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Original Research Article

AGE-SPECIFIC CLINICAL PROFILE, SPECTRUM OF TARGET ORGAN DAMAGE, AND PROGNOSIS IN PATIENTS WITH HYPERTENSIVE EMERGENCIES: A PROSPECTIVE OBSERVATIONAL STUDY FROM A SOUTH INDIAN TERTIARY CARE CENTRE

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ABSTRACT

Background: Hypertensive emergencies represent the most severe acute manifestation of systemic hypertension, characterised by markedly elevated blood pressure with acute target organ damage. Age-specific differences in clinical presentation, organ involvement, and outcomes remain incompletely characterised in Indian populations. **Objectives:** To compare age-specific differences in clinical profile, spectrum of target organ damage, and prognosis among young (<40 years), middle-aged (40–60 years), and elderly (>60 years) patients with hypertensive emergencies. **Materials and Methods:** This prospective observational study enrolled 116 consecutive patients admitted with hypertensive emergencies (SBP ≥180 mmHg and/or DBP ≥120 mmHg with target organ damage) over 18 months at a tertiary care centre in South India. Patients were stratified into three age groups. Clinical profile, target organ damage, management, and in-hospital outcomes were compared using Chi-square/Fisher's Exact and Kruskal-Wallis tests, with $p<0.05$ considered significant. **Results:** The mean age was 57.0±18.8 years; 48.3% were aged >60 years. Gender distribution differed significantly across age groups (60.3% male overall; $p=0.034$), with male predominance attenuating with advancing age. Mean systolic blood pressure at presentation was significantly higher in the elderly (217.8±16.9 mmHg vs 206.1±14.1 mmHg in <40 years; $p=0.023$). Neurological target organ damage predominated overall (45.7%), with posterior reversible encephalopathy syndrome and hypertensive encephalopathy characterising younger patients while ischaemic stroke and intracerebral haemorrhage predominated in the elderly. Ophthalmic involvement (Keith-Wagener-Barker Grade III–IV) was the commonest target organ affected overall (52.6%), most striking in patients <40 years (77.8%). Poor medication compliance was universal (100%) among known hypertensives under 40 years. All patients received intravenous antihypertensive therapy, achieving a comparable 24-hour blood pressure reduction of 24.5–24.7% across age groups. In-hospital mortality was 5.2%, with a clear age gradient (0%, 2.4%, and 8.9% in the young, middle-aged, and elderly groups respectively; $p=0.196$). **Conclusion:** Hypertensive emergencies exhibit distinct age-specific patterns of target organ damage, younger patients bearing a reversible neuro-ophthalmic burden driven largely by non-adherence, and older patients bearing greater cardiac, cerebrovascular, and mortality risk. Medication non-adherence is the principal modifiable determinant across all age groups and should be targeted through community-level adherence programmes.

INTRODUCTION

Systemic hypertension is a chronic, multifactorial cardiovascular disorder characterised by sustained elevation of arterial blood pressure, defined as systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg on repeated measurement.[1] It remains one of the most prevalent non-communicable diseases worldwide and a major modifiable risk factor for cardiovascular disease, stroke, chronic kidney disease, heart failure, and premature mortality. In India, hypertension affects approximately 28.1% of the adult population, with a higher burden in urban areas.[2,3]

Approximately 1–2% of hypertensive individuals develop a hypertensive emergency during their lifetime, defined as an acute SBP ≥180 mmHg and/or DBP ≥120 mmHg with new or worsening damage to one or more target organs, brain, heart, kidney, retina, or large vessels.[1,4] Although advances in antihypertensive pharmacotherapy have improved survival, affected patients continue to carry substantial residual cardiovascular risk.[3,4]

Hypertension is increasingly recognised in young adults (<40 years), driven by sedentary lifestyle, high-sodium diet, obesity, and psychosocial stress; secondary causes are proportionately more frequent in this group.[5,6] When young patients develop hypertensive emergencies, they often lack the chronic vascular remodelling seen in older patients, so acute severe presentations, including posterior reversible encephalopathy syndrome (PRES) and hypertensive encephalopathy, tend to predominate, frequently precipitated by poor medication adherence.[6,22]

