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Original Research Article

Factors contributing to acute heart failure after a first acute coronary syndrome episode

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ABSTRACT

Background: Diabetes and hypertension are common among the elderly and significantly increase the risk of cardiovascular and renal complications. Managing type 2 diabetes mellitus (T2DM) in geriatric patients is challenging due to age-related changes, polypharmacy, and susceptibility to adverse drug reactions. This study aimed to assess prescribing patterns of antidiabetic medications in elderly patients with T2DM and coexisting hypertension at a tertiary care center in India.

Methods: A retrospective cross-sectional study was conducted at Government General Hospital, Srikakulam, Andhra Pradesh, from February 2024 to February 2025. Prescriptions of patients aged ≥60 years with both diabetes and hypertension were analyzed. Data on drug classes, dosages, and regimens were collected. Statistical analysis was done using Microsoft Excel, with categorical variables expressed as percentages.

Results: A total of 586 prescriptions were reviewed. Metformin was the most prescribed antidiabetic (49.10%), followed by sulfonylureas (30.04%), dipeptidyl peptidase-4 (DPP-4) inhibitors (6.98%), sodium-glucose co-transporter-2 (SGLT2) inhibitors (3.93%), and α-glucosidase inhibitors (3.06%). Insulin was used in 3.06% of cases. Combination therapy was common, with 69.65% on dual-drug regimens, 12.02% on triple therapy, and 0.92% on more than three drugs. Most prescriptions (99.22%) used generics, with 84.15% from the National List of Essential Medicines (NLEM) 2022 and 89.80% from the World Health Organization Essential Medicines List (WHO-EML) 2023.

Conclusions: Metformin remains the mainstay of T2DM treatment in elderly patients. A high prevalence of combination and generic prescribing was noted. Ongoing evaluation of prescribing practices is essential to optimize care, minimize polypharmacy, and enhance outcomes in this population.

Keywords: Antidiabetics, Prescription patterns, Geriatrics, Diabetes, Hypertension, Polypharmacy

INTRODUCTION

Diabetes mellitus (DM) has emerged as a global health crisis, affecting approximately 537 million adults worldwide, with projections indicating an increase to 783 million by 2045. In India, the number of individuals with diabetes was 69.2 million in 2015 and is expected to rise to 123.5 million by 2040.[1,2] Once referred to as the 'diabetes capital of the world,' India now ranks second to China in terms of diabetes prevalence.[3,4] Among older adults, the prevalence is even higher, with 24% affected. Diabetes in this population elevates the risk of

complications such as cardiovascular diseases, kidney failure, and neuropathy, imposing a substantial burden on individuals and their families.

Hypertension frequently coexists with diabetes, adding complexity to disease management. In India, approximately 50% of individuals with diabetes also have hypertension, which significantly increases the risk of severe complications, including coronary artery disease, stroke, and kidney damage.[5] The mortality rate for hypertensive diabetic patients is estimated to be four to five times higher due to cardiovascular events.[6] Studies suggest that strict blood pressure management lowers the risk of stroke, heart failure, and kidney disease, emphasizing the need for effective control of both conditions, particularly in older adults.[7]

With a growing global elderly population, managing chronic conditions like diabetes and hypertension is increasingly crucial. Older adults are more susceptible to polypharmacy, and age-related changes in drug metabolism can influence treatment outcomes. Available antidiabetic medications include insulin secretagogues, biguanides such as metformin, and newer agents like glucagon-like peptide-1 (GLP-1) analogues and dipeptidyl peptidase-4 (DPP-4) inhibitors.[8] However, as diabetes progresses, polypharmacy often intensifies, increasing the risks associated with multiple medications. Despite these challenges, older drugs like sulfonylureas and metformin continue to be effective in managing the condition.[9]

Given the increasing prevalence of diabetes and hypertension in the elderly, drug utilization studies play a critical role in evaluating prescribing trends, medication use, and their medical, social, and economic impact. This study aims to analyze the prescription patterns of antidiabetic medications in hypertensive diabetic patients within the geriatric population at a tertiary care center in Srikakulam. The findings will offer valuable insights into optimizing treatment strategies and improving patient outcomes in this vulnerable group.

