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Research Article

# COST-EFFECTIVE ANALYSIS IN TREATING DIABETES MELLITUS WITH COMORBIDITY

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**ABSTRACT**

**Objective:** The main objective of this study is to sort out the most common prescription patterns and their cost-effective analysis (CEA).

**Methods:** A prospective study design is followed to collect the data. Based on the percentage, the first three comorbidities which occupy a major part of the sample are taken into consideration. The top two used prescriptions for each comorbidity are selected and CEA is performed for those.

**Results:** Diabetes mellitus (DM) with hypertension (HTN) comprise the majority of the sample (37%). Two majorly used prescription patterns are sorted out and CEA is performed which revealed that prescription pattern A is more cost effective than prescription pattern B. Second major part of the sample is occupied by only cases with DM (21%) which is excluded as it does not have any commodities. After only DM, DM + infections occupy a major part (8%). Two majorly used prescription patterns are sorted out and CEA is performed which revealed that prescription pattern A is more therapeutically effective than prescription pattern B but not cost effective. The 3rd major comorbidity is DM + CVA (8%). In this case, the results demonstrated that prescription pattern A is more cost effective than prescription pattern B.

**Conclusion:** The major commodities of DM are HTN, infections, and coronary artery disease. The cost-effectiveness evaluation revealed that physicians are only considering the therapeutic efficacy as a major concern but not the economic burden. This study concludes the importance of considering the financial burden with relationship to their respective therapeutic efficacy provided by an individual prescription.

**Keywords:** Cost-effectiveness, Diabetic comorbidity, Net monetary benefits, Incremental cost-effectiveness ratio.

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## INTRODUCTION

Diabetes is a chronic metabolic disease characterized by elevated levels of blood glucose and polyuria [1]. India stands first in the top 10 countries for numbers of people aged 20–79 years with diabetes in 2010 and 2030 [2]. Thirty-six percent of the estimated global increase of 154 million people with diabetes in India and China alone. India, the largest population of people living with diabetes, will spend an estimated USD 2.8 billion [3]. There are a number of studies on the pharmacoeconomics of diabetes mellitus (DM) are in developed countries [4] but few in developing countries like India. In India, lack of access to health-care services, lack of national welfare schemes, and health insurance coverage for diabetes makes the treatment unaffordable, resulting in late diagnosis and increased cost in the treatment of diabetes and early onset of complications [5]. This hyperglycemic condition is potential enough to damage the vital organs of our body such as heart, nerves, and nephrons. This chronic disease due to its increased prevalence in India had laid the biggest challenge to the Indian health-care team.

According to the WHO, India is estimated to have an 8.7% diabetic population between the ages of 20 and 70 years [6]. According to the International Diabetes Federation [7] – South East Asia, among the total adult population in India (829,491,000), diabetes constitutes of 72,940,400 cases. It shows a prevalence of 8.8%. A magazine "India Today" in its article "*Diabetes Epidemic*" stated that nearly 98 million people in India may have diabetes by 2030 [6]. Non-adherence increases the cost of the treatment [8]. All the above statistics replicate the alarming situation that diabetes creates in India and the treat it lays on its citizens.

The above data reveal the importance of an individualized and specialized framework of a prescription pattern. This intends to initiate a work which is concentrated in this particular area where the analysis is done on the different prescription patterns and their outcomes. It also focuses on sorting out the best economic prescription pattern.

This study was aimed to evaluate the outcomes of different prescription patterns and their cost utility. And to evaluate different prescription in diabetes co-morbidities, the outcomes concerning the expenditure spent on each co-morbidities respectively.

## METHODOLOGY

The study was conducted in a tertiary care teaching hospital in Rajahmundry, Andhra Pradesh. The study protocol was approved by the Institutional ethical committee. The study duration was conducted for a period of 6 months followed by 2 months statistical analysis.

### Inclusion criteria

The following criteria were included in the study:

- All patients suffering with diabetes solely and with comorbidities
- Patients of either gender
- Patients who are willing to participate in the study
- Patients who is on treatment from past 1 year.

### Exclusion criteria

The following criteria were excluded from the study:

- Patients newly diagnosed with diabetes
- Type-1 diabetes.

All patients who are involved in the study have signed a patient consent form. Case details and the lab values are noted using specially designed patient data collection pro forma. Random blood sugar (RBS) was recorded for a minimum of two visits. A cost-utility analysis was analyzed in the study.

