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ORIGINAL ARTICLE

Prediction of Contrast Induced Nephropathy Following Percutaneous Coronary Intervention

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Abstract:

Background: *Contrast induced nephropathy (CIN) is associated with significant morbidity and mortality after percutaneous coronary intervention (PCI). The aim of this study is to evaluate the collective probability of CIN in Bangladeshi population by prediction of several identified risk factors in patients undergoing PCI.*

Methods: This was a prospective single center study of 118 consecutive patients who underwent PCI from November 2014 to October 2015. CIN was defined as an increase of serum creatinine by e"25% and/or e"0.5 mg/dl at 48 hours after PCI when compared to baseline value. Top most independent predictors of CIN was identified using univariate followed by multivariate logistic regression analysis among identified risk factors including amount of contrast, diabetes mellitus, hypotension, peripheral vascular disease (PVD) & Chronic Kidney Disease (CKD). A predictive score was then developed to identify the probability of CIN using the logistic regression equation.

Results: *Amongst 118 patients included in our study, maximum patients (72.0%) were above 60 years, mean age was 61.88±9.12 years. 74.6% of the patients were male and 25.4% were female. So male were predominant in our study. Prevalence of diabetes mellitus, hypertension, smoker, hypotension, Heart failure, CKD & cerebrovascular accident were 56.8%, 50.0%, 29.7%, 5.9%, 3.4%, 8.5%, & 2.5% respectively. 16 (13.56%) patients developed CIN. Univariate logistic regression analysis for prediction of risk factors in CIN revealed that Age, CKD, Diabetes mellitus, Hypotension, Hypertension, LV dysfunction, Heart failure (HF), Cerebrovascular accident (CVA), PVD and Contrast volume are the individual risk factors for the development of CIN. Multivariate analysis revealed CKD, contrast volume, Diabetes mellitus, PVD, HF and hypotension as the predictors for development of CIN.*

Conclusion: *A simple prediction model can be employed to predict the probability of CIN following PCI, applying it to each individual. More vigilant preventive measures can be applied to the high risk candidates.*

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Introduction:

Radiologic procedures utilizing intravascular iodinated contrast media injections are being widely applied for both diagnostic and therapeutic purposes. This has resulted in an increased incidence of procedure related contrast induced

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nephropathy (CIN).[1] Although the risk of renal impairment associated with radiologic procedures is low in the general population, it may be very high in selected patient subsets, especially in cardiac procedures.[2]

Contrast induced nephropathy (CIN) is defined as a e"25% increase in serum creatinine from the baseline value, or an absolute increase of serum creatinine at least 0.5 mg/dL (44.2 mmol/L), 48 to 72 hours after the administration of radiographic contrast media that is not attributable to other causes.[3,4] CIN is the acute kidney injury caused by contrast media and is a common cause of hospital-acquired acute renal failure. It is associated with increased morbidity and mortality as well as prolonged duration of hospital stay, need for renal replacement therapy and major cardiac events.[1] At least two significant processes are known to be involved in the pathophysiology of CIN: vasoconstriction resulting in medullary hypoxia and direct toxicity caused by the contrast media to renal tubular cells. The mechanisms that have been implicated in these processes are dehydration, decreased prostaglandin and nitric oxide induced vasodilatation, impaired endothelial function, increase in renal adenosine concentration, increase in oxygen free radicals in response to hyperosmotic load, increased intratubular pressure owing to contrast induced diuresis, increased urinary viscosity and obstruction of the tubules.[5]