METHODS

Prior to initiation, ethical approval was obtained from the institutional ethics committee, and a no-objection certificate (NOC) was secured from the Head of the Geriatrics Department to ensure all necessary permissions were in place. The investigator thoroughly explained the study's objectives and methodology to the department head to facilitate understanding and support. The study encompassed all patients admitted to the Geriatrics Department at Government General Hospital, Srikakulam, between March 2024 and February 2025. To meet statistical standards, we adhered to World Health Organization (WHO) guidelines, which recommend a minimum of 300 patient encounters for a reliable prescription audit. In total, 586 prescriptions were reviewed. Prescription data was meticulously collected for each patient, with a focus on antidiabetic medications, including drug classes, dosages, and treatment regimens. Patients who withdrew from the study or had incomplete data (e.g., missing age or registration number) were excluded from the final analysis. All patient information was recorded in a structured case record form (CRF), ensuring confidentiality and anonymization during data analysis and reporting.

The study's source documents included CRFs from inpatient department (IPD) patients, records from the health management information system (HMIS), and medical records from the geriatrics department. These documents were carefully examined to extract relevant data aligned with the study's objectives.

Data analysis was performed using Microsoft excel, with categorical variables presented as percentages for clarity and comparison.

This study holds significant value in understanding the prescribing patterns of antidiabetic medications in elderly patients with both hypertension and type 2 DM (T2DM). By identifying trends and potential areas for improvement, the findings aim to optimize treatment strategies, enhance clinical outcomes, and contribute to better management of these chronic conditions in the geriatric population.

RESULTS

In this retrospective observational study, a total of 586 patients were included (Table 1). The male population comprised 322 patients (54.77), while 264 patients (45,.23%) were female.

Table 1: Gender distribution of patients.

Gender	N	Percentage (%)
Male	322	54.77
Female	264	45.23
Total	586	100

The age-wise distribution revealed that the majority of patients were in the 60-70 years age group, with 427 patients (72.89%) in this range. The next largest group was the 71-80 years group, consisting of 139 patients (23.72%). Smaller proportions were found in the 81-90 years group (17 patients, 2.90%) and the >90 years group (3 patients, 0.51%). Gender distribution across age groups showed that males were more prevalent than females in the 60-70 and 71-80 years groups, while females outnumbered males in the >90 years age group (Table 2).

The most commonly prescribed antidiabetic drug was metformin (500/1000 mg), accounting for 565 prescriptions (49.10%). The next most frequently prescribed drug class was sulfonylureas, particularly glimepiride (1/2/4 mg), with 346 prescriptions (30.04%). Other notable drugs included α-glucosidase inhibitors (Voglibose 0.2/0.3 mg) in 35 prescriptions (3.06%), DPP4 inhibitors (Teneligliptin 20 mg, Sitagliptin 50/100 mg, and

Vildagliptin 50 mg) in 80 prescriptions (6.98%), and SGLT2 inhibitors (Dapagliflozin 10/20 mg and Canagliflozin 100 mg) in 45 prescriptions (3.93%). Insulin formulations, including Insulin Degludec (12 prescriptions) and Insulin Mixtard (6 prescriptions), were prescribed in smaller numbers (Table 3).

Regarding treatment regimens, combination therapy was the most common approach. A total of 408 patients (69.65%) received a 2-drug combination, while 71 patients (12.02%) were prescribed a 3-drug regimen. 106 patients (17.41%) received monotherapy, and 5 patients (0.92%) were on more than three antidiabetic drugs (Table 4).

Table 2: Age-wise gender distribution.

Age group (years)	Total (N)	Percentage (%)	Male (N, %)	Female (N, %)
60-70	427	72.73	248 (42.22)	179 (30.51)
71-80	139	23.73	86 (14.64)	53 (9.09)
81-90	17	2.93	11 (1.85)	6 (1.08)
>90	4	0.62	0 (0.00)	4 (0.62)
Total	586	100	345 (58.71)	241 (41.29)

Table 3: Most prescribed antidiabetics.

