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Original research article

A STUDY OF ANGIOGRAPHIC PATTERN IN PATIENTS WITH ACUTE CORONARY SYNDROME WITH DIABETES MELLITUS IN CORRELATION WITH HBA1c LEVELS

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ABSTRACT

Background: Patients with diabetes mellitus (DM), have poor long term glycaemic control, even when fasting glucose concentrations are normal.[3, 4], Glycosylated haemoglobin (HbA1c) is a useful index of glucose intolerance and hyperglycaemia. HbA1c is an established marker of long-term glycaemic control. HbA1c can be assessed in the non-fasted state and has higher reproducibility than fasting glucose

Aim of the study : To study the blood levels of HbA1C in patients of Acute Coronary Syndrome at the time of admission and to find out the correlation with the angiographic pattern.

Materials and methods :Cross sectional study was conducted in the Department of general medicine, at Sundaram Arulrhaj Hospitals Tuticorin, Tamil Nadu in Patients with a confirmed diagnosis of Acute Coronary Syndrome .

Results : Among the people with SVD,18 (100%) participants had<6.5% HbA1c, 27 (56.25%) participants had 6.5-8.5 HbA1c and 8 (36.36%) participants had 8.5 – 10.5 HbA1c. Among the people with DVD,16 (33.33%) participants had 6.5-8.5 HbA1c, 10 (45.45%) participants had 8.5 – 10.5 HbA1c and 3 (25%) participants had >10.5 HbA1c. Among the people with TVD,5 (10.41%) participants had 6.5-8.5 HbA1c, 4 (18.18%) participants had been with 8.5 – 10.5 HbA1c and 9 (75%) participants had>10.5 HbA1c

Conclusion : Our data suggest that HbA1c level is a significant and independent maker for the severity of angiographic lesion in ACS patients, irrespective of other cardiovascular risk factors, age, and gender, smoking, alcoholism. HbA1c values can be a predictor of the prevalence of complex coronary artery lesions. It may be used as a cardiac marker in risk stratification of the patients presenting with acute coronary syndrome and indicated for coronary angiography.HbA1c levels are also to be included in investigations apart from routine Blood sugar levels in Out Patient Clinics and adoption of lifestyle changes & medications are to be taken to prevent the cardiovascular complications and morbidity from Diabetes mellitus.

Key words : HbA1c , Acute coronary syndrome

INTRODUCTION

Diabetes is a metabolic endocrine disorder spreading across the globe like an epidemic and is emerging as a silent killer.[1] It is considered as an important public health problem and one of four priority non-communicable diseases (NCDs) targeted for action in the world. Both the number of cases and the prevalence of diabetes have been steadily increasing over the past few decades.[2]

In patients with diabetes mellitus (DM), there may be poor long term glycaemic control, even when fasting glucose concentrations are normal.[3, 4], Glycosylated haemoglobin (HbA1c) is a useful index of glucose intolerance and hyperglycaemia. HbA1c is an established marker of long-term glycaemic control. HbA1c can be assessed in the non-fasted state and has higher reproducibility than fasting glucose. Elevated HbA1c levels are associated with an increased risk for both microvascular and macrovascular disease.[5] There is consistent evidence that optimal glycaemic control (defined as HbA1c $\leq$7%) results in a lower incidence of microvascular complications in both type 1 and type 2 DM.[6] Moreover, a recent report found that elevated HbA1c levels are also predictive for cardiovascular disease and mortality in patients without DM[7], independent of the fasting glucose value.[8] HbA1c levels may be of prognostic value regarding future cardiovascular disease. Several previous studies have demonstrated positive correlations of HbA1c with mortality and even subclinical cardiovascular disease in subjects without a history of diabetes.[9] Till 1980, diabetes and cardiovascular disease were recognised as separate entities, but the work of seegen et al[10], showed that they both have a greater correlation.

