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Cardiorenal Syndrome in the Emergency Department: Insights from a Moroccan Retrospective Study

Elhamzaoui H*, Oudrhirisafiani M, Benhlima A, Arfaoui M, Armel B, Louriz M, Leghlimi H and Alilou M

Department of emergency and Critical Care, Ibn SINA University Hospital, Rabat, Morocco.

***Correspondence:**
Elhamzaoui Hamza, Department of emergency and Critical Care, Ibn SINA University Hospital, Rabat, Morocco.

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ABSTRACT

Background: *Cardiorenal syndrome (CRS) represents a bidirectional dysfunction between the heart and kidneys, complicating clinical management, particularly in acute care settings. Its burden and characteristics in North African populations remain underexplored.*

Objective: *To describe the clinical profile, subtype distribution, and outcomes of patients with CRS admitted to a Moroccan emergency department.*

Methods: *We conducted a retrospective observational study of 40 patients diagnosed with CRS between January 2022 and October 2023 at the Ibn Sina University Hospital, Rabat. Data included demographics, comorbidities, laboratory, ECG, echocardiographic findings, treatment modalities, and in-hospital outcomes.*

Results: *The mean age was 59.7 ± 13.6 years; 60% were female. Hypertension (67.5%) and diabetes (40%) were the most common comorbidities. CRS type 1 was the most prevalent (80%), followed by type 3 (10%). ECG abnormalities included left atrial hypertrophy (47.5%) and left ventricular hypertrophy (37.5%). Transthoracic echocardiography revealed systolic dysfunction in 52.5% of cases. Diuretics were used in 97.5% and non-invasive ventilation in 90%. Hemodialysis was required in 10%. The in-hospital mortality rate was 17.5%, with age >70 and septic shock significantly associated with death ($p<0.05$).*

Conclusion: *CRS is a serious condition frequently encountered in emergency settings, particularly in its acute form. Early recognition and multidisciplinary management are crucial to improving outcomes. This study adds valuable epidemiological data on CRS in North Africa and underscores the need for context-specific protocols.*

Keywords

Cardiorenal Syndrome, Acute Heart Failure, Acute Kidney Injury, Morocco, Retrospective Study.

Introduction

Cardiorenal syndrome (CRS) refers to a complex clinical condition involving a bidirectional interplay between cardiac and renal dysfunction, in which impairment of one organ can precipitate or worsen dysfunction in the other. While originally conceptualized by Ledoux in the 1950s [1] as a unidirectional process — with heart failure leading to renal impairment — CRS is now recognized as a multifaceted, reciprocal syndrome with diverse etiologies and clinical expressions.

In 2010, the Acute Dialysis Quality Initiative (ADQI) group proposed a now widely accepted definition: "Disorders of the heart and kidneys whereby acute or chronic dysfunction in one organ may induce acute or chronic dysfunction in the other" [2].

This framework classifies CRS into five distinct subtypes based on the primary organ involved and the temporal sequence of dysfunction: acute cardiorenal (type 1), chronic cardiorenal (type 2), acute renocardiac (type 3), chronic renocardiac (type 4), and secondary CRS (type 5) resulting from systemic conditions such as sepsis or autoimmune disease.

Despite growing awareness, CRS remains under-recognized in emergency settings, particularly in low- and middle-income countries (LMICs) such as Morocco, where epidemiological data are scarce and healthcare infrastructure faces resource constraints.

The increasing burden of hypertension, diabetes, and heart failure in North African populations underscores the need to better characterize CRS in this context. Furthermore, emergency departments (EDs) represent a critical entry point for patients with acute decompensations, yet the clinical patterns, subtype distribution, and short-term outcomes of CRS in this setting remain poorly documented.

While international data on CRS have grown significantly in the last decade, particularly from Europe and North America, there remains a striking paucity of studies from African settings. In Morocco, only a few single-center cohorts have described CRS characteristics, with limited sample sizes and heterogeneity in definitions. More broadly across the African continent, available data remain sparse, fragmented, and often limited to nephrology or cardiology departments, with little representation of emergency populations. This gap underscores the need for studies that capture the acute manifestations of CRS in African emergency departments, where delays in care and diagnostic limitations may influence outcomes differently than in high-income settings.

