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CLINICAL EVALUATION OF RISK AND PROGNOSTIC FACTORS IN ACUTE CARDIORENAL SYNDROME: A CROSS-SECTIONAL STUDY

Medicine

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ABSTRACT

Background: Acute cardiorenal syndrome involves heart-kidney dysfunction, increasing hospital morbidity and mortality. Identifying key clinical and biochemical factors aids early diagnosis, risk stratification, and improved patient outcomes. **Objectives:** The study was conducted to evaluate the demographic, clinical, and laboratory risk factors contributing to the development of acute CRS and to assess prognostic indicators, including biochemical and echocardiographic parameters, associated with patient outcomes. **Methodology:** This cross-sectional study included 285 acute CRS patients. Data from clinical, lab, and echo findings were analyzed using SPSS, with logistic regression identifying significant outcome predictors ($p<0.05$). **Results:** Most patients were male and over 50 years. Diabetes, hypertension, and HFrEF predominated. Non-survivors had significantly worse biomarkers, anemia, and liver enzyme elevations ($p<0.001$). **Conclusion:** The study highlights the importance of integrating clinical comorbidities with prognostic biomarkers for effective risk prediction in acute CRS. Elevated cardiac and renal markers were significantly associated with mortality, underscoring the need for early identification and aggressive management in high-risk patients.

KEYWORDS

Acute Cardiorenal Syndrome, Acute Kidney Injury, Prognostic Factors, Pro-BNP, Serum Creatinine, Mortality Predictors.

INTRODUCTION

CRS is classified into five distinct types based on the organ of origin and acuity. Among them, Type 1 CRS (acute cardiorenal syndrome)—where acute cardiac decompensation leads to acute kidney injury—is the most prevalent and clinically significant. Evidence shows a strong correlation between elevated atherogenic index of plasma and the development of CRS, suggesting a link between dyslipidemia and renal-cardiac axis derangement [1]. The syndrome not only complicates the primary disease course but also leads to significantly higher morbidity and mortality. Early identification of risk factors in acute kidney injury is pivotal, as it may help predict and prevent the onset of CRS type 3 [2].

Patients with acute decompensated heart failure who develop CRS have a poorer prognosis, prolonged hospital stay, and increased resource utilization. Clinical profiling reveals that hypotension, reduced ejection fraction, raised serum creatinine, and neurohormonal dysregulation are frequently observed in these cases [3]. Furthermore, the complexity of CRS pathophysiology necessitates the development of novel biomarkers and diagnostic strategies to enhance early detection and intervention [4]. From the nephrologist's viewpoint, variables such as preexisting chronic kidney disease, low perfusion pressure, and aggressive diuresis can predispose patients to type 1 CRS [5].

Though CRS has been extensively studied in adults, emerging data highlight its relevance in the pediatric population as well, where unique etiological factors and hemodynamic responses must be considered [6]. In adult patients with decompensated heart failure, factors including older age, diabetes, anemia, and elevated inflammatory markers are independently associated with the development of CRS [7]. However, in rural Indian populations, the burden of CRS remains under-recognized due to limited awareness and inadequate diagnostic infrastructure. A cross-sectional study from central India has shown considerable prevalence and identified hypertension and diabetes as major risk factors [8].

MATERIALS AND METHODS

Study Design

This hospital-based cross-sectional study evaluated clinical risk, comorbidities, and prognostic factors in patients diagnosed with acute cardiorenal syndrome.

Study Population and Sampling Method

Adult patients with acute CRS were enrolled using consecutive sampling, based on clinical, echocardiographic, and laboratory criteria during the study period.

Inclusion Criteria

1. Patients with a confirmed diagnosis of acute CRS (Type 1 CRS) defined as acute decompensated heart failure leading to acute kidney injury (as per AKIN or KDIGO criteria).
2. Patients admitted to inpatient or intensive care settings during the study period.
3. Patients who provided informed consent (or consent obtained from legally authorized representatives in case of incapacity).

Exclusion Criteria

1. Patients with known chronic kidney disease (CKD) stage IV or V prior to admission.
2. Patients with chronic heart failure without acute decompensation.
3. Patients with cardiorenal syndromes of other types (e.g., types 2–5).
4. Patients with malignancy, active autoimmune disease, or end-stage liver disease.
5. Pregnant females.

Sample Size

A total of 285 patients enrolled, with sample size based on prevalence estimates and feasibility to ensure sufficient statistical power.

