

Short Communication

Can We Predict Length of Stay in Orthopaedic Rehabilitation?

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Abstract

Objectives

Rates of Joint Replacements and Neck of Femur (NOF) fractures are rapidly increasing due to an ageing population, thus placing an increasing demand on Rehabilitation Services.

Method

We conducted this retrospective study to investigate how pain at rest and on movement (documented on admission), type of operation (hip/knee replacement vs neck of femur fracture), age, gender and admission Functional Independence Measure (FIM) total score impacted on Length of Stay (LOS).

The cohort comprised all consecutive patients admitted to a Victorian Rehabilitation Hospital post Fractured NOF, Elective Total Hip and Total Knee Replacement surgery from 6 February 2012 – 6 June 2012.

The sample comprised 63 patients, predominantly female (54 or 85.7%), aged from 48-96 years (mean=74, sd=11.1). LOS ranged from 2-49 days (mean=17.2, sd=9.5). Multiple regression examined all 6 variables simultaneously. A contemporary variable selection method, known as LASSO regression, searched for key variables by attempting to shrink less important regression coefficients towards zero. The main outcome measure in this study length of stay. No interventions were used in this study.

Results

The full regression model of 6 variables accounted for 65.3% variation in LOS, however, LASSO regression selected 3 variables which accounted for 62.9% of variation in LOS, there being no statistically significant loss of performance with the smaller model. The 3 variables were admission FIM, operation type, and pain on movement. Increased admission FIM and knee or hip replacement were associated with shorter LOS, Neck of Femur fracture and increased pain on movement were associated with longer LOS.

Conclusion

Given the increased demand on rehabilitation beds, predicting length of stay using the 3 key markers identified in this study may help to optimise resource allocation.

List of Abbreviations: FIM – Functional Independence Measure; LASSO – Least Absolute Shrinkage and Selection Operator; LOS – Length of Stay; NOF – Neck of Femur Fractures; NRS – Numerical Rating Scale

Introduction

Rates of Joint Replacements and Neck of Femur (NOF) fractures are increasing due to an ageing population, thus placing an increasing demand on Rehabilitation Services.

This amount of hospital resource utilization calls for a greater understanding of the key factors associated with hospital Length of Stay (LOS) to ensure efficient provision of health services [1].

Currently, however, there is little research available to guide clinicians about factors influencing Length of Stay (LOS) in inpatient Orthopaedic

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Rehabilitation. The authors of this paper were unable to find research to guide which factors influence Length of Stay in this patient population.

A recent study looked at acute LOS following knee arthroplasty [2]. It was found that patients with a long LOS were older, had lower pre-operative range of knee flexion and had greater knee pain than patients with a short LOS. Our study extends the above study by predicting LOS in a Rehabilitation setting, as well as by employing contemporary methods of variable selection to identify key predictors.

Aim

To investigate how the variables listed in Table 1 impacted on Length of Stay (LOS) in inpatient Orthopaedic Rehabilitation via a retrospective study.

Methodology

The cohort comprised of all consecutive patients admitted to a Victorian Rehabilitation Hospital post Fractured NOF, Elective Total Hip and Total Knee Replacement surgery, from 6 February 2012 – 6 June 2012.

Information was obtained from case notes. Case notes were obtained from medical records.

Case notes were examined and information gathered on: documented Admission and Discharge FIM scores, documented pain score at the time of admission on movement and at rest using the Numerical Rating Scale (NRS). Information about Patients' demographic data namely age, gender and type of surgery was also gathered from case notes. During the 4 month period, 86 patients were admitted for rehabilitation post NOF surgery and Total Hip and Knee Replacement to the ward.

The outcome of interest in this study is Length of Stay in Patients admitted for Orthopaedic Rehabilitation. Six variables representing questions that should be routinely documented when a patient is admitted for rehabilitation post-surgery were chosen to see how they impacted on patients' LOS. The six variables consisted of age in years, female gender (yes/no), FIM total score on admission, whether hip/knee replacement or NOF fracture, 10-point pain score at rest and 10-point pain score on movement.

