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[Research Article]

Spectrum of Anti-Hypertensive Therapy in Tertiary Health Care Center of Rajasthan

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Abstract:

Globally, methods for controlling blood pressure in hypertensive patients remain suboptimal. A significant factor in achieving optimal hypertension control is the difficulty in prescribing drugs tailored to an individual's clinical profile (Schutte, 2023). Most hypertension studies investigating risk factors have used the traditional cut-off value of 140/90 mmHg to define hypertension, while few have applied the newer diagnostic threshold of 130/80 mmHg. In this study, we recruited 220 hypertensive patients receiving antihypertensive therapy, monitoring them at baseline, 24 hours, 7 days, and 30 days to evaluate the effectiveness of their medication regimen and the patients' responses in alignment with the revised hypertension definition of 130/80 mmHg. Overall, 8% of patients achieved systolic blood pressure control targeting <130/80 mmHg, while 92% remained uncontrolled, with systolic values exceeding 130 mmHg. Notably, no participants exhibited systolic blood pressure >180 mmHg at the study's conclusion, in contrast to the 33% of patients in hypertensive crisis (>180 mmHg) at recruitment. Diastolic blood pressure was better controlled, with 40% of patients achieving <80 mmHg and 60% remaining >80 mmHg. The findings suggest that antihypertensive therapy had a more pronounced impact on diastolic than systolic blood pressure in the context of the revised 130/80 mmHg threshold.

Keywords: Hypertension, Anti-Hypertensive drugs, Blood Pressure Control.

Introduction:

Hypertension, often termed the "silent killer," affects approximately 1.13 billion people worldwide, with an annual mortality rate of 13%. Each year, hypertension results in about 7 million deaths and 64 million people suffering from related disabilities. It is projected that by 2025, nearly one in three adults over 20 years old or approximately 1.56 billion people will have hypertension. In the United States, the 2018 Basic Health Research (Riskesdas) reported that 34.11% of adults over 18 had high blood pressure. Similarly, in Indonesia, the prevalence of hypertension among individuals aged 18 years or older was reported as 25.8% in 2013 (Sawitri & Maulina, 2022).

According to (Schutte, 2023), hypertension is a major modifiable risk factor for cardiovascular disease, accounting for substantial morbidity, mortality, and healthcare costs. Yet, less than half of hypertensive patients receiving medication achieve adequate blood pressure control. Barriers to effective management include therapeutic inertia, low adherence to treatment, and unhealthy lifestyle factors, such as high-fat and high-sodium diets, inactivity, and obesity. Patients with poorly controlled hypertension despite treatment are at an increased risk of cardiovascular complications and mortality.

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Methods:

This study was a prospective observational cohort study where participants were monitored and observed over time without intervention. It was conducted at the Ananta Institute of Medical Science and Research Centre, Rajsamand, Rajasthan. The study included diagnosed hypertensive patients, with or without comorbidities, from both inpatient and outpatient settings who were receiving antihypertensive treatment. Exclusion criteria included pregnant women and individuals under 18 years of age. No restrictions were placed on participants' sex or treatment duration. Ethical approval for the study was obtained from the Ananta Institute of Medical Science and Research Centre's ethical committee prior to initiation.

Statistical Analyses

All the data generated from the study were entered and cleaned using Microsoft Office Excel 365 into the computer system for analysis. SPSS version 23 and Microsoft Office Excel 365 was used to analyze the data. Categorical data was presented as percentages, while quantitative data was described using mean and standard deviation as appropriate.

Chi-square test was used to determine significant association between categorical variables. A p-value of ≤ 0.05 was considered significant.

Multivariate analysis, specifically logistic regression analysis, was used to identify blood pressure control among hypertensive patients. A confidence interval of 95% was used in this study and a p- value of ≤ 0.05 was considered significant.

Result

Table 1: Socio-demographic characteristics of the study participants

Variables	Frequency (N = 222)	Percent (%)
Age range		
20 – 29	3	1
30 – 39	7	3
40 – 49	40	18
50 – 59	58	26
>60	114	52
Mean ± SD	59.5 ± 11.85	
Sex		
Male	122	55
Female	100	45
Occupation		
Retired/Housewife	147	66
Famers	42	19
Laborer/Others	33	15
Marital status		
Married	173	78
Unmarried/Others	49	22

BMI		
Normal	153	69
Obese	69	31
Duration of Treatment		
Newly Diagnosed	71	32
< 1 year	84	38
1-5 years	67	30

Table 1 presents the socio-demographic characteristics of the 222 hypertensive patients who participated in the study. Of these, 122 (55%) were male and 100 (45%) were female. The mean age was 59 years with a standard deviation of ±11.85 years. The majority of patients (52%) were aged over 60 years, while the youngest age group (18–40 years) comprised only 4% of the participants.