Materials Used

- Standardized clinical examination kits
- Biochemical analyzers for serum creatinine, urea, electrolytes, and inflammatory markers
- Echocardiography machine for LVEF estimation
- ECG machine
- Portable ultrasound device (for renal and cardiac assessment as needed)
- Hospital records and laboratory information system (LIS) for data retrieval

Statistical Analysis Plan

Data analysis was conducted using SPSS Version 25.0. Categorical and continuous variables were compared using appropriate tests. Logistic regression identified independent mortality predictors. A p-value < 0.05 indicated statistical significance.

RESULTS AND OBSERVATION

Among the 285 studied patients, the majority belonged to older age groups, with 31.2% each in the 51–60 years and >60 years categories. The mean age was 54.07 ± 10.0 years. Younger age groups were less represented, with 8.8% aged 31–40 years and only 2.8% aged ≤30 years. A male predominance was observed, with 61.8% males and 38.2% females, yielding a male-to-female ratio of approximately 1.61:1.

Table 1 : Distribution of the Studied Patients Based on Risk Factor

Risk factor	Number of patients (n=285)	Percentage
Type 2 Diabetes Mellitus	140	49.10%
Systemic Hypertension	136	47.70%
Severe anemia	76	26.70%
Ischemic Cardiomyopathy	51	17.90%

Chronic Obstructive Pulmonary Disease	32	11.20%
DCMP	95	33.30%
Rheumatic Heart Disease	10	3.50%
Hypertrophic cardiomyopathy	5	1.80%
ACS	62	21.80%

Table 1 Show The most common risk factors among the patients were Type 2 Diabetes Mellitus (49.1%) and Systemic Hypertension (47.7%). Other notable risk factors included DCMP (33.3%), Severe anemia (26.7%), ACS (21.8%), and Ischemic Cardiomyopathy (17.9%). Less common risk factors included Chronic Obstructive Pulmonary Disease (11.2%), Rheumatic Heart Disease (3.5%), and Hypertrophic cardiomyopathy (1.8%).

Table 2 : Details of the Studied Patients Based on Laboratory Test

Laboratory test		MEAN ± SD (n=285)	Range
Pro. BNP (pg/mL)		4552.98±2342	979 to 67012
KFT (mg/dL)	S. Urea	67.1±33.4	3.63 to 235.64
	S. Creat	2.08±4.8	0.52 to 82.52
S. Elect (mmol/L)	Na+	137.1±15.2	3.65 to 174.1
	K+	4.17±1.0	1.62 to 7.22
	Ca2+	1.15±0.77	0.53 to 9.39
LFT (U/L)	SGOT	86.5±82.2	0.53 to 575.7
	SGPT	96.4±109	10.1 to 534.2
CBC	Hb (g/dL)	10.16±2.7	4.20 to 16.8
	TLC (cells/µL)	9880.5±2516	1100 to 16500
HbA1C (%)		5.99±1.5	2.90 to 13.1
Trop-I (ng/mL)		0.66±1.1	0.01 to 45.02

Table 2 Present The mean Pro-BNP level was 4552.98 pg/mL, suggesting cardiac stress. Mean serum urea and creatinine were 67.1 mg/dL and 2.08 mg/dL. Electrolytes were stable, and liver enzymes (SGOT/SGPT) were elevated. Hemoglobin averaged 10.16 g/dL, with a leukocyte count of 9880.5/µL. Mean HbA1C was 5.99%, and Troponin-I was 0.66 ng/mL.

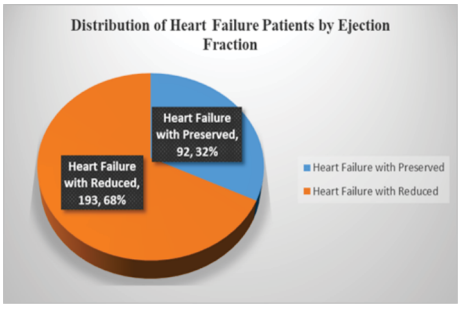

Figure 1 : Distribution of Heart Failure Patients by Ejection Fraction

Figure 1 Presents Among the patients with heart failure, 67.7% had Heart Failure with Reduced Ejection Fraction (HFrEF) and 32.3% had Heart Failure with Preserved Ejection Fraction (HFpEF). This suggests that HFrEF is more prevalent than HFpEF in the studied patient population, with a ratio of approximately 2:1.

