majority [50(40.3%)] had fracture of the femur. Five (4%) patients

developed complications during the post-operative period. Seventy-eight (62.9%) patients had medical insurance facilities.

The mean duration of hospital stay was 9.6±3.2 days among the patients. The mean duration of hospital stay among patients (n=115) before surgery was 2.4±1.6 days.

Increased pre-operative stay, increasing age, rural residential status, open type of fracture, and being given general anaesthesia for the operative procedure were significant predictors determining the period of stay among patients in the hospitals. Alcoholic status independently influenced the period of stay in the pre-operative period.

Conclusion: Both patient and treatment characteristics were important determinants associated with the duration of hospital stay. Targeting these predictors will help to manage in-patients better and shorten their duration of hospital stay.

Keywords: Fracture; In-patients; Duration of hospital stay; Determinants.

RESUMEN

Introduction

Fractures pose a tremendous burden on the health care systems due to the prolonged duration of admission at the hospitals and the cost involved with treatment.[1] Hence optimization of the duration of in-patient admission is essential to improve patient care. This requires a thorough understanding of its determinants.

Several determinants are known to influence the overall length of stay among fracture patients. Identifying and addressing these determinants can help reduce the in-patient admission period. This would reduce the overall cost of care, thereby improving patient satisfaction. It would also increase the availability of beds for the health service. This would be of particular interest under the current circumstances of scarcity in health care resources.[2] This study was hence done to identify the determinants associated with the duration of hospital stay among patients admitted with fractures.

Methods

This retrospective record-based observational study was conducted in February 2020 at a private tertiary care hospital in Mangalore. The Institutional Ethics Committee approved this study. Subsequently, permission to review the records was taken from the medical superintendent of the hospital. Records of patients with single bone fractures admitted at these hospitals during the preceding year (January 2019 to January 2020) were included in this study.

Patients aged ten years and below, those who had sustained multiple fractures simultaneously, those with pathological fractures, those who sustained periprosthetic fractures, those who died before discharge, and those who had a fracture of the same bone in the past were excluded.

The sample size was calculated using the formula $4\partial^2/d^2$. A previous regional study[3] had reported that the mean length of stay at the hospital among patients with various orthopaedic ailments was 16.7 days with a standard deviation of 13.9 days. Therefore at 95% confidence intervals and relative precision of 15%, the sample size was calculated as 124.

A semi-structured proforma was used for data collection. It was content validated with the help of a subject expert. Data regarding socio-demographic variables, type of fracture sustained, triage level, American Society of Anesthesiologists (ASA) classification, co-morbidities, fracture management, type of anaesthesia given during the operative procedure, complications developed during the post-operative period, duration of stay at the hospital and blood investigation findings were noted down by the investigators. No personal identifiers were used while extracting the information from the medical records. Alcohol consumption status and tobacco smoking status of the patients were determined based on their personal history details stated in the medical records.

The period of stay was defined as the duration between the date of admission and the date of discharge from the hospital.[3] Triage levels were categorized as "emergent" if the patient cannot wait till a space is available at the clinical area, "urgent" if the patient can wait for a short time till a space is available at the clinical area, and "non-urgent" if the patient can wait a long time till a space is available at the clinical area.[4] ASA classification was used to assess the patient's pre-operative health status and perioperative risks.[5] The haemoglobin level soon after the surgical procedure was considered to assess anaemia status during the post-

operative period. The normal reference blood values for sodium, potassium, bicarbonates, and chlorides were taken as 135 to 145, 3.5 to 5, 21 to 28, and 96 to 106 milliequivalents per litre, respectively. Body mass index (BMI) was categorized as per Asia-Pacific classification.[6]

Data were entered and analyzed using IBM SPSS for Windows version 25.0, Armonk, New York.

Descriptive statistics such as frequencies, proportions, medians, interquartile ranges, means, and standard deviations were calculated. The data normality was assessed using Kolmogorov-Smirnov test.