Regarding employment status, 66% of the participants were retired or housewives, 19% were farmers, and 15% were laborers or classified as "other." A significant portion of participants were unemployed. The majority (78%) were married.

In terms of body mass index (BMI), 69% of participants had a normal BMI. More than half of the participants were either newly diagnosed or had been on antihypertensive therapy for less than one year, with 32% newly diagnosed and 38% having less than one year of treatment. Only 30% had been on antihypertensive therapy for 1–5 years.

Table 2: Distribution of Blood Pressure after 30 days follow up intervals and assessment of patient response to antihypertensive therapy according to type of treatment selected.

Treatment	**No. of Patients**	**DAY 0 Mean ± SD**		**DAY 30 Mean ± SD**	
Monotherapy		SBP	DBP	SBP	DBP
CCBs	27	138±20	81±12	136±10	82±8
ARBs	33	152±18	87±14.5	137±9	82±6
Diuretics	7	153±12	92±4	145±0	84±2
Dual Therapy					
ARB + Diuretics	20	167±19	96±15	139±9	83±9
ARB + CCB	44	160±24	91±10	137±7	80±6
ARB + β Blockers	7	141±14.5	78±15	134±5	77±5
CCB + α Blockers	4	164±21	100±15	134±5	85±8
Diuretics + Diuretics	4	135±7	90±0	125±7	80±14
Triple Therapy					
ARB + CCB + Diuretics	25	178±24	105±13	136±4	79+6
ARB + βB + Diuretics	4	193±21	113±21	160±0	112±0

ARB + βB + CCB	4	190±25	107±16	137±5	84±7
ARB + βB + α Blockers	4	220±0	120±0	148±0	85±6
Poly Therapy					
ARB + CCB + αB + Diuretics[2]	7	205±22	120±15	142±4	89±15
ARB + CCB + Diuretics+	7	167±49	103±9	140±16	90±10
Others	25	183±30	107±22	144±7	84±6

Table 2 displays the distribution of blood pressure values at the time of admission (or recruitment) and compares the mean and standard deviation after 30 days of antihypertensive therapy, targeting the new hypertension definition of 130/80 mmHg. Most participants did not reach the target blood pressure within this timeframe. Only two patients, who were on a combination regimen including diuretics, achieved the target. However, as only four participants were prescribed this regimen, it is insufficient to draw a conclusive finding. Further research with a larger sample size will be necessary to comprehensively evaluate the response to different antihypertensive therapies.

Table 3: Distribution of Blood Pressure at different follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	**DAY 0**		**24HRS**		**DAY 7**		**DAY 30**	
SBP	Frequency (N=222)	%	Frequency (N=222)	%	Frequency (N=207)	%	Frequency (N=173)	%
<120 (Normal)	9	4	13	6	17	8	7	4
120-129 (Elevated)	2	1	9	4	27	13	7	4
130 – 139 (Stage 1)	31	14	27	12	42	20	93	54
140 > (Stage 2)	107	48	149	67	54	26	66	38
180 > (HTN Crisis)	73	33	24	11	67	33	0	
Mean ± SD	165±29		152±22		145±23		137±14	
DBP								
<80	31	14	44	20	51	24.5	69	40
80 - 89	51	23	53	24	72	35	55	32
90 - 99	62	28	67	30	49	23.5	31	18
>100	78	35	58	26	35	17	18	10
Mean ± SD	96±17		94±15		90±19		84±13	

At recruitment (Day 0), among the 222 participants, the mean systolic blood pressure (SBP) was 165 ± 29 mmHg, and the mean diastolic blood pressure (DBP) was 96 ± 17 mmHg. At this baseline, only 4% of participants had their SBP within the normal range (<120 mmHg), while 14% were in Stage 1 hypertension, 48% in Stage 2, and 33% were in hypertensive crisis (>180 mmHg). For DBP, 14% were within the controlled range (<80 mmHg), 23% in Stage 1, 28% in Stage 2, and 35% were in hypertensive crisis.