In contrast, hypertension in the elderly (>60 years) is characterised by progressive arterial stiffening, isolated systolic hypertension, and a high burden of comorbidities including coronary artery disease, diabetes, and chronic kidney disease, which lower the threshold for acute decompensation and predispose to ischaemic cerebrovascular and cardiac target organ damage.[1,4,8] Age-related impairment of baroreceptor sensitivity and altered cerebral autoregulation in the elderly necessitate a more graduated approach to blood pressure lowering.[8,9]

The pathophysiological hallmark of a hypertensive emergency is failure of vascular autoregulation: an abrupt rise in systemic vascular resistance triggers endothelial injury, fibrinoid necrosis of the arteriolar wall, and activation of the renin-angiotensin-aldosterone and sympathetic nervous systems, which in turn perpetuate further pressure elevation and end-organ ischaemia, a self-sustaining cycle of vascular injury.[7,10] Common clinical presentations include hypertensive encephalopathy, intracerebral haemorrhage, ischaemic stroke, acute coronary syndrome, acute left ventricular failure with pulmonary oedema, acute kidney injury, aortic dissection, and hypertensive retinopathy, reflecting the diverse organs vulnerable to this pathophysiological cascade.[1,4]

Although the pathophysiology and management principles of hypertensive emergencies are well described, age-specific differences in clinical profile, spectrum of target organ damage, and prognosis remain incompletely characterised in Indian populations, where the burden of both young-onset and elderly-onset hypertension is rising in parallel. A clearer understanding of how age modulates the pattern of target organ damage and clinical outcome could help clinicians triage and counsel patients more effectively, particularly with regard to the risk of under-triaging young patients whose presentations may be dramatic despite an overall favourable prognosis. This study was therefore designed to address this gap by prospectively comparing clinical profile, target organ damage, management, and in-hospital outcome data across three pre-defined age strata at a South Indian tertiary care centre.

Aim and Objectives

Aim: To compare age-specific differences in the clinical profile, spectrum of target organ damage, and prognosis of patients presenting with hypertensive emergencies.

Objectives

1. To describe the clinical profile of hypertensive emergencies among young (<40 years), middle-aged (40–60 years), and elderly (>60 years) patients.
2. To assess the spectrum of target organ damage and in-hospital outcomes of hypertensive emergencies among the three age groups.

MATERIALS AND METHODS

This hospital-based prospective observational study was conducted in the Department of General Medicine at a tertiary care teaching institute in Kuppam, Chittoor District, Andhra Pradesh, India, over 18 months (April 2024 to October 2025), following approval by the Institutional Ethics Committee. All patients aged above 18 years admitted with hypertensive emergency, defined as acute SBP ≥180 mmHg and/or DBP ≥120 mmHg with clinical or laboratory evidence of target organ damage (myocardial infarction, stroke, acute kidney injury, pulmonary oedema, aortic dissection, retinopathy, papilloedema, or hypertensive encephalopathy), were consecutively enrolled after written informed consent. Pregnant patients were excluded.

The minimum sample size, calculated using an expected prevalence of 53.03% derived from previously published data, a 10% precision, and 95% confidence interval, was 96; 116 patients were enrolled, exceeding this requirement.17 Patients were stratified into three pre-defined age groups: young (<40 years), middle-aged (40–60 years), and elderly (>60 years).

Detailed history (presenting symptoms, hypertension duration, treatment compliance, precipitating factors, and comorbidities) and clinical examination were

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recorded on a pre-designed proforma. Blood pressure was measured at admission, 1 hour, 6 hours, 24 hours, and at discharge. Investigations included complete blood count, renal and liver function tests, serum electrolytes, fasting glucose, lipid profile, urinalysis, cardiac biomarkers, 12-lead electrocardiography, 2D-echocardiography, chest radiography, fundoscopy (Keith-Wagener-Barker grading), and neuroimaging (CT/MRI brain) in neurologically symptomatic patients as per AHA/ACC 2017 guidelines. All patients received intravenous antihypertensive therapy (labetalol, nicardipine, or nitroglycerin) with gradual, controlled blood pressure reduction followed by oral maintenance therapy. Duration of hospital stay, requirement for intensive care and ventilatory support, and in-hospital mortality were documented and correlated with age and organ involvement at discharge.

