

Original Article

Medication safety in diabetes care and addressing medication errors and drug interactions

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Abstract

Didactic lectures are the major mode of traditional teaching (TT) in medical education, but they might not adequately equip students with skills for clinical practice. Early Clinical Exposure (ECE) combines hospital-based learning and clinical case discussion in the initial stages of medical education, perhaps enhancing knowledge retention, clinical problem-solving, and confidence. This study compares the relative effectiveness of ECE and TT for teaching physiology to first-year MBBS students. A prospective, cross-sectional study was done on 250 SRM University first-year MBBS students. Students first received TT in gastrointestinal physiology, then ECE. Pre-test, post-test, and retention test at one and three months evaluated learning and retention of knowledge. Case-based problem-solving exercises and student confidence surveys were employed to compare clinical application skills. Data analysis was performed using paired t-tests and ANOVA, with p-values < 0.05 as statistically significant. ECE better enhanced learning achievements than TT, with mean scores rising from 42.3% (pre-test) to 78.4% (post-ECE). Retention of knowledge at three months was better in the ECE group (74–80%) than in the TT group (38–50%). Diagnostic ability and clinical use were significantly enhanced, with problem-solving times being shortened by 43% in ECE. Confidence in making a diagnosis was boosted from 48% (TT) to 89% (ECE) ($p < 0.001$). ECE is more effective than TT in improving knowledge recall, clinical problem-solving, and student confidence. These conclusions recommend the incorporation of ECE into medical school curricula to enhance the transition between theory and practice.

Keywords: early clinical exposure, traditional teaching, medical education, physiology, knowledge retention, clinical problem-solving

Introduction

Ensuring the safety of patients is an international concern within healthcare networks. Pharmacotherapy is a problematic process which has to do with interaction between patients and healthcare providers at different points. Providing prescribed medicines to patients is a pivotal and high-risk job in healthcare which demands teamwork between different fields of medicine. The processes for giving the patients their drugs require precision, clear communication, and cautious attention from the hospital staff [1]. Diabetes mellitus, also referred to as diabetes, is a chronic and serious dis-

order of elevated blood glucose resulting from the inability of the body to make enough insulin or utilize properly the insulin produced [2]. The occurrence of Type 2 Diabetes Mellitus (T2DM) in India is high and has been growing gradually year after year. As per the International Diabetes Federation (IDF), the prevalence of diabetes in India has increased from 7.1% in 2009 to 8.9% in 2019 [3]. Drug-drug interactions (DDIs) are a frequent reason for medication errors in diabetes treatment. DDIs happen when two or more drugs interact with one another, leading to a change in pharmacokinetics or pharmacodynamics. Anti-diabetic drugs are most susceptible to DDIs, which may produce hypoglycemia,



hyperglycemia, or other side effects. The greater practice of polypharmacy in diabetes care even adds to the risk of DDIs [4]. Medication error is a potent danger to the safety of the patient. A medication error may take place at any point along the medication use process, ranging from prescription through administration. A medication error can lead to adverse drug events, hospitalization, and even fatality. The aim of this article is to present an overview of the status quo of medication errors and DDIs of anti-diabetic agents. The research will investigate the frequency and etiology and cause factor of these errors, and ways to improve patient safety in diabetes care.

Material and methods

Study design and setting

This research was done as a prospective observational study at a tertiary care centre, in patients with diabetes mellitus and those who were being treated with newer anti-diabetic drugs. The study sought to evaluate medication errors and drug-drug interactions of these newer drugs to provide improved patient safety and optimize clinical results. A systematic approach was used, in which patient information was collected and examined systematically to analyse the frequency, nature, and severity of medication errors and interactions.

Study population and sample size

The population under study included patients with diabetes mellitus being treated with new anti-diabetic drugs and had one or more comorbid conditions. Sample size was calculated by using Raosoft software, taking into account a 5% margin of error and 95% confidence level, and an estimated sample size of 218 patients was calculated. This sample size was adequate to yield statistically significant information about the prevalence and trends of drug-drug interactions and medication errors in the study population.

Inclusion and exclusion criteria

Patients enrolled in the study were individuals over 20 years of age, diagnosed with diabetes mellitus, and being treated with new anti-diabetic drugs. The presence of comorbid diseases was taken as a required inclusion criterion to assess polypharmacy-related er-

rors and interactions. Certain patients were, however, excluded, such as pregnant and breastfeeding women and patients who did not want to give informed consent. This helped the study concentrate exclusively on the target population while keeping ethical research practices intact.

Data collection and evaluation

Data were carefully gathered from patient case histories, medication order forms, laboratory results, and progress charts. Medication errors were categorized into prescribing, transcribing, dispensing, administration, and monitoring errors, and drug interactions were classified according to their clinical significance as major, moderate, or minor interactions. The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) Index was used to evaluate the severity of errors. Standard drug interaction databases were employed to identify potential interactions between new anti-diabetic drugs and other medications prescribed.