## RESULTS

A total of 275 patients were surveyed from a tertiary care teaching hospital in Rajahmundry, Andhra Pradesh.

### Case collection

The case profiles were randomly selected from among inpatients and outpatients from general ward, surgery ward, psychiatry, and orthopedic wards, respectively. Of which most of the cases were collected from general medicine (65%), surgery ward (18%), and few cases from psychiatry (11%) and orthopedic ward (6%). Data is provided in Table 1.

### Demographic data

*Age*

Among the case profiles, 38.9% were male patients (107) and 61.09% were female patients (168). Females were more sufferers among the age group of 50–60 years (18.9%) and males in the age group of 60–70 years (12%). Of all patients, male patients below the age group of 40 years were 8 (2.9%), 27 patients were in the age group of 40–50 years (9.81%), 26 patients were in the age group 50–60 years (9.45%), 33 patients were in the age group 60–70 years (12%), and 13 patients were above the age group of 70 years (4.72%). In the study of patterns of drug therapy among diabetic hypertensive patients with other complications, males were more sufferers (56.4%) than females (43.6%) whereas, in this study, females were found in more number (61.09%), in comparison with males (38.9%). These demographic characteristics were implicated in Fig. 1.

The majority of the population is with diabetes and hypertension (HTN) (37%), followed by diabetes alone (21%). DM with infections (8%) and DM + CVA (8%) both share 3rd place. While DM with respiratory problems (7%) occupy 4th place followed by DM with gastrointestinal tract complications (4%) in 5th place. The 6th place is shared by DM with coronary artery disease (CAD) (3%) and DM and respiratory problems (3%). DM with neurology disorders and DM with hepatic disease jointly share the 7th place. DM with orthopedic problems, DM with renal disease, DM with migraine, DM with anemia, and diabetes with renal diseases share 1% each and constitute to the last position in the population. The above-motioned data are depicted in Fig. 2. The top three comorbidities are the focused areas in this study.

### Prescribed drug types

Of 298 antidiabetic drugs, 188 were oral antidiabetic agents (63.08%) and insulin injection constituted 110 (36.91%). Based on the prescription, the patient population is divided into diabetic with HTN as Group A, diabetic with antibiotics as Group B, and diabetic with CVA as Group C. After performing a prescription review, two patterns of prescriptions, which are most commonly used in each study, are taken into consideration. Their therapeutic efficacy is measured and their cost-effectiveness is compared. The details of prescription and the dosage based on the Groups and the pattern are described in Tables 2-7.

### Group A

The therapeutic efficacies of both prescriptions are compared. To evaluate the glycemic control, the FBS levels are measured on the 1st day and 15th day and on the 30th day. A mean FBS was used to evaluate. This demonstrated that both the prescription patterns have good control over blood pressure but the prescription pattern A had better glycemic control than prescription pattern B. To cross-check the therapeutic efficacy of both the prescription patterns, the mean glycated hemoglobin levels are also measured and are compared. It revealed that the prescription pattern A provided a good glycemic control than pattern B. It is illustrated in Fig. 3.

### Group B

The therapeutic efficacy of both prescription patterns is done by measuring the RBS levels and infection levels through measuring total white blood cell (TWBC) levels. The analysis of RBS levels by mean RBS. The analysis revealed that prescription B provided a good

**Table 1: Case collection data**

| S. No. | Ward | No. of case profiles (%) |
|---|---|---|
| 1. | General medicine | 180 (65) |
| 2. | Surgery ward | 50 (18) |
| 3. | Psychiatry | 30 (11) |
| 4. | Orthopedic | 15 (6) |

**Table 2: Group A, pattern A**

| S. No. | Drug | Dose | Frequency |
|---|---|---|---|
| 1. | Pantoprazole | 40 mg | OD |
| 2. | Teneligliptin | 20 mg | OD |
| 3. | Telmisartan | 20 mg | OD |
| 4. | Metoprolol | 25 mg | OD |
| 5. | Metformin | 500 mg | TID |

**Table 3: Group A, pattern B**

| S. No. | Drug | Dose | Frequency |
|---|---|---|---|
| 1. | Pantoprazole | 40 mg | OD |
| 2. | Amlodipine | 5 mg | OD |
| 3. | Furosemide | 40 mg | OD |
| 4. | Metformin | 500 mg | TID |