For analytical purposes, target organ damage was classified into four primary categories, neurological (hypertensive encephalopathy, PRES, ischaemic stroke, intracranial haemorrhage), cardiac (acute coronary syndrome, acute pulmonary oedema, heart failure), renal (acute kidney injury or acute-on-chronic kidney disease), and isolated hypertensive retinopathy, assigned according to the dominant presenting diagnosis. Ophthalmic involvement (Keith-Wagener-Barker Grade III or IV) was additionally recorded as an independent, non-mutually-exclusive parameter across all patients, since retinopathy frequently co-existed with other organ involvement. Neurological and renal recovery at discharge were assessed only among the 110 survivors, expressed as a proportion of survivors within each age stratum, to avoid conflating mortality with poor organ-specific recovery.

Data were entered into Microsoft Excel and analysed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA) and R software. Continuous variables were expressed as mean±SD or median (interquartile range) as appropriate, and compared using Student's t-test, one-way ANOVA, or the Kruskal-Wallis test. Categorical variables were expressed as frequencies and percentages and compared using the Chi-square test or Fisher's Exact test where expected cell counts were small. A p-value <0.05 was considered statistically significant throughout. The study was conducted in accordance with the Declaration of Helsinki, and written informed consent was obtained from all participants or their legally authorised representatives prior to enrolment.

RESULTS

A total of 116 patients with hypertensive emergencies were enrolled, with ages ranging from 20 to 85 years (mean 57.0±18.8 years) and a mean BMI of 28.0±3.1 kg/m². The elderly (>60 years) constituted the largest proportion (48.3%), followed by the middle-aged (36.2%) and young (15.5%) groups; overall, 84.5% of patients were aged 40 years or older. Sixty percent (60.3%) of patients were male, and gender distribution differed significantly across age groups (Chi-square, p=0.034), with male predominance progressively attenuating from 83.3% in the <40 years group to an equal 50.0% distribution in the >60 years group.

A moderate lifestyle predominated overall (47.4%), and a high-salt diet was reported in 47.4% of patients. Alcohol consumption varied significantly with age (p=0.021), peaking in the 40–60 years group (47.6%), while diabetes mellitus showed a non-significant increasing trend with age (33.3% to 48.2%; p=0.427). Known hypertension was present in 69.8% of patients overall, increasing progressively with age (61.1% to 73.2%; p=0.617); among known hypertensives on treatment (n=60), poor compliance was documented in 80.0% overall and was universal (100%) in patients under 40 years. These baseline characteristics are summarised in Table 1.

Table 1: Age-wise baseline demographic, lifestyle, and hypertension-related characteristics of the study population (n=116)

Variable	<40 yrs (n=18)	40–60 yrs (n=42)	>60 yrs (n=56)	Total (n=116)	p-value
Male sex, n (%)	15 (83.3%)	27 (64.3%)	28 (50.0%)	70 (60.3%)	0.034*
Female sex, n (%)	3 (16.7%)	15 (35.7%)	28 (50.0%)	46 (39.7%)	
Sedentary lifestyle, n (%)	5 (27.8%)	14 (33.3%)	15 (26.8%)	34 (29.3%)	0.742
High-salt diet, n (%)	7 (38.9%)	21 (50.0%)	27 (48.2%)	55 (47.4%)	0.693
Current smoking, n (%)	8 (44.4%)	18 (42.9%)	23 (41.1%)	49 (42.2%)	0.964
Alcohol use, n (%)	3 (16.7%)	20 (47.6%)	15 (26.8%)	38 (32.8%)	0.021*
Diabetes mellitus, n (%)	6 (33.3%)	16 (38.1%)	27 (48.2%)	49 (42.2%)	0.427
Family history HTN/CVD, n (%)	8 (44.4%)	14 (33.3%)	22 (39.3%)	44 (37.9%)	0.688
Known hypertensive, n (%)	11 (61.1%)	29 (69.0%)	41 (73.2%)	81 (69.8%)	0.617
Poor compliance among treated (n=60), n (%)	7/7 (100%)	16/20 (80.0%)	25/33 (75.8%)	48/60 (80.0%)	—

