Original Article

Effectiveness of Diabetes Foot Screening in Primary Care in Preventing Lower Extremity Amputations

Gary Y Ang, [1]*MBBS, MPH, GDFM*, Chun Wei Yap, [1]*Bsc (Pharm) (Hons), PhD*, Nakul Saxena, [1]*PhD*

Abstract

Introduction: The risk of lower extremity amputations (LEAs) in diabetics is 20 times higher than in non-diabetics. Clinical practice guidelines recommend that all diabetics should receive an annual foot examination to identify high-risk foot conditions. Despite this recommendation, there is little evidence in the literature to show its effectiveness in preventing LEA. This study aims to evaluate the effectiveness of diabetes foot screening in primary care in preventing LEA and to identify LEA risk factors. Materials and Methods: This is a retrospective cohort study of diabetic patients who visited the National Healthcare Group Polyclinics for the first time from 1 January 2008 to 31 December 2012. The intervention of interest was foot screening performed at least once during 2 years of follow-up, and the outcome of interest was LEA (major and/or minor) performed during 2 years of follow-up. Patients who did foot screening (n = 8150) were compared to a propensity score matched control group (n = 8150) who did not do foot screening. Logistics regression was done to identify factors associated with LEA. Results: Among those who underwent foot screening, there were 2 (0.02%) major amputations and 15 (0.18%) minor amputations compared with 42 (0.52%) and 52 (0.64%) among those who did not (P <0.001). Conclusion: Lack of diabetes foot screening, lower socioeconomic status, hip fracture, Malay ethnicity, chronic kidney disease, poorer glycaemic control, longer diabetes duration and male gender have been found to be associated with a higher risk of LEA.

Ann Acad Med Singapore 2017;46:417-23

Key words: Diabetes mellitus, real-world, Singapore

Introduction

The prevalence of diabetes mellitus in Singapore has increased from 8.2% in 2004[1] to 11.3% in 2010[2] and is likely to increase to 15% in 2050.[3] Globally, the burden of diabetes both in terms of prevalence and number of adults affected has increased.[4] Diabetes mellitus is a disease known for its multifaceted complications, and foot ulceration, which often results in lower extremity amputations (LEAs)—one of the most common diabetes complications.[5] As the risk of LEAs in diabetics can be 20 times higher than in non-diabetics,[6] it is not surprising that there is an increasing trend in diabetes-related LEA in Singapore.[7] LEA can be further divided into major (ankle, through knee and up to hip amputations) and minor (foot and toes) amputations. LEA has high mortality (minor LEA: 1-year mortality 9.7% to 18.3%; major LEA: 1-year mortality 24.3% to 30.6%)[7] and substantial medical costs (minor LEA: S$5161; major LEA: S$9695),[8] highlighting the importance of primary prevention and early detection to prevent LEA.

Clinical practice guidelines recommend that all individuals with diabetes mellitus should receive an annual foot examination to identify high-risk foot conditions.[9,10] Despite this recommendation, there is weak evidence in the literature[11-13] to show that screening is effective in preventing diabetes-related LEA.

Since there is an increasing trend of diabetes-related LEA in Singapore,[7] our study aims to evaluate the effectiveness of diabetes foot screening in the primary care setting in preventing LEA and to identify risk factors for LEA.

Materials and Methods

Data Sources

National Healthcare Group (NHG) provides public healthcare services through an integrated network of 9 primary healthcare polyclinics, acute care and tertiary hospitals, national specialty centres and business divisions.[14] We obtained data from the NHG Diabetes Registry[15] which was launched in 2007. Details of how diabetic patients

[1]Health Services and Outcomes Research, National Healthcare Group, Singapore
Address for Correspondence: Dr Gary Ang Yee, Health Services and Outcomes Research, National Healthcare Group, 3 Fusionopolis Link, #03-08 Nexus@one-north, Singapore 138543.
Email: gary_ang@nhg.com.sg

were identfied have been described elsewhere.[15] In brief, patients with encounters in NHG from 2005 were identified for inclusion into the Diabetes Registry from existing stand-alone diabetes registries, ICD9CM diagnosis codes, anti-hyperglycaemic medication and laboratory confirmation.[15]

This was a retrospective cohort study. All resident diabetic patients residing in the central region of Singapore were eligible for the study. The study entry point for each patient was their first visit to any of the 9 NHG Polyclinics from 1 January 2008 to 31 December 2012. All patients were followed until their first LEA or 2 years from study entry, whichever is earlier. Patients with diabetes foot screening or LEA prior to study entry were excluded from the study. Patients with no LEA and who had died before the end of follow-up were also excluded.