Univariate analysis was done using independent Student's t-test for dichotomous variables and one-way analysis of variance (with post hoc test) for categorical variables with more than two levels. Karl Pearson's correlation coefficient was used to measure the level of relation between linearly related quantitative variables.

Multiple linear regression analysis was done to analyze the adjusted effect of predictors determining the length of preoperative period and total length of hospital stay. Variables entered the model if the p value was less than 0.15. All statistical tests were two-tailed. The significance level was set at p value ≤0.05.

Results

The mean age of the patients was 48.3±21.4 years. The majority were males [69(55.6%)] and were from urban areas [86(69.3%)]. Of the total patients, 88(71.0%) were married, 29(23.4%) were unmarried, and 7(5.6%) were widower/widow. Ten(8.1%) were from below poverty line families. Type of occupation was known among 29 patients. Among them, 6(20.7%) were semi-professional/ professional, 8(27.6%) were semi-skilled or skilled workers, 5(17.2%) were unskilled workers, 4(13.8%) were homemakers, and 6(20.7%) were students. Delirium state at the time of admission was present among two patients. Glasgow Coma Scale was 13/15 in one patient.

Based on the ASA classification, one patient had a severe systemic disease (Grade III). Two(1.6%) and 52(41.9%) patients were in the emergent and urgent group triage status, respectively.

Co-morbidities were present among 69(55.6%) patients. Past history of surgery was present among 22(17.7%) patients (table 1).

Table 1 - Clinical presentation and comorbidities among patients with fractures

Characteristics	Number	Percentages
Body mass index (kg per sq. mtrs) (n=21)		
Underweight (<18.5)	1	4.8
Normal (18.5-22.9)	8	38.1
Overweight (23-24.9)	4	19.0
Obese (≥25)	8	38.1
Morbidities at the time of admission (n=124)#		
Loss of consciousness	2	1.6
Splenic laceration	2	1.6
Hematemesis	1	0.8
Co-morbidities (n=69)#		
Hypertension	39	56.5
Diabetes Mellitus	17	24.6
Ischaemic Heart Disease	8	11.6
Asthma	7	10.1
Ischaemic Heart Disease	8	11.6
Congestive cardiac failure	6	8.7
Chronic Obstructive Pulmonary Disease	6	8.7
Tuberculosis	5	7.2
Hyperthyroidism	4	5.8
Chronic kidney disease	3	4.3
Anaemia	2	2.9
Poliomyelitis	2	2.9
Aortic valve sclerosis	2	2.9
Others*	11	15.9
Past history of surgery (n=22)		
Hysterectomy	5	22.7
Hernia repair	4	18.2
Surgery for urinary incontinence	3	13.6
Lung surgery	2	9.1
Others**	8	36.4
Past history of fracture (n=14)		
Radial head fracture	4	28.6
Ulnar fracture	2	14.3
Femoral shaft fracture	2	14.3
Tibial fracture	2	14.3
Other fractures***	4	28.6

Multiple responses, *Neurofibromatosis 1, Urinary Incontinence 1, Giant cell tumour 1, Infective Endocarditis 1, Parkinsonism 1, Epilepsy 1, Pneumonia 1, Filariasis 1, Subclinical hypothyroidism 1, Sickle cell anaemia 1, Dengue fever 1, **Hemiarthroplasty 1, Orchidectomy 1, Amputation 1, Tubectomy 1, Lower segment caesarean section 1, Percutaneous nephrolithotomy 1, Prostatectomy 1, Myomectomy 1, ***Radial shaft fracture 1, Calcaneal fracture 1, Clavicular fracture 1, Humerus fracture 1.

Out of the total patients, 8(6.4%) were alcoholics, and 10(8.1%) were tobacco smokers.

Out of the 124 patients, the majority [50(40.3%)] had a fracture of the femur. Five(4%) patients developed complications during the post-operative period (table 2). Physiotherapy services were rendered to all the patients in the post-operative period.

