Identifying Factors Predicting Hospital Length-of stay and Receiving Prosthesis of Lower Limb Amputee Patients after Amputation Surgery- A Singapore Perspective

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Abstract

Ains: To identify predictors affecting total hospital length of stay(TLOS) and receiving lower limb prosthesis of amputees after surgery in a Singapore tertiary hospital.

Materials and Methods: A retrospective study of 96 patients was undertaken with various levels of lower limb amputation admitted to Singapore General Hospital (SGH) fromJanuary 2009 to December 2014.Patients were divided into two groups: 40-59 and 60 to 80 years old. We correlate clinical variables with TLOS and receiving prosthesis at 6 months from surgery.

Results: For the cohort of age 40-59, presence of IHD (B=22.4), wound infection (B=17.8) and those needing inpatient rehabilitation(B=36.8) correlate to increased TLOS. Premorbid independence (B=28.6) and presence of care-giver (B=23.3) led to a reduction of TLOS. For successful receiving of prosthesis at 6months from surgery, diabetes (B=0.69) and CRF (B=0.31)were negative predictors. In the older cohort, presence of care-giver (B=18.6) predicted shorter TLOS whereas those needing inpatient rehabilitation contributed to longer TLOS(B=25.61). Those who needed for inpatient rehabilitation had statistically significant higher chance of receiving prosthesis later(B=0.53).

Conclusion: IHD, wound infection and need for inpatient rehabilitation, premorbid independence and care-giver availability are important predictors of TLOS. For receiving of prosthesis at 6months, predictors include needing inpatient rehabilitation, diabetes and CRF.

Key words: **Amputation, rehabilitation, length-of-stay.**

Introduction:

More than one million people undergo a lower limb amputation annually as a result of diabetes[1]. Diabetic foot with infections (such as abscess, wet gangrene, osteomyelitis and necrotising fasciitis) and peripheral vascular disease with ischaemic lower limbs are common reasons leading to amputation[2,3]. Besides diabetes, these patients who undergo lower limb amputation often have other existing comorbidities such as hypertension, ischaemic heart disease and renal impairment. In Singapore, diabetes patients with renal disease and of Malay ethnicity had higher rates of lower limb amputations[4]. After a lower limb amputation, the loss of limb often leads to immobility and early mobilisation is crucial to prevent the deleterious effects of immobility[5]. There are tertiary hospitals in Singapore providing inpatient rehabilitation service to patients who undergo major lower limb amputations. In addition to physical therapy, managing residual limb volume and prevention of wound infection are important aspects of clinical care. Because of these stated reasons, amputees often have considerable length of stay in hospitals(LOS). In addition, it takes another few weeks or months before prosthesis prescription takes place[6]. In a tertiary hospital like Singapore General Hospital, most amputee patients stay several days to weeks in the hospital after surgery and several factors often affect the decision for discharge. As such, LOS increases and this in terms translate to increase medical costs. Morever, at several months after surgery, not all amputees receive and use lower limb prosthesis due to many reasons.

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It is therefore, important to establish in the acute phase, clinical factors influencing the LOS and receiving prosthesis as optimising of these factors may potentially reduce LOS and increase the likelihood of receiving prosthesis.

Aims and objectives: This is a retrospective study on amputee patients of two different age groups(40-59 and 60-80)in an acute inpatient rehabilitation prior to prosthesis fitting. We aim to identify factors predicting LOS and receiving prosthesis in these two specific group of amputees.

Materials and Methods:

Ninety-six amputee patients were admitted to SGH Department of Rehabilitation Medicine from January 2009 to December 2014. The patients came from the Department of Vascular Surgery and the Department of Orthopedic Surgery. Inclusion criteria were: i) Unilateral lower limb amputation , ii) patients age between 40 and 80 years, and iii) patients who continued their hospital admission from surgical department to the Department of Rehabilitation for the purpose of inpatient therapy. Exclusion criteria were: i) bilateral lower limb amputees, ii) patients under the age of 40 and above the age of 80, iii) patients who were discharged home from Department of Vascular Surgery and those who declined recommendation for inpatient rehabilitation. The indication for amputation was severe peripheral vascular disease or progressive diabetic foot infection with wet gangrene and sepsis which could not be conservatively treated with debridement and antibiotics. Referrals to rehabilitation unit from the vascular and orthopaedic teams were made within 48 hours after surgery. A rehabilitation physician on duty reviewed the referral cases and medically stable cases were transferred to inpatients rehabilitation.

