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Coexistence of Cardiovascular and Renal Disease: A Study on Burden of Cardiorenal Syndrome in a Tertiary Care Hospital in Bangladesh

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Abstract

Cardiorenal syndrome (CRS) represents a complex, bidirectional interplay between cardiac and renal dysfunctions, leading to significantly increased morbidity, mortality, and healthcare burden. The epidemiological data on its prevalence and pattern in Bangladesh are scarce. A prospective, cross-sectional study was conducted in Community Based Medical College, Bangladesh (CBMC,B) Hospital, Mymensingh, Bangladesh, from June 2024 to July 2025, to determine the burden and characterize the profiles of patients with CRS. A purposive sample of 123 adult inpatients presenting with concomitant cardiovascular and renal disease got enrolled in the study. Data on demographics, clinical profiles, laboratory investigations, and echocardiographic findings were collected using a structured case record form. The CRS was classified into five subtypes based on established consensus definitions. The mean age was 62.4±10.7 years with male predominance (64.2%). Hypertension (88.6%) and diabetes mellitus (72.4%) were the most common comorbidities. Type 1 Cardiorenal Syndrome (41.5%) was most prevalent. Heart failure with reduced ejection fraction was common (58.5%). Anemia (78.0%) and hyperuricemia (65.0%) were frequent complications. In-hospital mortality was 12.2%, significantly associated with higher creatinine, lower eGFR, and elevated NT-proBNP levels ($p<0.05$). This study confirms a high burden of cardiorenal syndrome strongly linked to hypertension and diabetes, with significant complications and mortality. Integrated, multidisciplinary management strategies are crucial for improving outcomes in this high-risk population.

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Introduction

The intricate and bidirectional relationship between the heart and the kidneys is a cornerstone of pathophysiology in cardiovascular medicine. This interdependence means that dysfunction in one organ often initiates and perpetuates the decline of the other, creating a vicious cycle of disease progression.[1] This complex interplay is formally recognized as cardiorenal syndrome (CRS), a disorder of the heart and kidneys whereby acute or chronic dysfunction in one organ may lead to acute or chronic dysfunction in the other.[2] The clinical and epidemiological significance of CRS is profound. It is associated with drastically worse patient outcomes, including accelerated disease progression, frequent hospitalizations, poor quality of life, and alarmingly high mortality rates, which can exceed 50% within five years of diagnosis for some subtypes.[3,4] The syndrome presents a substantial economic burden on healthcare systems worldwide due to the need for complex management strategies and extended hospital stays.[5] The consensus classification system divides CRS into five distinct subtypes based on the primary organ affected and the acuity of the condition. Type 1 denotes acute cardiac dysfunction leading to acute kidney injury (AKI), Type 2 chronic cardiac dysfunction leading to chronic kidney disease (CKD), Type 3 acute kidney injury leading to acute cardiac

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dysfunction, Type 4 chronic kidney disease leading to chronic cardiac dysfunction, and Type 5 systemic conditions causing simultaneous cardiac and renal dysfunction.[2] The global prevalence of CRS is rising in tandem with the increasing burden of its key risk factors, primarily heart failure (HF), chronic kidney disease, hypertension, diabetes mellitus, and atherosclerosis.[6,7] An estimated 20-40% of all patients with heart failure exhibit some degree of renal impairment, and the presence of CKD is one of the strongest independent predictors of mortality in this population.[8,9] The pathophysiological mechanisms underlying CRS are multifactorial and not yet fully elucidated. They extend beyond simple hemodynamic alterations to include a complex web of neurohormonal activation (e.g., the renin-angiotensin-aldosterone system and sympathetic nervous system), chronic inflammation, oxidative stress, endothelial dysfunction, and iron metabolism abnormalities.[10,11] Despite its global importance, there is a critical paucity of robust epidemiological data on the burden, clinical patterns, and outcomes of CRS in low- and middle-income countries like Bangladesh. The country is experiencing a rapid epidemiological transition, with a soaring prevalence of non-communicable diseases, particularly hypertension and diabetes, which are the primary drivers of both cardiac and renal ailments.[12,13] This unique healthcare landscape, combined with potential genetic and environmental factors, may lead to a distinct profile of CRS that remains largely unexplored. Most existing data are derived from Western populations, and their findings may not be directly generalizable to the Bangladeshi context. Therefore, this study was proposed to bridge this knowledge gap by determining the prevalence, characterizing the clinical-demographic profiles, and assessing the in-hospital outcomes of patients with cardiorenal syndrome in a tertiary care setting in Bangladesh. The findings from this prospective investigation will provide crucial local evidence to inform healthcare policy, guide the development of multidisciplinary management protocols, and ultimately improve care for this high-risk patient population.

Methods

This prospective cross-sectional study was conducted in Community Based Medical College, Bangladesh (CBMC,B) Hospital, Mymensingh, Bangladesh, from June 2024 to July 2025. The study population consisted of 123 adult patients (aged ≥18 years) admitted to the cardiology, nephrology, and internal medicine departments.