24-Hour Follow-Up:
After 24 hours, the mean SBP decreased to 152 ± 22 mmHg, with 6% of participants achieving normal SBP, 12% in Stage 1, 67% in Stage 2, and 11% still in hypertensive crisis. The mean DBP was 94 ± 15 mmHg, with 20% in the controlled range, 24% in Stage 1, 30% in Stage 2, and 26% in crisis. Compared to Day 0, there was a notable reduction in hypertensive crisis cases, indicating some response to therapy, though changes in DBP remained minimal.

7-Day Follow-Up:
By Day 7, 94% of the participants remained in the study. The mean SBP was 145 ± 23 mmHg, with 7.5% reaching normal levels, 12% in the elevated range, 20% in Stage 1, 26.5% in Stage 2, and 33% still in hypertensive crisis. The mean DBP was 90 ± 19 mmHg, with 23% controlled, 33% in Stage 1, 22% in Stage 2, and 16% in crisis. Compared to baseline, there was a slight improvement in SBP, but 80% of participants still had uncontrolled SBP, with some fluctuations observed in individual cases. Changes in DBP remained minor.

30-Day Follow-Up:
At the final 30-day follow-up, 78% (173 participants) remained. The mean SBP further reduced to 137 ± 14 mmHg, with 4% at normal levels, 4% in the elevated category, 54% in Stage 1, 38% in Stage 2, and no participants in hypertensive crisis. The mean DBP was 84 ± 13 mmHg, with 40% controlled, 32% in Stage 1, 18% in Stage 2, and 10% in crisis. The 30-day follow-up showed a significant reduction in SBP, particularly in eliminating cases of hypertensive crisis. However, 60% of participants still did not achieve the target SBP, and a gap in DBP control remained, with only 40% of participants reaching the target range.

Overall, the findings indicate a progressive response to antihypertensive therapy, especially in reducing cases of severe hypertension. However, despite these improvements, a substantial proportion of participants still require further management to achieve optimal BP control, highlighting the need for additional interventions and potentially more aggressive treatment strategies.

Table 4: Distribution of Blood Pressure at 24 hours follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	DAY 0		24HRS		Test Statistic	P-Value
SBP	Frequency (N=222)	%	Frequency (N=222)	%		
<120 (Normal)	9	4	13	6	t= -0.41	0.967
120-129 (Elevated)	2	1	9	4		
130 – 139 (Stage 1)	31	14	27	12		
140 > (Stage 2)	107	48	149	67		
180 > (HTN Crisis)	73	33	24	11		
Mean ± SD	165±29		152±22			
DBP					t=1.999	0.022
<80	31	14	44	20		
80 - 89	51	23	53	24		
90 - 99	62	28	67	30		
>100	78	35	58	26		
Mean ± SD	96±17		94±15			

Table 4 presents the distribution of blood pressure (BP) categories at the time of recruitment (Day 0) and after 24 hours of antihypertensive therapy. Among the 222 participants, the mean systolic blood pressure (SBP) decreased slightly from 165 ± 29 mmHg at recruitment to 152 ± 22 mmHg after 24 hours. However, this change

was not statistically significant (t = -0.41, p = 0.967), indicating no significant reduction in SBP across all patient groups within the first 24 hours.

For diastolic blood pressure (DBP), the mean value decreased from 96 ± 17 mmHg at Day 0 to 94 ± 15 mmHg after 24 hours. This change was statistically significant (t = 1.999, p = 0.022), suggesting a slight but meaningful reduction in DBP within the 24-hour period following antihypertensive therapy.

In summary, while there was no statistically significant change in SBP after 24 hours of therapy (p > 0.05), there was a slight but statistically significant improvement in DBP (p < 0.05). This suggests that antihypertensive therapy may initially have a more immediate impact on DBP than on SBP within the first 24 hours.

