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Predicting Microvascular Complications in Diabetic Patients

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Abstract

Background Patients with diabetes have an increased risk of developing microvascular complications, diabetic retinopathy, diabetic nephropathy and diabetic neuropathy, which if not predicted, early detected and treated, place a significant burden on individual's health and can reduce life expectancy.

Objective To determine the main risk factors (predictors) that associated with microvascular complications in diabetes aiming to construct a module that can detect microvascular complications depending on these predictors.

Methods A cross sectional descriptive study was carried out with 364 diabetic patients. Data about diabetes microvascular complications (retinopathy, clinical peripheral neuropathy, and nephropathy) and their potential risk factors were collected. Primary point was detecting the < 0.01 level of significant association of risk factors with these complications to determine the predictors. These predictors were assessed for each individual's micro vascular complication and also as a composite outcome by logistic regression analysis.

Result Of the examined 364 diabetic cases, 174 (47.80%) patients were found with microvascular complications. Neuropathy, nephropathy, and retinopathy were detected in 66 (18.13%), 62 (17.03), and 46 (12.64%) patients, respectively. Out of 12 potential predictors, only six (age, smoking habit, duration of diabetes, uncontrolled hyperglycemia, hypertension, and macrovascular complications) found to be significantly associated with the presence of microvascular complication (p < 0.01) as compared with patients who had no such complications. Uncontrolled hyperglycemia was the first predictor in neuropathy and nephropathy groups, while diabetic duration was ranking first in retinopathy group.

Conclusions Microvascular complications in diabetic patients can be predicted, and avoided, by detecting their risk factors. Logistic regression equation provide suitable module for evaluation of these risk factors simultaneously.

Key words Microvascular complications, diabetes, logistic regression

Introduction

Diabetes mellitus (DM) is a global health problem, affecting all age groups. Currently, around 177 million people have diabetes worldwide; however, it has been projected that this number will increase to at least 300 million by 2025 [(1)]. This epidemic relates in particular to type II diabetes, which accounts for around 90% of all diabetes cases. The increased prevalence of type II diabetes can be attributed to the ageing population and rising incidence of obesity, besides other factors [(2)].

The greatest rate of rise is predicted to be in the Middle-East [(3)], and as a country of the Middle-East, Iraq is affected by this epidemic, with overall prevalence of 21.8 per 1000 in 2006. Further increases in the rates are seen after age 50, with a prevalence rate of 143.8 per 1000 [(4)].

DM is a disease that is strongly associated with both microvascular complications, (including retinopathy, nephropathy, and neuropathy) and

macrovascular complications, (including ischemic heart disease, peripheral vascular disease, and cerebrovascular disease), resulting in organ and tissue damage in approximately one third to one half of people with diabetes [5]. Although, much of the focus has been made on the macrovascular complications, it is clear that the microvascular complications have a significant impact on both morbidity and mortality amongst diabetic patients [6], and despite the introduction of treatment strategies, diabetes remains a major cause of new-onset blindness, end-stage renal disease, and lower leg amputation [7]. Furthermore, the management of diabetes-related complications generates substantial costs [8].

Diabetic retinopathy is the most common microvascular complication among people with diabetes and results in more than 10,000 new cases of blindness per year. It is slow to develop, and there is some evidence that it can begin to develop as early as 7 years before clinical diagnosis of type 2 diabetes [9]. As much as 90% of blindness due to retinopathy among people with diabetes may be preventable if detected and treated early. Annual dilated eye examinations are recommended for all patients with diabetes [10].

Diabetic nephropathy is defined as persistent proteinuria (more than 500 mg of protein or 300 mg of albumin per 24 hours) in patients without urinary tract infection or other diseases causing the proteinuria [11]. Diabetic nephropathy is a serious and progressive complication in DM. The first manifestation of diabetic nephropathy is typically microalbuminuria, which progresses to overt albuminuria (i.e. increased albumin levels in the urine, indicating more severe renal dysfunction) and eventually to renal failure and it is the leading cause of end-stage renal disease (ESRD) [12].

Diabetic neuropathy is a common complication of diabetes occurring over time in more than half of patients with type 2 diabetes. Nerve conduction studies demonstrate that neuropathy is already present in 10-18% of patients at the time of diabetes diagnosis, suggesting that peripheral nerve injury occurs at early stages of disease [13]. Diabetic neuropathy can be either peripheral (mono or poly) neuropathy or autonomic neuropathy and Physician commonly encounter diabetes associated peripheral neuropathy in the evaluation and treatment because these disorders frequently affect lower-extremity sensation and can cause lower-extremity pain. Loss of lower-extremity sensation coupled with impaired peripheral vascular function can contribute to lower-extremity (commonly foot) ulceration [14].