**Chi-square/Fisher's Exact test, p<0.05 considered statistically significant. HTN, hypertension; CVD, cardiovascular disease.*

Clinical Presentation and Spectrum of Target Organ Damage

Breathlessness was the most common presenting symptom overall (53.4%), followed by visual symptoms (50.9%), headache (50.0%), limb weakness (44.8%), and chest pain (38.8%); no symptom showed a statistically significant age-wise difference (all p>0.05), although breathlessness

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showed a rising trend with age (44.4% to 58.9%). Neurological target organ damage (TOD) was the most prevalent primary category overall (45.7%), followed by cardiac (32.8%), renal (15.5%), and isolated retinopathy (6.0%), with no statistically significant age-wise difference (p=0.115); however, the sub-type distribution shifted markedly with age, PRES and hypertensive encephalopathy predominated in patients <40 years (7 of 8 neurological cases), while ischaemic stroke and intracerebral haemorrhage (ICH) increasingly predominated in older patients. Cardiac TOD rose nearly four-fold from 11.1% in the young to 38.1% in the middle-aged group, while acute-on-chronic kidney disease was most prevalent in the youngest group (27.8% vs 10.7% in the elderly).

When target organ involvement was assessed comprehensively across all systems (rather than by primary diagnosis alone), ophthalmic involvement (Keith-Wagener-Barker Grade III–IV) emerged as the single most frequent abnormality (52.6% overall), and was disproportionately concentrated in the youngest group (77.8% vs 52.4% and 44.6% in the middle-aged and elderly groups respectively). Type-wise, ischaemic stroke (15.5%) and acute-on-CKD (15.5%) were the commonest individual diagnoses, followed by acute coronary syndrome (14.7%), ICH (12.1%), and acute pulmonary oedema (11.2%); PRES accounted for 7.8% overall but 22.2% of presentations in patients <40 years. These findings are summarised in Table 2.

Table 2: Age-wise distribution of presenting symptoms, type of hypertensive emergency, and spectrum of target organ damage (n=116)

Parameter	<40 yrs (n=18)	40–60 yrs (n=42)	>60 yrs (n=56)	Total (n=116)	p-value
Headache, n (%)	10 (55.6%)	19 (45.2%)	29 (51.8%)	58 (50.0%)	0.714
Breathlessness, n (%)	8 (44.4%)	21 (50.0%)	33 (58.9%)	62 (53.4%)	0.481
Chest pain, n (%)	3 (16.7%)	17 (40.5%)	25 (44.6%)	45 (38.8%)	0.102
Limb weakness, n (%)	10 (55.6%)	19 (45.2%)	23 (41.1%)	52 (44.8%)	0.560
Visual symptoms, n (%)	11 (61.1%)	19 (45.2%)	29 (51.8%)	59 (50.9%)	0.520
Primary neurological TOD, n (%)	8 (44.4%)	17 (40.5%)	28 (50.0%)	53 (45.7%)	0.115
Primary cardiac TOD, n (%)	2 (11.1%)	16 (38.1%)	20 (35.7%)	38 (32.8%)	
Primary renal TOD, n (%)	5 (27.8%)	7 (16.7%)	6 (10.7%)	18 (15.5%)	
Isolated retinopathy, n (%)	3 (16.7%)	2 (4.8%)	2 (3.6%)	7 (6.0%)	
Ischaemic stroke, n (%)	0 (0.0%)	6 (14.3%)	12 (21.4%)	18 (15.5%)	0.127
Acute-on-CKD, n (%)	5 (27.8%)	7 (16.7%)	6 (10.7%)	18 (15.5%)	
Acute coronary syndrome, n (%)	2 (11.1%)	7 (16.7%)	8 (14.3%)	17 (14.7%)	
Intracranial haemorrhage, n (%)	1 (5.6%)	5 (11.9%)	8 (14.3%)	14 (12.1%)	
Acute pulmonary oedema, n (%)	0 (0.0%)	6 (14.3%)	7 (12.5%)	13 (11.2%)	
Hypertensive encephalopathy, n (%)	3 (16.7%)	4 (9.5%)	5 (8.9%)	12 (10.3%)	
PRES, n (%)	4 (22.2%)	2 (4.8%)	3 (5.4%)	9 (7.8%)	
Heart failure, n (%)	0 (0.0%)	3 (7.1%)	5 (8.9%)	8 (6.9%)	
Ophthalmic TOD (KWB III–IV), n (%)*	14 (77.8%)	22 (52.4%)	25 (44.6%)	61 (52.6%)	—