Of the 86 patients, two (2.3%) had a missing FIM score, 14 (16.3%) were missing pain at rest score, and 19 (22.1%) were missing pain at movement score. No other information was missing. Due to the small sample size, missing observations were handled using complete-case analysis. 63 (73.3%) patients had complete information on the six predictor variables listed above as well as length of hospital stay, and so formed the analytic sample. Patients were predominantly female (54 or 85.7%), and had undergone knee or hip replacement surgery (43 or 68.2%). The 63 patients were aged from 48-96 years (mean=74, standard deviation (sd)=11.1). LOS ranged from 2-49 days (mean=17.2, sd=9.5), admission FIM from 23-113 (mean=82.7, sd=18.4), pain at rest from 0-10 (mean=3.5, sd=2.6)

and pain on movement ranged from 0-10, (mean=6.6, sd=2.6).

Ethics approval for this study was granted by the Eastern Health Human Research Ethics Committee (LR 94/1112).

Statistical Analysis

Multiple regression was initially employed to examine all 6 variables simultaneously. Models containing a small number of variables are generally easier to interpret, yet often perform comparably to more complex models [3,4,5]. A contemporary variable selection method, known as LASSO (Least Absolute Shrinkage and Selection Operator) regression [5], was therefore used to search for key variables by attempting to shrink regression coefficients towards zero, down-weighting less important predictors. As a model developed on one sample of patients may not generalize well to another sample [5], LASSO implements a method of internal validation known as k-fold cross-validation to maximize generalizability of its models. The sample is randomly divided into 10 subsamples and models developed on 9/10 subsamples are tested on the held-out 10th subsample, with each subsample being held-out in turn [6]. LASSO has recently been applied in rehabilitation medicine [7,8,9].

All statistical analyses were performed using SAS version 9.4 (SAS Institute Incorporated, Cary, North Carolina, 2014).

Results

Table 1: Multiple regression of six clinically selected predictors of length of stay

Variable	coefficient	95% Confidence Interval	p value
Pain at rest	0.48	-0.29 to 1.25	0.22
Pain on movement	0.46	-0.33 to 1.25	0.25
Hip/knee replacement versus NOF fracture	-8.16	-12.11 to -4.21	< 0.001
Age in years	0.10	-0.07 to 0.27	0.25
Female gender	-3.89	-8.65 to 0.86	0.11
Admission FIM total score	-0.20	-0.31 to -0.10	< 0.001
constant	34.86		

As shown in Table 1, higher pain at rest and pain on movement, and older age were associated with longer length of stay, although none of these associations was statistically significant.

Conversely, having a hip or knee replacement rather than a NOF fracture surgery, being female and having a higher admission total Functional Independence (FIM) Score was associated with shorter length of stay, e.g., each 10-point increase in Admission FIM was associated with a reduced LOS of two days. All of the associations with shorter length of stay, apart from that for female gender, were statistically significant.

The full model of six variables accounted for 65.3% of the variation in LOS.

Three variables with non-zero regression coefficients were selected by LASSO, using cross-validation as described earlier. These three variables, type of operation, admission FIM and pain on movement together accounted for 62.9% of the variation in LOS, only slightly less than that accounted for by all six predictors. A likelihood ratio test¹⁰ showed that there was no statistically significant difference in overall performance between the six and three predictor models, ($p=0.24$).

Regression on log-transformed LOS, as employed in a recent knee arthroplasty study [2] accounted for 56.9% and 55.7% of the variation in LOS, for six and three predictor models respectively, the difference in overall performance not being statistically significant ($p=0.65$).

Conclusion

Given the increased demand on rehabilitation services, predicting length of stay using Admission FIM, Operation Type and Immediate Release Pain Medication and Pain on Movement may help optimize resource allocation and potentially ensure a smooth discharge planning process.

Our study focused on post-operative variables and included admission FIM scores after common orthopaedic procedures (hip/knee replacement and NOF fracture) most commonly requiring rehabilitation services [10]. Although confirmation in larger populations is required, length of stay in inpatient orthopaedic rehabilitation appears to be satisfactorily predicted using a simple model comprising three readily obtainable post-operative variables.

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