This study aims to describe the demographic, clinical, and echocardiographic profile of patients diagnosed with CRS in the emergency department of a Moroccan tertiary hospital, to assess subtype distribution, and to identify predictors of in-hospital mortality. Our objective is to provide local evidence that may inform context-adapted protocols for early recognition and risk stratification.

Materials and Methods

Study Design and Setting

This was a retrospective, observational cohort study conducted over a 22-month period, from January 2022 to October 2023, in the Emergency Department of Ibn Sina University Hospital, a tertiary care center in Rabat, Morocco.

Study Population

We screened all adult patients (>18 years) admitted to the emergency department during the study period for suspected cardiorenal syndrome (CRS). Inclusion was based on clinical, laboratory, electrocardiographic, and echocardiographic findings suggestive of both cardiac and renal dysfunction.

A total of 58 patients were initially identified. After excluding 10 patients aged under 18 and 8 with incomplete records, a final sample of 40 patients was included in the analysis.

Case classification was independently reviewed by two senior intensivists with dual expertise in cardiology and nephrology. Discrepancies were resolved by consensus.

Diagnostic Criteria

CRS was diagnosed based on the ADQI 2010 classification. Subtypes were assigned as follows:

- Type 1: Acute cardiac event (e.g., decompensated heart failure, myocardial infarction) leading to acute kidney injury (AKI) [3-10].
- Type 2: Chronic heart failure associated with progressive chronic kidney disease (CKD) [11-15].
- Type 3: Acute kidney injury causing acute cardiac decompensation [12].
- Type 4: Chronic kidney disease resulting in cardiac dysfunction (e.g., hypertrophy, heart failure) [12].
- Type 5: Systemic conditions (e.g., sepsis, autoimmune diseases) simultaneously impairing cardiac and renal function [16,17].

AKI was defined according to KDIGO criteria [18]; CKD was defined as an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m², calculated using the MDRD formula [19]. Heart failure was diagnosed according to the 2021 ESC guidelines [20], based on clinical features, echocardiographic findings, and natriuretic peptide levels when available.

Exclusion Criteria

Patients were excluded if they:

- Had isolated heart or kidney dysfunction without evidence of dual organ involvement.
- Had incomplete records precluding CRS classification.

Data Collection

Collected variables included:

- Demographics: age, sex
- Medical history: hypertension, diabetes, heart failure, CKD, arrhythmias
- Clinical data: symptoms, cause of admission
- Laboratory parameters: serum creatinine, hemoglobin, proteinuria, CRP, potassium
- Imaging and ECG findings
- Transthoracic echocardiography results
- Treatment modalities: diuretics, dialysis, transfusion, antibiotics, ventilation
- Outcomes: in-hospital mortality, length of stay

Statistical Analysis

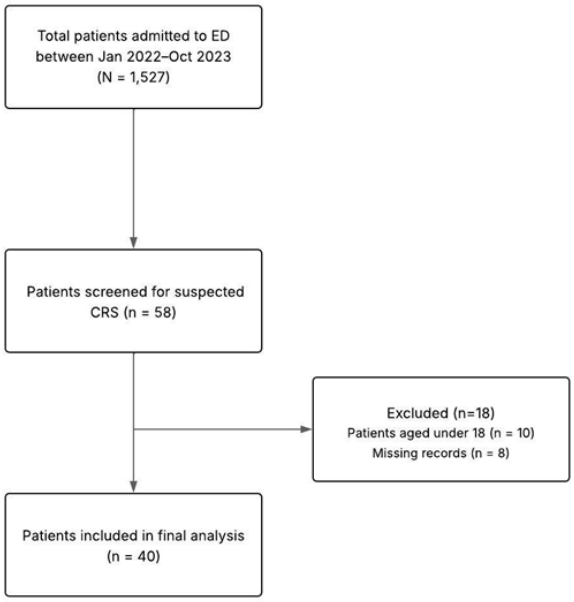
Continuous variables are presented as means ± standard deviation (SD) and compared using ANOVA. Categorical variables are presented as counts and percentages, and compared using Fisher's exact test.

To assess associations with in-hospital mortality, we calculated risk ratios (RR) with 95% confidence intervals. Given the limited sample size, we restricted our analysis to univariate associations. No multivariable regression was performed due to the risk of overfitting.

Statistical significance was set at a two-sided p-value <0.05.

Missing data were <10% for all variables and handled using complete case analysis. No imputation was performed.

Figure 1: Flow Diagram for Patient Inclusion and Exclusion.