Percutaneous coronary intervention (PCI) is a lifesaving procedure in the management of acute coronary syndrome and improves the quality of life in patients with stable coronary artery disease. However, PCI poses a risk of CIN due to the exposure to contrast media during the procedure.[6] There are several types of contrast media used during PCI e.g.- Ionic contrast media, Non-ionic contrast media, High-osmolar, Low- osmolar & Iso-osmolar contrast media. Different types of contrast media poses various magnitude of CIN. Amount of contrast media is also important. Amount of contrast media needed for PCI depends on complexity of coronary artery lesion, number of arteries diseased, number of lesion, morphology of lesion, location of lesion, presence of chronic total occlusion as well as operator's expertise. Various risk factors were identified based on studies conducted previously. Advanced age, female gender, anemia, pre-existing renal impairment, diabetes mellitus, reduced intravascular volume, congestive cardiac failure, presence of hypotension, presence of cardiogenic shock, use of intra-aortic balloon pulsations (IABP), type of contrast media, large volume of contrast media, co-administration of nephrotoxic drugs such as angiotensin-converting enzyme inhibitors (ACEI), angiotensin II receptor blockers (ARB), proteinuria (including nephrotic syndrome), multiple myeloma, hypercholesterolemia, hyperuricaemia, hypercalcemia, sepsis, atopic allergy are some of the recognized risk factors.[7,8]

Although many individual risk factors for the development of CIN have been reported, combination of two or more risk factors is rather common in daily practice. Therefore, cumulative risk of several variables on renal function is more important & more informative. So, prediction of contrast induced nephropathy following percutaneous coronary intervention by assessing cumulative effects rendered by individual risk factor can prognosticate the high risk patients for CIN after the exposure to the contrast.[9]

This study aimed to develop a risk score model to predict development of CIN following PCI in Bangladeshi population rendered by cumulative effect of several risk factors.

Though there were various risk scoring systems available for prediction of CIN, the risk factor profile and their cumulative effect in Bangladeshi patients had never been considered, to our knowledge. On the other hand, Bangladeshi people are different in terms of biophysical profile, food habit & nutritional status, geographical position, ethnicity and environmental & toxin exposures. So, risk scoring system developed elsewhere may or may not be applicable in our country. This had prompted us to conduct this prospective study with an aim to predict CIN in our sample population, to detect the incidence of CIN, to identify the predictors and to determine their collective effect in the development of CIN in patients undergoing PCI in our institution.

Materials & Methods

Aims

- To evaluate the collective risk of CIN in Bangladeshi population by several identified risk factors, in patients undergoing PCI.

Objectives

- To determine the incidence of CIN in the study group following PCI.
- To identify the risk factor profile for CIN in Bangladeshi patients.
- To estimate the cumulative risk rendered by individual risk factors and to develop a simple risk score model to predict CIN.

Study population: Consecutive 118 patients who underwent PCI during this period in the Department of Cardiology, University Cardiac Center, BSMMU.

Study protocol: Consecutive 118 patients were selected who got admitted in the department of cardiology, BSMMU to undergo PCI on the basis of inclusion & exclusion criteria. Informed written consent was taken from every patient in a preformed consent form . Patients' age & sex were noted from patients' demographic data. Medical history including diabetes mellitus, hypertension, cerebrovascular accident (CVA), congestive heart failure (CHF), chronic kidney disease (CKD) were noted. History was taken from patient and from patient's authentic medical documents. Detailed clinical examination was done for all patients. All data were noted in the preformed "data collection sheet".

A vigilant checkup was done to reveal the variables. The key variables were as follows

- Age (>70 yrs.),
- Male gender,
- Smoking,
- Diabetes mellitus,
- Cerebrovascular accident (CVA),
- Congestive heart failure
- Hypertension,
- Hypotension,
- Peripheral vascular disease (PVD),
- Anemia,
- LV dysfunction,
- Chronic kidney disease (CKD),
- Pre-PCI GFR &
- Amount of contrast.

Patients' smoking status was assessed from Patients' & their attendants' statement. Patients who had smoked at least 100 cigarettes in their lifetime were labelled as smoker. Those smokers who didn't smoke even for a single time in last 6 months were labelled as ex-smokers.[10]

Patients were enrolled as CKD who had the estimated GFR <60 ml/mt/1.73 m^2 or baseline serum creatinine e" 1.5 mg/dl.[11] Patients with diabetic nephropathy were also included in the CKD group.

History of cerebrovascular accident was sought from patient's authentic medical documents. Patients were examined for higher psychic function with speech, cranial nerves with optic fundi, cerebellar system, motor & sensory system to find out any focal neurological deficit.

