



Original Article

## Clinical and Biochemical Profile of Hypertensive Emergencies in a Tertiary Care Centre: A Cross-Sectional Observational Study

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### ABSTRACT

**Background:** Hypertensive emergency remains a high-risk presentation in emergency medicine because the level of blood pressure alone does not define the severity of illness. Acute hypertension-mediated organ damage, particularly involving the heart, kidneys, brain, lungs and retina, determines prognosis and urgency of treatment.

**Objectives:** This study aimed to describe the clinical profile of hypertensive emergencies, identify the pattern of target organ damage, and examine selected biochemical abnormalities associated with acute blood pressure elevation.

**Methods:** A cross-sectional observational study was conducted in the Department of General Medicine, Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad. Sixty-two adults with systolic blood pressure >180 mmHg or diastolic blood pressure >110 mmHg and clinical, laboratory or radiological evidence of target organ damage were included. Patients were evaluated using clinical history, treatment adherence details, blood pressure measurements at presentation and after 30 minutes, systemic examination, fundus evaluation, urine analysis, biochemical tests, chest radiography, electrocardiography, echocardiography, renal ultrasonography and neuroimaging where indicated.

**Results:** The mean age was  $52.16 \pm 16.30$  years and males formed 64.5% of the cohort. Breathlessness was the most common presenting complaint (50.0%), followed by headache and chest pain. Mean systolic and diastolic blood pressures at presentation were  $198.39 \pm 19.01$  mmHg and  $112.10 \pm 15.06$  mmHg, respectively. Known hypertension was present in 87.1%, but only 33.9% were compliant with antihypertensive therapy. Pulmonary edema (67.7%), acute decompensated heart failure (53.2%), acute kidney injury (53.2%), chronic kidney disease (37.1%), severe retinopathy or papilledema (22.6%), hypertensive encephalopathy (17.7%) and intracranial bleed (17.7%) were the major complications. Multi-organ involvement was frequent, with three or more organ systems affected in 75.8% of patients. Proteinuria correlated significantly with severe retinal disease ( $p = 0.024$ ). Left ventricular dysfunction and regional wall motion abnormality were significantly associated with acute decompensated heart failure. Uric acid was higher in ADHF, AKI and CKD, while magnesium was lower in ADHF.

**Conclusion:** Hypertensive emergencies in this tertiary care cohort showed a predominantly multisystem pattern, led by pulmonary, cardiac and renal complications. Poor adherence to antihypertensive therapy, retinal-renal microvascular correlation, and organ-specific biochemical changes were clinically important observations. Early syndromic recognition supported by targeted investigations may improve triage, risk stratification and acute management.

Received: 29-04-2026

Accepted: 12-06-2026

Available online: 18-06-2026

## INTRODUCTION

Hypertension is one of the most important contributors to cardiovascular, renal and cerebrovascular morbidity worldwide. Its clinical impact is not restricted to chronically elevated blood pressure values; it becomes especially serious when a sudden or severe rise in blood pressure overwhelms vascular autoregulation and produces acute damage in vital organs. This acute state is described as hypertensive emergency, usually defined by markedly elevated blood pressure with evidence of ongoing or imminent target organ damage. In clinical practice, the presence of organ injury is more important than the absolute blood pressure value because patients with similar readings may have very different risks and management needs.

The emergency physician and internist must therefore approach severe hypertension as a syndrome rather than a number. Neurological symptoms may indicate hypertensive encephalopathy, posterior reversible encephalopathy syndrome, intracranial hemorrhage or ischemic stroke. Dyspnea may reflect acute pulmonary edema or left ventricular failure. Chest pain may suggest acute coronary syndrome or, rarely, acute aortic pathology. Oliguria, edema and abnormal urine findings point toward renal involvement, while advanced hypertensive retinopathy provides a visible marker of microvascular injury. These presentations often overlap, and many patients arrive with more than one organ system affected.