**Ophthalmic TOD assessed independently across all patients (overlaps with other TOD categories); not mutually exclusive with primary TOD categories above. TOD, target organ damage; KWB, Keith-Wagener-Barker; CKD, chronic kidney disease; PRES, posterior reversible encephalopathy syndrome.*

Blood Pressure Profile and Management

Mean SBP at presentation was significantly higher in the elderly (217.8±16.9 mmHg) than in the middle-aged (214.1±15.4 mmHg) and young (206.1±14.1 mmHg) groups (Kruskal-Wallis, p=0.023; overall 214.6±16.4 mmHg). Mean arterial pressure (MAP) followed the same significant pattern (p=0.042), while DBP showed a non-significant increasing trend (p=0.071). Despite the higher presenting SBP in older patients, the mean 24-hour SBP reduction was comparable across all age groups (24.5–24.7%; overall 24.6±1.6%), within the ACC/AHA 2017 target of ≤25% reduction. All 116 patients received intravenous antihypertensive therapy; sodium nitroprusside was not used in any patient. IV nicardipine predominated in the young (61.1%), reflecting its cerebrovascular benefit in PRES and hypertensive encephalopathy, while IV labetalol predominated in the middle-aged and elderly groups (48–50%). The mean time to blood pressure control was 16.1±6.3 hours, with no significant age-wise difference (p=0.487). ICU admission was required in 63.8% overall (highest in the young, 72.2%) and ventilatory support in 44.8%, neither differing significantly by age (p=0.296 and p=0.951 respectively). These findings are detailed in Table 3.

Table 3: Age-wise blood pressure profile, serial blood pressure trend, and management strategies (n=116)

Parameter	<40 yrs (n=18)	40–60 yrs (n=42)	>60 yrs (n=56)	Total (n=116)	p-value
Mean SBP ± SD at presentation (mmHg)	206.1±14.1	214.1±15.4	217.8±16.9	214.6±16.4	0.023*
Mean DBP ± SD at presentation (mmHg)	124.3±9.3	128.6±7.7	131.1±9.0	129.1±8.8	0.071
Mean MAP ± SD at presentation (mmHg)	151.5±9.0	157.1±8.8	160.0±9.2	157.6±9.1	0.042*