Patients who were diagnosed case of diabetes mellitus previously were treated as per guidelines. RBS (Random Blood Sugar) was done for rest of the patients who were non-diabetic or didn't know whether they were diabetic or not. If RBS was < 5.5 mmol/L, no further action was taken, if it was 5.5 – 11.0 mmol/L then Oral glucose tolerance & HbA_1C were done. Those patients who had RBS e" 11.1 mmol/L were treated as per guidelines.

Patients who were diagnosed as hypertension were noted. Intake of antihypertensive medications were confirmed by checking patients' medical records & medicine box. Blood pressure was measured in all patients ideally. All patients were remained seated at rest for more than 5 minutes before taking the blood pressure. Avoidance of caffeinated products such as coffee, cola, or tea as well as activities such as smoking and exercising for at least 30 minutes prior to measuring the blood pressure was confirmed. Blood pressure was measured by aneroid sphygmomanometer keeping the patient's hand supported with arm at the level of the heart. Korotkoff phase I was used for systolic blood pressure & Korotkoff phase V for diastolic blood pressure measurement; but if there was a 10 mmHg or greater difference between Korotkoff phase IV and phase V then the pressure reading at phase IV was recorded as the diastolic blood pressure. Blood pressure was measured in both arms & highest value was taken if there were any discrepancy.

Authentic medical documents were searched for any previous diagnosis of PVD. Presence of intermittent claudication, blackish discoloration &/or gangrene of tip of toes and ankle-brachial pressure index < 0.9 were suggestive of PVD. Presence of PVD was confirmed using Doppler ultrasound if the clinical history & physical examination was suggestive of the diagnosis.

Congestive heart failure cases were enrolled from previous medical records as well as from bedside diagnosis. Clinical features suggestive of congestive heart failure were dyspnea, orthopnea, engorged jugular venous pressure, tender hepatomegaly, ascites, dependent edema, bilateral pulmonary basal crepitation & 3rd heart sound. Biomarkers including BNP (B-type natriuretic peptides) & NT-proBNP (N-terminal pro *B-type natriuretic peptide*) were measured in unresolved cases.

Hemoglobin was assessed before the procedure by standardized tests in our laboratory.

2 D & M-mode echocardiography was done for all patients. Left ventricular ejection fraction was measured by Teichholz M-mode method routinely. If any patient had left ventricular regional wall motion abnormalities, then Simpson's method was used.

Detailed drug history including ACEI, ARB, Metformin, NSAIDs were noted. Metformin, NSAIDs were withheld and doses of ACEI, ARB & other drugs including lipid lowering agents were adjusted as per guidelines.

Patients with pre-existing end-stage renal disease requiring dialysis and other contrast exposure within two week or less from the index procedure, patients treated with PCI for acute myocardial infarction, and patients in shock were excluded from the analysis. Patients underwent PCI according to current guidelines after informed written consent was obtained. Routine hydration was performed with 1 ml/kg/h of Normal saline for 4 to 12 h before PCI and 18 to 24 h after PCI. All patients received antiplatelet drugs as per guideline.

All PCIs were done by Iohexol 350; a non-ionic low osmolar contrast media; as per our hospital protocol. Iohexol 350 contain 350 mg of Iodine per mL of contrast media with an osmolality of 823 mOsm/Kg. Amount of contrast media used during the procedure was recorded in mL. PCI complicated by perforations of coronary arteries, development of cardiac tamponade, rupture of abdominal &/or thoracic aorta, acute myocardial infarction associated with PCI, development of cardiac arrest &/or development of cardiogenic shock were excluded from the study.

Serum creatinine was measured before the procedure and 48 to 72 hours after the procedure. GFR was calculated from S. Creatinine & body weight using the Cockcroft-Gault formula {GFR = (140 - Age in years) × Weight in kg × (0.85 for female) / 72 × serum creatinine in mg/dl} both pre & post procedure.