In India, hypertensive emergencies remain clinically relevant for several reasons. Many patients are diagnosed late, follow-up is irregular, treatment adherence is poor, and chronic kidney disease or hypertensive heart disease may already be present by the time of emergency presentation. The emergency department may be the first point of meaningful contact with the healthcare system. A detailed bedside assessment, combined with accessible investigations such as ECG, chest radiography, urine examination, renal function tests and fundoscopy, can rapidly identify high-risk patients even before advanced imaging is completed.

Biochemical abnormalities in hypertensive emergencies deserve greater attention. Acute renal dysfunction, hyperuricemia, electrolyte disturbances and altered magnesium levels may not only reflect disease severity but may also help to define organ-specific patterns. For example, rising creatinine and proteinuria suggest renal injury, hyperuricemia may accompany renal and cardiac complications, and lower magnesium may be relevant in cardiac dysfunction. However, such laboratory associations are not always systematically described in routine clinical studies, particularly in Indian tertiary care settings.

The present study was therefore undertaken to describe the clinical and biochemical profile of adult patients presenting with hypertensive emergencies in a tertiary care centre. The objectives were to characterize presenting symptoms, blood pressure trends, antihypertensive treatment history, medication compliance, target organ damage, imaging findings and selected biochemical parameters. The study also examined clinically meaningful associations between symptoms, treatment adherence, organ involvement and laboratory abnormalities, with the aim of improving early recognition and risk-oriented management.

## MATERIALS AND METHODS

### Study design and setting

This was a hospital-based cross-sectional observational study conducted in the Department of General Medicine, Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad, Telangana. The study was carried out over a period of one year after approval of the dissertation protocol.

### Study population

The study included 62 adult patients admitted with hypertensive emergencies. Patients aged 18 years or above were eligible when systolic blood pressure was more than 180 mmHg or diastolic blood pressure was more than 110 mmHg and there was clinical, laboratory or radiological evidence of target organ damage. Pregnant and lactating women, patients below 18 years, patients without target organ involvement and those with blood pressure values below the study threshold were excluded.

### Clinical evaluation

A structured proforma was used to record age, sex, presenting symptoms, previous diagnosis of hypertension, antihypertensive medication use and compliance. Blood pressure was documented at presentation and again after 30 minutes. All patients underwent detailed general and systemic examination, including cardiovascular, respiratory, abdominal and neurological assessment. Fundus examination was performed to identify hypertensive retinopathy, hemorrhages, exudates and papilledema.

## Investigations

Routine investigations included complete blood counts, blood glucose, serum urea, serum creatinine, serum electrolytes, calcium, magnesium, uric acid and complete urine examination. Chest radiography and ECG were performed in all patients. Two-dimensional echocardiography was used for assessment of left ventricular hypertrophy, regional wall motion abnormality, left ventricular dysfunction and diastolic dysfunction. Renal ultrasonography was performed to identify renal size, renal parenchymal changes and loss of corticomedullary differentiation. CT or MRI brain was obtained in patients with neurological symptoms or suspected neurological complications.

## Definitions and outcome variables

Hypertensive emergency was defined as severe elevation of blood pressure associated with evidence of acute or ongoing target organ damage. Target organ complications included pulmonary edema, acute decompensated heart failure, acute kidney injury, chronic kidney disease, hypertensive encephalopathy, intracranial bleed, coronary artery disease and severe hypertensive retinopathy or papilledema. The number and combination of involved organ systems were also recorded.

## Statistical analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 23. Continuous variables were summarized as mean with standard deviation or median with interquartile range. Categorical variables were expressed as frequency and percentage. Associations between categorical variables were assessed using appropriate tests of significance. A p-value below 0.05 was considered statistically significant.

## RESULTS

### Demographic profile

The study included 62 patients with hypertensive emergencies. The age ranged from 23 to 89 years, with a mean age of  $52.16 \pm 16.30$  years and median age of 53 years. There were 40 males (64.5%) and 22 females (35.5%). Female patients presented at a significantly higher mean age than males ( $58.68 \pm 14.10$  years versus  $48.58 \pm 16.47$  years;  $p = 0.014$ ) (Table 1).