Although it is clear that diabetes micro vascular complications result from the abnormal metabolic environment engendered by chronic hyperglycemia the actual development of these complications in any individual appeared to be a cumulative function of many factors that specifically affected their occurrence [15]. In order that timely treatment can be given, it is essential that patients at risk for the development of diabetic microvascular complications are identified earlier. Effective evaluation and monitoring of these complications in clinical practice is clearly important, however, it is also important to predict these complications depending on several predictors that might lead to primary prevention of these complications, together with retardation of their progression by tight control of these predictors' "risk factors".

A review of the literature has shown several risk factors (e.g. diabetes duration and glycemic control, blood pressure, ….etc) have consistently been shown to correlate with diabetic retinopathy, neuropathy, and nephropathy, and actually these complications develop and progress in unison and indeed share many common risk factors, but to date, the relationship and the mutual action of these

factors has not been clearly described [16], raised the question that presence or absence of these risk factors simultaneously in diabetic patient might play a summation rule in the pathogenesis of these complication as the role of these risk factors is necessary but not sufficient. This approach appears to be much stronger and beneficial for complications prediction than the sparse of risk factors as in most of time two or more of these factors are existed [17].

The prevalence of microvascular complications has been previously reported in Iraq and was high among diabetic in specialized diabetic centers and in outpatients referring to general hospitals [4,17,18,19], but we did not find any article which assess the risk factors for these complications.

It is essential however, that risk factors associated with the progression and development of diabetic micro vascular complications are detected and treated at an early stage in order to further reduce morbidity and mortality. So, the aim of this study was to determine the main risk factors that associated with micro vascular complications in diabetic patients aiming to construct a module that can predict these complications.

Methods

This was a cross sectional descriptive study set up in a university hospital (Al-Kindy Teaching Hospital) and a diabetic-specialized center (The Specialized Center for Endocrinology and Diabetes 'SCED')- Baghdad, that lasted 2 years (November 2008 – October 2010). The SCED is a referral centre for patients from the greater Baghdad area. The objective of this center is to closely monitor patients to ensure nearly normal life and early detection of any complication of diabetes or other endocrinology disorders. The study was approved by the Al-Kindy Medical College Council and the authority of SCED.

The Study population was diabetic patients attending the above center. The diagnosis was fully established by the specialists in the center and each patient had a file that contains the medical and sociodemographic information. Each registered diabetic patient is supposed to visit the center at least once every month, to be followed up by the caring physician, examined for any complaint or complication, tested for blood sugar, receive his/her drugs or be referred to the hospital for check-up if needed.

The inclusion criteria were patients with DM (type 1 and 2), had recruited in the center for more than one year, with age of 30 years or more, and had disease duration for more than five years. Patient should have file with complete information and regular visits.

Exclusion criteria included gestational diabetes, incomplete laboratory data and follow-up visits requested over the last two years.

The study sample was a convenience one of 364 patients recruited from the above center fulfilled the inclusion criteria.

Data collection:

After explaining the objectives of the study to the patient and taking their verbal consent, the data were collected from the patients and their files by using specially constructed questionnaire. The data obtained about our predictors (risk factors) were age, sex, weight, height, smoking history, type and duration of DM, family history for DM, level of physical activity, presence of uncontrolled hyperglycemia, hypertension, dyslipidemia, microvascular and macrovascular complications.

Dichotomous predictor variables were used to note occurrence of these predictors. We classified and coded the values of variables as 0 and 1. This dichotomous verification is useful for both dummy variables in logistic regression analysis and in interpretation of odds ratio (OR). Age was classified into 30-49 years group (coded 0) and ≥ 50 years' group (coded 1). Sex was marked as 0 for female and 1 for male, type 1 DM was coded as 0 and type 2 as 1. Duration of diabetes in years from time of diagnosis to

enrolment was calculated. Patients with DM of 5-10 years duration were coded as 0 and those with more than 10 years were coded as 1.

Physical activity determination was based on the reported average leisure physical activity per week [20], and classified as active (coded 0), and inactive (coded 1).