To get eligible 118 sample, a total of 132 patients were needed to enroll. 14 patients were excluded from the study due to late appearance of exclusion criteria, patients' denial & irrelevant data. Variables from eligible 118 sample collected in raw data sheet was then entered into master data sheet (SPSS 22 for Windows).

The outcome variable was Contrast Induced Nephropathy (CIN) which was defined as a e"25% increase in serum creatinine from the baseline value, or an absolute increase of serum creatinine e"0.5 mg/dL (44.2 mmol/L), 48 to 72 hours after PCI. Total 16 patients were found who developed CIN which were identified from SPSS by sorting ascending for CIN. Then, association of CIN with each of 14 variables were assessed by 2 X 2 contigency table in univariate analysis. 11 variables were found to be significantly associated with CIN. These significant 11 variables were then assessed in the multivariate analysis in a stepwise selection procedure where 6 variables were found to be significantly associated. The strength of association was determined by the OR (Odds Ratio) which was more simplified by giving an integer 1 for each 1 OR. The sum of integer of each variable of individual patient was his or her score. Scale of this score was then further divided into 4 groups. Incidence of CIN was then determined in each group.[12]

Inclusion criteria

- All consecutive patients who underwent PCI in Bangabandhu Sheikh Mujib Medical University Hospital from November 2014 to October 2015 were enrolled into the study.

Exclusion criteria

- Patients with renal failure on regular dialysis,
- Acute renal failure before PCI,
- Cardiogenic shock,
- Patients who exposed to contrast media within last 14 days of PCI,
- Patients requiring intra-aortic balloon pump (IABP) support and
- Patients who developed PCI related complications.

Statistical Analysis

- Statistical analyses were carried out by using the Statistical Package for Social Sciences version 22.0 for windows software (SPSS Inc., Chicago, Illinois, USA).
- Quantitative variables were expressed as the minimum, maximum, mean, standard deviation (SD)
- Qualitative variables were expressed as frequencies and percentage.
- Univariate and multivariate analyses were performed to identify individual risk factors.
- The results were presented in tables, figures, diagrams
- 'p' value <0.05 was considered statistically significant.

Risk score development. Eligible patients from the entire data were tabulated on master dataset. The risk score development dataset was initially used for identifying univariate associations between 14 variables from baseline clinical and key procedural characteristics and CIN. Cut off value for age was considered 70 yrs.[7] Cut off value for GFR was considered 50 ml/min/m^2.[12] Other variables were entered into dataset as present (yes) or absent (no). These variables were

- Age (>70yrs),
- Male gender,
- Smoking,
- Anemia,
- Diabetes mellitus,
- Hypertension,
- Hypotension,
- Peripheral vascular disease (PVD),
- LV dysfunction,
- Congestive heart failure
- Cerebrovascular accident (CVA),
- Chronic kidney disease (CKD)
- Pre-PCI GFR,
- Amount of contrast.

11 variables were found to be significantly associated with CIN in univariate analysis, these variables were:

- Age (>70yrs),
- Diabetes mellitus,
- Hypertension,
- Hypotension,
- Peripheral vascular disease (PVD),
- Heart failure,
- LV dysfunction,
- Cerebrovascular accident (CVA),
- Chronic kidney disease (CKD)
- Pre-PCI GFR,
- Amount of contrast.

Variables that were significant in univariate analysis were included in the final multivariate model. Multivariate logistic regression analysis was then performed to identify independent predictors of CIN and to estimate odds ratios (ORs). Risk factors that were significant in the multivariate analysis were available for selection in the final model; for each sample, a stepwise selection procedure was used to choose independent predictors of CIN. Significant risk factors in the multivariate analysis were:

- Diabetes mellitus,
- Hypotension,
- Peripheral vascular disease (PVD),
- Heart failure,
- Chronic kidney disease (CKD) &
- Amount of contrast,