**Table 1: Demographic profile of the study population**

Variable	Value
Sample size	62 patients
Age, mean $\pm$ SD	$52.16 \pm 16.30$ years
Age, median (IQR)	53 (38-63) years
Age range	23-89 years
Male	40 (64.5%)
Female	22 (35.5%)
Mean age in males	$48.58 \pm 16.47$ years
Mean age in females	$58.68 \pm 14.10$ years
Age difference by sex	$p = 0.014$

### Clinical presentation and blood pressure profile

Breathlessness was the leading symptom, occurring in half of the patients. Headache and chest pain were reported by about one-fifth each. Giddiness and lower limb swelling were also common, while seizures and vomiting were less frequent. The mean systolic blood pressure fell from 198.39 mmHg at presentation to 184.03 mmHg after 30 minutes of emergency care, while mean diastolic blood pressure decreased from 112.10 mmHg to 103.06 mmHg (Table 2; Figure 1 & 2).

**Table 2: Clinical presentation and early blood pressure trend**

Parameter	No. / Mean	Percentage / SD
Breathlessness	31	50.0%
Headache	12	19.4%
Chest pain	12	19.3%
Giddiness	11	17.7%
Lower limb swelling	11	17.7%
Loss of consciousness	9	14.5%
Visual complaints	6	9.7%
Decreased urine output	6	9.7%
Vomiting	5	8.1%
Seizures	4	6.5%
SBP at presentation	198.39 mmHg	SD 19.01
DBP at presentation	112.10 mmHg	SD 15.06
SBP after 30 minutes	184.03 mmHg	SD 15.09
DBP after 30 minutes	103.06 mmHg	SD 9.34

SBP: systolic blood pressure; DBP: diastolic blood pressure. Symptoms were not mutually exclusive.

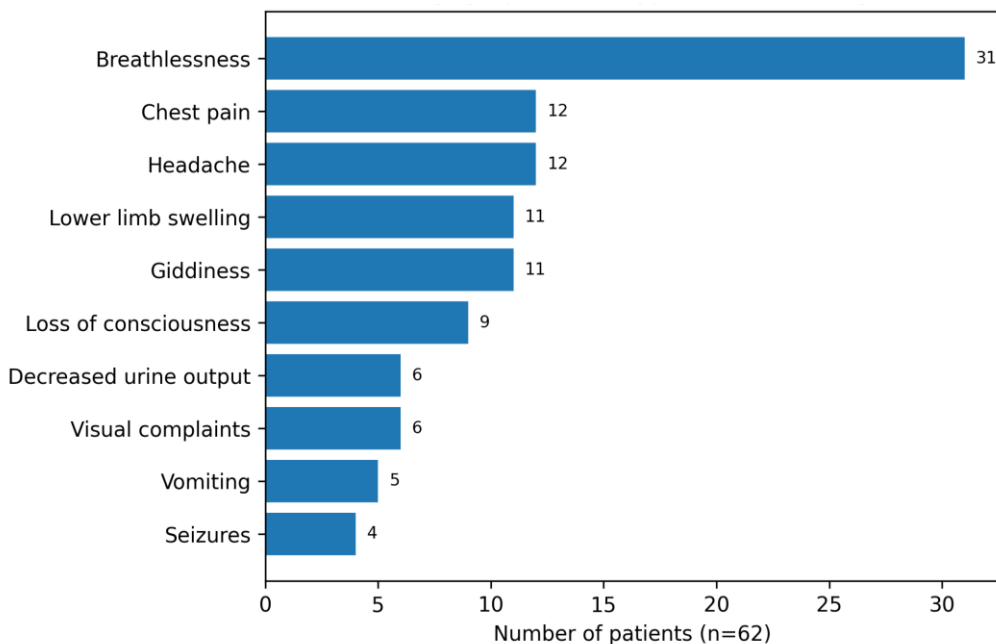


Figure 1: Distribution of presenting symptoms among patients with hypertensive emergencies.