Inclusion criteria: Patients were included if they presented with concomitant acute or chronic dysfunction of both the heart and kidneys, fulfilling the consensus criteria for any subtype of cardiorenal syndrome (CRS). This included individuals with an established diagnosis of heart failure, acute coronary syndrome, or valvular heart disease co-existing with acute kidney injury or chronic kidney disease (eGFR <60 ml/min/1.73m² for ≥3 months).

Exclusion criteria: Patients were excluded from the study if they had a solitary organ dysfunction, pre-existing end-stage renal disease on maintenance dialysis before admission, post-renal obstruction, or known congenital heart or kidney disease. Patients who declined to provide informed consent were also excluded.

Participants were enrolled via purposive sampling. Data on demographics, medical history, clinical examination, laboratory parameters (e.g., serum creatinine, eGFR, NT-proBNP), and echocardiographic findings were collected using a

pre-designed, structured questionnaire. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 25.0 for Windows. Descriptive statistics was computed for continuous variables as mean±SD (standard deviation) and for categorical variables as frequency and percentage. The data were summarized and presented in tables.

The study was approved by the Ethical Review Committee of Community Based Medical College, Bangladesh (CBMC,B), Mymensingh, Bangladesh.

Results

A total of 123 patients diagnosed with cardiorenal syndrome were included in the final analysis. The mean age of the participants was 62.4±10.7 years, with an age range from 38 to 85 years. There was a notable male predominance, accounting for 79(64.2%) of the study population, while 44(35.8%) were female. The most prevalent cardiovascular comorbidity was hypertension, present in 109(88.6%) patients, followed closely by diabetes mellitus, which was found in 89(72.4%) individuals. Dyslipidemia and a history of smoking were found in 45.5% and 38.2% of patients respectively. A history of coronary artery disease was present in 52(42.3%) patients (Table-I).

Table-I: Comorbidities/risk factors among the patients

Comorbidities/risk factors	Frequency	Percentage
Hypertension	109	88.6
Diabetes Mellitus	89	72.4
Coronary artery disease	52	42.3
Dyslipidemia	56	45.5
History of smoking	47	38.2

The distribution of CRS subtypes revealed that Type 1 was the most common as found in 51(41.5%) patients, followed by Type 2 in 29(23.6%) patients, Type 4 in 24(19.5%) patients, Type 5 in 12(9.8%) patients, and Type 3 in 7(5.7%) patients (Table-II). Echocardiographic data showed that heart failure with reduced ejection fraction (HFrEF; LVEF ≤40%) was the most frequent cardiac phenotype, present in 72(58.5%) patients. Heart failure with preserved ejection fraction (HFpEF; LVEF ≥50%) was observed in 36(29.3%) patients, while 15(12.2%) had a mid-range ejection fraction (HFmrEF). Renal function parameters indicated a mean baseline serum creatinine of 2.8±1.2 mg/dL and a mean eGFR of 28.5±12.4 mL/min/1.73m². Markers of cardiac stress were significantly elevated, with a mean NT-proBNP level of 9856±7854 pg/mL (Table-III). The most common complication observed was anemia, found in 96(78.0%) patients, followed by hyperuricemia in 80(65.0%) and electrolyte imbalances in 52(42.3%) patients (Table-IV).

Table-II: Distribution of cardiorenal syndrome (CRS) subtypes

CRS Subtype	Description	Frequency (Percentage)
Type 1	Acute heart failure leading to AKI	51 (41.5)
Type 2	Chronic heart failure leading to CKD	29 (23.6)
Type 3	AKI leading to acute cardiac dysfunction	7 (5.7)
Type 4	CKD leading to chronic cardiac disease	24 (19.5)
Type 5	Systemic condition causing heart and kidney dysfunction	12 (9.8)

Table-III: Laboratory and echocardiographic findings

Variables	Mean±SD
Serum Creatinine (mg/dL)	2.8±1.2
eGFR (mL/min/1.73m²)	28.5±12.4
NT-proBNP (pg/mL)	9856±7854
Left ventricular ejection fraction (LVEF) (%)	39.8±12.5
LVEF categories in heart failure	**Frequency (Percentage)**
HFrEF (LVEF ≤40%)	72 (58.5)
HFmrEF (LVEF 41-49%)	15 (12.2)
HFpEF (LVEF ≥50%)	36 (29.3)

HFrEF: Heart failure with reduced ejection fraction; HFmrEF: Heart failure with mid-range ejection fraction; HFpEF: Heart failure with preserved ejection fraction.

Table-IV: Prevalence of associated complications

Complication	Frequency	Percentage
Anaemia (Hemoglobin <12g/dL for women, <13g/dL for men)	96	78.0
Hyperuricemia (Serum uric acid >7.0mg/dL)	80	65.0
Electrolyte Imbalance (Hypokalemia/Hyperkalemia)	52	42.3
Acidosis (Serum bicarbonate <22mmol/L)	41	33.3

The overall in-hospital mortality rate was 5(12.2%) (Table-V). A comparative analysis between survivors and non-survivors revealed that non-survivors had significantly higher levels of serum creatinine (3.9 mg/dL vs. 2.5 mg/dL; p=0.000) and NT-proBNP (15654 pg/mL vs. 8452 pg/mL; p=0.003), and a lower e-GFR (30.1±11.8 mL/min/1.73m² vs. 19.2±10.5 mL/min/1.73m²; p=0.001) and mean ejection fraction (33.5% vs. 42.8%; p=0.008) (Table-VI).