Drug class and name	N	Percentage
Sulfonylureas		
Tab. glimepiride 1/2/4 mg	346	30.04
Tab. glipizide 5 mg	17	1.49
Tab. gliclazide 60 mg	25	2.2
Biguanides		
Tab. metformin 500/1000 mg	565	49.1
Thiazolidinediones		
Tab. pioglitazone 15 mg	2	0.16
α-Glucosidase inhibitors		
Tab. voglibose 0.2/0.3 mg	35	3.06
DPP4 inhibitors		
Tab. teneligliptin 20 mg	34	2.98
Tab. sitagliptin 50/100 mg	33	2.9
Tab. vildagliptin 50 mg	13	1.1
SGLT2 inhibitors		
Tab. dapagliflozin 10/20 mg	37	3.22
Tab. canagliflozin 100 mg	8	0.71
Insulin		
Insulin Degludec	12	1.02
Insulin Actrapid	3	0.24
Insulin Mixtard	6	0.55
Inj. crystalline insulin	14	1.25
Total	1158	100

For monotherapy, biguanides (metformin) were the most commonly prescribed class, with 90 patients (84.96%) receiving metformin. Among these, 60 patients (57.52%) were prescribed metformin 500 mg BD. Other monotherapy agents included SGLT2 inhibitors, specifically dapagliflozin (10 mg), which was prescribed to 3 patients (2.65%), and insulin, which was used in 13 patients (12.39%), with crystalline insulin being the most common formulation (Table 5).

Table 4: Treatment approaches for antidiabetics.

Therapy type	N	Percentage
Monotherapy	106	17.41
2-drug	408	69.65
3-drug	71	12.02
>3-drug	5	0.92
Total	586	100

For two-drug regimens, the most commonly prescribed combination was biguanides + sulfonylureas, which was used for 321 patients (79.42%). The predominant combination was metformin 500 mg with glimepiride (1-4 mg). Other common combinations included biguanides + DPP4 inhibitors (prescribed to 41 patients, 9.96%) and biguanides + SGLT2 inhibitors (prescribed to 24 patients, 5.75%) (Table 6).

In terms of three-drug regimens, the most frequently used combination was biguanides + sulfonylureas + α-glucosidase inhibitors, prescribed to 25 patients (34.62%). The second most common three-drug regimen was biguanides + sulfonylureas + DPP4 inhibitors, given to 21 patients (29.49%) (Table 7).

Table 5: Monotherapy drug classes for antidiabetics.

Monotherapy class	N	Percentage	Drug name
Biguanides	90	84.96	Tab. metformin 500 mg OD
			Tab. metformin 500 mg BD
			Tab. metformin 500 mg TDS
			Tab. metformin 1000 mg BD
SGLT2 inhibitors	3	2.65	Tab. dapagliflozin 10 mg OD
Insulin	13	12.39	Inj. crystalline insulin
			Insulin Degludec
			Insulin Mixtard
Total	106	100	

Table 6: Combination therapy for antidiabetics.

Drug Class	N	Percentage	Drug 1	Drug 2	N	Percentage
Insulin + biguanides	13	3.1	Inj. crystalline insulin	Tab. metformin 500 mg	9	2.21
			Insulin Degludec	Tab. metformin 500 mg	4	0.88
Biguanides + sulfonylureas	321	79.42	Tab. metformin 500 mg	Tab. gliclazide 60 mg	21	5.09
			Tab. metformin 500 mg	Tab. glipizide 5 mg	13	3.1
			Tab. metformin 500 mg	Tab. glimepiride 1 mg	187	46.24
			Tab. metformin 500 mg	Tab. glimepiride 2 mg	72	17.92
			Tab. metformin 500 mg	Tab. glimepiride 4 mg	21	5.31
			Tab. metformin 1000 mg	Tab. glimepiride 2 mg	5	1.33
			Tab. metformin 1000 mg	Tab. glimepiride 4 mg	2	0.44
Biguanides + DPP4 inhibitors	41	9.96	Tab. metformin 500 mg	Tab. teneligliptin 20 mg	18	4.42
			Tab. metformin 1000 mg	Tab. teneligliptin 20 mg	3	0.66
			Tab. metformin 500 mg	Tab. sitagliptin 50 mg	20	4.87
Biguanides + SGLT2 inhibitors	24	5.75	Tab. metformin 500 mg	Tab. canagliflozin 100 mg	6	1.33
			Tab. metformin 500 mg	Tab. dapagliflozin 10 mg	16	3.98
			Tab. metformin 500 mg	Tab. dapagliflozin 20 mg	2	0.44
Biguanides + α-glucosidase inhibitors	6	1.33	Tab. metformin 500 mg	Tab. voglibose 0.3 mg	6	1.33
DPP4 inhibitors + SGLT2 inhibitors	2	0.44	Tab. teneligliptin 20 mg	Tab. dapagliflozin 10 mg	2	0.44
Total	408	100			408	100