Statistical analysis

The data gathered were processed with SPSS software, and descriptive statistical techniques such as mean, standard deviation, and percentage distributions were used. Paired statistical tests were used where appropriate to ascertain the clinical effect of drug errors and interactions. The findings were determined to provide evidence-based recommendations for reducing medication-related risk in diabetic patients.

Ethical considerations

The research was done according to ethical guidelines in the Declaration of Helsinki and was approved by the Institutional Ethics Committee (IEC) of J.K.K. Nattraja College of Pharmacy. The ethical clearance number for this research is JKKNCP/IEC-CER/0622123/38. Written informed consent was taken from all the study participants before enrolling them into the study, and they were assured of voluntary participation and privacy of personal health information.

Study timeline

The research was conducted over a period of six months, structured into three distinct phases. Phase I, spanning two months, involved an extensive literature

review, study design finalization, and IEC approval. Phase II, lasting three months, focused on data collection, including patient enrolment and documentation of medication errors and interactions. Lastly, Phase III, lasting one month, comprised data analysis, interpretation, and the final submission of findings. This organized method guaranteed the methodical completion of the study, which resulted in a thorough assessment of medication safety issues in patients with the application of new anti-diabetic drugs.

Results

A total of 230 prescriptions were gathered, and of those, 174 medication errors and 110 prescriptions with errors related to diabetes mellitus issues were identified. It was determined that there 105 men or 60.34%, of the population. The participants between the ages of 51 and 60 had the highest rate of medication errors (34.48%), followed by those between the ages of 41 and 50 (23.56%). The distribution of medication errors by type is shown in Table 1, while the major causes of medication errors are summarized in Table 2.

The majority of medication errors were coming under Category B 119 (68.39%) but there is no harm this category makes the highest percentage of medication error in our study population and the second highest is Category C 51 (29.31%) in our study and Category D 4 (2.29%) in our study.

A total of 230 prescriptions were collected out of that 40 prescriptions were found with DDI's for diabetic mellitus conditions, and 63 DDI's were observed. Out of which 38 (60.3%) were females and 25 (39.6%) were males and concluded that the majority were females. The severity distribution of the identified drug-drug interactions is presented in Table 3.

The highest number of severities of the interaction comes under moderate interaction 58.7% and followed by the major one 41.2%. Aspirin + Metformin

and Enalapril + Metformin show the same range of 23% which has the major interactions. Sitagliptin and glimepiride range of 13.5% which has the major interaction and followed by Sitagliptin and enalapril, Teneligliptin and glimepiride occurs in the same range of 10.8%. The distribution of drug interactions across antidiabetic drug classes is summarized in Table 4.

Discussion

A total of 230 prescriptions were gathered out of which 110 prescriptions were erroneous for diabetic mellitus conditions, and 174 errors in medications were noted. Out of which 105 60.34% were male and 39.65% were female and found that most were males. Mangi, A.A. et al., medication error noted was 513 for both sexes. Among males, 289 (56.3%) errors and among females 224 (43.7%) prescriptions were detected [5]. Based on the results of this study, female patients were found to be disproportionately impacted by medication errors, possibly due to the greater number of medications they receive. Increased medication burden could result from the presence of comorbid conditions, which are more prevalent in women. 51–60 years age group reveals 34.48% had maximum rate of medication error and was followed by 41–50 years 23.56% within our population. Monika Pury Oktora et al., where nearly about half of the error was found to lie under 45–60 years 50.8% [6]. The prevalence of polypharmacy use was higher by 1–2% in the age group of young (45–64 years) compared to elderly (≥ 65 years) ages while using same potentially inappropriate drug. We further found that among medication errors the majority were in the form of prescribing error, followed by monitoring error and also administering error.

Research carried out by Peddolla Sushma Reddy et al., in which it was established that Prescribing errors 62.19% were the most common type of error, followed by administration errors 37.8% [7]. The need to enhance

Table 1: Represents the types of medication error that occurs in majority.

S.No	Types of medication errors	Number of medication errors (n=174)	Percentage (%)
1.	Prescribing	140	80.45%
2.	Transcribing	05	2.87%
3.	Dispensing	07	4.02%
4.	Administering	11	6.32%
5.	Monitoring	11	6.32%

Table 2: Represents the causes of medication error that occurs in majority.