An accurate diagnosis is of great importance for appropriate treatment and estimation of prognosis in patients with Acute coronary syndrome, although the patients history, physical examination and other non-invasive techniques like resting ECG, stress test (TMT), echocardiography, stress thallium imaging are valuable in establishing the diagnosis of myocardial ischemia, the definitive diagnosis of CAHD, its arterial confinement and to assess the severity of stenosis, we require invasive diagnostic modality like coronary angiography. A breakthrough in the field of cardiology came with the introduction of "interventional cardiology" which serves as a diagnostic as well as a therapeutic aid in the management of coronary artery disease.[11] ,[12]Coronary angiography or arteriography remains the 'Gold-standard' technique for diagnosing and evaluating coronary artery disease. There are multiple studies in the past, which have documented different angiographic pattern of coronary artery disease and differences in the severity of CAD, between diabetic and non-diabetic population. But there are very few studies, which have explored the association between HbA1C level and angiographic pattern among the diabetic population.

AIMS AND OBJECTIVES:

To study the blood levels of HbA1C in patients of Acute Coronary Syndrome at the time of admission and to find out the correlation with the angiographic pattern.

MATERIALS AND METHODS

Study site: This study was conducted in the Department of general medicine, at Sundaram Arulrhaj Hospitals Tuticorin, Tamil Nadu

Study population: Patients with a confirmed diagnosis of Acute Coronary Syndrome in the Department of general medicine and cardiology at Sundaram Arulrhaj Hospitals Tuticorin, Tamil Nadu were considered as the study population.

Study design: The current study was a cross sectional study

Sample size:

Sample size was calculated by assuming the proportion of HbA1c level was 24% in TVD as per the study by Srinidhi S. Hegde et al.[10] Considered the maximum difference in proportion of HbA1c level in other CAG (like SVD & DVD) as 20%. The other parameters considered for sample size calculation, included were 80% power of study and 5% two-sided alpha error. The following formula was used for sample size calculation.[83]

$$N = \frac{(u\sqrt{[\pi_1(1-\pi_1) + \pi_0(1-\pi_0)]} + v\sqrt{[2\bar{\pi}(1-\bar{\pi})]})^2}{(\pi_0 - \pi_1)^2}$$

$$\bar{\pi} = \frac{\pi 0 + \pi 1}{2}$$

N	Sample Size
π_1 ,π_0	Proportion (0.24 and 0.44)
u	one-sided percentage point of the normal distribution corresponding to 100 % – the power (if power = 80%, u =0.84)
v	Percentage point of the normal distribution corresponding to the (two-sided) significance level, for significance level of 5%, *v* = 1.96

As per the above mentioned calculation, the required sample size was 86 subjects. To account for a loss to follow up of about 15%, another 14 subjects will be included in each group. Hence the final required sample size would be 100 subjects .

Sampling method: All the eligible subjects were recruited into the study consecutively by convenient sampling till the sample size is reached.

Study duration: The data collection for the study was done between June 2017 to Feb 2019 for a period of 20 months.

Inclusion Criteria:

Patients diagnosed:

- ST-Elevation myocardial infarction as per the criteria for the universal definition of myocardial infarction 2012.
- Unstable angina and Non-ST elevation MI as per the criteria for the definition of UA and NSTEMI.
- Diagnosed cases of Diabetes mellitus.

Known diabetes was defined in the presence medical records documenting past history of DM or past laboratory results compatible with the diagnosis of DM, according to the American Diabetes Association (ADA- 2017) Revised Clinical Practice Guidelines for diabetes diagnosis or if the patient was already informed about the presence of Diabetes by a physician before the admission or was on oral antihyperglycemic agents, insulin, or diet

therapy. The definition of known DM was regardless of the duration of disease or the need for antidiabetic agents.

Criteria for the Diagnosis of Diabetes as per American Diabetes association 2017
Fasting plasma glucose (FPG)≥126 mg/dl (7.0 mmol/L) or
2-h plasma glucose ≥200 mg/dl (11.1 mmol/L) during an OGTT or
A1C>6.5% or
Classic diabetes symptoms + random plasma glucose ≥200 mg/dl (11.1 mmol/L)

Exclusion criteria:

Patients with:

- Haemoglobinopathies
- Severe iron deficiency/vitamin B12 anemia or on iron/vitamin B12 supplements or erythropoietin administration
- Chronic liver Disease
- Chronic kidney disease (GFR <90 ml/min/1.73 $m^{2)}$

Methodology:

A detailed history was taken and patients were examined thoroughly. Written informed consent was obtained from all the patients. HbA1C was done along with other routine investigations & reports were collected & study was conducted based on their Coronary Angiography pattern.