Table 3 : Comparison of Renal Function in Heart Failure Patients by Ejection Fraction

2DECHO	Kidney function test	
	Serum Urea (MEAN±SD)	Serum creatinine (MEAN±SD)
Heart Failure with Preserved Ejection Fraction (HFpEF)	65.9±35.20	1.79±0.83
Heart Failure with Reduced Ejection Fraction (HFrEF)	69.8±29.4	1.82±0.68
p-value	0.359	0.8

Table 3 shows The Kidney function was comparable between HFpEF and HFrEF patients. Mean serum urea levels were 65.9 mg/dL and 69.8 mg/dL, and creatinine levels were 1.79 mg/dL and 1.82 mg/dL, with non-significant p-values of 0.359 and 0.800.

Table 4 : Association Between Laboratory Test and Outcome

Pro. BNP (pg/mL)	Survived (n=179)	Expired (106)	p-value
	4109.4±2120	5302±2320	<0.001
KFT (mg/dL)	S. Urea	64.0±30.9	67.4±37.4	0.407
	S. Creat	1.77±0.89	2.26±2.1	<0.001
S. Elect (mmol/L)	Na+	138.0±7.9	135.7±22.7	0.213
	K+	4.20±0.98	4.11±1.0	0.474
	Ca2+	1.17±0.08	1.12±0.59	0.615
LFT (U/L)	SGOT	84.4±81.3	88.6±84.0	0.981
	SGPT	88.3±94.8	101.1±116	0.342
CBC	Hb (g/dL)	10.4±2.8	9.9±2.7	0.199
	TLC (cells/µL)	9922.0±2717	9810.6±2143	0.719
HbA1C (%)		5.40±1.4	6.1±1.5	<0.001
Trop-I (ng/mL)		0.45±0.8	0.78±1.1	0.003

Table 4 Present Expired patients had significantly higher Pro-BNP (5302 pg/mL), serum creatinine (2.26 mg/dL), HbA1C (6.1%), and Troponin-I (0.78 ng/mL) levels compared to survivors, with respective p-values <0.001, <0.001, <0.001, and 0.003, indicating worse clinical profiles.

DISCUSSION

In the present study, most acute CRS patients were aged over 50 years, with a mean age of 54.07 ± 10.0 years and male predominance (61.8%). This aligns with Zhao et al. (2021) [7] who reported older age as a contributing factor, though they observed a higher prevalence in females, differing from the male dominance noted here. Kumar et al. (2023) [3] similarly reported female predominance in CRS1, highlighting population-based variation. Type 2 Diabetes Mellitus (49.1%) and Hypertension (47.7%) were the most common risk factors, comparable to Prothasis et al. (2020) [8] who reported hypertension in 47.92% and highlighted CAD and anemia as key contributors. Dutta et al. (2023) [4] also emphasized the growing CRS burden in the presence of these comorbidities. DCMP (33.3%) in this cohort aligns with Kumar et al. (2023) [3] who identified it as a major CRS1 trigger.

Biochemical findings reflect significant cardiorenal dysfunction, with Pro-BNP averaging 4552.98 pg/mL and serum creatinine at 2.08 mg/dL—values consistent with CRS severity, as also noted by Zhao et al. (2021).[7] High urea levels (67.1 mg/dL) and anemia (mean Hb 10.16 g/dL) match observations from Seckinger et al. (2022) [5] where renal dysfunction and low hemoglobin predicted poor outcomes. The mean HbA1C (5.99%) was lower than expected, contrasting Lin et al. (2024) [2] who found insulin-dependent diabetes to be a strong mortality predictor.

HFrEF was more prevalent than HFpEF (67.7% vs. 32.3%), supporting Prothasis et al. (2020) [8] who identified reduced EF as a key risk factor. Renal parameters were comparable between both HF types. Non-survivors showed significantly elevated Pro-BNP (5302 pg/mL), serum creatinine (2.26 mg/dL), HbA1C (6.1%), and Troponin-I (0.78 ng/mL), indicating worse prognosis—consistent with Seckinger et al. (2022) [5], Lin et al. (2024) [2] and Dutta et al. (2023).[4]

CONCLUSION

In this study of 285 patients with acute cardiorenal syndrome, the majority were over 50 years (mean age 54.07 ± 10.0) and male (61.8%). Common risk factors included diabetes (49.1%), hypertension (47.7%), and DCMP (33.3%). HFrEF predominated (67.7%). Non-survivors had significantly higher Pro-BNP (5302 pg/mL), creatinine (2.26 mg/dL), HbA1C (6.1%), and Troponin-I (0.78 ng/mL) ($p < 0.001$). Renal function did not differ between HF types. These findings emphasize the prognostic importance of cardiac and renal biomarkers and the need for early identification of high-risk patients to reduce morbidity and mortality in acute CRS.

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Consent: Written consent secured.

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