Then the regression model was created based on the baseline serum creatinine value. The six

variables in the final model with $p < 0.05$ were assigned a weighted integer coefficient value. For this purpose, the estimated ORs from the logistic model were used, giving an integer of 1 to each 1.0 value of OR; the integer of 1 was given for each 100-ml increment in contrast media administered during the procedure. The final risk score represented the sum of integer coefficients (Mehran et al. 2004). Based on the attained score, patients were further divided into low, moderate, high, very high risk groups as score of 0-5, 6-10, 11-15 & e"16 and then the incidence of CIN in each risk group was assessed.[12]

Operational Definitions

Anemia: Anemia was defined as hemoglobin <13 g/dl in men and, <12 g/dl for women.[13]

Cardiogenic shock: Cardiogenic shock was defined as prolonged hypotension (systolic blood pressure <90 mm Hg) with evidence of decreased organ perfusion caused by severe left ventricular dysfunction, right ventricular infarction, or mechanical complications of infarction and not due to hypovolemia, bradyarrhythmias, or tachyarrhythmias.[14]

CIN (Contrast Induced Nephropathy): CIN was defined as an increase of ≥25% and/or ≥0.5 mg/dl in serum creatinine at 48 hours after PCI when compared to the baseline value.[15]

CKD (Chronic Kidney Disease): CKD was defined as the estimated GFR <60 ml/mt/1.73 m2 or baseline serum creatinine ≥1.5 mg/dl.[11]

CVA (Cerebrovascular Accident): Cerebrovascular accident was defined as diagnosed case of stroke or patients with focal neurological deficit.[8]

Diabetes mellitus: Diabetes mellitus[16] was defined as presence of any of-

1. Patient is taking antidiabetic drugs
2. Fasting blood sugar ≥7.0 mmol/L
3. Blood sugar 2 hours after breakfast ≥11.1 mmol/L
4. HbA_1C ≥7.0 %

Hypertension: Hypertension was defined as systolic blood pressure ≥140 mm Hg (≥150 mm Hg ≥60 yrs. older patients) or diastolic blood pressure ≥90 mm Hg or patients who are taking antihypertensive drugs.[17]

Hypotension: Hypotension was defined as systolic blood pressure <100 mm Hg for at least 1 hour within 24 hours peri-procedurally.[12]

PCI related complications[18] includes-

- Perforations of coronary arteries
- Cardiac tamponade
- Ruptured abdominal &/or thoracic aorta
- Development of cardiac arrest
- Development of cardiogenic shock
- Development of myocardial infarction associated with PCI

GFR (Glumerular Filtration Rate): GFR was calculated using the Cockcroft-Gault formula[19]:

GFR = (140 - Age in years) × Weight in kg × (0.85 for female) / 72 × serum creatinine in mg/dl

LV dysfunction: Left ventricular dysfunction was defined as Left ventricular ejection fraction <50%.[20]

Smokers[10]:

Former Smokers (Ex-Smokers) – Adults who had smoked at least 100 cigarettes in their lifetime, but didn't smoke even for a single time in last 6 months.

Nonsmokers – Adults who didn't smoke even for a single time in last 6 months & either never smoked or had smoked less than 100 cigarettes in their lifetime.

Smokers (Current Smokers) – Adults who have smoked 100 cigarettes in their lifetime and currently smoke cigarettes every day (daily) or some days (nondaily) or smoked at least once in last 6 months.

Results:

Distribution of demographic characteristics of the study subjects:

Baseline demographic characteristics of the study population are summarized in Table-I & Table-II. Amongst 118 patients included in this study, maximum patients (72.0%) were above 60 years, mean age was 61.88±9.12 years.

Distribution of demographic characteristics of the study subjects:

Table-II showed that 74.6% of the patients were male and 25.4% of patients were male. So male were predominant in this study.

Distribution of the patients by variables from medical history

Table-III shows the medical history of the patients: 57.8% patients had diabetes mellitus, 50.0% patients had hypertension, 29.7% patients were smoker, 3.4% patients had heart failure, 8.5% patients had CKD and only 2.5% patients had cerebrovascular accident.