Parameters collected in database include premorbid ambulation status, age, gender, ethnicity, comorbidities, presence of care-giver, wound infection of residual limb after surgery, and LOS; outcome measures include LOS and the sucessful recipient of prosthesis. As in previous amputee study where amputees of different age range were analysed individually[7], the age of our cohort were divided into 2 categories: 40 to 59 and 60 to 80 years of age. This cohort comprised of Chinese, Malay, Indian and other minority races. The comorbidities reviewed in this study included diabetes, hypertension, cerebrovascular accident, ischaemic heart disease, chronic renal impairment.TLOS was defined as the total number of days spent in the hospital. All the patients received a standard daily 2-hour therapy comprising 1 hour of physiotherapy(PT) and 1 hour of occupational therapy(OT).

After amputation surgery, one physiotherapist and one occupational therapist approached the patient daily for therapy from 2nd postoperative day. At 5th post-operative day, the rehabilitation physician on duty would review the patient and discuss with the respective physiotherapist and occupational therapists if each amputee patient needed inpatient rehabilitation in hospital. Factors considered include ability of individual amputee to cope with daily-activities-of-livings and ambulation safely within the home and community. Amputee would be offered additional hospital stay to enhance physical function and minimise burden of care. Patients were then transferred to the Department of Rehabilitation Medicine for further therapy. These patients were recorded as requiring inpatient rehabilitation services on data collection. Those who do not need inpatient therapy were discharged with outpatient therapy sessions. Wound inspection of the residual limb was done daily and those who developed wound infection requiring further treatment were recorded. Amputees with care-giver and those without were also recorded. Upon discharge, these amputees were followed up to six months after surgery to followup on those amputees who received prosthesis successfully and those who did not.

Statistical Analysis:

For both cohorts, all statistical analyses were performed using SPSS 18.0 with statistical significance set at $p<0.05$. Independence t-test was used for continuous variables, Chi-square test and one way ANOVA were applied to predictive factors for categorical variables. Linear regression analysis was applied for clinical variables correlating with outcomes TLOS and successful recipient of prosthesis.

Results:

There were 46 amputees between the age of 45 and 59 years old. The mean age of this cohort (45-59 years of age) was 52 ±SD 6 years. Fourteen (30%) were female while the remaining 32(70%) were male, 40(78%) were premorbid walking independently without aid. Six (22%) needed walking aid or wheelchair for ambulation; 44%(n=20) of the amputees had ischaemic heart disease(IHD), 95% (n=44) had diabetes(DM), 15%(n=7) had cerebrovascular accident(CVA), 70%(n=32) had hypertension(HTN)whereas 37%(n=17) had chronic renal failure (CRF). Thirty-three(72%) of this younger cohort had below-knee amputation(BKA), 20%(n=9) had above-knee amputation(AKA), 4%(n=2) had through-knee amputation(TKA) while the remaining were others (Rays or Symes amputation). Twenty-one

Table 1 : *Description of Demographics and Clinical Characteristics of the Two Groups of Amputee*

Clinical variables	Age(40-59), n=46	Age(60-80), n=50
Mean age (years)	52(±SD6)	70(±SD7)
Gender:		
Female	14(30%)	21(42%)
Male	32(70%)	29(58%)
Premorbid ambulation	40(78%)	25(50%)
Independent without aid		
Walking aid or wheelchair	6(22%)	25(50%)
IHD	20(44%)	26(52%)
DM	44(95%)	45(90%)
HTN	32(70%)	44(88%)
CRF	17(37%)	25(50%)
CVA	7(15%)	10(20%)
Amputation level:		
BKA	33(72%)	28(56%)
TKA	9(20%)	10(20%)
AKA	2(4%)	8(16%)
Others	2(4%)	4(8%)
Wound infection	20(44%)	17(34%)
Care-giver	21(46%)	33(66%)
Inpatient rehabilitation services	21(46%)	17(34%)
TLOS(days)	45(±SD 31)	40(±SD 29)

AKA: above-knee amputation, BKA: below-knee amputation, TKA: through-knee amputation, IHD: ischemic heart disease, DM: diabetes mellitus, CRF: chronic renal failure, CVA: cerebrovascular accident, HTN: hypertension, TLOS: total length-of-stay, SD: standard deviation.

