# Outcome of Diabetic and Non-Diabetic Patients who Underwent Coronary Artery Bypass Graft Surgery (CABG) at Chinese General Hospital and Medical Center from January 2010 to December 2016

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## Abstract

**Introduction:** Several studies have shown that diabetes mellitus increases the risk of having adverse events after CABG. This study was conducted to compare outcome of diabetic and non-diabetic patients after CABG and to test if diabetes mellitus is the strongest predictor of adverse outcomes.

**Methods:** This is a retrospective cohort study using charts review of CABG patients from January 2010 to December 2016. Odds ratio were computed to evaluate which risk factors have the strongest association with the occurrence of complications and mortality after CABG.

**Results:** Our study population consists 107 non-diabetic (48%) and 114 diabetic (52%) patients. Diabetic patients have higher post-operative complications at 47% (54) than non-diabetics with 30.8% (33/107) (*p*-0.012). The most significant risk factor for complication occurrence was hypertension (*p*-0.015) (OR: 4.123). Every year added above 37 years old has a corresponding six percent increase in the odds of developing morbidity for both groups (*p*-0.001, OR: 1.06). Advanced age (*p*-0.000) (OR: 1.07), male gender (*p*-0.030) (OR: 3.10) and diabetes (*p*-0.043) (OR: 0.043) increase the risk of arrhythmia. The odds of developing pneumonia is higher among males (*p*-0.005) (OR:0.18) and smokers (*p*-0.041)(OR: 3.50) in both groups. The odds of developing acute kidney injury was increased by 12% for every year added above 37 years old (*p*-0.035)(OR: 1.12).There is a two percent increase risk for developing acute kidney injury for mean post operative blood glucose above 110mg/dL (*p*-0.030) (OR: 1,025).

**Discussion:** Hypertension and age are significant predictors of morbidity in this study. Age related changes in cardiac physiology can be contributory. Male smokers have a higher risk of developing pneumonia in both groups pointing the significance of this risk factor. Elevated post-operative blood glucose must be addressed fully because of its association with acute kidney injury.

**Conclusion:** More complications are encountered among diabetic patients. However, diabetes mellitus is not the strongest predictor of mortality. Instead, age and hypertension showed higher association with adverse outcome.

**Keywords:** coronary artery bypass graft surgery, diabetes mellitus,

## Introduction

The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030.[1] Diabetes ranked six as the leading cause of death in the Philippines.[2] Patients with diabetes are at high risk for coronary artery disease.[3] Therefore, it is not surprising that the number of patients presenting for coronary artery bypass grafting (CABG) who have diabetes is also on the rise. The proportion of patients undergoing coronary surgery who had diabetes drastically increased from 7% in the 1970s to 40% in 2010.[4]

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While multiple studies[12, 29] have proven that diabetic patients have poorer prognosis than non- Diabetic patients, this study aims to test if Diabetes is the strongest predictor of adverse outcome. Moreover, this study aims to determine the relationship of other risk factors to the occurrence of complications after CABG. Furthermore, no local studies have been done on the outcome of CABG among Diabetic and Non Diabetic patients, thus this study. The general objective of this study is to compare the outcome of diabetic and non-diabetic patients who underwent CABG.

The general objective of this study is to compare the outcome of diabetic and non-diabetic patients who underwent CABG at Chinese General Hospital from January 2010 to December 2016.

The specific objectives are the following:

1. To compare the prevalence of post-operative complications of diabetic and non-diabetic patients who underwent CABG specifically the following:
   a. sternal wound infection
   b. pneumonia
   c. cardiac arrhythmia
   d. acute kidney injury
   e. myocardial infarction
   f. acute stroke
2. To compare the mortality rate of diabetic and non-diabetic patients
3. To compare the median total length of hospital and telemetry stay in terms of days among diabetic and non-diabetic patients.
4. To determine if diabetes is the strongest predictor of adverse events
5. To determine the relationship of the following risk factors: age, sex, history of hypertension, diabetes and smoking to the occurrence of complications and mortality after CABG.
6. To determine the relationship of elevated mean intraoperative blood sugar and postoperative blood sugar level to the occurrence of complications and mortality after CABG among diabetic patients.

## Methods

This is a retrospective cohort study using records review. All patients who underwent CABG from January 2010 to December 2016 at Chinese General Hospital and Medical Center were analyzed.