Variables extracted from the NHG Diabetes Registry for the study included demographic data (age, gender and ethnicity), duration of diabetes mellitus, glycated haemoglobin (HbA1c), body mass index (BMI) and comorbid conditions. We also used Medifund (a medical endowment fund set up by the Singapore Government) status as a surrogate for low socioeconomic status as only needy patients who face financial difficulties with their medical bills will qualify for it.

Yearly diabetes foot screening in NHG Polyclinics comprised the following components: i) assessment of medical history and current symptoms (e.g. type of diabetes, date of diagnosis, latest HbA1c, history of ulceration or amputation, presence of paraesthesia or pins and needles, etc.); and ii) clinical examination (e.g. examination of the skin, vascular assessment, neurological assessment, presence of deformity).

Doppler reading of ankle-brachial index and toe-brachial index was done for all newly diagnosed diabetic patients at baseline and annually in patients with risk factors such as the following: i) age ≥50 years old; ii) history of smoking; iii) presence of ischaemic heart disease, transient ischaemic attack/cardiovascular accident, previous foot complications (ulcers, cellulitis); iv) presence of poor capillary refill (>3 seconds), absent pulses, intermittent claudication or rest pain; and v) presence of poorly controlled diabetes, hypertension or dyslipidaemia.

Based on the findings from the diabetes foot screening, patients would be risk stratified using the King's Classification[16] with low-risk patients seen yearly and patients with risk factors seen earlier (depending on their risk factors). Depending on the findings, patients may also be referred to the podiatrist for management of skin conditions, foot deformity or non-infected ulcer. For patients with more severe findings, they would be referred to the doctor for further management. This may lead to referral to specialists in tertiary hospitals, if necessary.

In this study, patients were assigned to the intervention group if they had at least one diabetes foot screening before any LEA during the 2 years follow-up period. Otherwise, they were assigned to the control group. As this was a retrospective study, we used propensity score matching[17,18] to balance the distribution of baseline characteristics between diabetic patients who went for foot screening and those who did not. We used baseline variables and logistic regression to obtain the probability of undergoing diabetes foot screening. From this, we predicted the probability for each diabetic patient to undergo foot screening (propensity score) and matched patients based on their propensity scores using a 1:1 matching and a caliper of width equal to 0.2 of the standard deviation of the estimated propensity scores.

After propensity score matching, multiple logistic regression analysis was then used to identify risk factors for LEA. We further divided LEA into major (above ankle, through knee and up to hip amputations) and minor (foot and toes) amputations as costs incurred for major and minor amputations were very different.

Statistical Analysis

Characteristics of the study population are described for categorical variables by n (%) and for continuous variable as the mean (standard deviation) if the distribution was normal and median (range) if the distribution was not normal. All analyses were conducted using STATA (StataCorp, College Station, TX, USA) statistical software, version 12.0.

Ethical Approval

The study was approved by the NHG's Domain-specific Ethics Review Board which is an independent committee constituting medical, scientific and non-scientific members. As this was a retrospective study using de-identified data, waiver of consent was granted.

Results

Description

A total of 26,173 patients were included in the analysis. Of these, 16,382 (62.6%) had undergone at least one diabetes foot screening during the follow-up period of 2 years while 9791 did not undergo any foot screening. Patients who underwent foot screening were younger, less likely to use Medifund subsidies, had shorter duration of diabetes mellitus and higher HbA1c compared to patients who did not undergo diabetes foot screening. In terms of comorbid conditions, those who underwent diabetes foot screening had higher prevalence of dyslipidaemia and hypertension, but lower prevalence of chronic kidney disease, coronary heart disease, stroke, asthma, atrial fibrillation, heart failure, chronic obstructive pulmonary disease, osteoporosis, hip and spine fracture (Table 1).