Table-V: In-hospital outcomes

Outcome	Frequency	Percentage
Discharge with improvement	92	74.8
Left against Medical Advice	16	13.0
In-hospital mortality	15	12.2

Table-VI: Comparison of parameters between survivors and non-survivors

Variables	Survivors (n=108) Mean±SD	Non-survivors (n=15) Mean±SD	p-value
Age (in years)	61.8±11.2	66.2±9.8	0.142^{NS}
Serum creatinine (mg/dL)	2.5±0.9	3.9±1.5	0.000^{S}
eGFR (mL/min/1.73 m²)	30.1±11.8	19.2±10.5	0.001^{S}
NT-proBNP (pg/mL)	8452±7021	15654±8954	0.003^{S}
LVEF (%)	42.8±11.9	33.5±10.2	0.008^{S}

Analysis done using an independent samples t-test; S=significant, NS=not significant.

Discussion

The key findings of the present study revealed a high prevalence of CRS among hospitalized patients, predominantly affecting older males with a substantial comorbidity burden, and were characterized by a high rate of in-hospital mortality. The demographic profile of our cohort, with a mean age of 62.4 years and a male predominance (64.2%), aligns with the epidemiology of CRS reported in studies from other regions, which typically identify advanced age and male gender as significant risk factors for both cardiovascular and renal disease progression.[3,14]

The overwhelming prevalence of hypertension (88.6%) and diabetes mellitus (72.4%) as the principal underlying comorbidities is a cornerstone finding. This reinforces their established role as potent drivers of endothelial dysfunction, atherosclerosis, and end-organ damage in both the heart and kidneys, creating a perfect pathophysiological storm for CRS to develop.[6,15] This pattern is particularly relevant to Bangladesh, which is experiencing a rampant surge in these non-communicable diseases.[12,13] The distribution of CRS subtypes in our study offers valuable insights. The predominance of Type 1 CRS (41.5%), followed by Type 2 (23.6%), indicates that acute and chronic cardiac dysfunction are the primary instigators of renal impairment in our population. This is consistent with global data where acute decompensated heart failure is a leading cause of hospital admissions and subsequent AKI.[8,16] The high proportion of HFrEF (58.5%) further underscores the severity of the cardiac disease burden. The lower frequency of Type 3 CRS (primary renal-initiated) is also consistent with the broader literature.[2] The laboratory parameters paint a picture of severe dual organ dysfunction. The markedly elevated mean NT-proBNP level reflects significant cardiac stress and wall stretch, while the severely reduced mean eGFR confirms advanced renal impairment.[9,17] The exceptionally high prevalence of complications like anemia (78.0%) and hyperuricemia (65.0%) is noteworthy. Anemia in CRS is multifactorial, often resulting from a combination of chronic kidney disease-related erythropoietin deficiency, iron metabolism dysregulation, and chronic inflammation, all of which contribute to worse clinical outcomes.[10,18] Most critically, our study identifies factors significantly associated with the grim outcome of in-hospital mortality (12.2%). Non-survivors had significantly higher serum creatinine and NT-proBNP levels, and lower eGFR and LVEF compared to survivors. The results powerfully validate the concept that the severity of dysfunction in both organs is synergistic and additive in predicting mortality, rather than merely additive.[4,19] The degree of renal impairment, in particular, remains one of the strongest prognostic markers in heart failure populations.[8,20] Early and aggressive management of modifiable risk factors, particularly hypertension and diabetes, in primary care settings is paramount to curb the rising tide of CRS.[21]

Our study has certain limitations. The single-center design and purposive sampling method limit the generalizability of our prevalence estimates to the wider Bangladeshi population. The cross-sectional nature allows for the assessment of association but not causality. Furthermore, we reported in-hospital outcomes only; longer-term follow-up data would provide a more comprehensive understanding of the natural history and prognosis of CRS in this context. Despite those limitations, the implications of our study are substantial. They highlight an urgent need for integrated, multidisciplinary care models involving cardiologists and nephrologists from the point of admission for high-risk patients. However, future research should focus on longitudinal studies to track outcomes and randomized controlled trials to test novel therapeutic strategies tailored to this specific patient population.

Conclusion

This study confirms a high burden of cardiorenal syndrome, predominantly Type 1, among hospitalized patients in Bangladesh, strongly linked to hypertension and diabetes. The condition is associated with severe complications and significant in-hospital mortality. These findings underscore the

critical need for integrated, multidisciplinary management strategies and early intervention to improve outcomes in this high-risk population. We need to implement integrated cardio-nephrology clinics for multidisciplinary management, prioritize early screening for renal dysfunction in heart failure patients and vice versa and develop hospital-specific clinical pathways for the early diagnosis and standardized management of cardiorenal syndrome to improve patient outcomes.

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