Table 5: Distribution of Blood Pressure at 7 days follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	**DAY 0**		**DAY 7**		**Test Statistic**	**P-Value**
SBP	Frequency (N=207)	%	Frequency (N=207)	%		
<120 (Normal)	9	4	17	8	t=0.042	0.677
120-129 (Elevated)	2	1	27	13		
130 – 139 (Stage 1)	31	14	42	20		
140 > (Stage 2)	107	48	54	26		
180 > (HTN Crisis)	73	33	67	33		
Mean ± SD	165±29		145±23			
DBP					t=1.473	0.026
<80	31	14	51	24.5		
80 - 89	51	23	72	35		
90 - 99	62	28	49	23.5		
>100	78	35	35	17		
Mean ± SD	96±17		90±19			

Table 5 provides the distribution of blood pressure (BP) categories at recruitment (Day 0) and after 7 days of antihypertensive therapy among the 207 participants who were available for follow-up. The mean systolic blood pressure (SBP) decreased from 165 ± 29 mmHg at baseline to 145 ± 23 mmHg after 7 days. However, this reduction was not statistically significant (t = 0.042, p = 0.677), indicating no substantial improvement in SBP across all patient groups within the first week of therapy.

In contrast, diastolic blood pressure (DBP) showed a significant reduction, with the mean value decreasing from 96 ± 17 mmHg on Day 0 to 90 ± 19 mmHg on Day 7 (t = 1.473, p = 0.026), suggesting that DBP was more responsive to antihypertensive treatment over the 7-day period.

Among the participants, 8% achieved a normal SBP (<120 mmHg) by Day 7, compared to only 4% at baseline, and 13% had elevated SBP (120-129 mmHg), an increase from 1% at recruitment. For DBP, 24.5% of patients reached controlled levels (<80 mmHg), up from 14% on Day 0, while the percentage of patients with DBP over 100 mmHg decreased significantly from 35% to 17%.

In summary, while there was no statistically significant change in SBP after 7 days (p > 0.05), the DBP reduction was significant (p < 0.05), indicating an improvement in diastolic control.

Table 6: Distribution of Blood Pressure at 30 day follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	DAY 0		DAY 30		Test Statistic	P-Value
SBP	Frequency (N=222)	%	Frequency (N=173)	%		
<120 (Normal)	9	4	7	4	t= -0.755	0.032
120-129 (Elevated)	2	1	7	4		
130 – 139 (Stage 1)	31	14	93	54		
140 > (Stage 2)	107	48	66	38		
180 > (HTN Crisis)	73	33	0			
Mean ± SD	165±29		137±14			
DBP					t= -1.582	0.118
<80	31	14	69	40		
80 - 89	51	23	55	32		
90 - 99	62	28	31	18		
>100	78	35	18	10		
Mean ± SD	96±17		84±13			

Table 6 shows the distribution of blood pressure (BP) categories among participants at recruitment (Day 0) and after 30 days of antihypertensive therapy. Among the 222 participants recruited, 173 were available for follow-up on Day 30.

The mean systolic blood pressure (SBP) significantly decreased from 165 ± 29 mmHg at baseline to 137 ± 14 mmHg after 30 days of therapy ($t = -0.755$, $p = 0.032$), indicating a statistically significant improvement in SBP control over the 30-day period ($p < 0.05$). By Day 30, 54% of participants were in Stage 1 hypertension (130-139 mmHg), up from 14% at baseline, while those in Stage 2 hypertension (≥140 mmHg) decreased from 48% to 38%. Notably, no participants remained in the hypertensive crisis category (SBP >180 mmHg) by Day 30, compared to 33% at recruitment.

For diastolic blood pressure (DBP), the mean decreased from 96 ± 17 mmHg at baseline to 84 ± 13 mmHg after 30 days ($t = -1.582$, $p = 0.118$). Although this reduction showed a trend towards significance, it did not reach statistical significance ($p > 0.05$). However, 40% of participants achieved DBP control (<80 mmHg), up from 14% at recruitment. Additionally, the percentage of participants with DBP >100 mmHg decreased substantially from 35% to 10%.

In summary, there was a statistically significant improvement in SBP control over the 30-day period, with a notable reduction in hypertensive crises. While the reduction in DBP was not statistically significant, a meaningful shift towards controlled levels was observed.

Discussion:

Most hypertension studies have traditionally defined hypertension using a cut-off value of 140/90 mmHg, with only a few adopting the revised threshold of 130/80 mmHg. In this study, we assessed the blood pressure control of 222 hypertensive patients on antihypertensive therapy over intervals of 0, 24 hours, 7 days, and 30 days, using the new diagnostic criterion of 130/80 mmHg as a target for optimal BP control.