Table 7: Three-drug therapy for antidiabetics.

Drug class	N	Percentage	Drug 1	Drug 2	Drug 3	N	Percentage
Biguanides + sulfonylureas + α-glucosidase inhibitors	25	34.62	Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. voglibose 0.2 mg	8	11.54
			Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. voglibose 0.3 mg	3	3.85
			Tab. metformin 500 mg	Tab. glimepiride 2 mg	Tab. voglibose 0.2 mg	5	7.69
			Tab. metformin 500 mg	Tab. glimepiride 2 mg	Tab. voglibose 0.3 mg	2	2.56
			Tab. metformin 500 mg	Tab. glimepiride 4 mg	Tab. voglibose 0.2 mg	2	2.56
			Tab. metformin 500 mg	Tab. glipizide 5 mg	Tab. voglibose 0.2 mg	5	6.41
Biguanides + sulfonylureas + DPP4 inhibitors	21	29.49	Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. teneligliptin 20 mg	7	10.26
			Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. sitagliptin 50 mg	4	5.13
			Tab. metformin 500 mg	Tab. glimepiride 2 mg	Tab. sitagliptin 50 mg	2	2.56
			Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. vildagliptin 50 mg	6	8.97
			Tab. metformin 500 mg	Tab. gliclazide 60 mg	Tab. sitagliptin 50 mg	2	2.56
Biguanides + sulfonylureas + SGLT2 inhibitors	7	10.26	Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. dapagliflozin 10 mg	2	2.56
			Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. dapagliflozin 20 mg	2	2.56

Continued.

Drug class	N	Percentage	Drug 1	Drug 2	Drug 3	N	Percentage
			Tab. metformin 500 mg	Tab. glimepiride 2 mg	Tab. dapagliflozin 10 mg	3	5.13
Biguanides + sulfonylureas + thiazolidine-diones	2	2.56	Tab. metformin 500 mg	Tab. glimepiride 1 mg	Tab. pioglitazone 15 mg	2	2.56
Biguanides + SGLT2 inhibitors + DPP4 inhibitors	3	5.13	Tab. metformin 500 mg	Tab. dapagliflozin 10 mg	Tab. sitagliptin 50 mg	2	2.56
			Tab. metformin 500 mg	Tab. dapagliflozin 10 mg	Tab. vildagliptin 50 mg	1	2.56
Biguanides + SGLT2 inhibitors + α-glucosidase inhibitors	2	2.56	Tab. metformin 500 mg	Tab. dapagliflozin 20 mg	Tab. voglibose 0.2 mg	2	2.56
Biguanides + DPP4 inhibitors + α-glucosidase inhibitors	2	2.56	Tab. metformin 500 mg	Tab. teneligliptin 20 mg	Tab. voglibose 0.2 mg	2	2.56
SGLT2 inhibitors + DPP4 inhibitors + α-glucosidase inhibitors	2	2.56	Tab. dapagliflozin 10 mg	Tab. sitagliptin 100 mg	Tab. voglibose 0.3 mg	2	2.56
Insulin + biguanides + DPP4 inhibitors	4	6.41	Insulin Mixtard	Tab. metformin 500 mg	Tab. vildagliptin 50 mg	2	2.56
			Insulin Actrapid	Tab. metformin 500 mg	Tab. teneligliptin 20 mg	2	3.85
Insulin + biguanides + sulfonylureas	2	3.85	Insulin Degludec	Tab. metformin 500 mg	Tab. glimepiride 1 mg	2	3.85
Total	71	100				71	100

A small proportion of patients (5, 0.92%) received more than three antidiabetic drugs. These regimens typically included insulin combined with oral agents such as metformin and glimepiride (Table 8).