Table 1. Patient Demographics

Variable	Foot Screening Done		*P* Value
	Yes (n = 16,382)	No (n = 9791)	
Age in years, mean (SD)	66.7 (12.0)	68.2 (14.5)	<0.001
Gender, n (%) Male	8229 (50.7)	5092 (52.1)	0.035
Ethnicity, n (%)			0.045
Chinese	12,659 (77.3)	7073 (72.2)	
Malay	1318 (8.1)	892 (9.1)	
Indian	1956 (13.2)	1494 (15.3)	
Others	781 (3.0)	332 (3.4)	
Medifund user, n (%)	1360 (8.3)	1393 (14.2)	<0.001
Duration of diabetes, median (range)	0.1 (0 to 45.4)	1.4 (0 to 43.5)	<0.001
HbA1c categories, n (%)			<0.001
Below 7.0	3804 (23.2)	1263 (12.9)	
7.0 – 7.9	1903 (11.6)	505 (5.2)	
8.0 – 8.9	898 (5.5)	266 (2.7)	
9.0 and above	1963 (12.0)	571 (5.8)	
Unknown	7814 (47.7)	7186 (73.4)	
BMI categories in kg/m^2, n (%)			<0.001
Risk of nutritional deficiency diseases and osteoporosis (<18.5)	198 (1.2)	164 (1.7)	
Low-risk (18.5 – 22.9)	2040 (12.5)	1130 (11.5)	
Moderate-risk (23.0 – 27.4)	4883 (29.8)	2086 (21.3)	
High-risk (≥27.5)	4364 (26.6)	1693 (17.3)	
Unknown	4897 (29.9)	4718 (48.2)	
Comorbid conditions, n (%)			
Dyslipidaemia	13,251 (80.9)	7261 (74.2)	<0.001
Hypertension	10,942 (66.8)	6408 (65.5)	0.026
Chronic kidney disease	2030 (12.4)	2011 (20.5)	<0.001
Coronary heart disease	2005 (12.2)	1897 (19.4)	<0.001
Stroke	1413 (8.6)	1073 (11.0)	<0.001
Asthma	502 (3.1)	493 (5.0)	<0.001
Atrial fibrillation	287 (1.8)	330 (3.4)	<0.001
Heart failure	278 (1.7)	518 (5.3)	<0.001
Chronic obstructive pulmonary disease	172 (1.1)	210 (2.1)	<0.001
Osteoporosis	179 (1.1)	184 (1.9)	<0.001
Transient ischaemic attack	155 (1.0)	117 (1.2)	0.055
Hip fracture	81 (0.5)	117 (1.2)	<0.001
Spine fracture	53 (0.3)	63 (0.6)	<0.001
Subarachnoid haemorrhage	9 (0.1)	6 (0.1)	0.836

BMI: Body mass index; HbA1c: Glycated haemoglobin

After propensity score matching, there were statistical differences in ethnicity, median duration of diabetes, HbA1c categories, BMI categories, prevalence of dyslipidaemia, hypertension and chronic kidney disease (Table 2).

Outcomes

During the follow-up period, there were a total of 111 LEAs. Major LEA (n = 44) accounted for 39.6% of LEA. Those who underwent diabetes foot screening had lower percentage of major LEA (0.02% vs 0.52%) and minor LEA

Table 2. Patient Demographics after Propensity Score Matching

Variable	Foot Screening Done		*P* Value
	Yes (n = 8150)	No (n = 8150)	
Age in years, mean (SD)	68.1 (12.4)	67.8 (14.4)	0.246
Gender, n (%) Male	4241 (52.0)	4226 (51.9)	0.814
Ethnicity, n (%)			0.045
Chinese	5904 (72.4)	6063 (74.4)	
Malay	735 (9.0)	688 (8.4)	
Indian	1228 (15.1)	1142 (14.0)	
Others	283 (3.5)	257 (3.2)	
Medifund user, n (%)	1016 (12.5)	950 (11.7)	0.112
Duration of diabetes, median (range)	0.2 (0 to 45.4)	1 (0 to 43.5)	<0.001
HbA1c categories, n (%)			0.003
Below 7.0	1128 (13.8)	1226 (15.0)	
7.0 – 7.9	437 (5.4)	493 (6.1)	
8.0 – 8.9	222 (2.7)	259 (3.2)	
9.0 and above	526 (6.5)	563 (6.9)	
Unknown	5837 (71.6)	5609 (68.8)	
BMI categories in kg/m^2, n (%)			<0.001
Risk of nutritional deficiency diseases and osteoporosis (<18.5)	137 (1.7)	127 (1.6)	
Low-risk (18.5 – 22.9)	1053 (12.9)	985 (12.09)	
Moderate-risk (23.0 – 27.4)	1777 (21.8)	1957 (24.0)	
High-risk (≥27.5)	1397 (17.1)	1594 (19.6)	
Unknown	3786 (46.5)	3487 (42.8)	
Comorbid conditions, n (%)			
Dyslipidaemia	5994 (73.6)	6185 (75.9)	0.001
Hypertension	5250 (64.4)	5384 (66.1)	0.028
Chronic kidney disease	1524 (18.7)	1400 (17.2)	0.011
Coronary heart disease	1459 (17.9)	1379 (16.8)	0.066
Stroke	893 (11.0)	847 (10.4)	0.243
Asthma	363 (4.5)	350 (4.3)	0.619
Atrial fibrillation	211 (2.6)	219 (2.7)	0.696
Heart failure	259 (3.2)	279 (3.4)	0.381
Chronic obstructive pulmonary disease	133 (1.6)	129 (1.6)	0.803
Osteoporosis	140 (1.7)	130 (1.6)	0.539
Transient ischaemic attack	98 (1.2)	97 (1.2)	0.943
Hip fracture	71 (0.9)	71 (0.9)	1.00
Spine fracture	46 (0.6)	43 (0.5)	0.750
Subarachnoid haemorrhage	8 (0.1)	6 (0.1)	0.593