Distribution of the patients by variables from clinical parameters

Table-IV shows the clinical examination of the study patients, mean systolic blood pressure were 125.5±17.9 mmHg and mean diastolic blood pressure were 78.26±12.5 mmHg;

Distribution of the patients by variables from pre-procedure laboratory & procedural parameters

Table-V shows mean Hemoglobin level was 12.04±1.40 (g/dl). Mean LVEF was 60.25±7.65 (%) & mean contrast volume used was 150.85±43.95 (ml). pre-procedure mean Serum creatinine was 1.14±0.23 (mg/dl) with mean eGFR 64.64±17.54 (ml/min).

Post procedure Serum creatinine & eGFR

Table-VI shows post-procedure mean Serum creatinine was 1.2668±.35497 (mg/dl) with mean eGFR 59.7088±16.91982 (ml/min).

Comparison of pre & post procedure Serum creatinine & eGFR and rise in Serum creatinine in those patients who developed CIN.

Table-VII shows pre procedure Serum creatinine & eGFR as well as post procedure Serum creatinine & eGFR in those patients (n =16) who developed CIN. The absolute rise in S. Creatinine (mg/dl) & percent rise in S. Creatinine Post-PCI from Pre-PCI baseline S. Creatinine were also shown.

Univariate analysis for predictors of CIN

In Table VIII, Univariate analysis for prediction of risk factors in CIN. Age (e"70 yrs), CKD, Diabetes mellitus, Hypotension, Hypertension, low GFR, LV dysfunction, CHF, CVA, PVD and Contrast volume are the individual risk factors for the development of CIN.

Multivariate logistic regression analysis for prediction of risk factors of CIN

Table IX provides an overview of the multivariate analysis for development of CIN. Logistic regression analysis (Table VII), had shown that CKD, DM, contrast volume, Heart failure, Peripheral vascular disease and hypotension as a predictor for the development of CIN.

Integer scores of variables that were significant in multivariate logistic regression analysis:

Table-X shows the Integer scores depending on the Odds Ratio, the assigned Integer is 1 for OR of each 1.0 for CKD, PVD, Hypotension, DM, CHF & 1 for each 100 mL of contrast dye used.

Risk score group of CIN with their incidence

Table-XI shows the risk score of CIN with their incidence, 49 patients were found in mild risk group (0 – 5) and there was no incidence of CIN, moderate risk group (6-10) had 53 patients and 6(11.3%) cases developed CIN, high risk group (11-15) had 12 patients and 7(58.3%) cases developed CIN. Very high risk group (>15) had 4 patients and CIN developed in 3(75.0%) cases.

Table-I

Distribution of the patients by variables from medical history (n =118)

Variables	Frequency (no)	Percentage (%)
Diabetes mellitus	67	57.8
Hypertension	59	50.0
Smoking	35	29.7
Congestive Heart failure	4	3.4
Chronic kidney disease	10	8.5
Cerebrovascular accident	3	2.5
Peripheral vascular disease	3	2.5

Data are presented as Percentage (%)
n = Number of study population

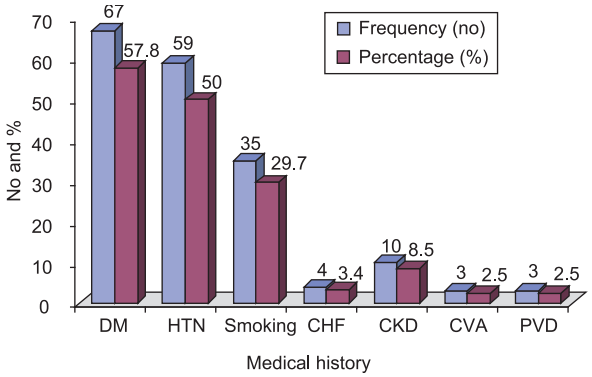

Fig.-1: *Bar diagram showing frequency & percentage (%) of variables present in the study population (n = 118). Here, DM = Diabetes Mellitus, HTN = Hypertension, CHF = Congestive Heart Failure, CKD = Chronic Kidney Disease, CVA = Cerebrovascular Accident, PVD = Peripheral Vascular Disease*