**Table 4: Group B, pattern A**

| S. No. | Drug | Dose | Frequency |
|---|---|---|---|
| 1. | Piperacillin+Tazobactam | 4.5 g | TID |
| 2. | Metronidazole | 500 mg | TID |
| 3. | Pantoprazole | 40 mg | OD |
| 4. | Glimepiride | 1 mg | BD |
| 5. | Cilnidipine | 10 mg | BD |

**Table 5: Group B, pattern A**

| S. No. | Drug | Dose | Frequency |
|---|---|---|---|
| 1. | Piperacillin+Tazobactam | 4.5 g | TID |
| 2. | Metronidazole | 500 mg | TID |
| 3. | Pantoprazole | 40 mg | OD |
| 4. | Glimepiride | 1 mg | BD |
| 5. | Cilnidipine | 10 mg | BD |
| 6. | Ondansetron | 4 mg | SOS |
| 7. | Actrapid | 100 IU | TID |

**Table 6: Group C, pattern A**

| S. No. | Drug | Dose | Frequency |
|---|---|---|---|
| 1. | Heparin | 5000 IU | QID |
| 2. | Clopidogrel | 91/158 | OD |
| 3. | Atorvastatin | 40 mg | OD |
| 4. | Pantoprazole | 40 mg | OD |
| 5. | Telmisartan | 40 mg | OD |
| 6. | Metformin | 500 mg | TID |
| 7. | Glyceryl trinitrate | 2.0 mg | BD |

**Table 7: Group C, pattern A**

| S. No. | Drug | Dose | Frequency |
|---|---|---|---|
| 1. | Heparin | 5000 IU | QID |
| 2. | Furosemide | 40 mg | OD |
| 3. | Ramipril | 2.5 mg | OD |
| 4. | Pantoprazole | 40 mg | OD |
| 5. | Metformin | 500 mg | TID |