Table 2 - Clinical features reported among patients with fractures

Characteristics	Number	Percentages
Site of fracture		
Femur	50	40.3
Radius	25	20.2
Humerus	16	12.9
Metatarsal	10	8.1
Tibia	10	8.1
Fibula	6	4.8
Ulna	3	2.4
Others*	4	3.2
Type of fracture		
Open	15	12.1
Closed	109	87.9
Side of fracture		
Left-sided	69	55.6
Right-sided	55	44.4
Type of surgery underwent for fracture (n=115)		
Closed reduction-Internal Fixation	44	38.3
Open reduction-Internal Fixation	40	34.8
Arthroplasty	28	24.3
Radial head excision	2	1.7
External fixation	1	0.9
Type of anaesthesia (n=115)		
General	40	34.8
Regional	75	65.2
Complications developed during the post-operative period (n=5)#		
Urinary retention	4	80.0
Bedsores	2	40.0
Electrolyte imbalance	2	40.0
Neuropraxia	1	20.0
Breathlessness and Psychological problems	1	20.0
Infections	1	20.0
Intensive Care Unit Admission during the post-operative period (n=124)	13	10.5
Need for Blood transfusion (n=124)	32	25.8
No. of units of transfused blood (n=32)		
One	19	59.4
Two	11	34.4
3 to 4	2	6.2

#Multiple responses, *Pubic ramus 1, Patella 1, Rib 1, Clavicle 1. (n=124)

As many as 52(41.9%) patients were anaemic at the time of admission (table 3).

Table 3 - Blood investigation findings among patients with fractures

Characteristics	Number	Percentages
Anaemia status at the time of admission (n=124)		
Present	52	41.9
Absent	72	58.1
Anaemia status during the post-operative period (n=115)		
Present	27	23.5
Absent	88	76.5
Serum electrolyte levels		
Sodium (n=75)		
Decreased	13	17.3
Normal	62	82.7
Potassium (n=69)		
Decreased	4	5.8
Normal	59	85.5
Increased	6	8.7
Chloride (n=63)		
Decreased	32	50.8
Normal	30	47.6
Increased	1	1.6
Bicarbonate (n=62)		
Decreased	24	38.7
Normal	35	56.5
Increased	3	4.8

Seventy-eight (62.9%) patients had medical insurance facilities.

The mean duration of hospital stay was 9.6±3.2 days among the patients. The median duration of stay was seven days (IQR 4, 13). In males it was seven days (IQR 5, 15) and in females, it was six days (IQR 3, 12).

There was no association of gender (p=0.076), marital status (p=0. 213), occupation (p=0.638), socio economic status (p=0.392), type of diet (p=0.202), BMI (p=0.886), past history of surgery (p=0.766), visceral injury sustained during trauma (p=0.367), triage status during admission (p=0.456), delirium at the time of admission (p=0.437), type of bone involved (p=0.246), right or left side of the body involved in fracture (p=0.239), serum sodium levels (p=0.359), serum bicarbonate (p=0.581), serum potassium levels (p=0.913) and serum chloride levels at the time of admission (p=0.856), haemoglobin levels of venous blood pre (p=0.372) and post (p=0.758) operatively, presence of comorbidities (p=0.516), complications suffered during post-operative period (p=0.493), admission in intensive care unit

after the operation (*p*=0.424) and need of blood transfusion (*p*=0.585) with duration of stay in the hospital.

The mean duration of hospital stay among patients (n=115) before surgery was 2.4±1.6 days. It was 7.1±3.2 days among patients who were alcoholic (n=8) in comparison to 2±1.4 days among non-alcoholics (n=107) (t=3.019, *p*=0.003). It was 6.0±2.0 days among patients who were tobacco smokers (n=10) in comparison to 2±1.3 days among non-smokers (n=105) (t=2.574, *p*=0.011).

The mean duration of hospital stay was significantly more among patients aged >60 years (*p*<0.001), those from rural areas (*p*=0.023), tobacco smokers and alcoholics (*p*=0.023), those without a past history of fracture (*p*=0.018), those with an open type of fracture (*p*=0.033) and among those who received general anaesthesia during the operative procedure (*p*=0.002) (table 4).