Table 8: More than three-drug therapy for antidiabetics.

Drug 1	Drug 2	Drug 3	Drug 4	N
Insulin Degludec	Tab. metformin 500 mg	Tab. gliclazide 60 mg	Tab. vildagliptin 50 mg	3
Tab. metformin 500 mg	Tab. glimepiride 2 mg	Tab. sitagliptin 50 mg	Tab. canagliflozin 100 mg	2
Total				5

The WHO-DUS prescribing indicators (Table 9) showed that 586 prescriptions were analyzed, with a total of 1153 drugs prescribed. On average, 1.97 drugs were prescribed per encounter. Almost all drugs were prescribed using their generic names (99.22%), and 84.15% of the prescribed drugs were from the National Essential Drug List of India 2022. A total of 6% of encounters involved the prescription of injections.

Table 9: WHO-DUS prescribing indicators.

Prescribing indicators	Adjusted values
Total number of prescriptions analyzed	586
Total number of drugs prescribed	1153
The average number of drugs per encounter	1.97
Percentage of drugs prescribed by generic name	99.22
Percentage of drugs prescribed from essential drug list (India 2022)	84.15
Percentage of drugs prescribed from essential drug list (WHO 2023)	89.80
Percentage of encounters with an injection prescribed	6

Regarding drug prescriptions, an overwhelming majority of drugs were prescribed by their generic names. 99.22%

of prescriptions (1144 prescriptions) were for generic drugs, while only 0.78% (9 prescriptions) were for brand-name drugs (Table 10).

Table 10: Drugs prescribed by generic and brand names.

Type of prescription	N	Percentage
Generic	1144	99.22
Brand	9	0.78
Total	1153	100

DISCUSSION

In this study, we found that the majority of patients with diabetes and hypertension were male (54.77%), which aligns with findings from previous studies where males comprised 57% and 60%, respectively.[1,2] This male predominance may be attributed to a higher incidence of these conditions among men, particularly in the elderly population. However, a study by David et al reported that females had a higher prevalence of both conditions.[3] Similarly, in our study, the most affected age group was 60-70 years (72.89%), which is consistent with trends observed in other studies identifying this age group as the most susceptible to diabetes and hypertension.[4,5] These findings suggest that diabetes and hypertension are particularly prevalent in the aging population, emphasizing the need for targeted interventions in this demographic.

In terms of treatment patterns, metformin was the most commonly prescribed antidiabetic medication, accounting for 49.10% of all prescriptions. This is consistent with findings from prior research indicating metformin as the first-line treatment for most T2DM patients.[6,7] Metformin remains the gold standard due to its effectiveness in lowering blood glucose levels, its low risk of hypoglycemia, and its beneficial impact on weight, making it especially suitable for elderly patients.[8] However, sulfonylureas, particularly glimepiride, were prescribed in 30.04% of cases, a finding consistent with previous studies that reported a similar preference for sulfonylureas in managing diabetes in older patients.[7-9] Despite their higher risk of hypoglycemia, sulfonylureas continue to be widely used, likely due to their long-standing effectiveness, particularly when blood glucose control is suboptimal with metformin alone.

Interestingly, DPP4 inhibitors (such as sitagliptin and teneligliptin) and SGLT2 inhibitors (such as dapagliflozin) were prescribed to a lesser extent, accounting for 6.98% and 3.93%, respectively. These drug classes have gained popularity in recent years due to their additional cardioprotective and renal protective benefits, which are particularly important for elderly patients with comorbidities such as cardiovascular disease and renal dysfunction.[10-12] The lower prescription rates may be attributed to cost concerns or prescriber hesitation to switch from traditional therapies such as metformin and sulfonylureas.