A total of 1,527 patients were admitted to the emergency department between January 2022 and October 2023. Fifty-eight were screened for suspected cardiorenal syndrome (CRS), of whom 18 were excluded due to age (n = 10) or missing data (n = 8). The final analysis included 40 patients.

Results

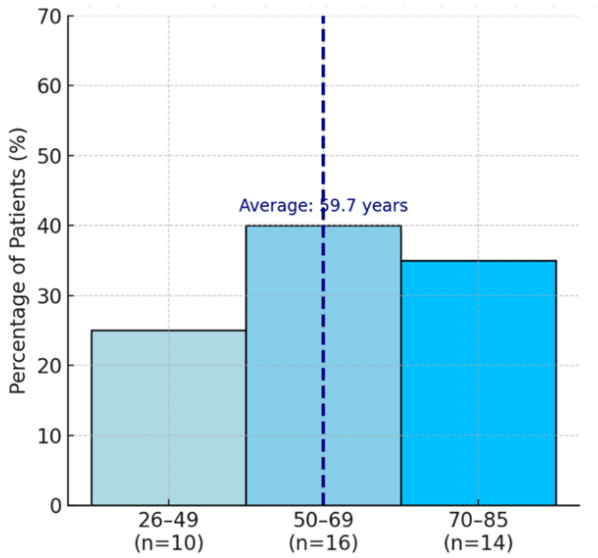
Epidemiology

Among 1,527 patients admitted during the study period, 58 were screened for suspected cardiorenal syndrome (CRS). After exclusions, 40 patients met inclusion criteria, yielding an overall CRS prevalence of 2.6% among emergency admissions (Figure 1).

The mean age of the cohort was 59.7 years (range: 26-85), with 16 patients (40%) aged between 50 and 70 years, and 14 patients (35%) between 70 and 85 years, as shown in Figure *2*.

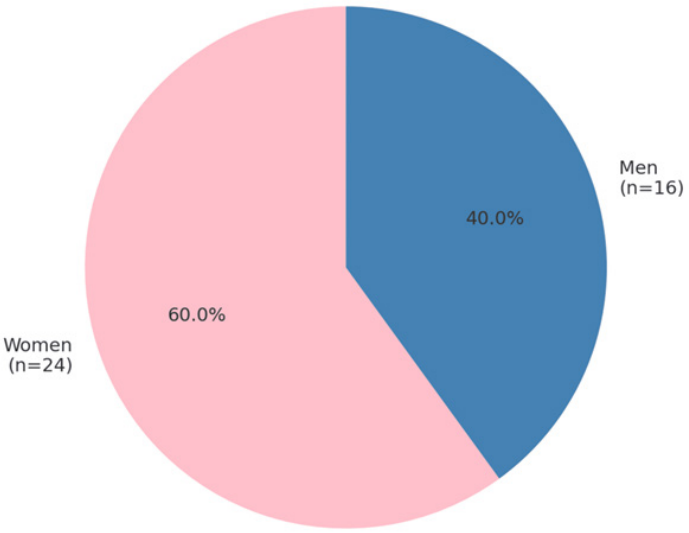
The female-to-male ratio was 1.5:1, corresponding to 24 women (60%) and 16 men (40%) (Figure 3)

Figure 2: Age distribution of patients diagnosed with cardiorenal syndrome (CRS) (n = 40).



Bar chart showing the distribution of patients by age groups: 26–50, 50–70, and 70–85 years.

Figure 3: Gender distribution of CRS patients (n = 40).



Pie chart illustrating the proportion of female (60%) and male (40%) patients in the study population.

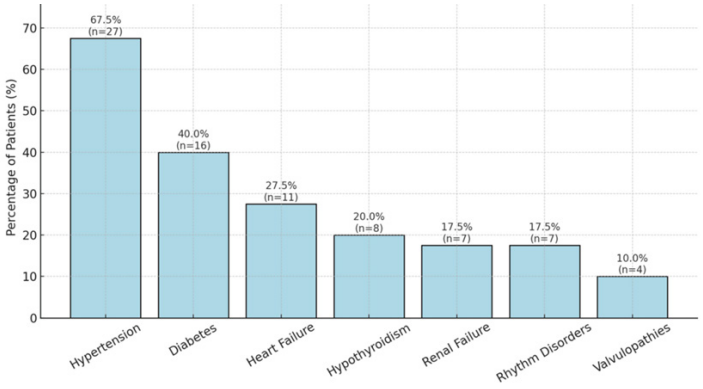
Clinical Characteristics

Regarding past medical history, hypertension was present in 27 patients (67.5%), and diabetes mellitus in 16 (40%), followed by heart failure in 11 (27.5%), hypothyroidism in 8 (20%), chronic kidney disease in 7 (17.5%), and arrhythmias also in 7 patients (17.5%) (Figure 4).