Subjects included in the study are: a) patients age 18 years old and above; b.) admitted for CABG with no underwent concurrent cardiac or noncardiac surgery; c.) angiogram showing ≥1 vessel CAD; d.) diagnosed Type 1 and Type 2 diabetic patients or on anti diabetic medications; and e.)patient with history of prior MI, post PTCA

Subjects excluded in the study are those who: a.) concurrent valve surgery and CABG; b.) diagnosed ESRD on chronic hemodialysis or peritoneal dialysis; c.) had emergent operation; d.) presence of sepsis, liver failure, pneumonia pre-operative; e.) recent stroke (<24 hours); and f.) incomplete patient profile

For a population of 221, with 5% margin of error and proportion of 50%, the minimum sample size is 141. The patients' charts conforming to the inclusion criteria were reviewed and classified. Then, the data collection sheet was filled out according to the information of their profiles. Finally, the obtained data were statistically analyzed. The samples included in the study were collected from filed charts of patients who underwent CABG at Chinese General Hospital.

Descriptive statistics for nominal variables like sternal wound infection, arrhythmia, pneumonia, stroke, and acute kidney injury was derived using frequency and percentage tables via cross tabulation approach. Tabulations were done using MS Excel 2013 and the modeling procedures were done using STATA 14.0.

Median was used to determine the central tendencies for ratio variables such as telemetry and hospital stay. To determine relationship of risk factors (age, gender, history of hypertension and smoking) to morbidity and mortality, odds ratios were computed. Odds ratios were derived through the use of logistic models to account for other variable effects. Level of confidence was placed at 95%.

The research protocol was approved by the Research Ethics Review Board of the Chinese General Hospital (CGHMC RERB 2017-R-144). The identities of all participants are protected and were recorded on the forms without any personal information or case number. Information from the patients' charts was treated with utmost confidentiality.

**Definition of terms and variables**

Definitions for some baseline data were based on the Society of Thoracic Surgeons National Database 2017 and KDIGO 2017 Clinical Practice Guidelines

- Type 2 diabetes mellitus - documented based on history, regardless of duration or need for antiglycemic medications
- Pre-existing arrhythmia - refers to history of atrial fibrillation documented on pre-operative ECG
- Chronic kidney disease - estimated GFR <60 ml/min
- Ejection fraction - refers to percent cardiac output determined through echocardiography
- Left main disease – indicates narrowing of the diameter of the lumen by more than or equal to 50% in the left main coronary artery
- Three vessel CAD - indicates involvement of three coronary vessels determined through coronary angiography
- Length of stay at telemetry- the number of days the patient stayed at telemetry
- Length of hospital stay- refers to the total number of days from hospital admission to discharge
- Mortality- this means that the patient died during the hospitalization in which CABG was performed
- Morbidity - refers to post-operative complications as follows:
  1. Acute Kidney injury- indicates acute renal failure in which the serum creatinine increased to 0.3 mg/dl or 50% increase of creatinine from baseline
  2. Myocardial infarction- indicates a creatinine kinase MB elevation 5 or more times the upper limit of normal and presence of Q waves in two or more contiguous ECG leads during the initial 24 postoperative hours, or evolutionary ST segment changes or new left bundle branch block or the aforementioned criteria after the initial 24 postoperative hours.
  3. Acute stroke - is a central neurologic deficits

persisting more than 72 hours, or transient ischemic attack in which the deficit is resolving within 24 hrs.

4. Arrhythmia- refers to new onset atrial fibrillation or flutter, ventricular tachycardia in the post-operative setting.

5. Pneumonia- refers to new pneumonic infiltrates seen on chest X ray post operatively.

6. Sternal wound infection- wound infection of either to the subcutaneous tissue, bone and mediastinum

- Mean intraoperative blood glucose- average blood glucose at CVOR and CVRR
- Mean postoperative blood glucose-average blood glucose in the first three days after CABG

## Results

Two hundred fifty four patients underwent CABG from January 2010 to June 2017. There were 221 patients analyzed for the study. Thirty-three were excluded due to incomplete records and performance of simultaneous CABG and valve surgery. (Table I)

Shown in Table II are the prevalence rates of sternal wound infection, pneumonia, cardiac arrhythmia, acute kidney injury, myocardial infarction and acute stroke and mortality in CABG patients (n=221).

Subsequent tables will show the relationships of mean perioperative blood glucose level and the occurrence of complications and mortality among diabetic patients.