BMI: Body mass index; HbA1c: Glycated haemoglobin

(0.18% vs 0.64%) compared to those who did not undergo foot screening (Table 3).

Risk Factors for LEA

Multivariate logistic regression analysis showed that patients who did not undergo foot screening had a 6.3-fold increased risk of a LEA compared to patients who underwent foot screening after adjustment for other risk factors. The other risk factors were Medifund user, hip fracture, chronic kidney disease, Malay ethnicity, male

Table 3. Lower Extremity Amputations by Screening Status

LEA	Foot Screening during Study Period	
	Yes (n = 8150)	No (n = 8150)
Major, n (%)	2 (0.02)	42 (0.52)
Minor, n (%)	15 (0.18)	52 (0.64)
Total, n (%)	17 (0.21)	94 (1.15)

LEA: Lower extremity amputation

gender, poor glycaemic control and increasing duration of diabetes (Table 4).

Discussion

Only 62.6% of diabetic patients had diabetes foot screening done at least once in 2 years. This figure is similar to another study done in Singapore that reported annual foot screening rates of 53% to 69.5%.[19] Internationally, diabetes foot screening rates in primary care environments vary from 50% to 86.7%[20-24] suggesting potential for increasing screening uptake.

There were differences in the percentage of both major and minor LEA between diabetic patients who underwent foot screening and diabetic patients who did not. From Table 3, we estimated that approximately 106 (95% CI, 84 to 145) patients need to be screened to prevent one LEA [(1/{1.15-0.21})*100]. Taking the unsubsidised cost of diabetes foot screening in Singapore to be S$50, the cost for screening 106 patients would be S$5300. The average cost for a minor LEA is S$5161 and the average cost for a major LEA is S$9695 in the local Singapore context. Thus, even if we screen 106 patients at a cost of S$5300 and avert one minor LEA, it would cost the healthcare system about S$139. However, if we can avert a major LEA (Table 5), we can save about S$4395. Thus it may be cost-saving to screen for diabetic foot from the healthcare providers' perspective, and this is also in accordance with current clinical practice guidelines.[9,10]

Table 4. Risk Factors for Lower Extremity Amputation

Risk Factor	Odds Ratio (95% CI)
No diabetes foot screening	6.3 (3.7 – 10.6)
HbA1c categories	
Below 7.0	Reference
7.0 – 7.9	2.1 (0.7 – 6.1)
8.0 – 8.9	3.9 (1.4 – 11.1)
9.0 and above	5.6 (2.3 – 13.2)
Unknown	2.0 (0.9 – 4.4)
Medifund user	4.0 (2.7 – 5.9)
Hip fracture	3.7 (1.1 – 12.5)
Ethnicity	
Chinese	Reference
Malay	2.2 (1.3 – 3.6)
Indian	1.0 (0.6 – 1.8)
Others	1.0 (0.3 – 3.2)
Chronic kidney disease	1.8 (1.2 – 2.8)
Duration of diabetes	1.1 (1.0 – 1.1)
Gender	
Male	Reference
Female	0.6 (0.4 – 0.9)

HbA1c: Glycated haemoglobin

Medifund status was associated with higher risk for LEA which is consistent with findings that lower socioeconomic status is associated with diabetes-related foot diseases and LEA.[25-28] Chronic kidney disease, poorer glycaemic control and longer duration of diabetes were associated with higher risk for LEA which is consistent with other studies.[29-33] Efforts can be made to improve glycaemic control and diabetes foot education in these high-risk groups to prevent LEA.