The primary causes for admission was decompensated hypertensive cardiopathy (18 cases, 45%), followed by coronary insufficiency (7 cases, 17.5%), valvular heart disease and mixed cardiopathy (4

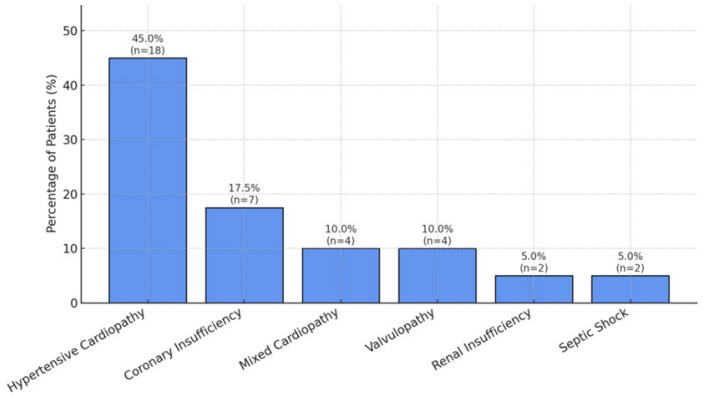
cases each, 10%), and dialysis-related decompensation and sepsis (2 cases each, 5%) (Figure *5*)."

Figure 4: Prevalence of comorbidities among CRS patients (n = 40).



Bar chart showing the number of patients with major comorbidities including hypertension, diabetes, heart failure, hypothyroidism, chronic kidney disease (CKD), and arrhythmias.

Figure 5: Primary causes of admission among CRS patients (n = 40).



Distribution of clinical presentations at admission including hypertensive heart disease, coronary insufficiency, valvular disease, mixed cardiopathy, dialysis-related decompensation, and sepsis.

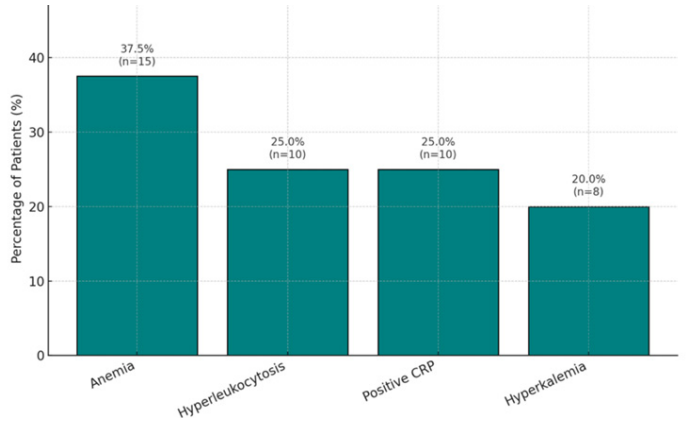
Laboratory and Imaging Findings

Renal assessment revealed a mean serum creatinine level of 38.2 ± 12.4 mg/L. Proteinuria was identified in 9 patients (22.5%).

Anemia was observed in 15 patients (37.5%), including 6 with severe anemia (Hb < 7 g/dL; 15%) and 9 with moderate anemia (22.5%). Biological inflammatory syndrome, defined by leukocytosis and elevated C-reactive protein (CRP), was noted in 10 patients (25%). Hyperkalemia was found in 8 cases (20%) (Figure 6).