Globally, effective hypertension control remains challenging. One key factor is the complexity of prescribing antihypertensive drugs that are specifically tailored to the patient's individual clinical characteristics, which

complicates achieving ideal blood pressure targets (Schutte et al., 2022). At recruitment, the mean systolic blood pressure (SBP) was 165 ± 29 mmHg, which reduced to 137 ± 14 mmHg after 30 days of therapy. Similarly, the mean diastolic blood pressure (DBP) declined from 96 ± 17 mmHg at baseline to 84 ± 13 mmHg after 30 days. Despite these improvements, only 8% of participants achieved the target SBP of <130 mmHg, while 92% remained above this threshold. Notably, however, none of the participants were classified within the hypertensive crisis range (>180 mmHg) by Day 30, marking a significant shift from the initial 33% of participants in this category at recruitment. In the present study, single drug therapy accounting for 54.0% of the treatment regimens and there's no significant difference in blood pressure control among other regimens, indicating a higher preference for single-drug therapy over combination therapy. This trend toward single-drug treatment over combination therapy is consistent with findings from our previous study (Ayuba et. Al., 2024), and is further supported by Adake et al., who emphasized the efficacy of monotherapy in achieving adequate blood pressure control.

For DBP, 40% of participants achieved control (<80 mmHg), while 60% remained above the target. The antihypertensive therapy thus appeared to have a more pronounced effect on DBP than SBP under the 130/80 mmHg threshold, reflecting a differential impact that warrants further investigation.

Regression analysis of BP changes over the 30-day period indicated a statistically significant reduction in SBP ($p < 0.05$), as shown in Table 6. Although the reduction in DBP showed only a slight significance, the observed improvement suggests positive therapeutic effects on diastolic control as well. Out of the initial 222 participants, 173 remained for follow-up at Day 30, underscoring the importance of sustained patient engagement to monitor and optimize long-term blood pressure outcomes.

Conclusion:

Antihypertensive drug therapy is fundamental in managing hypertension, particularly under the revised diagnostic threshold of 130/80 mmHg. In this study, 92% of participants had uncontrolled hypertension, underscoring the persistent challenge in achieving optimal blood pressure control. Hypertension remains a major risk factor for cardiovascular diseases, including heart attack, stroke, and kidney damage, making effective BP management essential for reducing these serious health risks.

Choosing the right antihypertensive therapy depends on individual patient characteristics, medical history, concurrent health conditions, and potential drug interactions. Healthcare providers must tailor treatment plans to each patient's unique needs, often utilizing a combination of medications to improve efficacy.

For patients with hypertension, adherence to prescribed treatment regimens is critical, along with consistent blood pressure monitoring. Complementary lifestyle modifications, such as a healthy diet, regular physical activity, stress management, and avoidance of tobacco and excessive alcohol, further support blood pressure control.

Regular follow-ups with healthcare providers are essential to assess treatment efficacy and make necessary adjustments. With a combination of tailored medication, lifestyle changes, and ongoing medical supervision, individuals with hypertension can significantly reduce their risk of complications and enhance overall cardiovascular health.

Limitations

1. **Sample Size and Diversity:** The study's sample size, while adequate, may limit the generalizability of the findings. The majority of participants were recruited from a specific healthcare setting, which may not fully represent the broader population of hypertensive patients. A more diverse cohort could provide insights into different demographics and their responses to antihypertensive therapy.
2. **Short Follow-Up Period:** The follow-up periods of 24 hours, 7 days, and 30 days, while informative, may not capture long-term trends in blood pressure control. Future studies should consider extended follow-up to assess the sustainability of treatment effects and to identify any delayed responses to antihypertensive therapy.
3. **Potential Bias in Self-Reported Adherence:** If patient adherence to medication was self-reported, there may be a risk of bias in the data. Patients may overestimate their adherence to treatment due to social desirability or misunderstanding their medication regimen. Utilizing objective measures of adherence, such as pharmacy refill records, could enhance the accuracy of future studies.

4. **Lack of Control Group:** The absence of a control group limits the ability to attribute changes in blood pressure solely to the antihypertensive therapy administered. Future research could benefit from randomized controlled trials to establish causality more firmly.
5. **Variation in Treatment Protocols:** The variability in antihypertensive medications prescribed and the lack of standardization in treatment protocols could influence the outcomes. More controlled studies that adhere to specific treatment guidelines would provide clearer insights into the effectiveness of various antihypertensive strategies.

Conflict of Interest: None declared

Reference:

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