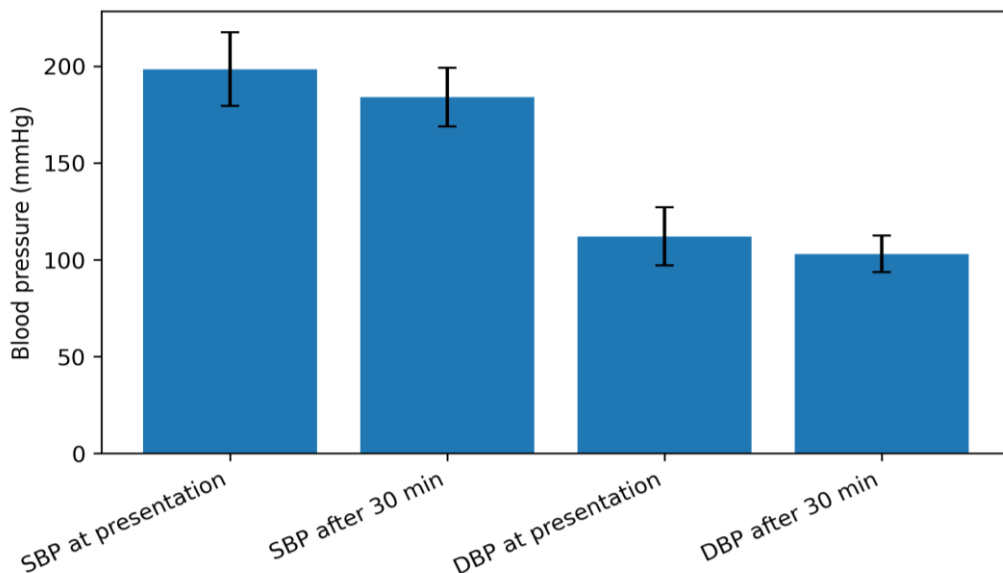


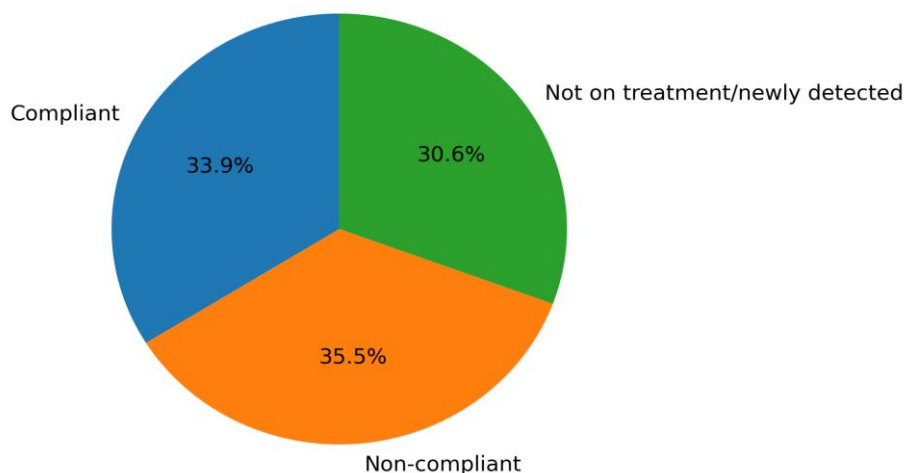
Figure 2: Mean blood pressure values at presentation and after 30 minutes. Error bars represent standard deviation.

### Hypertension history and medication adherence

Most patients were already known to have hypertension. Although 77.4% were on antihypertensive medication, only one-third were compliant. Non-compliance and newly detected or untreated hypertension together accounted for nearly two-thirds of the cohort, highlighting a preventable pathway to emergency presentation (Table 3; Figure 3).

Table 3: Hypertension history, treatment status and compliance

Parameter	No. of patients	Percentage
Known history of hypertension	54	87.1%
Newly detected hypertension	8	12.9%
On antihypertensive medication	48	77.4%
Not on antihypertensive medication	14	22.6%
Compliant with antihypertensives	21	33.9%
Non-compliant with antihypertensives	22	35.5%
Not on treatment / not applicable	19	30.6%