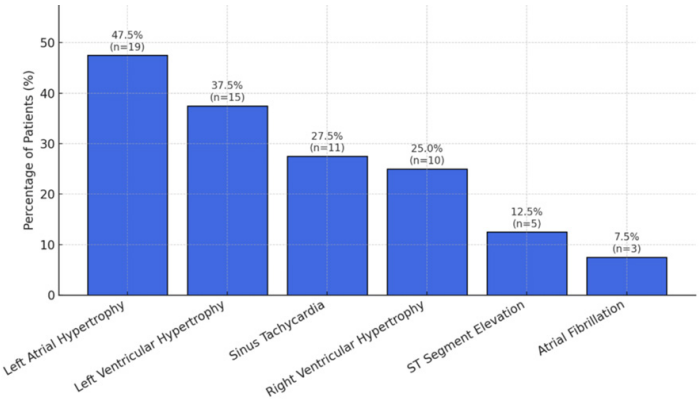
Electrocardiographic (ECG) findings were available for 37 patients. 19 patients (47.5% of all patients) had left atrial hypertrophy, 15 (37.5%) had left ventricular hypertrophy, 10 (25%) had right ventricular hypertrophy, 11 (27.5%) presented sinus tachycardia, 5 (12.5%) exhibited ST-segment elevation, and 3 (7.5%) had atrial fibrillation (Figure 7).

Figure 6: Main biological abnormalities in CRS patients (n = 40).



Bar chart showing frequencies of laboratory findings including proteinuria, anemia (moderate/severe), inflammatory syndrome (CRP elevation + leukocytosis), hyperkalemia, and mean serum creatinine levels.

Figure 7: Electrocardiographic findings among CRS patients (n = 37).



Proportions of patients with specific ECG abnormalities.

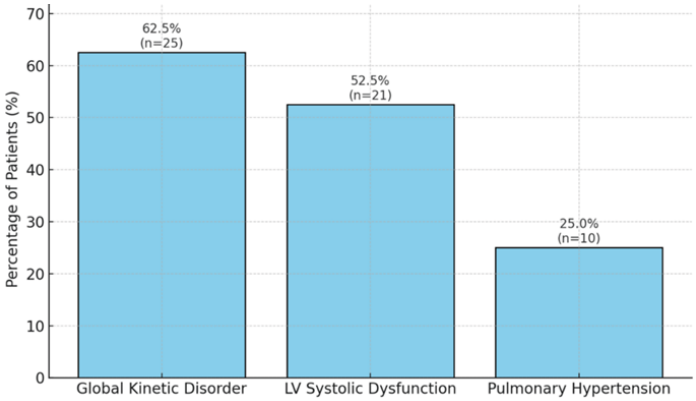
Transthoracic echocardiography revealed global kinetic disorders in 25 patients (62.5%), left ventricular systolic dysfunction in 21 (52.5%), and pulmonary hypertension in 10 patients (25.0%) (Figure 8).

Chest X-rays were available for 28 patients, showing cardiomegaly in 23 cases (57.5%), hilar congestion in 15 (37.5%), and pulmonary foci suggestive of pneumonia in 8 patients (20%).

CRS Subtypes

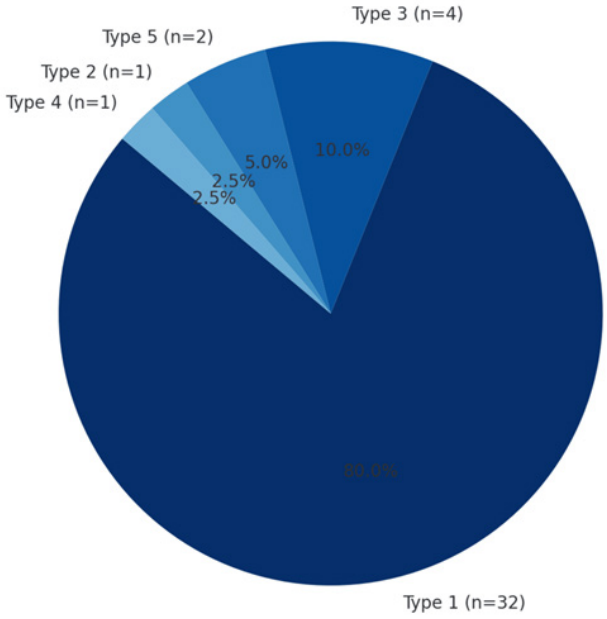
CRS subtype distribution varied significantly, with a marked predominance of type 1 (32 patients, 80%). Other subtypes included type 3 (4 patients, 10%), type 5 (2 patients, 5%), and types 2 and 4 (one patient each, 2.5%) (Figure 9)."

Figure 8: Transthoracic echocardiography findings (n = 40).



Prevalence of major echocardiographic abnormalities: global kinetic disorders, left ventricular systolic dysfunction, and pulmonary hypertension.