Patients were divided into four classes based on their HbA1c levels
Class with HbA1c levels<6.5%,
Class of patients with HbA1c level 6.5-8.5,
Class of patients with HbA1c level 8.5-10.5
Class of patients with HbA1c level >10.5

These classes were compared with their Angiographic pattern & categorized into those with Normal coronaries, Single vessel disease, Double vessel disease & Triple vessel disease. The severity of lesion was identified based on AHA classification into Type A, B, C lesions.

Data collection tools: All the relevant parameters were documented in a structured study proforma.

Statistical methods:

HbA1c levels and CAG were considered as primary outcome variables. Age, gender, smoker, alcoholic etc., were considered as secondary explanatory variables.

Descriptive analysis: Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Data was also represented using appropriate diagrams like bar diagram and pie diagrams.

The association between categorical explanatory variables and the quantitative outcome was assessed by comparing the mean values. The mean differences along with their 95% CI were presented. ANOVA was used to assess statistical significance.

Categorical outcomes were compared between study groups using Chi square test /Fisher's Exact test (If the overall sample size was < 20 or if the expected number in any one of the cells is < 5, Fisher's exact test was used.). P value < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.[13]

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RESULTS

A total of 100 subjects were included in the final analysis.
The mean age of the participant was 53.19 ± 7.55 in the study population, ranging between 41 to 74 years in the study population (95% CI 51.69 to 57.82).

Among the study population, 39 (39%) participants were aged between 40-50 years, 48 (48%) participants aged between 50-60 years and 13 (13%) participants were aged more than 60 years.

Among the study population,47 (47.00%) participants were male and remaining 53 (53.00%) participants were female.

Among the study papulation, 18 (18%) participants had <6.5 HBA1c, 48 (48%) participants had 6.5 to 8.5 HBA1c, 22 (22%) participants had 8.5 – 10.5 HBA1c and 12 (12%) participants had >10.5 HBA1c

Among the study population, 56 (56%) participants were STEMI, 22 (22%) participants were NSTEMI and 22 (22%) participants were UA

Among the study population, 53 (53%) were with SVD, 29 (29%) were with DVD and 18 (18%) were with TVD
Among the study population, 15 (15%) were with A type, 40 (40%) were with B type, 23 (23%) were with C type, 6 (6%) were with A, B type and 16 (16%) were with B, C type.

Among the study population, 15 (15%) participants were smokers.13 (13%) participants were alcoholic, 29 (29%) participants had hypertension, 62 (62%) participants had dyslipidaemia

The mean DM duration of the participant was 7.03 ± 4.47 in the study population, ranging between 2 to 22 years in the study population (95% CI 6.14 to 7.92).

Among the people with SVD,18 (100%) participants had<6.5% HbA1c, 27 (56.25%) participants had 6.5-8.5 HbA1c and 8 (36.36%) participants had 8.5 – 10.5 HbA1c. Among the people with DVD,16 (33.33%) participants had 6.5-8.5 HbA1c, 10 (45.45%) participants had 8.5 – 10.5 HbA1c and 3 (25%) participants had >10.5 HbA1c. Among the people with TVD,5 (10.41%) participants had 6.5-8.5 HbA1c, 4 (18.18%) participants had been with 8.5 – 10.5 HbA1c and 9 (75%) participants had>10.5 HbA1c.

Among the people with SVD, 13 (24.52%) participants were aged between 40-50 years, 35 (66.03%) participants were aged between 50-60 years and 5 (9.433%) participants were aged above 60 years. Among the people with DVD,14 (48.27%) participants were aged between 40-50 years, 11 (37.93%) participants were aged between 50-60 years and 4 (13.79%) participants were aged above 60 years. Among the people with TVD, 12 (66.66%) participants were aged between 40-50 years, 2 (11.11%) participants were aged between 50-60 years and 4 (22.22%) participants were aged above 60 years. The difference in the proportion of age group across CAG was statistically significant (P value 0.001)
Among the people with SVD,22 (41.50%) participants were male and 31 (58.49%) participants were female. Among the people with DVD,17 (58.62%) participants were male and 12 (41.37%) participants were female. Among the people with TVD, 8 (44.44%) participants were male and 10 (55.55%) participants were female. The difference in the proportion of gender between CAG was statistically not significant (P value 0.323).