**Figure 3: Antihypertensive treatment and adherence status in the study population.**

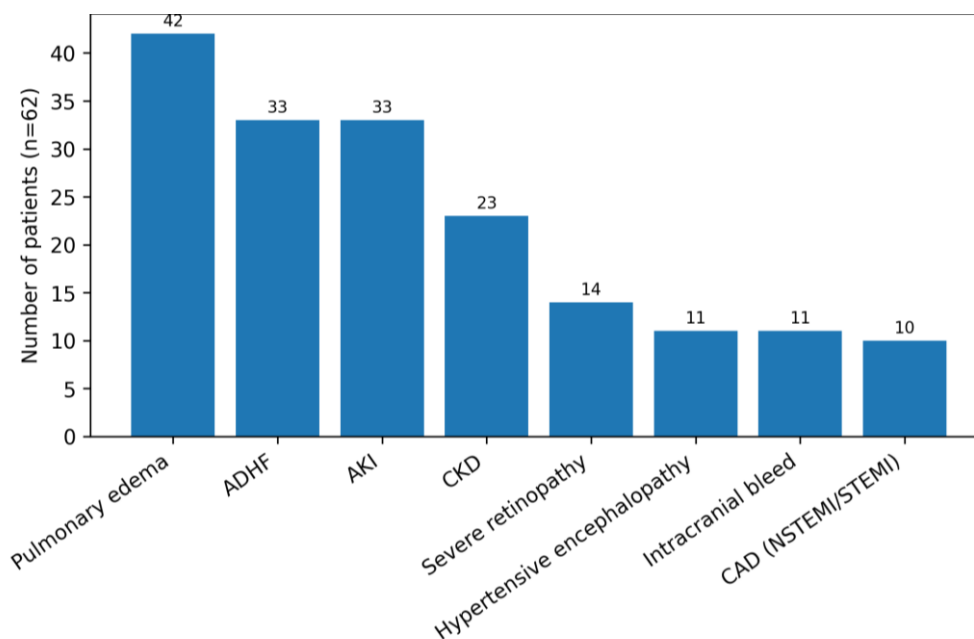
### Target organ complications

Pulmonary edema was the most frequent target organ complication, followed by acute decompensated heart failure and acute kidney injury. Renal and cardiac complications often coexisted with retinal and neurological involvement. Three or more organ systems were involved in 75.8% of patients, showing that hypertensive emergency was usually a multisystem presentation rather than an isolated organ event (Table 4; Figure 4; Table 5).

**Table 4: Spectrum of target organ complications**

Complication	No. of patients	Percentage
Pulmonary edema	42	67.7%
Acute decompensated heart failure	33	53.2%
Acute kidney injury	33	53.2%
Chronic kidney disease	23	37.1%
Grade 3 retinopathy or papilledema	14	22.6%
Hypertensive encephalopathy	11	17.7%
Intracranial bleed	11	17.7%
Coronary artery disease (NSTEMI/STEMI)	10	16.1%

*Patients could have more than one complication.*



**Figure 4: Frequency of major target organ complications in hypertensive emergencies.**

**Table 5: Extent of multisystem involvement**

Number of organ systems involved	No. of patients	Percentage
One organ system	3	4.8%
Two organ systems	12	19.4%
Three organ systems	26	41.9%
Four organ systems	17	27.4%
Five organ systems	4	6.5%
Three or more organ systems	47	75.8%

Cardiac, renal, retinal and neurological findings

Chest radiography showed pulmonary edema in 71.0% of patients. ECG showed left ventricular hypertrophy in 72.6%, while echocardiography demonstrated concentric left ventricular hypertrophy in 77.4%. Moderate or severe left ventricular dysfunction was present in 41.9%. Proteinuria was frequent on urine examination, with proteinuria of at least 1+ in 69.4%. Severe retinal disease was significantly associated with urine protein level ( $p = 0.024$ ), supporting a renal-retinal microvascular link (Table 6). In patients undergoing brain imaging, posterior reversible encephalopathy-like T2/FLAIR hyperintensities and intracranial bleeds were prominent findings.