(46%) in this group had care-giver to look after their daily functional needs. Postoperatively, 44%(n=20) of this cohort developed wound infection after surgery and 46%(n=21) in this group needed inpatient hospital rehabilitation before discharge while the remaining sought outpatient rehabilitation services.

There were 50 amputees in the older cohort of age 60 to 80 years. Their mean age was 70 ±SD 7 years, 42%(n=21) were female and the rest were male, 50%(25) were independent without aid while the remaining half needed walking aid or wheelchair, 52%(n=26) had IHD, 90%(n=45) had DM, 20%(n=10) had CVA, 88%(n=44) had HTN and 50%(n=25) had CRF.

Twenty-eight cases (56%) in this cohort had BKA, 20%(n=10) had AKA, 16%(n=8) had TKA with the remaining 8%(n=4) under others. Postoperatively, 66%(n=33) had care-giver, 34%(n=17) developed wound infection and 34%(n=17) required inpatient rehabilitation services. The mean total length-of-stay (TLOS) in the younger cohort was 45(±SD 31) days while the older cohort had mean TLOS of 40 days(±SD 29). These demographic information are summarised in Table 1.

When comparing the two cohorts, there was a higher proportion in the younger cohort with premorbid independence compared to older cohort. The latter cohort had higher proportion requiring wheelchair or walking aid ($p<0.001$). The older cohort also had higher proportion of amputees with hypertension ($p=0.025$) and care-giver ($p=0.039$) compared to cohort of age 40 to 59 years old. There was no statistical significance difference between the two cohorts in terms of other comorbidities such as IHD, DM, CVA and CRF. Similarly, there were no differences between the two cohorts amputation level, wound infection, TLOS and proportion of patients who required further inpatient rehabilitation. These information are highlighted in Table 2.

Using regression analysis for the cohort of age 40-59, presence of IHD (B=22.4), wound infection (B=17.8)

Table 2 : *Comparison of Clinical Variables between 2 groups Using Chi-square Test and Independent t-test*

Clinical variables	P-value
Gender	0.396
Premorbid	*<0.001
IHD	0.314
DM	0.442
CVA	0.604
CRF	0.152
HTN	*0.025
Amputation level:	00
BKA	0.089
TKA	0.098
AKA	0.798
Others	0.681
Wound infection	0.298
Care-giver	*0.039
Inpatient rehabilitation services	0.213
TLOS	0.322

*Significant

Table 3 : *Linear Regression of Clinical Variables Correlating TLOS and Receiving Prosthesis in 40-59 Years Old Amputee Group*

Variables with TLOS	Unstandardised coefficient(B)	P-value	Variables with receiving prosthesis	Unstandardised coefficient (B)	P-value
IHD	22.4	*0.029	IHD	-0.10	0.988
DM	2.0	0.985	DM	-0.69	*0.043
CRF	3.5	0.690	CRF	-0.31	*0.046
HTN	2.4	0.808	HTN	-0.14	0.411
Wound infection	17.8	*0.040	Wound infection	0.04	0.794
Care-giver	-23.3	*0.006	Care-giver	0.03	0.763
Premorbid independent	-28.6	*0.024	Premorbid independent	0.34	0.084
Inpatient rehabilitation	36.8	*<0.001	Inpatient rehabilitation	0.06	0.644

Adjusted R square 0.40/0.32; *Significant

Table 4 : *Linear Regression of Clinical Variables Affecting TLOS in 60-80 years Old Amputee Group*