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Table 1: Comparison of ACS across CAG (N=100)

ACS	CAG		
	SVD	DVD	TVD
STEMI (N=56)	24 (45.28%)	16 (55.17%)	16 (88.88%)
NSTEMI (N=22)	14 (26.41%)	6 (20.68%)	2 (11.11%)
UA (N=22)	15 (28.30%)	7 (24.13%)	0 (0%)

**No statistical test was applied- due to 0 subjects in the cells*

Among the people with SVD,24 (45.28%) participants had STEMI, 14 (26.41%) participants had NSTEMI and 15 (28.30%) participants had UA. Among the people with DVD,16 (55.17%) participants had STEMI, 6 (20.68%) participants had NSTEMI and 7 (24.13%) participants had UA. Among the people with TVD,16 (88.88%) participants had STEMI and 2 (11.11%) participants had NSTEMI.

Table 2: Comparison of type across cag (N=100)

Type	CAG		
	SVD	DVD	TVD
A (N=15)	15 (28.30%)	0 (0%)	0 (0%)
B (N=40)	19 (35.84%)	18 (62.06%)	3 (16.66%)
C (N=23)	6 (11.32%)	6 (20.68%)	11 (61.11%)
A, B (N=6)	6 (11.32%)	0 (0%)	0 (0%)
B, C (N=16)	7 (13.20%)	5 (17.24%)	4 (22.22%)

**No statistical test was applied- due to 0 subjects in the cells*

Among the people with SVD,15 (28.30%) participants had type A, 19 (35.84%) participants had type B, 6 (11.32%) participants had type C, 6 (11.32%) participants had type A, B and 7 (13.20%) participants had type B, C. Among the people with DVD,18 (62.06%) participants had type B, 6 (20.68%) participants had type C, and 5 (17.24%) participants had type B, C. Among the people with TVD,3 (16.66%) participants had type B, 11 (61.11%) participants had type C, and 4 (22.22%) participants had type B, C.

Among the people with SVD,5 (9.433%) participants were smokers. Among the people with DVD,7 (24.13%) participants were smokers. among the people with TVD, 3 (16.66%) participants were smokers. The difference in the proportion of smoker across CAG was statistically not significant (P value 0.199).

Among the people with SVD,5 (9.4%) participants were alcoholic. Among the people with DVD,6 (20.7%) participants were alcoholic. Among the people with TVD,2 (11.1%) participants were alcoholic. The difference in the proportion of alcoholic across CAG was statistically not significant (P value 0.338).

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Among the people with SVD, 16 (30.18%) participants had hypertension. Among the people with DVD,10 (34.48%) participants had hypertension. Among the people with TVD,3 (16.66%) participants had hypertension. The difference in the proportion of hypertension across CAG was statistically not significant (P value 0.409).

Among the people with SVD,34 (64.15%) participants had dyslipidaemia. Among the people with DVD,16 (55.17%) participants had dyslipidaemia. Among the people with TVD,12 (66.66%) participants had dyslipidaemia. The difference in the proportion of dyslipidaemia across CAG was statistically not significant (P value 0.656).

Table 3: Comparison of mean DM duration (in years) across the study groups (N=100)

CAG	DM Duration (in years) Mean ± SD	Mean difference	95% CI		P value
			Lower	Upper	
SVD	5.53 ± 3.02				
DVD	8.79 ± 4.92	3.265*	1.33	5.20	0.001
TVD	8.61 ± 5.79	3.083*	0.80	5.36	0.009

The mean DM duration was5.53 ± 3.02 yrs in SVD, it was 8.79 ± 4.92 in DVD and it was 8.61 ± 5.79 yrs in TVD. Taking SVD as base line, the mean difference of DM duration between CAG in DVD (3.265) and in TVD (3.083) was statistically significant (P value <0.05). (Table 23).