## Discussion

In the present study, 221 patients consisting of 107 non-diabetic (48%) and 114 diabetic (52%) patients. Diabetic patients have higher post-operative complications at 47% (54) than non-diabetics with 30.8% (33/107) (*p*-0.012). Various studies have shown that diabetes is associated with higher morbidity and mortality. This was observed in the study of Whang et al. showing diabetes has increased post-operative complications and re-hospitalization.[11]

The total mortality rate in this study is low at 0.9% observed only among diabetic patients. Mortality rate was lower compared to previous studies, but population size of this study is smaller. Rate of mortality was reported to be at 2.2% in 877 diabetic patients and one percent in 4,382 non-diabetic patients by Rajakaruna.[12] In our study, most common complication observed is cardiac arrhythmia at 31.7% (n=70), which is higher among diabetics than non-diabetics (39% vs. 23%, *p*-0.010).

Occurrence of acute stroke and sternal wound infection do not show any statistical significance. They were observed only in patients with diabetes. No incidence of myocardial infarction was observed in this study. Conducting this study in a larger population is recommended.

In this study, mortality rate of diabetic patients was low at 1.8%. The presence of complications can influence the length of admission in the telemetry and total hospital stay. This implies additional costs for the patient and family. Study by Kubal et al.[18] demonstrated that diabetic patients have higher length of hospital stay. However, our study showed no significant difference in the days of telemetry stay and total hospital stay for both groups. A study from Koochemeshki V, et al.[10] showed no significant difference between diabetics and non-diabetics concerning the length of ICU stay (day) and length of hospital stay (day). There could be other factors that could influence patients' hospital stay aside from presence of complications. Additional factors may be considered such as the need for continued cardiac rehab, failed to settle bills and admission due to acute coronary syndrome and subsequent CABG. According to the study of Koochemeshki V, et al.[10] female gender, smoking, renal complications, reoperation, readmitting, reintubation, and rising operation time predicted the postoperative length of hospital stay >10 days. This reaffirms that presence of diabetes does not automatically predict longer hospital stay after CABG.

This study conformed to previous studies, which showed that Diabetic patients have higher prevalence of complications. Thourani et al.[27] showed that diabetes is an independent risk factor for significant morbidity. However, our study showed that the primary predictors for overall morbidity were age and hypertension. Diabetes did not add to overall morbidity. Though the risk of developing cardiac arrhythmia (*p*-0.043) (OR: 0.043) is higher among diabetics, it did not show similar findings for pneumonia and acute kidney injury. On logistic regression analysis, diabetes was not found to be a predictor of mortality. Study of Filsoufi et al.[28] demonstrated that Diabetes was not an independent predictor of hospital mortality after CABG. Decrease of mortality in diabetic patients is most likely multifactorial, owing mainly to improvements in peri-operative management of cardiac surgery patients. Furnary et al.[25] have reported that maintaining glucose level in the range of 100–150 mg/dl decreased mortality in their study group (2.5% vs. 5.3%, *P*<0.001). However, in our study perioperative management of blood glucose did not influence outcome of CABG except for occurrence of acute kidney injury.

Age is a significant predictor of morbidity. For every year added above 37 years old, the odds of developing morbidity were six percent. This study affirms previous studies that advancing age is a risk factor for poor outcome in CABG patients. A study by Natarajan explained that this is due to age related changes in cardiac physiology.[13] Older people may not show signs of impaired hemodynamics, but stresses of surgery and anesthesia may uncover such limited

**Table I.** Patients' demographics

| Characteristic | Without diabetes 49% (n=107) | With diabetes 51% (n=114) | Total (n=221) | *p*-value |
|---|---|---|---|---|
| Age > 65 | 33.64 (36) | 42.98 (49) | 38.46 (85) | 0.154 |
| Male | 83.18 (89) | 82.46 (94) | 82.81 (183) | 0.887 |
| BMI ≥25 | 51.40 (55) | 64.04 (73) | 57.92 (128) | 0.057 |
| With history of hypertension | 86.92 (93) | 85.09 (97) | 85.97 (190) | 0.695 |
| With pre-existing arrhythmia | 2.80 (3) | 6.14 (7) | 4.52 (10) | 0.233 |
| With history of smoking | 57.94 (62) | 50.00 (57) | 53.85 (119) | 0.236 |
| LVEF | | | | |
| < 20% | 1.87 (2) | 0.88 (1) | 1.36 (3) | 0.524 |
| 20%-30% | 3.74 (4) | 6.14 (7) | 4.98 (11) | 0.412 |
| >30% | 94.39 (101) | 92.98 (106) | 93.67 (207) | 0.667 |
| LMD | | | | |
| ≥50% stenosis | 42.06 (45) | 66.67 (76) | 54.75 (121) | 0.0002* |
| 3 Vessel CAD | 85.05 (91) | 92.98 (106) | 89.14 (197) | 0.0581 |
| EGFR < 60 ml/min | 14.00 (15) | 37.00 (42) | 26.00 (57) | 0.0001* |