Regarding Smoking habit, patients were classified as not smokers (either never smokers or ceased smoking before two years, coded as 0), and smokers (either current smoker, or ex smokers and ceased smoking before less than two years, coded as 1). Patients with no family history of DM were coded as 0 and those with such history coded as 1.

Body mass index (BMI) was calculated for each patient as weight (kg) divided by height squared (meter^2) and was used as the criteria for diagnosis of obesity. Participants with BMI < 30 kg/m^2 considered not obese and coded as 0, while those with BMI ≥ 30 kg/m^2 considered obese and coded as 1 [21].

Presence or absence of uncontrolled hyperglycemia was assessed by measurement HbA1c % level. Measurements for the last 2 years was added together and divided by the number of times were done to get the mean of HbA1c % level (average HbA1c level during 2009-2010).

Patients with mean HbA1c % level 6.5% or less were considered to be with controlled hyperglycemia and coded with 0, and those with level more than 6.5% was considered to be with uncontrolled hyperglycemia and coded with 1 [22].

Definitions Patients were considered hypertensive if already diagnosed and receiving antihypertensive medications. While the criteria for dyslipidemia were according to National Cholesterol Education Program adult treatment panel guidelines. Patients with cholesterol≥ 200 mg/dl, triglycerides > 150 mg/dl, low-density lipoprotein cholesterol (LDL-C) ≥ 160 mg/dl and high-density lipoprotein cholesterol (HDL-C) ≤ 40 mg/dL in the last two years were defined as having dyslipidemia [23].

To assess the presence of diabetic microvascular complications, patients with well established complication were denoted for these complications. Neuropathy was assessed by neurologist through history of symptoms provided by the patient and physical examination with evidence of bilateral decreased pressure sensation by monofilament test. Retinopathy was based on a dilated eye examination by a retinal specialist; moderate to severe non proliferative or proliferative retinopathies were included. Nephropathy was defined as a urinary albumin rate equal or above 300 mg/24 hr in at least two out of three consecutive samples. Patient appeared to have two of these complications were restricted to the one that detected first. To avoid data duplication, Patients with more than two micro vascular complications were restricted to the oldest one [24,25,26].

Macrovascular complications were provided by the patient history and review of the medical chart. A subject was considered to have coronary artery disease (CAD) if there was history of a coronary event including angina, myocardial infarction, cardiovascular intervention, while cerebrovascular disease (CVD) included history of transient ischemic attack or stroke diagnosed by a physician regardless of absence of residual neurological deficit on physical examination [27].

Statistical analysis:

Data were entered and analyzed by MINI TAB software version 14. Statistical analysis was done after examining bivariate associations of predictors and outcomes, Chi square test was used to estimate the association between predictors and outcomes and $p < 0.01$ was required to identify the risk factor as predictor to be included in the logistic equation. So, only the variables that had shown statistically significant p-value when examined individually

were allowed to enter the model. Separate stepwise logistic regression models were conducted in the derivation data set to build the best model to predict each complication depending on associated risk factors predictors. Coefficients for significant predictors were applied to predictor values of the validation data set members. Risk scores for each factor were calculated by summing coefficients across all predictors. We used odds ratio (OR) to find the degree of association of each predictors with absence or presence of risk factors while keeping other constant.

Results

Of the examined 364 diabetic cases, 174 (47.80%) patients were found with microvascular complications. Neuropathy, Nephropathy, Retinopathy were detected in 66 (18.13%), 62 (17.03), and 46 (12.64%) patients, respectively (Table 1). The patients studied were divided into four groups according to the presence of microvascular complications: three with +ve microvascular complications (retinopathy group, nephropathy group, and neuropathy group) and one with -ve microvascular complications group. And when the bivariate analysis was performed to evaluate the predictive qualities for these microvascular complications in cross tabulation with 12 potential risk factors (age, sex, smoking habit, type and duration of DM, family history for DM, level of physical activity, presence of obesity, uncontrolled hyperglycemia, hypertension, dyslipidemia, and macrovascular complications), only six of these risk factors (age, smoking habit, duration of DM, uncontrolled hyperglycemia, hypertension, and macrovascular complications) found to be significantly associated with microvascular complication ($p < 0.01$) as compared with patients with -ve microvascular complications group (Table 1). These six factors were selected to be our predictors and analyze together in logistic regression module. In the stepwise binary logistic regression analysis of these six factors (predictors), the uncontrolled hyperglycemia (measured by HbA1c % level more than 6.5%) found to be the variable with highest association in diabetic group with neuropathy (OR=7.39 and $p = 0.000$). That mean diabetes with uncontrolled hyperglycemia has a risk 7.39-fold greater than that of those with controlled hyperglycemia for neuropathy development after controlling other independent variables. Duration of disease, smoking, age, presence of hypertension and macrovascular complications were following in order with OR values of 5.94, 3.89, 2.86, 1.82, 1.48 respectively (Table 2). In the nephropathy group, the uncontrolled hyperglycemia was also ranking first in prediction with OR = 6.92 and $p = 0.000$, but the subsequent ranking for the other five predictors was duration, age macrovascular complication, hypertension, and smoking with OR values of 5.91, 3.15, 2.36, 2.09, 1.65 respectively (Table 3). The probability that a 30 years old DM patient (male or female) having the disease for more than 10 years, smoker, and presented with HbA1c level > 6.5, HT, and positive macrovascular complications to have retinopathy can be evaluated as follow: -6.024+1.8742 +1.7196 + 1.4728 + (1.1554x0) + 1.0256 + 0.9854 = 1.0539. And by substituting 1.0539 in the equation for the probability ($P_x = 1/1+\exp(-b_0+b_1x_{1+} b_2x_{2+} b_3x_3)$)