Table 4: Comparison of type across hba1c (N=78)

Type	HBA1c			
	<6.5% (N=16)	6.5-8.5 (N=40)	8.5-10.5 (N=12)	>10.5 (N=10)
A	15 (93.75%)	0 (0%)	0 (0%)	0 (0%)
B	1 (6.25%)	36 (90%)	3 (25%)	0 (0%)
C	0 (0%)	4 (10%)	9 (75%)	10 (100%)

**No statistical test was applied- due to 0 subjects in the cells*

Among the <6.5% HBA1c, 15 (93.75%) participants were with type A and 1 (6.25%) participants were with type B. Among the 6.5-8.5 HBA1c, 36 (90%) participants were with type B and 4 (10%) participants were with type C. Among the 8.5 to 10.5 HBA1c 3 (25%) participants were with type B and 9 (75%) participants were with type c. Among the >10.5 HBA1c, 10 (100%) participants were with type c. (Table 24)

DISCUSSION

Coronary heart disease (CHD) is the main cause of morbidity and mortality in developed countries and the prevalence is increasing in developing countries. Cardiovascular diseases including CAD are more common among diabetics than among non-diabetics. HbA1c is a useful index of glucose intolerance and hyperglycaemia, even when fasting glucose concentrations are normal[3, 4], we conducted a cross sectional study to evaluate the blood

levels of HbA1C in patients of Acute Coronary Syndrome at time of admission and to find out the correlation of HbA1C levels with the angiographic pattern.

With respect to age, the studies are controversial. In some of them, diabetic patients with CHD are older[14], whereas in others the age is similar .[15] This finding should be interpreted cautiously, because diabetes is associated with older age, and this in turn, to a higher prevalence of CHD, especially in women. Singer DE[16], observed in their study that, diabetics were older and noted that females are commonly affected with cardiovascular disease, which agrees with our study. Diabetes mellitus is linked to a poorer outcome in patients with coronary atherosclerotic disease, especially in women. Stein et al [17]demonstrated that, in patients who underwent angioplasty, the presence of diabetes was related to a poorer prognosis.

In our study, 82% of patients with ACS had HbA1C levels > 6.5%, but the data on the prognostic role of HbA1c in patients with acute MI are still controversial. Similar results were reported by Girdhar et al.[18] Saleem et al[19] demonstrated that HbA1C is an independent factor influencing the severity of CAD. On the contrary, Lazzeri et al[20], showed that patients with HbA1c levels higher than 6.5% did not show a higher infarct size (as indicated by troponin I and left ventricular ejection fraction) or a more critical illness
There is an association between the percentage of glycosylated hemoglobin and the number of diseased vessels. In our study SVD (53%) was most common than DVD(29%) or TVD(18%), Souse et al[21], reported that in their study, diabetic patients more frequently had more three-vessel disease and less frequently single-vessel disease. Patients with <6.5% HbA1C had only single vessel disease, whereas those with HbA1C >6.5% were found to suffer from either DVD or TVD. These findings suggest that poorly controlled diabetics as depicted by HBA1C of >6.5%, is associated with multivessel disease in known diabetic patients presenting with ACS.

Similar results were obtained by the study done by Giridhar et al [18], they demonstrated that diabetic patients had a higher prevalence of three-vessel disease (TVD) (32.78% versus 26.19%) and lower prevalence of single vessel disease (SVD) (26.24% versus 33.33%).Sousa JM et al[22], showed severe three-vessel disease was significantly more frequent in diabetic patients (28% x10%). A study by Ikeda N et al[23], indicated that HBA1C values are associated with coronary lesion complexity. cakmak M et al[24], also demonstrated a significant association between elevated HBA1C levels and a number of diseased vessels in AMI patients. Another Indian study Hegde, S. S. et al.[10] had compared the angiographic profile of diabetic and non-diabetic patients among patients presenting with the acute coronary syndrome. Among diabetic patients, 44% had the triple or multi-vessel disease compared to 16% of non-diabetics. Another study by Uddin, S. N. et al[25], had reported similar findings, Type 2 diabetic patients had a higher CAS (11.74+/-5.04 vs 8.72+/-4.87; P<0.001) as compared to the non-diabetic patients. The multivessel disease was more prevalent in both the groups (82% vs 68%; P>0.05) but diabetic patients had a significantly higher number of triple vessel disease (58% vs. 38%; P<0.001). Normal coronary arteries and single vessel disease were more prevalent in non-diabetic patients (32% vs. 18%; P<0.05). As compared to non-diabetic group diabetic patients had a higher total number of diseased vessels (78.66% vs. 68%; P<0.01). Morphometric analysis of coronary artery lesions revealed that diabetic patients had a significantly higher number of multiple irregularity lesions (24.37% vs. 15.33%; P<0.01) and lesions were more obstructive (lesion involving 70-90% of coronary lumen: 70.53. % vs. 57.33%; P<0.05).