**Table 6: Key investigation findings**

Investigation domain	Important finding	No. / Percentage
Chest radiograph	Pulmonary edema	44 (71.0%)
ECG	Left ventricular hypertrophy	45 (72.6%)
2D echocardiography	Concentric LVH	48 (77.4%)
2D echocardiography	Moderate or severe LV dysfunction	26 (41.9%)
2D echocardiography	Grade 2/3 LV diastolic dysfunction	47 (75.8%)
Urine examination	Proteinuria $\geq 1+$	43 (69.4%)
Renal ultrasound	Any renal parenchymal change	37 (59.7%)
Renal ultrasound	Loss of corticomedullary differentiation	16 (25.8%)
Brain imaging	PRES-like T2/FLAIR hyperintensities among imaged patients	7/27 (25.9%)
Brain imaging	Intracranial bleed patterns among imaged patients	10/27 (37.0%)

*LVH: left ventricular hypertrophy; PRES: posterior reversible encephalopathy syndrome.*

Biochemical profile and clinical associations

Serum creatinine and blood urea were markedly elevated in the cohort, reflecting the high burden of renal involvement. Uric acid showed significant elevation in patients with ADHF, AKI and CKD. Magnesium was significantly lower among patients with ADHF, while potassium was significantly higher in ADHF and pulmonary edema. Sodium and calcium did not show significant organ-specific variation (Table 7; Figure 5). These patterns suggest that biochemical testing can complement clinical assessment in identifying the dominant organ injury pattern.

**Table 7: Overall biochemical profile at presentation**

Parameter	Mean $\pm$ SD	Median (IQR)	Range	Trend / p-value
Serum creatinine (mg/dL)	2.81 $\pm$ 1.82	2.38 (1.41-3.86)	0.78-8.40	Elevated; $p < 0.001$
Blood urea (mg/dL)	82.2 $\pm$ 41.6	72.0 (56.0-103.0)	20-202	Elevated; $p < 0.001$
Uric acid (mg/dL)	6.80 $\pm$ 2.20	6.5 (5.62-7.7)	1.7-12	Elevated; $p = 0.012$
Magnesium (mg/dL)	0.80 $\pm$ 0.15	0.78 (0.7-0.85)	0.52-1.4	Low-normal; $p = 0.017$
Sodium (mEq/L)	137.4 $\pm$ 4.8	137.0 (134-141)	123-149	Not significant
Potassium (mEq/L)	4.25 $\pm$ 0.62	4.2 (3.8-4.7)	2.8-5.9	Not significant overall
Chloride (mEq/L)	101.3 $\pm$ 6.2	101.0 (97-106)	85-116	$p = 0.045$
Calcium (mg/dL)	8.89 $\pm$ 0.69	8.9 (8.5-9.2)	7.3-10.4	Not significant