**BMI, Body Mass Index; LVEF, Left Ventricular Ejection Fraction; LMD, Left Main Disease, narrowing of left main artery ≥ 50%. EGFR, estimated glomerular filtration rate*

**Table II.** Prevalence of morbidity and mortality of patients after CABG

| Outcome | Total N (%) | With Type 2 DM n (%) | Without Type 2 DM n (%) | *p*-value |
|---|---|---|---|---|
| Morbidity | 87(39.4) | 54(47.4) | 33(30.8) | 0.012* |
| Sternal wound infection | 2(0.9) | 2(1.8) | 0(0) | 0.169 |
| Pneumonia | 19(8.6) | 8 (7) | 11(10.4) | 0.387 |
| Cardiac arrhythmia | 70(31.7) | 45(39.5) | 25(23.4) | 0.010* |
| Acute kidney injury | 11(5) | 10(8.8) | 1(0.9) | 0.007* |
| Myocardial infarction | 0(0) | 0(0) | 0(0) | - |
| Acute stroke | 2(0.9) | 2(1.8) | 0(0) | 0.168 |
| Mortality | 2(0.9) | 2(1.8) | 0(0) | 0.168 |

**p-value <0.05*

**Table III.** Risk factors and the occurrence of morbidity & mortality in CABG patients

| Risk factors | Morbidity | | Mortality | |
|---|---|---|---|---|
| | Odds ratio | *P*-value | Odds ratio | *P*-value |
| Age (for every year added above 37 years old) | 1.060 | 0.001* | 1.724 | 0.094 |
| Male | 1.593 | 0.284 | omitted | omitted |
| BMI (for every unit increased in kg/m$^2$ above 16.9kg/m$^2$) | 0.952 | 0.218 | 2.101 | 0.224 |
| History of hypertension | 4.123 | 0.015* | omitted | omitted |
| With pre-existing arrhythmia | omitted | omitted | omitted | omitted |
| With diabetes | 1.832 | 0.061 | omitted | omitted |
| With chronic kidney disease (EGFR <60 ml/min) | 1.432 | 0.325 | 0.058 | 0.112 |
| History of smoking | 1.354 | 0.343 | 0.834 | 0.924 |

** significant at α = 0.05*

*Omitted, all mortalities are male, hypertensive, diabetic and with pre existing arrhythmia; all morbidities have pre existing arrhythmia*

**Table IV.** Risk factors associated with the occurrence of cardiac arrhythmia, pneumonia and acute kidney injury

| Risk factors | Cardiac arrhythmia | | Pneumonia | | Acute kidney injury | |
|---|---|---|---|---|---|---|
| | Odds ratio | *P*-value | Odds ratio | *P*-value | Odds ratio | *P*-value |
| Age (for every year added above 37 years old) | 1.075 | 0.000* | 1.022 | 0.434 | 1.120 | 0.035* |
| Male | 3.105 | 0.030* | 0.186 | 0.005* | 0.402 | 0.352 |
| BMI (for every unit increased in kg/m2 above 16.9kg/m$^2$) | 0.927 | 0.100 | 0.954 | 0.461 | 1.133 | 0.074 |
| History of hypertension | 2.719 | 0.092 | omitted | omitted | 0.908 | 0.937 |
| With pre-existing arrhythmia | omitted | omitted | 1.123 | 0.920 | 2.804 | 0.312 |
| With diabetes | 2.052 | 0.043* | 0.496 | 0.198 | 8.495 | 0.062 |
| With chronic kidney disease (EGFR <60 ml/min) | 1.163 | 0.696 | 2.636 | 0.088 | 4.358 | 0.055 |
| History of smoking | 0.935 | 0.845 | 3.507 | 0.041* | 4.390 | 0.086 |

** significant at α = 0.05*

*Omitted, all patients who develop pneumonia are hypertensive, all patients with pre-existing arrhythmia have persistence of arrhythmia post CABG*