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Mean SBP at 1 hour (mmHg)	182.1±13.8	188.5±13.7	192.1±14.8	189.0±14.3	—
Mean SBP at 6 hours (mmHg)	166.8±12.5	172.6±12.9	176.0±13.6	173.0±13.3	—
Mean SBP at 24 hours (mmHg)	156.3±11.7	161.5±12.0	164.6±12.8	161.8±12.4	—
Mean SBP at discharge (mmHg)	146.9±11.4	151.9±12.2	154.8±12.7	152.1±12.6	—
Mean % SBP reduction at 24 h	24.7%	24.7%	24.5%	24.6%	0.912
IV Labetalol used, n (%)	5 (27.8%)	21 (50.0%)	27 (48.2%)	53 (45.7%)	—
IV Nicardipine used, n (%)	11 (61.1%)	13 (31.0%)	20 (35.7%)	44 (37.9%)	—
IV Nitroglycerin used, n (%)	2 (11.1%)	8 (19.0%)	9 (16.1%)	19 (16.4%)	—
Mean time to BP control ± SD (hours)	16.8±6.5	15.4±6.1	16.5±6.4	16.1±6.3	0.487
ICU admission required, n (%)	13 (72.2%)	23 (54.8%)	38 (67.9%)	74 (63.8%)	0.296
Ventilatory support required, n (%)	8 (44.4%)	18 (42.9%)	26 (46.4%)	52 (44.8%)	0.951

**p<0.05, Kruskal-Wallis test. SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; BP, blood pressure.*

Prognosis and Hospital Outcomes

Among the 110 survivors, neurological recovery at discharge was achieved in 59.1% (65/110), with residual neurological deficit in 40.9%; complete renal recovery occurred in 34.5%, partial recovery in 35.5%, and no recovery in 30.0%. In-hospital mortality was 5.2% (6/116), with a clear age gradient, 0% in patients <40 years, 2.4% in the middle-aged, and 8.9% in the elderly, though this did not reach statistical significance (p=0.196). Mean hospital stay was 11.2±4.2 days (range 3–18 days), comparable across all age groups (p=0.847). Notably, the youngest group had the highest ICU utilisation (72.2%) despite recording zero mortality, an apparent paradox explained by the predominance of physiologically severe but reversible conditions (PRES, acute-on-CKD) in this age group. These outcomes are summarised in Table 4.

Table 4: Age-wise comparison of prognosis and in-hospital outcomes (n=116)

Outcome	<40 yrs (n=18)	40–60 yrs (n=42)	>60 yrs (n=56)	Total (n=116)	p-value
ICU admission, n (%)	**13 (72.2%)**	**23 (54.8%)**	**38 (67.9%)**	**74 (63.8%)**	**0.296**
Ventilatory support, n (%)	**8 (44.4%)**	**18 (42.9%)**	**26 (46.4%)**	**52 (44.8%)**	**0.951**
Neurological recovery*, n/N (%)	**10/18 (55.6%)**	**22/41 (53.7%)**	**33/51 (64.7%)**	**65/110 (59.1%)**	**0.533**
Residual neuro deficit*, n/N (%)	**8/18 (44.4%)**	**19/41 (46.3%)**	**18/51 (35.3%)**	**45/110 (40.9%)**	—
Complete renal recovery*, n/N (%)	**4/18 (22.2%)**	**14/41 (34.1%)**	**20/51 (39.2%)**	**38/110 (34.5%)**	**0.549**
Partial renal recovery*, n/N (%)	**7/18 (38.9%)**	**17/41 (41.5%)**	**15/51 (29.4%)**	**39/110 (35.5%)**	—
No renal recovery*, n/N (%)	**7/18 (38.9%)**	**10/41 (24.4%)**	**16/51 (31.4%)**	**33/110 (30.0%)**	—
Mean hospital stay ± SD (days)	**11.3±4.4**	**11.0±4.0**	**11.4±4.2**	**11.2±4.2**	**0.847**
In-hospital mortality, n (%)	**0 (0.0%)**	**1 (2.4%)**	**5 (8.9%)**	**6 (5.2%)**	**0.196**

**Neurological and renal outcomes expressed as a percentage of survivors (n=110; excluding 6 deceased patients) within each age stratum (denominators: <40 years n=18, 40–60 years n=41, >60 years n=51).*

Investigational Findings

Electrocardiographic and echocardiographic LVH were present in 37.9% and 38.8% overall respectively, both increasing with age, while chest radiography showed pulmonary oedema in 44.0% overall. Documented acute kidney injury (27.6%) and urine protein ≥1+ (37.1%) both declined with age. Neuroimaging, performed only in neurologically symptomatic patients, showed PRES concentrated in the young (22.2%) and ischaemic stroke concentrated in the elderly (21.4%); mean serum creatinine was comparable across age groups (1.68±1.16 mg/dL).