Regarding diabetes with retinopathy, duration of the disease (more than 10 years) was the main and number one predictor (OR = 6.52, $p = 0.000$), while uncontrolled hyperglycemia was the second (OR = 5.58, $p = 0.000$). Smoking, age, macrovascular complications, and hypertension were followed in order with OR values of 4.36, 3.18, 2.05, 1.85 respectively.

Table 1. The distribution of the study sample regarding microvascular complications and their potential risk factors

Variable	+ve Microvascular complications n=174						-ve Microvascular complications	Total
	Retinopathy No. (%)	P*	Nephropathy No. (%)	P*	Neuropathy No. (%)	P*	No. (%)	
Frequency	46 (12.64)	-	62 (17.04)	-	66 (18.14)	-	190 (52.20)	364
Gender								
Male	26 (11.40)	0.573	38 (16.67)	0.973	48 (21.05)	0.089	116 (50.88)	228
Female	20 (14.71)		24 (17.65)		18 (13.24)		74 (54.24)	136
Age (years)								
30-49	12 (7.89)	0.000	19 (12.50)	0.000	13 (8.55)	0.000	108 (71.05)	152
≥50	34 (16.04)	S	43 (20.28)	S	53 (25.00)	S	82 (38.68)	212
Type of DM								
1	14 (14.58)	0.233	19 (19.79)	0.173	21 (21.88)	0.115	42 (43.75)	96
2	32 (11.94)		43 (16.05)		45 (16.79)		148 (55.22)	268
Duration of DM								
(years) 5-10	11 (7.54)	0.001	20 (13.70)	0.008	17 (11.64)	0.000	98 (67.12)	146
>10	35 (16.05)	S	42 (19.27)	S	49 (22.48)	S	92 (42.20)	218
Family history of DM								
No	17 (12.23)	0.854	22 (15.83)	0.679	27 (19.42)	0.721	73 (52.52)	139
Yes	29 (12.89)		40 (17.78)		39 (17.33)		117 (52.00)	225
Smoking								
No	13 (7.83)	0.000	18 (10.84)	0.000	23 (13.86)	0.001	112 (67.47)	166
Yes	33 (16.67)	S	44 (22.22)	S	43 (21.72)	S	78 (39.39)	198
Obesity								
No	28 (17.18)	0.762	25 (15.34)	0.861	31 (19.02)	0.446	79 (48.46)	163
Yes	18 (8.96)		37 (18.41)		35 (17.41)		111 (55.22)	201
Physical activity								
Yes	11 (14.10)	0.449	13 (16.67)	0.727	18 (23.08)	0.153	36 (46.15)	78
No	35 (12.24)		49 (17.13)		48 (16.78)		154 (53.85)	286
Uncontrolled hyperglycemia								
No	10 (7.58)	0.001	13 (9.85)	0.000	16 (12.12)	0.000	93 (70.45)	132
Yes	36 (15.52)	S	49 (21.12)	S	50 (21.55)	S	97 (41.81)	232
Hypertension								
No	15 (7.98)	0.000	19 (10.11)	0.000	22 (11.70)	0.000	132 (70.21)	188
Yes	31 (17.61)	S	43 (24.43)	S	44 (25.00)	S	58 (32.96)	176
Dyslipidemia								
No	24 (14.37)	0.841	23 (13.77)	0.066	24 (14.37)	0.047	96 (57.49)	167
Yes	22 (11.17)		39 (19.80)		42 (21.32)		94 (44.72)	197
Macrovasculr complications								
No	14 (7.25)	0.000	17 (8.81)	0.000	19 (9.84)	0.000	143 (74.09)	193
Yes	32 (18.71)	S	45 (26.31)	S	47 (27.49)	S	47 (27.49)	171