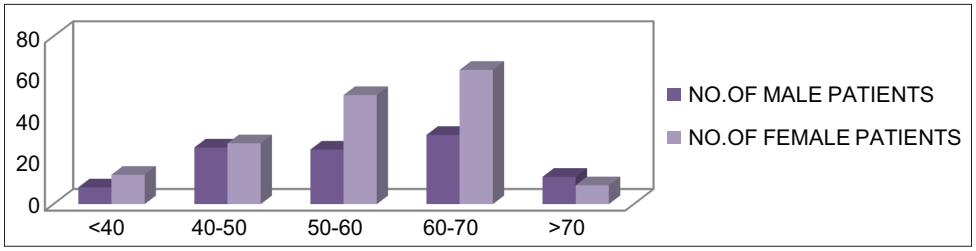


**Fig. 1: Prevalence of diabetes based on age as factor**

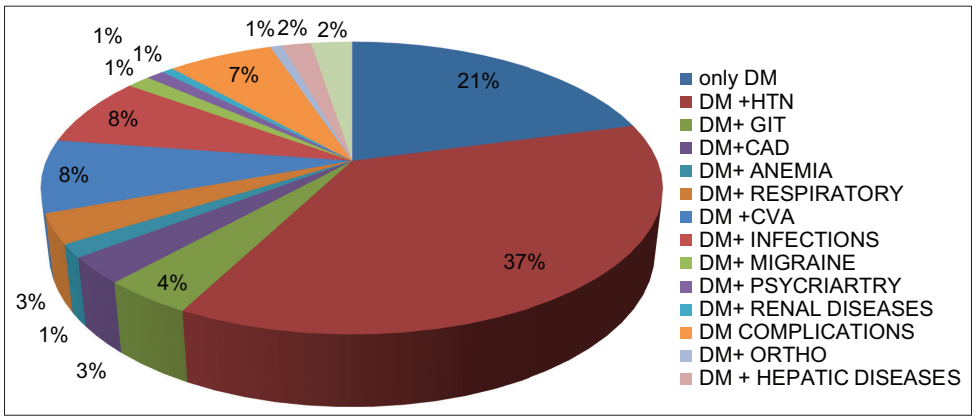


**Fig. 2: Analysis of comorbidities present along with diabetes and hypertension**

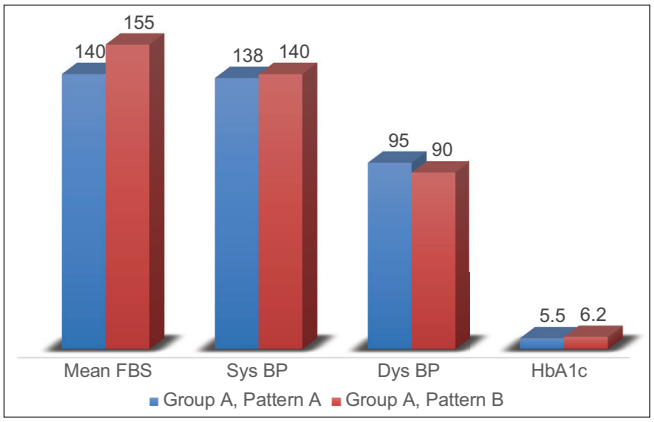


**Fig. 3: Comparisons of therapeutic efficacies in Group A**

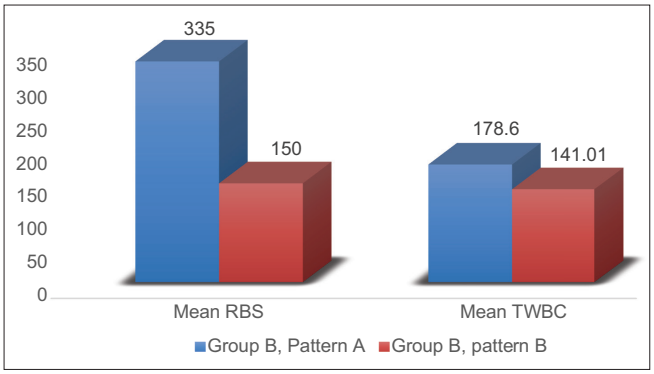


**Fig. 4: Comparisons of therapeutic efficacies in Group B**

glycemic control than prescription pattern A. The effect of antibiotics is calculated by evaluating the TWBC. The mean TWBC was analyzed. The results demonstrated in Fig. 4.

**Group C**

To evaluate the glycemic control, the FBS levels are measured on the 1st day and 15th day and 30th day, mean was calculated. The results revealed that the prescription pattern provided better glycemic control than prescription pattern B. The therapeutic efficacies of both prescriptions are compared. It is illustrated in Fig. 5.

**Cost-effectiveness analysis**

In Group A, the overall therapeutic efficacy and cost-effectiveness analysis revealed that prescription pattern A is more effective than prescription pattern B. In Group B, prescription pattern A is more effective than prescription pattern B, but it is not cost effective. Group C, prescription pattern A is more effective than prescription pattern B. The analysis is given in Table 8.

## DISCUSSION

A total of 275 patients were surveyed from a tertiary care teaching hospital in Rajahmundry, Andhra Pradesh. We have evaluated and analyzed different prescription patterns for their therapeutic efficacy and their cost-effectiveness of each. The therapeutic efficacy of each prescription pattern is weighed with its cost to evaluate its cost-effectiveness.

A basic literature review is done before the initiation of the study. Each literature provided valuable information regarding each outcome parameter. The conclusions regarding each outcome parameter in each literature are compared to the conclusions of the present study and discussed.

Singla *et al.* [9] conducted a study which is entitled "Drug Prescription Patterns and Cost Analysis of Diabetes Therapy in India." It is a study done using an Audit of an Endocrine Practice. This study is aimed to analyze the current trend in the use of antidiabetic as well as other drugs for comorbidities along with the duration of diabetes. The study also aimed to analyze the direct drug cost to patients. The study included a sample size of 489 patients for 6 months. Restricting to exclusion and inclusion criteria, 403 diabetic patients was included in the study. This study gave a conclusion that metformin remains the most preferred drug across

**Table 8: Cost-effectiveness analysis**

| Parameters | Group A | | Group B | | Group C | |
|---|---|---|---|---|---|---|
| | Prescription A | Prescription B | Prescription A | Prescription B | Prescription A | Prescription B |
| Per day cost | 24.8 | 27.5 | 1928 | 1466 | 992 | 902 |
| Total costs | 744 | 825 | 13494 | 10260 | 27660 | 27060 |
| Lab value | 5.5 | 6.2 | 108 | 170 | 130 | 120 |
| Incremental costs | 81 | | 3234 | | 600 | |
| Incremental effects | 0.7 | | -62 | | 10 | |
| ICER | 116 | | -52 | | 60 | |
| WTP | 300 | | 1000 | | 900 | |
| NMB | 94 | | -61948 | | 8940 | |

Incremental costs=cost of prescription A–cost of prescription B, Incremental effects=effects of prescription A–effects of prescription B, Incremental cost-effectiveness ratio (ICER)=Incremental costs/Incremental effects, Willingness to pay (WTP) Net monetary benefits (NMB)=(WTP x Incremental effects)–Net Costs