DISCUSSION

This prospective study of 116 patients demonstrated two statistically significant age-related findings, a shift in gender distribution (p=0.034) and significantly higher presenting SBP in the elderly (p=0.023), consistent with the classical definition of hypertensive emergency as severe blood pressure elevation with acute target organ damage.[1,4,5]

Hypertensive emergencies predominantly affected patients aged 40 years and above (84.5%), consistent with Konuganti and Swamy, who reported a peak in the fifth and sixth decades, and with the South Indian data of Vinaykumar et al. and Salagre et al.[20,14,16]

Male predominance progressively attenuated with advancing age, likely reflecting loss of oestrogen-mediated vascular protection after menopause, a pattern also described by Vilela-Martin et al. and Zampaglione et al.[11,9]

Poor medication compliance was found in 80.0% of treated known hypertensives and was universal (100%) in patients under 40 years. Since non-adherence as a primary driver of hypertensive crises is well established in Indian literature, this observation implies that every emergency in a young, previously treated hypertensive in this cohort was, in principle, avoidable with adequate adherence.[12,15]

Alcohol consumption varied significantly with age, peaking in the working middle-aged group (47.6%; p=0.021), plausibly reflecting sympathetic and renin-angiotensin-aldosterone activation from chronic alcohol use superimposed on occupational drinking patterns in this demographic.

Neurological TOD was the leading category overall (45.7%), but its sub-type composition shifted markedly with age, PRES and hypertensive encephalopathy, reversible pressure-related syndromes, dominated in patients <40 years, while ischaemic stroke and ICH, reflecting atherosclerosis and microangiopathy, predominated in the

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elderly.[6,22,10] Cardiac TOD rose nearly four-fold from 11.1% in the young to 38.1% in the middle-aged group, consistent with age-related accumulation of subclinical left ventricular hypertrophy and coronary disease, while acute-on-CKD was most prevalent in the young, likely reflecting a higher proportion of secondary and renovascular hypertension in this group.[7,10]

Ophthalmic involvement (Grade III–IV retinopathy) was the single most frequent target organ finding overall (52.6%) and was disproportionately concentrated in the youngest group (77.8%). In younger patients, the absence of chronic arteriolar remodelling means acute pressure surges are transmitted directly to the retinal microvasculature, producing florid changes even after a shorter duration of hypertension.[10,12] This finding underscores the importance of mandatory fundoscopy in every hypertensive emergency, particularly in young patients, as retinal examination may reveal severe end-organ involvement even when cardiac and renal markers appear preserved.

Renal target organ damage followed an inverse age gradient, being most prominent in the young (acute-on-CKD 27.8% vs 10.7% in the elderly), which likely reflects a higher relative contribution of secondary causes, renal parenchymal and renovascular disease, in this age group, in contrast to the predominantly essential, atherosclerosis-associated hypertension of older patients. This observation reinforces published recommendations that young patients presenting with hypertensive emergencies should undergo focused evaluation for secondary hypertension once the acute crisis has been controlled. Cardiac target organ damage, by contrast, showed the steepest positive age gradient among all organ systems, rising nearly four-fold from the young to the middle-aged group, mirroring the cumulative, dose-dependent effect of chronic pressure loading on left ventricular mass and coronary vasculature that is well described in longitudinal hypertension cohorts.