**p* value as compared with -ve microvascular complications

S: significant to enter the module

Table 2. Logistic Regression analysis for diabetes with and without neuropathy

Variable	Value	Count
Neuropathy	1	66 (Event)
	0	190
	Total	256

Predictor	Coef	SE Coef	Z	P	Odds ratio	95% CI
Constant	-4.5829	0.6218	-7.73	0.000	-	-
HbA1c level	2.0007	0.3919	5.11	0.000	7.39	3.43-15.94
Duration	1.7810	0.4177	4.26	0.000	5.94	2.62-13.46
Smoking	1.3583	0.36.38	3.69	0.000	3.89	1.89-8.01
Age	0.2821	0.3652	2.56	0.004	2.86	1.56-4.34
Hypertension	0.7335	0.4091	1.98	0.004	1.82	1.59-6.67
Macrovascular	0.1809	0.3982	1.64	0.006	1.48	1.02-7.82

Table 3. Logistic Regression analysis for diabetes with and without nephropathy

Variable	Value	Count
Nephropathy	1	62 (Event)
	0	190
	Total	252

Predictor	Coef	SE Coef	Z	P	Odds ratio	95% CI
Constant	-5.5537	0.8774	-6.33	0.000	-	-
Hb%1c level	1.9344	0.7883	2.45	0.004	6.92	1.48-22.44
Duration	1.7767	0.4320	4.11	0.000	5.91	2.53-13.78
Age	1.1488	0.4426	2.60	0.009	3.15	1.3 2-7.51
Macrovasc	0.8584	0.3938	2.18	0.029	2.36	1.09-5.10
Hypertension	0.8365	0.5337	1. 80	0.049	2.09	0.89-4.89
Smoking	0.9682	0.5909	1.24	0.031	1.65	1.03-4.56

Tabale 4. Logistic Regression analysis for diabetes with and without retinopathy

Variable	Value	Count
Retinopathy	1	46 (Event)
	0	190
	Total	236

Predictor	Coef	SE Coef	Z	P	Odds ratio	95% CI
Constant	-6.024	1.034	-5.82	0.000	-	-
Duration	1.8742	0.5925	3.16	0.002	6.52	2.04-16.81
Hb%1c level	1.7196	0.7002	2.15	0.032	5.58	1.16-18.79
Smoking	1.4728	0.4532	3.25	0.001	4.36	1.79-10.60
Age	1.1554	0.5804	1.99	0.037	3.18	1.02-9.90
Macrovasc	1.0256	0.6340	1.86	0.038	2.05	1.55-6.78
hypertension	0.9854	0.5450	1.18	0.045	1.85	1.24-4.43

Discussion

Diabetic microvascular complications develop sooner or later in most people with type 1 or type 2 diabetes and are associated with clinically significant morbidity and mortality. Individuals may be susceptible to microvascular complications due to many factors such as uncontrolled hyperglycemia, age, disease duration …. etc. However, it has been found that subset of risk factors in patients may give rise to one type of microvascular complications differs from other subsets [28]. Predictors of outcome in critical care are well described and they include clinical, diagnostic, and physiologic factors [29]. To our knowledge, this study is the first that focused on the problem of prediction and avoidability, and thus on the quality of care-related issues in Iraq. This type of study required the involvement of a large number of patients, reflecting different practice styles, so we included 364 consecutive diabetic patients. Furthermore, patients were enrolled from main diabetic center in Baghdad, making the results more generalized to handle the clinical predictors and facilitate the prediction of microvascular complications in our diabetes management.

The results found only six probable risk factors associated with microvascular complications, uncontrolled hyperglycemia was the main factor in neuropathy and nephropathy groups followed by DM duration. But the duration of DM was the first risk factor in retinopathy group. This finding agrees with the results from the Diabetes Control and Complications Trial (DCCT) and the United Kingdom Prospective Diabetes Study (UKPDS) which convincingly demonstrated the importance of glycemic control for the prevention of microvascular complications of diabetes [30,31]. However, these studies highlighted the importance of other modifiable risk factors such as hypertension, smoking, and presence of macrovascular complications besides the age factor, which is non- modifiable risk factor that may all play a part.