Figure 9: Distribution of CRS subtypes among patients (n = 40).



Pie chart illustrating the proportion of CRS subtypes: Type 1 (acute cardiorenal), Type 2 (chronic cardiorenal), Type 3 (acute renocardiac), Type 4 (chronic renocardiac), and Type 5 (secondary).

Treatment and Outcomes

Diuretics were administered to 39 patients (97.5%), while 36 patients (90%) required non-invasive ventilation. Hemodialysis was necessary in 4 patients (10%). Etiological treatments included blood transfusion in 15 patients (37.5%), antibiotic therapy in 8 (20%), anticoagulant therapy in 3 (7.5%), and corticosteroids in 2 patients (5%).

The overall in-hospital mortality rate was 17.5% (7 patients), varying significantly by CRS subtype, with notably higher rates observed in type 5 (2 out of 2 patients, 100%) and type 3 (1 out of 4, 25%) compared to type 1 (4 out of 32, 12.5%). The average length of hospital stay was 7.4 ± 4.6 days (range: 2-26 days). Patients with CRS type 3 had the longest average hospital stay (10.3 ± 4.5 days), whereas those with type 5 had the shortest (2.5 ± 0.5 days).

Factors Associated with In-Hospital Mortality

Two variables were significantly associated with in-hospital death:

– Age > 70 years: RR = 4.64 [1.03–20.93], $p = 0.039$
– Septic shock as cause of admission: RR = 7.60 [3.36–17.20], $p = 0.027$

Other variables (sex, comorbidities, CRS subtype, admission type) did not reach statistical significance (Table 2).

Table 1: Demographic, Clinical, and Biological Data of CRS Patients.

Variable	N (%) or Mean ± Standard Deviation
Prevalence of CRS	40 / 1527 (2.6%)
Mean age	59.7 ± 13.6 years
Age groups	-
– 26–50	10 (25%)
– 50–70	16 (40%)
– 70–85	14 (35%)
Sex	-
– Female	24 (60%)
– Male	16 (40%)
Comorbidities	-
Arterial hypertension	27 (67.5%)
Diabetes mellitus	16 (40%)
Heart failure	11 (27.5%)
Hypothyroidism	8 (20%)
Known chronic kidney disease	7 (17.5%)
Arrhythmias	7 (17.5%)
Biology	-
Proteinuria	9 (22.5%)
Anemia	15 (37.5%)
– Moderate	9 (22.5%)
– Severe	6 (15%)
Inflammatory syndrome	10 (25%)
Hyperkalemia	8 (20%)
Serum creatinine	38.2 ± 12.4 mg/L
Length of hospital stay	7.4 ± 4.6 days
Types of CRS	-
– Type 1	32 (80%)
– Type 2	1 (2.5%)
– Type 3	4 (10%)
– Type 4	1 (2.5%)
– Type 5	2 (5%)
In-hospital mortality	7 (17.5%)

Data are presented as N (%) for categorical variables and mean ± standard deviation (SD) for continuous variables.

Statistical significance was evaluated using the Fisher test for categorical variables and ANOVA (F) for continuous variables.

Table 2: Analysis of Factors Associated with In-Hospital Mortality (N = 7 deaths).

Variable	Statistical Test	R-R (95% CI)	p-value	Significant
Age > 70 years	Fisher	4.64 (1.03–20.93)	0.039	Yes
Sex	-	-	-	-
– Female	Fisher	0.50 (0.13–1.94)	0.407	No
– Male	Fisher	2.00 (0.52–7.77)	0.407	No
Comorbidities	-	-	-	-
– Hypertension	Fisher	2.89 (0.39–21.58)	0.393	No
– Diabetes	Fisher	2.00 (0.51–7.77)	0.407	No
– Heart failure	Fisher	0.44 (0.06–3.25)	0.650	No
– Known CKD	Fisher	1.89 (0.45–7.89)	0.584	No
Reason for admission	-	-	-	-
– Hypertensive heart disease	Fisher	0.92 (0.23–3.58)	1.000	No
– Coronary insufficiency	Fisher	0.79 (0.11–5.54)	1.000	No
– Acute kidney injury	Fisher	3.17 (0.66–15.20)	0.323	No
– Septic shock	Fisher	7.60 (3.36–17.20)	0.027	Yes
CRS type	-	-	-	-
– Type 1	Fisher	0.24 (0.09–1.20)	0.128	No
– Type 3	Fisher	1.50 (0.24–9.52)	0.552	No
– Type 5	Fisher	7.60 (3.36–17.20)	0.027	Yes
Length of hospital stay (days)	ANOVA	F = 2.18	0.128	No

The significance threshold was set at $p < 0.05$.