SBP and MAP at presentation were significantly higher in the elderly, with a non-significant increasing trend in DBP, a pattern consistent with isolated systolic hypertension due to age-related large-vessel stiffness and reduced vascular compliance.[7] Despite this, all age groups achieved a comparable 24-hour SBP reduction of approximately 24–25%, confirming guideline-adherent, age-independent management consistent with the ACC/AHA 2017 target.[1] IV nicardipine predominated in the young for its cerebrovascular benefit in PRES, while IV labetalol predominated in older groups for broad-spectrum efficacy; sodium nitroprusside was not used in any patient, reflecting contemporary guideline practice.[23]

A clinically important paradox emerged: patients <40 years had the highest ICU admission rate (72.2%) yet recorded zero in-hospital mortality, whereas the elderly had a comparatively lower ICU rate (67.9%) but the highest mortality (8.9%). This is explained by the nature of the dominant emergencies in each group, PRES and acute-on-CKD in the young are physiologically severe, demanding intensive monitoring, but are fundamentally reversible with timely management, whereas ischaemic stroke and ICH in the elderly carry irreversible neuronal injury whose outcome depends more on pre-existing cerebrovascular reserve than on acute blood pressure control. This finding reinforces that young patients must not be under-triaged on the basis of age alone, since their presentations are frequently florid and require ICU-level care despite an overall favourable prognosis.

The observed in-hospital mortality of 5.2% compares favourably with the pooled estimate of approximately 10% reported in the meta-analysis of Siddiqi et al. and the 15.8% reported by Salagre et al., likely reflecting high ICU utilisation (63.8%) and early initiation of intravenous therapy at our centre.[19,14] Yizengaw et al. reported a higher mortality of 17.4%, identifying age >60 years, diabetes, and delayed therapy as independent predictors of death, all of which are consistent with the age-mortality gradient observed in the present cohort.[18] Neurological TOD predominance in this study (45.7%) is comparable to the 56% reported by Konuganti and Swamy.[20]

Taken together, these comparisons suggest the favourable mortality outcome in this cohort reflects process-of-care factors, high ICU utilisation and early intravenous therapy, rather than a fundamentally different patient population, with implications for resource prioritisation in similar tertiary centres.

Strengths of this study include consecutive enrolment minimising selection bias, serial blood pressure measurement at five time points, and systematic multi-organ assessment performed in every patient regardless of presenting complaint, which revealed the substantial ophthalmic target organ burden that might otherwise be overlooked in young patients.

Limitations

This study has certain limitations. The single-centre design may limit generalisability of findings to other populations and settings, and the young (<40 years) subgroup was relatively small (n=18), potentially limiting statistical power to detect subtle age-wise differences. The study captured only in-hospital outcomes, and long-term post-discharge follow-up data, including recurrence rates, were not available. Treatment decisions were guided by clinical judgement rather than a standardised institutional protocol, introducing potential management variability, and biochemical markers of endothelial dysfunction and inflammation were not uniformly available, which may have underestimated subclinical target organ damage.

CONCLUSION

Hypertensive emergencies in this South Indian cohort demonstrated distinct age-specific patterns: younger patients bore a disproportionate burden of reversible

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neurological (PRES, hypertensive encephalopathy) and ophthalmic target organ damage, largely attributable to medication non-adherence, whereas older patients bore a greater burden of cardiac and cerebrovascular target organ damage and in-hospital mortality despite comparable blood pressure control. Medication non-adherence, universal among young known hypertensives in this cohort, represents the single most important modifiable determinant of hypertensive emergencies across all age groups. This preventable disease burden in the young argues strongly for community-level hypertension screening and structured medication adherence programmes targeted specifically at young and working-age hypertensives, since a substantial proportion of the reversible neuro-ophthalmic morbidity documented in this study could plausibly have been avoided through sustained treatment adherence alone.

Larger multicentric, prospective studies with standardised diagnostic criteria, uniform management algorithms, and at least six months of post-discharge follow-up are recommended to validate these age-specific patterns, evaluate recurrence rates, and refine risk-stratified management protocols. Integration of biomarkers such as NT-proBNP, high-sensitivity troponin, and high-sensitivity CRP, together with outcome-focused predictive models incorporating presenting SBP, target organ damage type, and compliance status, may further improve risk stratification and guide individualised, age-appropriate management of hypertensive emergencies.

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