The strength of this study is as follows: we have a relatively large population of diabetic patients in a multiethnic Asian population with a follow-up period of 2 years. Our study entry period spans across 5 years, from 2008 to 2012.

This study has some limitations. This is a retrospective study and variables not captured at the start of the study such as smoking status, dietary habits and presence of foot ulcers would not be able to be used for analysis. Our diabetic patients might have gone for foot screening in private clinics and this would not be captured by our system. Similarly, they might have LEA performed in private hospitals and we would not have known about this. However, we expect these numbers to be small as we have restricted our study population to patients who were seen by our healthcare system and who were expected to utilise our healthcare system. We were unable to look at the link between diabetes foot screening and foot ulcers, as the presence and severity of foot ulcers were not captured in the database. Thus, we may have underestimated the cost savings for diabetes foot screening, if diabetes foot screening prevented foot ulcers as well.

We looked at the effect of missing variables on our analysis using complete case analysis. After removing patients with missing HBA1c and/or BMI readings, we redid the analysis using 1533 diabetic patients with foot screening and 1533 diabetic patients without foot screening. We found that the percentage of LEA remained statistically different ($P = 0.001$) between those who had foot screening (0.26%) and those who did not have foot screening (1.4%).

Table 5. Cost Savings Due to Foot Screening

Number Needed to Screen	Cost of Screening*	Cost Saving if Minor LEA is Averted†	Cost Saving if Major LEA is Averted†
106	$5300	-$138.51	$4395.20
Lower 95% CI : 84	$4200	$961.49	$5495.20
Upper 95% CI: 145	$7250	-$2088.51	$2445.20

LEA: Lower extremity amputation

*Unsubsidised cost of diabetic foot screening is $50 per patient.

†Average cost for minor LEA is $5161.49 and for major LEA is $9695.20 (source: Tan JH, Hong CC, Shen L, Tay E, Lee J, Nather A. Costs of Patients Admitted for Diabetic Foot Problems. Ann Acad Med Singapore 2015;44:567).

Note: All costs are in Singapore Dollars. Cost savings are from the healthcare providers' perspective.

Our propensity score matching narrowed the differences between the 2 groups but there were still differences between the 2 groups as shown in Table 2. We did a separate analysis using only patients who are well matched by using a caliper of width equal to 0.02 of the standard deviation of the estimated propensity score. A total of 0.34% of those who had foot screening had amputations, while 1.34% of those who did not have foot screening had amputations, and this was still statistically significant.

We have looked at the effectiveness of diabetes foot screening in the primary care setting and found that it could potentially prevent LEA, resulting in cost savings from the healthcare providers' perspective. We have also identified risk factors for LEA and more efforts can be made to improve glycaemic control in these high-risk groups and ensure they go for annual diabetes foot screening.