Table-II

Distribution of the patients by variables from pre-procedure laboratory & procedural parameters (n =118)

Variables	Mean±SD
Hemoglobin level (g/dl)	12.04±1.40
LVEF (%)	60.25±7.65
Contrast volume	150.85±43.95
Serum creatinine (mg/dl)	1.14±0.23
eGFR (ml/min)	64.64±17.54

Data were presented as mean±SD
SD =Standard deviation
eGFR= Estimated glomerular filtration rate
LVEF= Left ventricular ejection fraction
n = Number of study population

Table-III

Post procedure Serum creatinine & eGFR (n =118)

Variables	Mean±SD
Serum creatinine (mg/dl)	1.2668±.35497
eGFR (ml/min)	59.7088±16.91982

Data were presented as mean±SD
SD =Standard deviation
eGFR= Estimated glomerular filtration rate
n =Number of study population

Table-IV

Comparison of pre & post procedure Serum creatinine & eGFR and rise in Serum creatinine CIN group (n =16)

Sl No.	Code No.	Pre-PCI		Post-PCI		Increase in S. creatinine	
		S. Creatinine (mg/dl)	eGFRS. (ml/min)	S. Creatinine (mg/dl)	eGFR (ml/min)	Absolute Increase (mg/dl)	% Increase
1	5	1.20	53.26	1.80	35.51	0.60	50.00
2	16	1.55	45.17	2.20	31.82	0.65	41.90
3	43	1.95	25.67	2.65	18.89	0.70	35.90
4	48	0.90	60.52	1.40	38.91	0.50	55.60
5	56	1.83	41.00	2.30	32.62	0.47	25.70
6	64	1.00	80.28	1.85	43.39	0.85	85.00
7	66	0.90	61.52	1.60	34.61	0.70	77.80
8	69	1.20	56.88	1.90	35.92	0.70	58.30
9	72	1.80	24.67	2.60	17.08	0.80	44.40
10	77	1.60	43.13	2.05	33.67	0.45	28.12
11	83	0.95	81.05	1.45	53.10	0.50	52.60
12	88	1.62	38.45	2.10	29.67	0.48	29.63
13	90	1.20	47.40	1.70	33.46	0.50	41.70
14	97	1.20	63.89	1.80	42.59	0.60	50.00
15	109	1.90	26.64	2.50	20.25	0.60	31.60
16	117	1.20	37.73	1.75	25.87	0.55	45.80

eGFR= Estimated glomerular filtration rate
Code no= Code number of patients in the study
Pre-PCI= Before Percutaneous Coronary Intervention
Post-PCI= 24-72 hours after Percutaneous Coronary Intervention
% Increase = % Increase in Post-PCI S. Creatinine from Pre-PCI baseline S. Creatinine

Discussion

Coronary artery disease has reached epidemic proportions in Asia including in Bangladesh. Percutaneous coronary intervention is a lifesaving procedure for many patients and occupies a significant place in the practice of interventional cardiology. As the number of coronary interventions increase, so do the consequent complications such as CIN. CIN contributes to significant morbidity and mortality after PCI. Hence, identification of high risk patients for CIN by risk stratification is indispensable.[18]

Prior studies have reported varying levels of incidence of CIN: 13.1% in the study conducted by Roxana Mehran[12], 9.7% in the study conducted by Suma M. Victor [18], and 5.5% in the study conducted by Amal[21]. In an analysis by McCullough et al, the incidence of CIN in patients undergoing PCI was 14.5% (in the derivation set of 1826 patients)[22]; it was 13.56% in this study which is similar with other studies.

Various factors have been identified as risk markers for CIN in different studies. Diabetes mellitus is proven to be a strong predictor for CIN.[12, 22. 23] Diabetes significantly influences the outcome of CIN in this study also. This may be because of the higher association of diabetes in the development off CIN.