**Table V.** Risk factors associated with the occurrence of sternal wound infection and acute stroke

| Risk factors | Sternal wound infection | | Acute stroke | |
|---|---|---|---|---|
| | Odds ratio | *P*-value | Odds ratio | *P*-value |
| Age (for every year added above 37 years old) | 1.078 | 0.431 | 1.006 | 0.957 |
| Male | omitted | omitted | 0.050 | 0.156 |
| BMI (for every unit increased in kg/m$^2$ above 16.9kg/m$^2$) | 0.790 | 0.338 | 1.377 | 0.163 |
| History of hypertension | omitted | omitted | omitted | omitted |
| With pre-existing arrhythmia | omitted | omitted | omitted | omitted |
| With diabetes | omitted | omitted | omitted | omitted |
| With chronic kidney disease (EGFR <60 ml/min) | 1.242 | 0.886 | 1.964 | 0.680 |
| History of smoking | 0.904 | 0.946 | 3.986 | 0.482 |

** significant at α = 0.05*

*Omitted, female gender, absence of hypertension, arrhythmia, and diabetes did not develop sternal wound infection,all patients who develop acute stroke were hypertensive, diabetic, and with pre-existing arrhythmia*

**Table VI.** Telemetry and hospital stay

| Length of days | Without diabetes | With diabetes | *p*-value |
|---|---|---|---|
| Telemetry (2-8) | 3 days | 3 days | 0.465 |
| Total hospital stay (7-26) | 9 days | 9 days | 0.377 |

**Table VII.** Relationship of mean intraoperative and postoperative blood sugar level to the occurrence of complications in diabetic patients

| | Mean blood glucose level | |
|---|---|---|
| | Intraoperative blood glucose | Postoperative blood glucose |
| Cardiac arrhythmia | | |
| Odds ratio | 0.99 | 1.00 |
| *P*-value | 0.75 | 0.491 |
| Pneumonia | | |
| Odds ratio | 1.021 | 1.003 |
| *P*-value | 0.080 | 0.771 |
| Acute kidney injury | | |
| Odds ratio | 1.011 | 0.376 |
| *P*-value | 1.025 | 0.030 |
| Acute stroke | | |
| Odds ratio | 0.71 | 0.98 |
| *P*-value | 0.22 | 0.77 |
| Wound infection | | |
| Odds ratio | 0.00 | - |
| *P*-value | 7.00 | - |
| Morbidity | | |
| Odds ratio | 0.997 | 0.98 |
| *P*-value | 0.22 | 0.77 |
| Wound Infection | | |
| Odds ratio | 0.081 | - |
| *P*-value | 28.00 | - |

Table VIII. **Relationship of mean intraoperative and postoperative blood sugar level to the telemetry and total hospital stay among diabetic patients**

| Mean blood glucose level | Telemetry stay | | Total hospital stay | |
|---|---|---|---|---|
| | Coefficient | *P*-value | Coefficient | *P*-value |
| Intraoperative blood glucose | 0.0004 | 0.80 | 0.000 | 0.87 |
| Postoperative blood glucose | 0.0001 | 0.91 | 0.001 | 0.23 |

cardiac reserve. Similar finding was shown in previous study Zacek et al. which showed a higher mortality and associated morbidity in patients >70 years old. This can be caused by higher preoperative prevalence of known risk factors as well as generally reduced vital capacity among older subjects.[22] Every year added above 37 years old has a corresponding six percent increase in the odds of developing morbidity for both groups (*p*-0.001, OR: 1.06). Advanced age (*p*-0.000) (OR: 1.07), increases the risk of arrhythmia. The odds of developing acute kidney injury were increased by 12% for every year added above 37 years old (*p*-0.035) (OR: 1.12). The odds of having kidney injury increase by 12% for each year added above 37 years old (Table IV). Aging kidneys contribute to declining renal function. Elderly patients are prone to hypovolemia and pre renal azotemia.

We demonstrated in this study that male patients will likely develop pneumonia with the odds of 81% (Table IV). The risk increases by 250% if they are smokers. Majority of the smokers are male and majority of our patients who smoke are non-diabetics. However, pulmonary status and history of COPD were not obtained in this study. Pre-existing pulmonary status might also influence the vulnerability to pneumonia. We have found out that diabetes does not predict occurrence of pneumonia. The odds to develop pneumonia for male smokers are the same for diabetic and non-diabetics. There are other factors that can contribute to pneumonia post CABG. Study of El Sohl et al. demonstrated several factors in elderly that can contribute to nosocomial pneumonia which include, reintubation, transfusion, and mean daily dose of morphine.[16] However, such risk factors were not evaluated in this study. Male gender (*p*-0.030) (OR: 3.10) increases risk for cardiac arrhythmia.