Table 4 - Distribution of mean duration of admission among patients with fractures

Characteristics	N	Mean duration of hospital admission	t value/F value	*p* value
Age (years)				
≤30	26	4.4±1.7		
31-60	59	8.8±3.5		
>60	39	14.4±6.2	22.26	<0.001
Gender				
Males	69	10.6±4.0		
Females	55	8.3±3.9	1.787	0.076
Place of residence				
Urban	86	8.6±3.1		
Rural	38	11.8±4.9	2.307	0.023
Tobacco smoking status				
Present	10	14.5±8.3		
Absent	114	9.1±3.3	2.307	0.023
Alcohol usage status				
Present	8	15.1±9.7		
Absent	116	9.2±4.3	2.305	0.023
Past history of fracture				
Present	14	6.8±3.8		
Absent	110	9.9±5.4	2.509	0.018
Types of fracture				
Open	15	13.3±6.3		
Closed	109	9.1±5.3	2.162	0.033
Type of anaesthesia received during the fracture management (n=115)				
General	40	10.8±4.3		
Regional	75	7.2±4.2	3.099	0.002
Insurance facility				
Present	78	11.2±5.6		
Absent	46	8.4±3.3	1.481	0.149

n=124

There was a significant correlation between the period of in-patient stay before surgery with the total duration of hospital stay among the patients (n=115) (r=0.738, *p*<0.001).

All variables significant at p value less than 0.15 were introduced into the multiple linear regression model as independent variables. These variables were then adjusted for the confounding effects of the other variables using this model. The multiple correlation coefficient "R" of the regression model was 0.832, indicating a good level of prediction of the dependent variable, namely the period of inpatient stay at the hospital. The independent variables in the model could explain 69.2% of the variability of the period of stay among the patients in this study. The independent variables in the model significantly predicted the dependent variable (F=22.653, *p*<0.001). The regression model was therefore a good fit for the data.

Increased preoperative stay, increasing age, rural residential status, open type of fracture, and being rendered general anaesthesia for the operative procedure were found to be significant predictors determining the period of stay among patients in the hospital in the multivariable analysis model (table 5).

Table 5 - Multiple linear regression analysis showing significant predictors of duration of hospital stay among the patients

Characteristics	Unstandardized coefficients		Standardized coefficients	t value	*p* value	95% CIs for B	
	B	SE	Beta	-	-	Lower limit	Upper limit
Constant	8.649	5.811		3.664	<0.001	12.523	42.087
Period of stay before operation (n=115)	0.901	0.096	0.606	9.241	<0.001	0.712	1.091
Age	0.11	0.02	0.442	5.614	<0.001	0.097	0.203
Gender	0.265	0.848	0.061	0.78	0.437	-1.387	3.185
Residential status	1.586	0.966	0.165	2.028	0.045	0.059	5.248
Tobacco smoking status	-2.34	1.745	-0.177	-1.937	0.056	-9.245	0.11
Alcoholic status	0.072	1.925	-0.123	-1.357	0.178	-8.599	1.612
Past history of fracture	-0.409	1.303	-0.057	-0.742	0.46	-4.829	2.2
Type of fracture	-1.555	1.348	-0.18	-2.285	0.024	-7.687	-0.544
Type of anaesthesia (n=115)	-1.039	0.959	-0.204	-2.503	0.014	-5.7	-0.66
Insurance status	0.051	0.968	-0.033	-0.376	0.707	-3.11	2.118

(n=124)

The coding given for categorical variables in this model was: 1 for female and 2 for male, residential status: 1 for urban and 2 for rural, tobacco smoker and alcoholic status as 1 if yes and 2 if no, past history of fracture as 1 if absent and 2 if present, type of fracture as 1 if open and 2 if closed, type of anaesthesia as 1 for general, 2 for regional, and insurance status as 1 if absent and 2 if present.