The study showed that smoking is an important predictor for neuropathy, retinopathy, and to a lesser extent nephropathy. This result is surprising as one would assume that hypertension would be more predicting in DM patients for microvascular complication than smoking, but the results of this study found that smoking was associated with neuropathy and retinopathy, but not nephropathy, more than hypertension (In neuropathy group, the OR for smoking was 3.8 versus 1.8 for hypertension, In retinopathy group, the OR for smoking was 4.36 versus 1.85 for hypertension, while in nephropathy group, the OR was 2.09 for hypertension versus 1.65 for smoking). The harmful effects of smoking are now well established, and include a substantial increase not only in cardiovascular and peripheral vascular disease, as well as the best known consequences of lung cancer and chronic obstructive pulmonary disease, but also higher rates of both neuropathy and retinopathy which have been well documented [32].

The importance of arterial hypertension and blood pressure levels to development of diabetic microvascular disease has also been demonstrated in previous studies for the microvascular as well as for macrovascular complications. Tight blood pressure control in patients with hypertension and diabetes achieves a clinically important reduction in the risk of deaths related to diabetes and its complications [33,34].The largest and most comprehensive was the UKPDS, which showed that improved metabolic control and tight blood pressure control reduced the risk of microvascular complication development [35]. In this study, hypertension was important predictors for all diabetic microvascular complications but in different strength. The highest was with retinopathy and the lowest was with neuropathy.

Macrovascular complications, especially CVD are the primary cause of death in people with either type 1 or type 2 diabetes [36]. Although the precise mechanisms through which diabetes increases the likelihood of atherosclerotic plaque formation are not completely defined, the association between the two is profound [37]. And this might explain the existence of both macrovascular and microvascular complications in the same diabetic patient and the presence of complication can predict the other. Other surprising results in this study that neither BMI nor physical activity and dyslipidemia were associated significantly with microvascular complications although many studies had showed this association [38,39]. There are might be many possible explanations for this observation as the social and cultural style of our community differ from that in other communities. The prevalence of obesity as well as dyslipidemia were also high in diabetic group with -ve microvascular complications, but regarding dyslipidemia, the most obvious potential explanation is that quarterly measurement of the lipid profiles in the SCDE did not capture the actual criteria for dyslipidemia. Logistic regression is one of the important methods to perform the statistical modules in epidemiological and medical research It allows the investigators to examine the relationship between a binary dependent variable and a set of continuous and/or discrete independent variables [40]. One advantage of logistic regression analysis is that it requires no assumption about the distribution of the independent variables. Another is that the regression coefficient can be interrupted in term of odd ratio (OR). In other words, the OR of retinopathy in DM patients with disease duration more than 10 years is 6.52 (Table 2). And the OR for those patients with less than 10 years duration is the reciprocal, 1/6.52=0.15; therefore diabetic patient with disease duration of more than 10 years is about six times more likely to have retinopathy than other DM patient with less than 10 years duration after controlling the other important predicting factors. The same interpretations are giving to other predicting factors (HbA1c level, age, smoking, hypertension, and macrovascular complications).

From other hand, the logistic equation can be used to find the probability for any giving DM patient. For example, the probability that a 30 years old DM patient (male or female) having the disease for more than 10 years, smoker, and presented with HbA1c level > 6.5, HT, and positive macrovascular complications to have retinopathy can be evaluated (table 4) [41].the probability result is 0.49. Therefore the chance that this patient has retinopathy is about 49%. In the same manner we can calculate the chance for nephropathy (from table 3) which is 46% and the chance for neuropathy (from table 2) which is 41%.

In summery micro vascular complications are prevalent among diabetes. Earlier diagnosis and improved management of multiple potential risk factors together with the introduction of novel more predictive module may limit their development and progression. Effective evaluation and monitoring of these predictors in clinical practice is clearly important, however, it is also relevant to health education development program addressing the role of these predictors in development of microvascular complications among diabetic patient.

Recommendation

Earlier diagnosis and improved management of multiple potential risk factors together with the introduction of novel more predictive module may limit their development and progression. Effective evaluation and monitoring of these predictors in clinical practice is clearly important, however, it is also relevant to health education development program addressing the

role of these predictors in development of micro vascular complications among diabetic patient.

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