Hypertension is a modifiable risk factor for hospital morbidity. In our study, hypertension significantly increased the odds of developing morbidity by 312.3%. This finding affirmed the study of Vavlukus et al.[14] Similar finding was seen by Hossain et al, that hypertension increases the risk for developing complications after CABG.[23] Hypertension revealed to be one of the prognostic factors for in hospital mortality after CABG.[24] This finding does not support the hypothesis that Diabetes is the strongest predictor of adverse events after CABG.

In our study, diabetes significantly predict occurrence of cardiac arrhythmia post-operative. The risk increases by 105% in diabetic patients compared with non-diabetics. This could be explained by the link of autonomic dysfunction to diabetes in developing cardiac arrhythmia. This study supports the findings of Galante et al. which showed that

cardiac arrhythmia was more frequent in diabetic patients (42.4%) compared with non-diabetics.[15] During CABG, myocardial metabolism is altered by both the ischemic and diabetic pathologic states. Insulin deficiency promotes utilization of free fatty acids and inhibit glycolysis. Ischemic cardiac muscles will have to obtain majority of energy required from free fatty acid (FFA) metabolism. FFAs and their partially oxidized intermediates accumulate and are known to decrease contractility and increase the incidence of ventricular arrhythmias.[25] In contrast, Koohemishki et al. demonstrated that there is no significant increase in the incidence of arrhythmia among the two groups. This can be explained by multiple factors that can influence the occurrence of cardiac arrhythmia such as hypertension, dyslipidemia and electrolyte abnormalities aside from the presence of diabetes.[10]

According to Koohemeshki et al.,[10] there is a significant association between diabetes and renal complication. Rajakaruna et al.[12] and Szabo et al.[29] also identified diabetes as independent predictor of renal failure (OR=1.6 and 1.8, respectively).Though diabetes is a major risk factor for CKD and subsequent acute kidney injury after surgery, in this study it did not reach statistical significance. We need to consider other factors like low cardiac output syndrome in post CABG that can cause renal ischemia and can lead to acute kidney injury. Thus, presence of diabetes does not automatically confer increased risk of acute kidney injury after CABG.

This study showed that mean perioperative blood sugar has lesser influence to the occurrence of complications and mortality. In the study of Szekely et al.[17], hyperglycemia was not associated with mortality among diabetic patients. In our study, only the occurrence of acute kidney injury was associated with elevated mean postoperative blood sugar level. For every unit increase above 110 mg/dL, there was an increased risk of two percent. Similar result was provided by Mc Alister[18] that average blood sugar during the first post op day was associated with adverse outcome. He added that there was a 17% increase risk for adverse outcome for each mmol/L increased above 6.1mmol/L in the post-operative blood glucose. The renal complications can be due to dehydration and electrolyte disturbances resulting from uncontrolled hyperglycemia.[26] Furnary et al.[25] shows a highly significant relationship ($P$<.001) between mortality and postoperative glucose levels rising above 175 mg/dL. However, in this study it was not demonstrated.

Among the risk factors, the strongest predictors for overall morbidity were hypertension and age. Apparently, hypertension is a modifiable risk factor, thus addressing such risk factor should be carried out with further effort. Though age is a predictor of adverse outcome after CABG, the said procedure should not be withheld in patients who would benefit it most. Proper risk evaluation and careful pre-operative preparation should be conducted in these subjects. A study[30] demonstrated that long term survival of these patients was good after CABG. According to Likosky et al.,[30] among patients 80 to 84 years old, median survival time was 7.4 years, with an annual incidence rate of death of 10.3% after CABG. For patients aged 85 or more years, median survival was 5.8 years, and the annual incidence of death was 13.7% after CABG. We have shown that the prevalence of post-operative complications was higher among diabetics than the non-diabetics. Nevertheless, our study showed that diabetes did not add to overall morbidity. Results showed that diabetes is not the strongest predictor of adverse events. This can be explained by the presence of confounding factors that contribute to poorer outcome. The study of Tsuneyoshi et al.[31] revealed that presence of certain risk factors among diabetics confer poorer prognosis. These include old age, presence of peripheral vascular diseases, and the severity of carotid atherosclerosis. Thus, Diabetes does not out rightly confer poorer outcome. Other risk factors need to be equally accounted for adverse outcome after CABG.

**Limitations**

This study had limitations. It is a single centered, retrospective study using charts review. Medical history was limited, thus other significant confounders were not included in the study. Data were collected from the medical records and relied on the notes from the medical professionals that could affect the quality and completeness of the data.