In this study, older age (age >70 years: 17.9%) is an independent predictor for CIN in univariate analysis that is similar to the studies done by Roxana Mehran[12] & Dangas[23]. But unlike other studies[21.24], female gender is not independent predictors for CIN that is similar to the study conducted by Suma M. Victor[18] . Male patients were predominant in this study population (female gender: 25.4%) that is also similar to the study conducted by Suma M. Victor. This may be due to the under representation of this subgroup in this study. This is not uncommon in the context of Bangladesh where females receive fewer coronary interventions[20] and those who do receive usually belong to the higher economic strata. Other established risk factors like peripheral vascular disease[25, 26]. Hypotension[23], renal impairment[22, 26] and high contrast volume[27] form the rest of the components of this risk scoring system that are similar to other relevant studies. Unlike other studies, Anemia[28] was not an independent predictors for CIN in this study. This may be due to stringent exclusion of anemic patient in our hospital and small study sample may be another cause.

Similar risk prediction models have been published previously.[12, 21, 25] Mehran et al. developed and validated a scoring system in 8357 patients with eight variables consisting of hypotension (5 points), IABP (5 points), heart failure (5points), chronic kidney disease (4 points), diabetes (3 points), age 75 years (4 points), anemia (3 points), and volume of contrast (1 point for each 100 cc).[12] Based on the attained score, patients were further divided into low, moderate, high, very high risk groups, and the incidence of CIN, risk of RRT and mortality were calculated for each group. Risk scoring system of this study differs from this in few aspects. IABP patients were excluded in this study as IABP use itself may precipitate renal dysfunction either by releasing atheroembolic milieu to renal circulation or by impeding the renal blood flow if placed low in the aorta and thus making it difficult to differentiate it from CIN. Our risk scoring system allows risk calculation pertaining to each individual rather than to a cluster. It also allows the actual values of the variables to be entered in to the formula rather than group them further, hence it is convenient to use, even when there is lack of standardized definitions pertaining to Bangladeshi population for diagnosis, as in the case of anemia. However, no formula to calculate individual risk of RRT or mortality was developed in this study. Thus, the scoring system proposed in this study is formed by easily available clinical, laboratory and procedural variables and allows identification of high risk groups for developing CIN, allowing prophylactic measures to be employed early.

Finally, patients were grouped into four groups on the basis of total integer score as mild, moderate, high & very high risk group. Risk of development of CIN was increased with increase in integer score that is increase in the order of risk group. This finding is very relevant & is similar to other studies.

Conclusion:

CIN is a frequent complication following PCI, and is associated with complicated hospital stay and high mortality rate. The risk factor profile in Bangladeshi population as determined by this study

is unique to the subcontinent and may also be applicable to other countries across the world. Individual patient risk for CIN after PCI can be predicted based on the easily available clinical and procedural information to predict the probability of CIN following PCI. High risk groups can be identified using this risk scoring system and more vigilant preventive measures can then be applied for the prophylaxis of CIN. This CIN risk prediction can be used for both clinical and investigational purposes.

Study Limitations

1. This is a study involving a single center in Dhaka, hence multicentric validation across the country is required to authenticate this scoring system.
2. The sample size is also small, so it requires similar study in large scale.
3. There are many other risk factors as well that were not included in this study.
4. Although the rise in serum creatinine occurs within the first 24 h after exposure to contrast media in 80% of the patients, the absence of data on serum creatinine later than 48-72 h after PCI in the present study might result in the slight underestimation of CIN (McCullough & Sandberg 2003).
5. Sampling is purposive sampling, not a random one.
6. We did not use creatinine clearance value based on 24-h urine collection during a true baseline clinical condition, and our eGFR calculation is subject to limitations due to the formula used and the possibility that patients may not be at their true baseline condition before PCI because of dehydration or cardiac illness; however, we believe that the assessment of CIN risk based on the utilized cutoffs of serum creatinine and eGFR is fairly accurate for the clinical purposes of this study and certainly more practical and readily available than direct measurement of creatinine clearance.

Recommendations

1. Studies with larger sample size and longer duration with long term follow up could overcome some of the shortcomings that this study had.
2. A multicentric study can be done across the country with more risk factors analysis.
3. A further validation study should be done to validate this study.

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