REFERENCES

1. National Health Survey 2004. Epidemiology & Disease Control Division, Ministry of Health, Singapore.
2. National Health Survey 2010, Singapore. Epidemiology and Disease Control Division, Ministry of Health Singapore, 2011.
3. Phan TP, Alkema L, Tai ES, Tan KHX, Yang Q, Lim WY, et al. Forecasting the burden of type 2 diabetes in Singapore using a demographic epidemiological model of Singapore. BMJ Open Diabetes Res Care 2014;2:e000012.
4. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. Lancet 2016;387:1513-30.
5. Wu SC, Driver VR, Wrobel JS, Armstrong DG. Foot ulcers in the diabetic patient, prevention and treatment. Vasc Health Risk Manag 2007;3:65-76.
6. Vamos EP, Bottle A, Edmonds ME, Valabhji J, Majeed A, Millett C. Changes in the incidence of lower extremity amputations in individuals with and without diabetes in England between 2004 and 2008. Diabetes Care 2010;33:2592-7.
7. Ang Y, Yap CW, Saxena N, Lin LK, Heng BH. Diabetes-related lower extremity amputations in Singapore. Proceedings of Singapore Healthcare 2016;26:76-80.
8. Tan JH, Hong CC, Shen L, Tay E, Lee J, Nather A. Costs of Patients Admitted for Diabetic Foot Problems. Ann Acad Med Singapore 2015;44:567.
9. Ministry of Health, Singapore. MOH Clinical Practice Guidelines, Diabetes Mellitus 2014.
10. Standards of Medical Care in Diabetes-2017 Abridged for Primary Care Providers. Clin Diabetes 2017;35:5-26.
11. McCabe CJ, Stevenson RC, Dolan AM. Evaluation of a diabetic foot screening and protection programme. Diabet Med 1998;15:80-4.
12. Formosa C, Gatt A, Chockalingam N. A critical evaluation of existing diabetic foot screening guidelines. Review Diabet Stud 2016;13:158-86.
13. Sloan FA, Feinglos MN, Grossman DS. Receipt of care and reduction of lower extremity amputations in a nationally-representative sample of U.S. elderly. Health Serv Res 2010;45:1740-62.
14. Communications NHGC. NHG Corporate Yearbook 2014/2015.
15. Heng BH, Sun Y, Cheah JT, Jong M. The Singapore National Healthcare Group Diabetes Registry–descriptive epidemiology of type 2 diabetes mellitus. Ann Acad Med Singapore 2010;39:348-52.
16. Munro N, Rich N, McIntosh C, Foster AVM, Edmonds ME. Infections in the diabetic foot. Br J Diabetes Vasc Dis 2003;3:132-6.
17. Rosenbaum PR, Rubin DB. Reducing bias in observational studies using subclassification on the propensity score. J Am Stat Assoc 1984;79:516-24.
18. Rosenbaum PR, Rubin DB. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. Am Stat 1985;39:33-8.
19. Tan WS, Ding YY, Xia WC, Heng BH. Effects of a population-based diabetes management program in Singapore. Am J Manag Care 2014;20:e388-98.
20. Tapp RJ, Zimmet PZ, Harper CA, de Courten MP, Balkau B, McCarty DJ, et al. Diabetes care in an Australian population: frequency of screening examinations for eye and foot complications of diabetes. Diabetes Care 2004;27:688-93.
21. Webster G, Sullivan-Taylor P, Terner M. Opportunities to improve diabetes prevention and care in Canada. Healthc Q 2011;14:18-21.
22. Mc Hugh S, Marsden P, Brennan C, Murphy K, Croarkin C, Moran J, et al. Counting on commitment; the quality of primary care-led diabetes management in a system with minimal incentives. BMC Health Serv Res 2011;11:348.
23. Group SDSM. Scottish Diabetes Survey 2014. Available at: http://www.diabetesinscotland.org.uk/publications/sds2014.pdf. Accessed on 1 September 2017.
24. National Diabetes Audit - Report 1: Care Proccesses and Treatment Targets. 2016. Available at: https://digital.nhs.uk/catalogue/PUB23241. Accessed on 1 September 2017.
25. Venermo M, Manderbacka K, Ikonen T, Keskimäki I, Winell K, Sund R. Amputations and socioeconomic position among persons with diabetes mellitus, a population-based register study. BMJ Open 2013;3:pii:e002395.

26. Stevens CD, Schriger DL, Raffetto B, Davis AC, Zingmond D, Roby DH. Geographic clustering of diabetic lower extremity amputations in low income regions of California. Health Aff (Millwood) 2014;33:1383-90.
27. Bergin SM, Brand CA, Colman PG, Campbell DA. The impact of socio-economic disadvantage on rates of hospital separations for diabetes-related foot disease in Victoria, Australia. J Foot Ankle Res 2011;4:17.
28. Nather A, Siok Bee C, Keng Lin W, Qi Odelia KS, Yiong Huak C, Xinyi L, et al. Socioeconomic profile of diabetic patients with and without foot problems. Diabet Foot Ankle 2010;1.
29. Shojaiefard A, Khorgami Z, Larijani B. Independent risk factors for amputation in diabetic foot. Int J Diabetes Dev Ctries 2008;28:32-7.
30. Yang Y, Østbye T, Tan SB, Abdul Salam ZH, Ong BC, Yang KS. Risk factors for lower extremity amputation among patients with diabetes in Singapore. J Diabetes Complications 2011;25:382-6.
31. Zhou ZY, Liu YK, Chen HL, Yang HL, Liu F. HbA1c and lower extremity amputation risk in patients with diabetes: a meta-analysis. Int J Low Extrem Wounds 2015;14:168-77.
32. Pemayun TGD, Naibaho RM, Novitasari D, Amin N, Minuljo TT. Risk factors for lower extremity amputation in patients with diabetic foot ulcers: A hospital based case-control study. Diabet Foot Ankle 2015;6:29629.
33. Monteiro-Soares M, Boyko EJ, Ribeiro J, Ribeiro I, Dinis-Ribeiro M. Predictive factors for diabetic foot ulceration: a systematic review. Diabetes Metab Res Rev 2012;28:574-600.