The emphasis of the study was on post-operative morbidity such as: sternal wound infection, pneumonia, cardiac arrhythmia, acute kidney injury, myocardial infarction, and acute stroke. Other outcome and complications of CABG were not studied. The status of glycemic control must be obtained using hba1c to best assess the relationship of glycemic control to the occurrence of complications. In this, study hba1c was not available since it is not routinely requested. Pulmonary function status of COPD and smokers were not assessed to determine its role in the occurrence of complications.

## Conclusion

There are more complications encountered among diabetic patients who underwent CABG. Cardiac arrhythmia and acute kidney injury are higher in diabetic patients compared to non-diabetics. However, diabetes did not provide added risks for the occurrence of pneumonia, stroke and sternal wound infection. Furthermore, Diabetes did not add to overall morbidity. Presence of diabetes alone did not predict longer telemetry and total length of hospital stay. Age is a common predictor for developing cardiac arrhythmia and acute kidney injury. The strongest predictors of overall morbidity were hypertension and age. Diabetes is not the strongest predictor of adverse events.

### Recommendations

This retrospective study largely relies on the information from the charts. We recommend a follow up prospective study. Since, diabetes is associated with higher incidence of morbidity; we recommend longer follow up of these patients for monitoring of late complications. Other confounding factors that might influence the outcome of CABG must also be studied. Status of gylycemic control should be taken to determine its influence. Multicenter and larger population is encouraged to better evaluate relationship of risk factors and complications.