Variables with TLOS	Unstandardised coefficient (B)	P - value	Variables with receiving prosthesis	Unstandardised coefficient(B)	P - value
IHD	7.6	0.399	IHD	-0.11	0.424
DM	3.8	0.796	DM	0.21	0.376
CRF	1.9	0.830	CRF	0.14	0.312
HTN	12.3	0.372	HTN	0.01	0.956
Wound infection	0.8	0.934	Wound infection	-0.16	0.273
Care-giver	-18.6	*0.040	Care-giver	0.15	0.265
Premorbid independent	-9.65	0.275	Premorbid independent	0.15	0.278
Inpatient rehabilitation	25.61	*0.008	Inpatient rehabilitation	0.53	*0.001

*Significant

and those needing further inpatient rehabilitation (B=36.8) are predictors that correlated positively to increased TLOS (Table 3). Premorbid independence without aid (B=28.6) and presence of care-giver (B=23.3) led to a reduction of TLOS. For successful receiving of prosthesis at the later stage of rehabilitation, diabetes and CRF were negative predictors (B=0.69) and (B=0.31) respectively.

In the older cohort, presence of caregiver (B=18.6) led to shorter TLOS whereas those needing inpatient rehabilitation contributed to longer TLOS (B=25.61) (Table 4). Amputees who needed and spent time for inpatient rehabilitation had statistically significant higher chance of receiving prosthesis at a later stage(B=0.53).

Discussion:

There is very scarce literature in Singapore or Southeast Asia that attempted to identify predictors for hospital length-of-stay and proportion of amputees eventually receiving lower limb prosthesis measures. Increase hospital length of stay contributes to increase hospital cost and it is crucial of healthcare providers to study and identify potential predictors. Jibby [8] studied factors associated with LOS amongst veteran amputees and

commented two of the factors associated with longer LOS include specialised inpatient rehabilitation services and medical morbidities and issues such as heart failure. Results are comparable to our study population of age 40-59 with IHD and needing inpatient rehabilitation services as potential factors. Inpatient rehabilitation would require patient to have considerable LOS in order to observe and evaluate functional outcomes, hence it is not surprising amputees needing inpatient rehabilitation services had longer LOS.

In Singapore, hospital inpatient rehabilitation provides daily weekday therapy sessions which amputee patients at outpatient setting might not be able to achieve in terms of frequency duration. There is therefore, a future need for more robust outpatient therapy for amputees to eventually substitute the need for inpatient stay. In relation of social, medical comorbidities and postoperative wound issues with TLOS, early identification of amputees with background history of IHD and its related cardiac complications, adequate treatment of residual wound infection and early care-giver identification could potentially reduce TLOS. Amputee with care-giver might need shorter TLOS as physical burden could be assisted by the helper whereas amputee patients without carer might need more time to reach modified independence for daily activities and mobility before discharge from hospital. Pre-amputation counselling by medical social services to identify potential care-giver issues might be useful for amputees lacking social support. This would allow early pre-operative planning of discharge destination for patients without carers rather than only to initiate the discharge planning after surgery. Optimising of medical complications with clinical pathway from diabetes and CRF would also increase the likelihood of lower limb amputees receiving prosthesis. Measures could include stringent monitoring of blood sugar levels pre- and post amputation surgery, early treatment of end organ complications arising from diabetes in amputee and frequent review of medications to retard the progression of CRF in amputee patients. For the older group of amputees, those needing inpatient rehabilitation services have higher likelihood of receiving prosthesis. We postulated besides the physical therapy provided, other aspects including education of wound care and care-giver training to families of amputees could contribute to successful making and receiving of prosthesis at 6months. More studies are needed to validate this.

Limitations: Limitations of this study include small sample size, being a retrospective study and there was lack of review of patients below age group of under 40 and above 80. In addition, patients who were discharged back home from surgical departments were excluded from data. We are unable to postulate if factors for receiving prosthesis in this study can be extrapolated to them. Affordability of lower limb prosthesis was also not evaluated as a potential predictor of successful recipient of prothesis.

Conclusions:

This is a useful study identifying potential predictors affecting hospital length-of-stay of lower limb amputees after surgery and factors predicting sucessful recipient of prosthesis fitting. Clinical amputee pathway could include optimising these potential predictors to minimise TLOS and maximise likelihood of successful recipient of lower limb prosthesis.

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