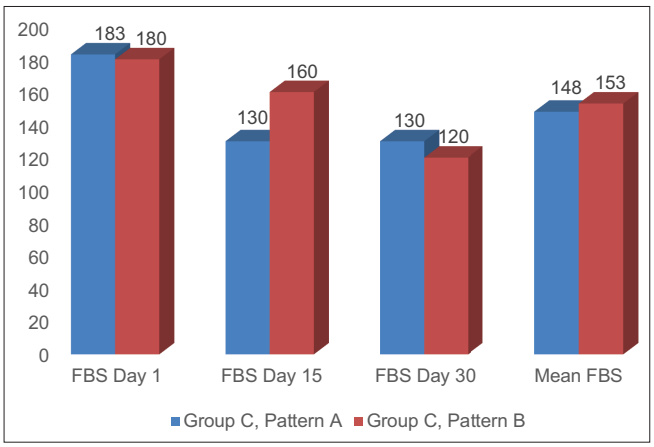


**Fig. 5: Fasting blood glucose levels comparison between the selected prescription patterns**

all the duration of diabetes. DPP4i seems to be fast catching up with sulfonylureas as second-line treatment after metformin. SGLT2 inhibitors are being used as a third- or fourth-line drug. The cost of diabetes is likely to escalate. In our study, the most common comorbidities which are along with DM are sorted out and the 2 most common prescription patterns are taken out and their therapeutic efficacy is compared followed by cost-effectiveness. We got a conclusion that the cost-effectiveness of each prescription not only depends on the duration of diabetes but also on the selection of each drug based on their therapeutic efficacy. Overall, we conclude that cost is also an important parameter that is to be noted as it has an impact on factors like medication adherence.

Kumar *et al*. [10] conducted a study which is entitled "Assessment of the prescription pattern of antidiabetic drugs in type-2 DM patients." It was a cross-sectional, questionnaire-based study was carried out in 160 diabetic patients attending the diabetic outpatient department of a public tertiary care hospital to assess their prescribing pattern of antidiabetic drugs. In this study, a sample size of 160 patients was included in the study. They conclude that oral antidiabetic drugs are on top with metformin is the drug of choice in prescribing pattern, but the use of insulin preparations in the treatment of type 2 DM is increasing continuously. To maintain the clinical standard of prescribing, a constant effort is mandatory for every physician to follow the guidelines recommended by various international bodies. In our study, we found that metformin is the most commonly used antidiabetic drug followed by sulfonyl urea's which are followed by dipeptidyl peptidase-4 inhibitors. Insulin is less used as the sample included in the study is only type 2 DM where insulin has less role than oral hypoglycemic agents. We in our study conclude that the selection of drugs should be made by comparing the therapeutic efficacy and also the cost of each drug.

Shah *et al*. [11] conducted a study which is entitled "Evaluation of antidiabetic prescriptions, cost, and adherence to treatment guidelines." It is a prospective, cross-sectional study at a tertiary care teaching hospital. It included a sample size of 250 patients. They concluded that metformin was the most commonly prescribed drug. Sulfonylurea and biguanide combination drugs were used. In these glimepiride and metformin combination, drugs were prescribed and used commonly. In this study, the cost of drugs per prescription was found to be very high. The cost of a prescription can be reduced by choosing the most economical drugs (generic) without changing its quality. In our study, we found metformin as the most common drug. The cost of a prescription can be reduced by choosing an appropriate brand which is cheaper and with good therapeutic efficacy. The omission of unnecessary drugs also can reduce the economic burden on the patient. Avoiding medication errors like drug-drug interactions and all also reduce the economic burden.

Hence, our study concludes that the cost of a prescription plays a key role in a patient's economy as well as disease prognosis.

## CONCLUSION

The major comorbidities of DM are HTN, Infections, and CAD. The most probably used two prescription patterns are taken into account; their therapeutic and cost-effectiveness evaluation revealed that physicians are only considering the therapeutic efficacy as a major concern but not the economic burden. This study concludes the importance of considering the financial burden with relationship to their respective therapeutic efficacy provided by an individual prescription.

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## AUTHORS' CONTRIBUTIONS

J John Kirubakaran: Concept, design, analysis, manuscript editing, and manuscript review. D. R. Deepika, Mina Jafarnia, and Farzaneh Raveshi data acquisition and manuscript preparation.

## CONFLICTS OF INTEREST

None declared.

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