In our study all those who had HbA1C< 6.5% had single vessel disease. It is well known that the macro vascular complications start taking place at lower blood sugar levels than the diagnostic cut off values for diabetics. Khaw et al[8], found a continuous and significant relationship between HbA1C and cardiovascular events. A 1% increase in absolute concentrations of glycated haemoglobin is associated with about 10-20% increase in cardiovascular disease risk. Similar results were obtained by Vora SD et al[26], among patients with HbA1C < 6.5, the maximum number of patients were having single vessel disease. A significant increasing trend of HbA1c level over the increasing number of significantly stenotic coronary vessels was found in our study which is in comparison with the study done by Ravipati et al.[27]

The relationship between glycemic control and coronary atherosclerosis is not a simple one. There are many unmeasured potentially important covariates that may play a role. Maybe, for example, the duration of the diabetic process leads to both worse coronary atherosclerosis and higher HbA1c. In our study, the incidence of MVD was significantly higher with the duration of diabetes >8 years. These findings correlate with the other study by Fox et al[28], showing that the risk of coronary heart disease increases with increase in the duration of DM. Incidence of triple / multi vessel disease was significantly higher with the duration of diabetes >10 years as reported by Hegde et al.[10] In this study, among people with HbA1c levels of >8.5%, 69.2% had triple/multi vessel disease and 73.1% of patients who had to undergo CABG had HbA1c levels >8.5%.

Concerning risk factors, the present study showed no significant effect of hypertension, dyslipidaemia, smoking, alcohol intake on risk of cardiovascular disease. The principal findings of our study indicate that HbA1c values are associated with coronary lesion Complexity. The patients in the lowest HbA1C quartile had a distinctly lower risk of complex coronary artery disease. More the levels of HbA1C more severe are the type of lesions. In our study, those patients with HbA1C <6.5% have type A, B lesions, whereas those with HbA1C >6.5% have type B and C lesions. Ikeda et al[23], found that HbA1c is an independent predictor of the prevalence of complex coronary artery lesions. Diabetes mellitus is linked to poorer prognosis in patients with coronary atherosclerotic disease. Not only the angiographic pattern, But HbA1C level has also been reported to be associated with severity of coronary artery disease as reported by Syntax score by many previous studies. In a study by Hegde et al[10], among people with HbA1c levels of >8.5%, 69.2% had triple/multi vessel disease and 73.1% of patients who had to undergo CABG had HbA1c levels >8.5%. In another study Won, K. B et al[29], have reported serum Advanced Glycated End products (AGEs), which are consequences of high HbA1C levels, to be higher among diabetics with obstructive CAD than in those without obstructive CAD (2.16+/-0.29 vs. 1.85+/-0.29 mU/mL, p=0.010) and were significantly correlated with the number of vessels involved. The authors of this study have also reported the AGEs to be highly useful predictors of obstructive CAD. with 64% sensitivity and 63% specificity among the diabetic population.

CONCLUSION:

The present study demonstrated that the severity and extend of coronary artery disease and triple/multiple vessel disease was significantly high in long standing diabetics and those with high HbA1C levels. The severity of Coronary Artery disease (CAD), was also found to be directly related to the quality of glucose control in Diabetic patients. Patients with poor glycemic control with elevated levels of HbA1c had diffuse(Type C) pattern of atherosclerotic disease. With good control of HbA1c there was only type A, type B pattern of atherosclerotic disease seen.

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Our data suggest that HbA1c level is a significant and independent maker for the severity of angiographic lesion in ACS patients, irrespective of other cardiovascular risk factors, age, and gender, smoking, alcoholism. HbA1c values can be a predictor of the prevalence of complex coronary artery lesions. It may be used as a cardiac marker in risk stratification of the patients presenting with acute coronary syndrome and indicated for coronary angiography.

HbA1c levels are also to be included in investigations apart from routine Blood sugar levels in Out Patient Clinics and adoption of lifestyle changes & medications are to be taken to prevent the cardiovascular complications and morbidity from Diabetes mellitus.

Nevertheless, because HbA1c appears to be an independent predictor comparable in magnitude with classical cardiovascular risk factors, it may be a useful indicator of people at greatest absolute risk of cardiovascular disease. Whether HbA1c should be added to cardiovascular risk prediction charts will require further evidence from prospective studies as to whether and how much it adds to risk prediction over and above conventional factors.

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