Discussion

In this retrospective cohort study conducted in a Moroccan emergency department, cardiorenal syndrome (CRS) accounted for 2.6% of all adult admissions. Our findings confirm that CRS is not uncommon in acute care settings and that acute phenotypes, particularly type 1 CRS, predominate in this context. The mean patient age was 59.7 years, and hypertension and diabetes were the most frequent comorbidities.

Several key findings merit discussion. First, the observed predominance of CRS type 1 (80%) aligns with international data from emergency and critical care units, where acute decompensated heart failure is a major driver of acute kidney injury (AKI) [21]. This distribution likely reflects the acute nature of emergency presentations, where chronic phenotypes (types 2 and 4) may be underrepresented or managed in outpatient settings.

Second, the mean age of our cohort was lower than in most European or North American studies, where patients with CRS are typically in their late 60s or older [22]. This younger profile likely reflects a combination of earlier onset of cardiovascular risk factors, limited access to preventive care, and late presentation in low- and middle-income countries. Our data support previous Moroccan studies reporting similar trends [23,24].

Third, our cohort exhibited a female predominance (60%), which contrasts with most CRS registries showing male predominance [25,26]. This discrepancy may be explained by local sociodemographic factors, including gender-based differences in healthcare-seeking behavior, referral bias, or community-level epidemiology.

Prognostic Factors and Clinical Implications

The in-hospital mortality rate in our study was 17.5%, consistent with other reports ranging from 10% to 20% depending on CRS subtype and severity [27-29]. **Septic shock and advanced age (>70 years) were independently associated with in-hospital death.** This is clinically relevant, as both are potentially modifiable risk factors through earlier recognition, sepsis bundles, and targeted hemodynamic support.

The 100% mortality rate observed in type 5 CRS (sepsis-related) underscores the severity of systemic insults on cardio-renal function. Systemic inflammation, endothelial dysfunction, and multiorgan hypoperfusion are likely contributors to this poor prognosis [17]. Notably, CRS type alone was not statistically associated with mortality in our analysis, suggesting that clinical context (e.g., infection, age, volume overload) may outweigh the subtype in prognostic relevance — a finding consistent with recent literature [30].

Despite a high burden of left ventricular systolic dysfunction (52.5%) and pulmonary hypertension (25%), echocardiographic severity was not independently associated with mortality. This may reflect the multifactorial pathophysiology of CRS, where hemodynamic compromise, inflammation, and neurohormonal activation interact in complex ways.

Strengths and Limitations

To our knowledge, this is one of the few studies focusing on CRS in a North African emergency department. It adds context-specific data from a region with limited epidemiological coverage, using standardized CRS definitions and a multidisciplinary validation process.

However, several limitations should be acknowledged:

1. Small sample size (n=40) and single-center design limit generalizability and preclude multivariable modeling.
2. Retrospective design introduces risks of selection bias and misclassification.
3. Lack of natriuretic peptide levels and longitudinal renal follow-up limits the precision of classification and outcome analysis.
4. No post-discharge follow-up was available, restricting our analysis to in-hospital outcomes only.

Perspectives and Recommendations

Our findings highlight the urgent need for local diagnostic protocols for CRS in emergency settings, particularly for high-risk groups such as elderly patients and those presenting with sepsis. The

systematic use of echocardiography and renal function assessment should be integrated into acute care algorithms.

We also recommend capacity-building efforts to enhance emergency physician awareness of CRS subtypes and their prognostic implications. In parallel, multicenter prospective studies are needed to better characterize the temporal dynamics, treatment responses, and long-term outcomes of CRS in resource-limited settings.

Conclusion

Cardiorenal syndrome remains a complex and life-threatening entity, particularly in acute care settings. This study provides novel insights into the clinical profile and short-term prognosis of CRS in a Moroccan tertiary hospital. Septic shock and advanced age emerged as key predictors of mortality. Future research should aim to develop context-appropriate algorithms for early detection and risk stratification in similar healthcare environments.

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