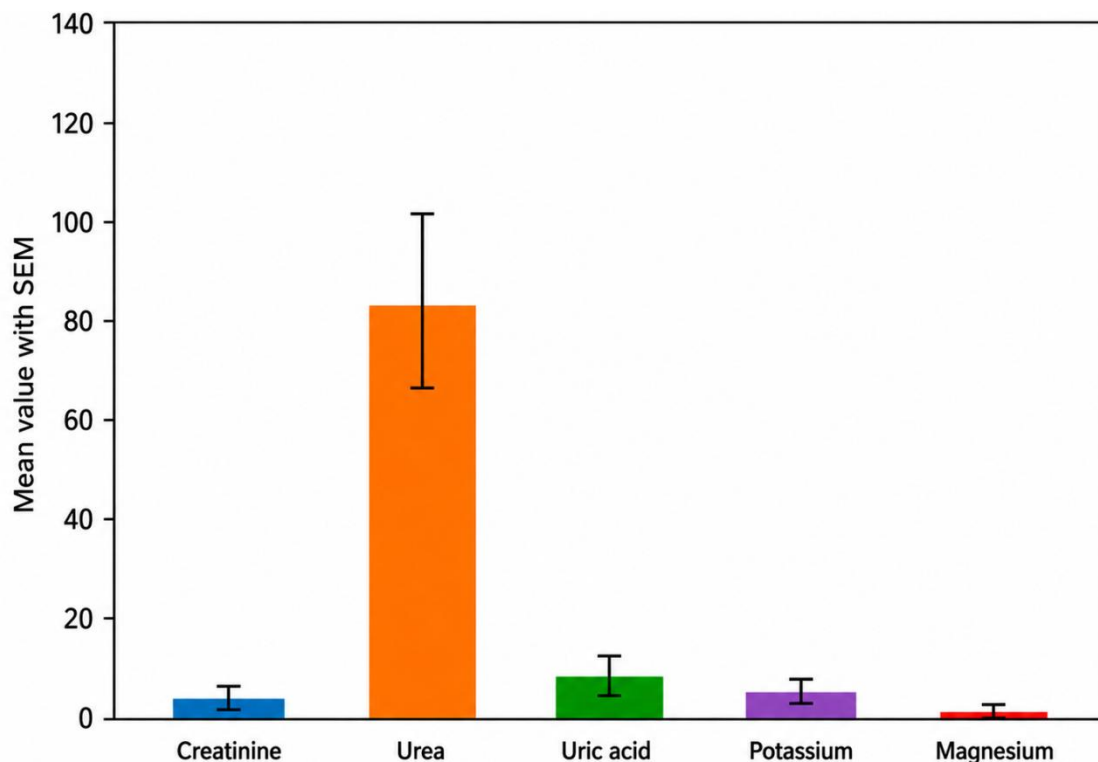


Figure 5: Selected biochemical parameters at presentation. Error bars represent standard deviation.

Table 8: Selected statistically relevant clinical associations

Association	Observation	p-value
Retinopathy and proteinuria	Severe fundus changes correlated with higher urine protein grade	0.024
LV dysfunction and ADHF	Moderate/severe LV dysfunction was more frequent in ADHF	0.001
RWMA and ADHF	Regional/global wall motion abnormality was more frequent in ADHF	0.010
Uric acid and ADHF	Uric acid was higher in ADHF patients	0.012
Uric acid and AKI	Uric acid was higher in AKI patients	0.001
Uric acid and CKD	Uric acid was higher in CKD patients	0.017
Magnesium and ADHF	Magnesium was lower in ADHF patients	0.017
Potassium and pulmonary edema	Potassium was higher in pulmonary edema	0.008
Medication status and $\geq 3$ organ damage	$\geq 3$ organ involvement: compliant 57.1%, non-compliant 86.4%, newly diagnosed 84.2%	Descriptive

ADHF: acute decompensated heart failure; AKI: acute kidney injury; CKD: chronic kidney disease; RWMA: regional wall motion abnormality.

## DISCUSSION

This study describes hypertensive emergency as a distinctly multisystem illness in a tertiary care setting. The typical patient was a middle-aged male with known hypertension, but the emergency presentation was not simply a reflection of blood pressure magnitude. The clinically decisive feature was target organ injury, most often involving the lungs, heart and kidneys, with frequent overlap across organ systems. The high proportion of patients with three or more involved organ systems is important because it suggests late presentation, chronic uncontrolled vascular injury or both.

The symptom profile was clinically practical. Breathlessness was the commonest complaint and corresponded with the high frequency of pulmonary edema and acute decompensated heart failure. Chest pain, although less frequent, retained importance because acute coronary syndromes may coexist with severe hypertension or may be precipitated by abrupt

pressure overload and increased myocardial oxygen demand. Neurological symptoms such as headache, seizures, loss of consciousness and visual complaints were less common than dyspnea but were strongly relevant when present, as they guided the need for neuroimaging and helped identify encephalopathy, intracranial hemorrhage and PRES-like changes.

Medication adherence emerged as one of the most actionable findings. Although most patients were already diagnosed with hypertension, only 33.9% were compliant with treatment. Non-compliant patients and those not on treatment showed a high burden of extensive organ involvement. While the study design does not prove causality, the finding is biologically and clinically plausible. Interruption of antihypertensive therapy, inadequate follow-up and poor long-term control are well-recognized contributors to hypertensive crises. These data support the need for discharge counselling, simplified drug regimens, early review visits and community-level adherence strategies.