The two variables, tobacco smoking status and alcoholism status, were put in the multiple linear regression model to determine the predictor of patients' duration in the preoperative period. Only alcoholic status was associated after adjusting the confounding effect of tobacco smoking status among the operated patients (t=1.947, *p*=0.054, 95% CI -7.754, -0.065).

Discussion

Several factors influenced the length of stay among patients admitted with single fractures in this study. This information will be beneficial to planning health care services to reduce the length of hospital stay and, thereby the cost of treatment for the betterment of patient care.[7]

The mean length of hospital stay was found to be 9.6 days among in-patients in this study. This was much lesser than 15.6 days[7] and 30.8 days[8] reported in previous studies. Similarly, the median duration of hospital stay was 7 days in this study in comparison to 8 days reported in a Brazilian study.[9]

There was one patient in this study with a high ASA score. Such patients require a multidisciplinary management approach to minimize morbidity and mortality in the postoperative period.

The most common complication noticed among patients in this study in the post-operative period was urinary retention compared to decubitus ulcer formation reported in another study done in USA.[10]

The determinants associated with the duration of hospital stay among patients in this study were prolonged preoperative stay, increasing age, rural residential status, open type of fracture, and being rendered general anaesthesia for the operative procedure.

Patients above the age of 60 years are usually more likely to have multiple comorbidities and, therefore, require more time for preoperative optimization. Moreover, elderly

patients are more likely to be non-compliant for early/aggressive rehabilitation and, therefore, require more time to settle down. Patients from rural areas had increased length of stay, possibly because of poor transportation and local healthcare facilities. Therefore, they would wish to get their post-surgical wound care to be completed in the hospital before returning to their villages. So improving the transportation facilities and improving health care infrastructure in rural areas can possibly minimize their hospital stay. Open fractures would invariably require multiple surgeries, resulting in prolonged hospital stay among these patients. Patients who underwent general anaesthesia were also found to have a greater duration of hospital stay. Hence, the usage of modern anaesthetic devices/procedures like nerve stimulators and ultrasound-guided regional blocks for orthopaedic procedures is necessary to reduce hospital stay possibly.

Further, the duration of pre-operative stay was influenced by the alcoholic status among patients. This could be because alcoholic patients are advised to discontinue alcohol consumption before surgery. This might lead to alcohol withdrawal symptoms among these patients, resulting in delays incurred while managing these withdrawal symptoms before surgery. Identifying such high-risk patients during the preoperative period and minimizing the preoperative events with appropriate care will help to further reduce hospital stay.

In other studies, periods of inpatient stay among patients with fractures were seen significantly more among elderly,[8,11,12] females,[11] those with single marital status,[11] those using walking aids in the pre-operative period,[11] those with poor pre-existing activities of daily living,[7] high ASA score,[7,11,12] those with co-morbidities,[7,8,11,12] high preoperative Charlson Comorbidity Index,[13] increased duration of pre-operative period,[12] pre- and post-operative hemoglobin levels,[11] type of fracture,[12] need for blood transfusion,[11] presence of surgical site infections[9] and increased post-operative complications.[8,14]

This study identified both patient and treatment characteristics as independent predictors associated with the duration of hospital stay. Targeting these predictors will support care providers to develop appropriate treatment strategies and pathways to manage better and shorten the duration of hospital stay among patients admitted with fractures.

If these strategies are implemented, the duration of hospital stay can be reduced substantially and the cost of treatment accordingly. This will benefit by improving patient satisfaction and would also ensure bed availability at the hospitals.

Limitations

This was a retrospective single-centre study, and hence findings may not be generalizable to various settings. Furthermore, a prospective study involving interviewing the patients with periodic follow-up until their discharge would give a better accuracy and completeness of the information.

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Conflict of interest

None declared

Contributions of authors

Nitin Joseph: guarantor of this research work, concept, design, literature search, proforma preparation, revising the work critically for important intellectual content, manuscript preparation.

Atmananda Hegde: interpretation of data, revising the work critically for important intellectual content, manuscript editing.

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