## References


1. **Wild S, Roglic G, Green A, Sicree R, King H**; Global Prevalence of Diabetes Estimates for the year 2000 and projections for 2030. Diabetes Care, 2004;May;27(5):1047-53.
2. **Irma A, Benegas-Segarra A**; Department of Health Epidemiology Bureau.The 2013 Philippine Health Statistics. P91.
3. **Jahangiry L, Najafi M ,Farhangi MA, Jafarabadi MA.** Coronary Artery Bypass Graft Surgery Outcomes following 6.5 years: A nested case control study,8:23,2017
4. **Raza S, Blackstone E, Sabik J**. Coronary Artery Bypass Grafting. New England Journal of Medicine, 375(10):e22,2016.
5. **Safaie N, Montazerghaem H, Jodati A, Maghamipour N.** In hospital complication of coronary artery bypass graft surgery in patients older than 70 years. Journal of Cardiovascular and Thoracic research, 7(2):60-62, 2015.
6. **Hawkes,AL, Nowak M, Bidstrup B, Speare R.**Outcomes of coronary artery bypass graft surgery.Vascular Health Risk Management, 2(4):477-484, 2006.
7. **Goldberg,I.** Diabetic Dyslipidemia: Causes and Consequences. Journal of Clinical Endocrinology and Metabolism, P965-971, 2011.
8. **Hahr A, Molitch M.** Management of Diabetes Mellitus in patients with chronic kidney disease. Clinical Diabetes and Endocrinology,1:2, 2015.
9. **Santos K, Berto B, Sousa A,da Costa AA .** Prognosis and complications of Diabetic Patients undergoing isolated coronary artery bypass surgery. Brazilian Journal of Cardiovascular Surgery, 31(1):7-14, 2016.
10. **Koochemeshki V, Salmanzadeh HR, Sayyadi H, Amestejani M, Ardabili SS.** The effect of Diabetes mellitus on short term mortality and morbidity after coronary artery bypass graft surgery, 7(2):41-45,2013
11. **Whang W, Bigger JT.** Diabetes and Outcomes of Coronary Artery Bypass Graft Surgery in Patients With Severe Left ventricular Dysfunction: Results from the CABG Patch Trial Database. Journal of the American College of Cardiology, 36(4):1166-72, 2000.
12. **Rajakaruna C, Rogers CA, Suranimala C, Angelini GD, Ascione R.** Effect of Diabetes Mellitus on Patients undergoing coronary surgery. Journal of Thoracic and Cardiovascular Surgery, 132(4):802-10, 2006.
13. **Natarajan A, Samadian S, Clarck S.** Coronary Artery Bypass Surgery in elderly people. Postgraduate Medical Journal, 83(977):154-158, 2007.
14. **Vavlukis M, Borozanov V, Georgievska-Ismail L, Bosevski M, Taneva B, Kostova N, Peovska I.** Arterial hypertension in patients with coronary artery disease treated with surgical myocardial revascularization. Bratisl Lek Listy 108(7):301-6, 2007.
15. **Galante A, Pietroiusti A, Cavazzini C, Magrini A, Bergamaschi A, Sciarra L, Chartouni G, Lgramante JM, Carta S.** Incidence and risk factors associated with cardiac arrhythmia during rehab after coronary artery bypass graft surgery. Arch Phys Med Rehabil, 81(7):947-52, 2000.
16. **El Sohl AA, Bhora M, Pineda L, Dhillon R.** Nososcomial Pneumonia in Elderly Patients following cardiac surgery. Respiratory Medicine, 100(4):729-36, 2006.
17. **Szekely A, Levin J, Miao Y, Tudor IC, Vuylsteke A, Ofner P, Mangano DT.** Impact of Hyperglycemia on Perioperative Mortality after Coronary Artery Bypass Graft Surgery. Journal of Thoracic and Cardiovascular Surgery, 142(2):430-7, 2011.
18. **Mc Alister F, Man J, Bistriz L, Amad H, Tandon P.** Diabetes and Coronary Artery Bypass Surgery. Diabetes Care, 26(5):1518-24, 2003.
19. **Kubal, C,Srinivasan A, Grayson A, Fabri B, Chalmers J.** Effect of risk adjusted diabetes on mortality and morbidity ater coronary artery bypass surgery. ANN Thorac Surg, 79(5):1570-76,2005.
20. **Khwaja A.** KDIGO Clinical Practice Guideline for Acute Kidney Injury. Nephron Clin Pract,120(4):c179-84,2012.
21. **Raman M, Nesto RW.** Heart Disease in Diabetes Mellitus. Endocrinology and Metabolism Clinics of North America, 25(2):425-38, 1996.
22. **Zacek P, Dominik J, Harrer J, Lonky V, Mndak JKunes P, Solar M.** Morbidity and mortality in patients 70 years of age and over undergoing isolated coronary artery bypass surgery. Acta Medic, 44(3):109-14.2001.
23. **Hossain A, Hoque R, Khan S, Adhikary AB, Rahman M, Sulatn AU.** Influence of Hypertension on early outcome after coronary artery bypass surgery. University Heart Journal, 7(1):13-15, 2011.
24. **Karimi A, Ahmadi H,Davoodi S, Movahedi N, Marzban M, Abassi K, Omran AS, Sadeghian S, Yazdanifard P, Abassi SH, Fallah N.** Factors affecting postoperative morbidity and mortality in isolated coronary artery bypass graft surgery.Surgery Today, 38(10):890–98,2008.
25. **Furnary, A, Guangquiang G, Grunkemeier G, Yingxing W, Zerr K, Bookin S, Floten S, Starr A.**Continuous insulin infusion reduces mortality in patients with diabetes undergoing coronary artery bypass grafting. The Journal of Thoracic and Cardiovascular Surgery,125(5):1007-21,2003.
26. **Moshtaghi N, Karimi A, Shirzad M, Ahmadi H.** Outcome of coronary artery bypass surgery in diabetic and non-diabetic patients: A comparative, retrospective study. Journal of Diabetology, 3:2,2009.
27. **Thourani V, Weintraub WS, Stein B, Gebhart SS, Craver JM, Jones EL, Guyton RA.** Influence of diabetes mellitus on early and late outcome after coronary artery bypass grafting.The Annals of Thoracic Surgery, 67(4):1045-1052,1999.
28. **Filsoufi F, Rahmanian P, Castillo J, Mechanick J, Sharma S, Adams D.** Diabetes is not a risk factor for hospital mortality following contemporary coronary artery bypass grafting. Interactive CardioVascular and Thoracic Surgery, 6(6):753-8,2007.
29. **Szabo Z, Hakanson E, Svedjeholm R.** Early post-operative outcome and medium term survival in 540 diabetic and 2239 non diabetic patients undergoing coronary artery bypass grafting, Ann Thoracic Surg,74(3):712-9, 2002..
30. **Likosky DS, Dacey LJ, Baribeau YR, Leavitt BJ, Clough R, Cochran RP, Quinn R, Sisto DA, Charlesworth DC, Malenka DJ, MacKenzie TA, Olmstead EM, Ross CS, O'Connor GT**. Long term survival of the very elderly undergoing coronary artery bypass grafting. The Annals of Thoracic Surgery, 85(4):1233-37, 2008.
31. **Tsuneyoshi H, Komiya T, Shimamoto T, Sakai J, Hiraoka T, Wada K, Kaneko H, Fujimoto Y, Furuichi Y, Jinno T, Tominaga O.** Risk factors for poor prognosis of coronary artery bypass grafting in patients with Diabetes. J Jpn Coron Assoc, 22:251-257, 2016.