Cardiac involvement was prominent. ECG detected left ventricular hypertrophy in nearly three-fourths of patients, and echocardiography showed concentric LVH in an even higher proportion. Moderate or severe systolic dysfunction and wall motion abnormalities were significantly associated with ADHF, emphasizing the need for early echocardiographic evaluation in patients with breathlessness, pulmonary edema or abnormal ECG. The coexistence of left ventricular hypertrophy and diastolic dysfunction also indicates chronic pressure overload preceding the acute presentation.

Renal injury formed another central component of the clinical picture. More than half of the patients had AKI, over one-third had CKD and proteinuria was common. The significant association between severe hypertensive retinopathy and proteinuria is particularly interesting. The retina and kidney share susceptibility to small-vessel injury, and the combination of advanced retinopathy with proteinuria may serve as a simple bedside-laboratory signal of systemic microvascular damage. In resource-limited settings, fundoscopy and urine examination can therefore provide valuable information even before advanced testing is available.

The biochemical profile added depth to the clinical interpretation. Elevated creatinine and urea reflected the high renal burden, while uric acid was significantly higher in ADHF, AKI and CKD. Hyperuricemia may be a marker of renal dysfunction, oxidative stress, endothelial dysfunction and neurohormonal activation. The lower magnesium levels seen in ADHF are also clinically relevant because magnesium has vascular and myocardial effects, although this observation requires confirmation in larger studies. Potassium elevation among patients with ADHF and pulmonary edema may reflect renal impairment, neurohormonal disturbance, drug exposure or acute cardiorenal interaction.

Compared with previous studies, the present findings broadly agree with the reported male predominance and middle-age clustering in hypertensive emergencies. The organ involvement pattern was also similar, although the burden of renal and pulmonary complications appeared high in this cohort. The study contributes by linking clinical presentation, imaging, urine findings and biochemical parameters in the same patient group. This integrated view may be more useful for real-world emergency triage than isolated descriptions of blood pressure or single-organ complications.

From a clinical standpoint, the findings support a structured approach to hypertensive emergencies. Initial assessment should include symptom-directed triage, confirmation of severe blood pressure elevation, rapid search for organ damage, urine protein testing, renal function assessment, ECG, chest radiograph and fundoscopy. Echocardiography and neuroimaging should be guided by clinical suspicion but used early when cardiac or neurological symptoms are present. Management should not end with acute blood pressure reduction; it must include prevention of recurrence through adherence counselling and long-term risk factor control.

### **Limitations**

The study was conducted at a single tertiary care centre and included 62 patients, which limits generalizability to other healthcare settings. The cross-sectional design does not allow causal inference between adherence, biochemical abnormalities and organ damage. Medication compliance was based on patient or attendant history and may be affected by recall bias. Biochemical parameters were measured during acute presentation, and serial post-stabilization trends were not available. Long-term outcomes such as mortality after discharge, readmission and recurrence of hypertensive emergency were not assessed.

### **CONCLUSION**

Hypertensive emergencies in this tertiary care cohort most often affected middle-aged men with previously known hypertension and suboptimal treatment adherence. Breathlessness was the dominant presenting symptom, and pulmonary, cardiac and renal complications were the major forms of target organ damage. Multisystem involvement was common, with three or more organ systems affected in nearly three-fourths of patients. Retinopathy showed a significant relationship with proteinuria, pointing toward shared microvascular injury, while uric acid, magnesium and potassium demonstrated clinically relevant organ-specific patterns. These findings reinforce the need for rapid bedside evaluation, early organ-directed investigations, careful biochemical assessment and strong post-discharge adherence interventions.

## Clinical Implications

In emergency settings, patients with severe hypertension should be evaluated for organ damage rather than treated on blood pressure values alone. Breathlessness should prompt early assessment for pulmonary edema and cardiac dysfunction. Fundoscopy and urine protein testing should be used together whenever possible, as they may identify systemic microvascular injury. Patients with known hypertension but poor adherence need focused counselling before discharge, because non-compliance was common and extensive organ involvement was frequent in this group.

## Funding

No external funding was received for this study.

## Conflict of Interest

The authors declare no conflict of interest.

## Acknowledgement

The authors thank the faculty, residents, nursing staff and patients of the Department of General Medicine, Nizam's Institute of Medical Sciences, Hyderabad, for their support and cooperation during the study.

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