Regarding treatment regimens, combination therapy was the most commonly used approach, with 69.65% of patients receiving a two-drug regimen. This aligns with findings from studies where combination therapy was preferred due to superior blood sugar control.[13,14] Among two-drug regimens, the most common combination was metformin + sulfonylureas (79.42%), followed by metformin + DPP4 inhibitors (9.96%) and metformin + SGLT2 inhibitors (5.75%).[14,15] The preference for two-drug combinations reflects a balanced approach to optimizing efficacy while minimizing the risk of adverse effects such as hypoglycemia.[16]

Notably, three-drug combinations were prescribed in 12.02% of patients, with the most frequently used regimen being biguanides + sulfonylureas + α-glucosidase inhibitors (34.62%), followed by biguanides + sulfonylureas + DPP4 inhibitors (29.49%). This highlights the complexity of managing elderly patients with diabetes and hypertension, as multiple medications are often necessary for optimal disease control. The increased use of combination therapies aligns with clinical guidelines that recommend multi-drug regimens for elderly patients with poorly controlled diabetes, as supported by previous research.[17,18]

A small proportion of patients (0.92%) were prescribed more than three antidiabetic drugs, a finding consistent with studies indicating that polypharmacy is uncommon but may occur in cases of poorly controlled diabetes or multiple comorbidities.[19,20] The relatively low proportion of patients on more than three drugs suggests an effort to minimize polypharmacy, which is crucial in elderly patients due to the higher risk of drug interactions and adverse effects.

Regarding prescribing practices, generic medications were overwhelmingly preferred, comprising 99.22% of all prescriptions, with only 0.78% of drugs prescribed by brand name. These findings align with studies demonstrating a high prevalence of generic prescribing, likely reflecting efforts to reduce healthcare costs, especially in elderly patients with limited financial resources.[21,22] The widespread use of generic medications may also be due to their increased availability and proven efficacy, which is comparable to branded medications.

Finally, our study used the WHO-DUS parameters to assess prescribing quality, revealing that the average number of drugs per prescription was 1.97, which is consistent with previous research reporting similar values.[23] This indicates a rational approach to polypharmacy in managing elderly patients with diabetes and hypertension. Additionally, a small proportion of prescriptions (6%) included injectable medications, a finding consistent with existing studies.[24] Furthermore, 89.80% of the prescribed drugs were from the WHO

Model List of Essential Medicines (WHO-EML), which is higher than previous reports showing 72.3% adherence.[25] In our study, 84.15% of prescribed drugs were from the National List of Essential Medicines (NLEM) India 2022, highlighting some variability in prescribing patterns, particularly regarding essential medicines in geriatric care.[22-26]

Limitations

While these findings provide valuable insights, certain limitations must be acknowledged. As a retrospective study, the data rely on the accuracy of medical records, making them susceptible to inherent biases. Additionally, this study was conducted at a single tertiary care center, which may limit its generalizability to other healthcare settings or populations. Future prospective studies are needed to evaluate the long-term outcomes of prescribed antidiabetic regimens, particularly concerning glycemic control, cardiovascular events, and renal function in elderly patients. Furthermore, investigating the impact of individualized treatment approaches, considering factors such as frailty, polypharmacy, and comorbid conditions, will be crucial in optimizing therapeutic strategies for this vulnerable population.

CONCLUSION

This study highlights that metformin remains the most frequently prescribed antidiabetic medication for elderly patients with diabetes and hypertension. The findings indicate a strong preference for generic drugs and combination therapies, aligning with WHO-DUS prescribing indicators and national guidelines. The widespread use of combination therapy suggests a strategic approach to optimizing glycemic control while minimizing adverse effects. These insights emphasize the importance of ongoing evaluation of prescribing patterns to ensure safe and effective treatment for the geriatric population. Future research should focus on assessing long-term outcomes and refining individualized treatment strategies to enhance patient care.

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