S.No	Causes of errors	No of Medication errors (n=174)	Percentage (%)
1.	Incomplete prescription (Missed dose & missed frequency)	98 (41+57)	56.3% (23.56%+32.75%)
2.	Monitoring	24	13.79%
3.	Omission	15	8.62%
4.	Wrong frequency	11	6.32%
5.	Wrong patient	7	4.02%
6.	Wrong strength	7	4.02%
7.	Drug shortage	4	2.29%
8.	Wrong drug	3	1.72%
9.	Wrong dose	2	1.14%
10.	Wrong route	1	0.57%
11.	Drug duplication	1	0.57%
12.	Incorrect medication	1	0.57%

prescribing and administering practices and ensure that health professionals possess the knowledge and skills required to accurately and safely prescribe and administer drugs. The highest number of medication error comes under category B and this may be caused due to an environment which is susceptible to medication error. It is almost true that more than half of the error comes

under category B because of the simple carelessness of the health care professionals in prescribing the drugs for the patient. Research carried by Manasij Mitra *et al.*, in which it was observed that 97.67% of the Medication errors were Category B errors whereas only 2.33% were Category C errors [8]. Through this study, we observed that incomplete prescriptions 56.3% is the predominant

Table 3: Represents the level of severity of drug interactions that occurs in majority.

S.No	Level of severity	Number of prescriptions with drug interactions (n=63)	Percentage (%)
1.	Major	26	41.2%
2.	Moderate	37	58.7%
3.	Minor	0	0

Table 4: Represents the drug class of anti diabetic drugs interactions that occurs in majority.

S.No	Antidiabetic drugs	Number of Interactions (n=63)	Percentage (%)
1	Sulfonylureas	5	7.93%
2	Biguanides	17	26.9%
3	Dipeptidylpeptidase4 inhibitors(DPP4)	25	39.6%
4	Sodium glucose cotransporter inhibitors(SGLT2)	5	7.93%
5	Thiazolidinediones	5	7.93%
6	Alpha glucosidase inhibitors	2	3.17%
7	Insulin	4	6.34%

cause that is done while medication error and another predominant cause is monitoring 13.37%, omission 8.62%, wrong frequency 6.32%.

A study by Bothiraj et al., in which it was observed that wrong time administration 40.9% followed by wrong dose 10.2% [9]. The difference between the two studies indicates the necessity for further research to understand the underlying causes of medication errors, as the contributing factors may differ in different healthcare settings and patient populations. The contributing factors to medication errors were distraction 43 (24.71%), forgetting 39 (22.41%), confusion with frequency 28 (16.09%) in our study. The results are consistent with the results of a study by Mohammad Al-Shara, who reported that heavy workload was the most common cause of medication errors (41.4%), followed by errors due to new staff (20.6%) [10]. The results of the study emphasize the need to implement systems to minimize the risk of medication errors, such as electronic medication administration records and barcoding systems. Out of that 40 prescriptions were found with DDI's for diabetic mellitus conditions, and 63 DDI's were observed. Out of which 60.3% were females and 39.6% were males and concluded that the majority were females.

A study done by Lujaw Ratna Tuladhar et al., where 39.28% were male and 60.71% female [11]. Most drug interaction in the current study was seen in the age group 51–60 (24%), followed by the age group 61–70 (18%). Most of the interaction happens because of the multiple drug therapy and multiple disease condition patients predominantly on comorbid conditions. The results align with a study conducted by Sankar V et al., where it was found that the results of the age categorization revealed that maximum drug interactions 38% were found in the prescriptions of patients in the age group 61–70 years followed by 20% each in the 51–60 [12]. Of the 63 interaction moderate 58.7% major 41.2% and there is no minor interactions occurs. While the life-threatening drug interactions are rare, clinically significant DDI's impact the drug response or appearance of serious adverse effects have been and can impact long term outcomes. Same study was done by Vijay Kulkarni et al., where it was observed that a severity assessment revealed that most of the DDIs were moderate 70% and minor 28% [13].

In the current study we saw that same DDI's happen in the following drugs Aspirin with Metformin 23% and Enalapril with Metformin 23%. Major of the DDI's are occurs under the Biguanides class only and the rest of them are comes under the sulfonylureas with comorbid condition drugs like Beta blockers etc.

Pinky Mariyam Thomas et.al., where it revealed that the predominant class of drug which was responsible for interaction was cardiac drugs 92% and NSAIDs 66%, followed by antibiotics 52% with Anti-diabetic drugs [14]. With this we also revealed that the maximum interaction is in the class of DDPI4 39.6% and followed by that Biguanides 26.9% in our study population. In addition to ME, medication documentation mistakes and drug interactions can enhance the likelihood of ME. Prescription mistakes were more prevalent than other types of mistakes in drug documents. Most drug-drug interactions noted were of moderate severity.

The main limitations of this study were its relatively short duration and small sample size. The limited study period may have prevented the identification of all types of medication errors and potential drug interactions that could contribute to adverse outcomes or harm to patients. Furthermore, the small number of cases may have limited the generalizability of the findings and reduced the likelihood of detecting less frequent medication-related problems.

Conclusion

The study highlighted the significant impact of multiple drug therapy and the presence of multiple disease conditions, particularly in patients with comorbidities, on the occurrence of Medication errors and drug-drug interactions associated with anti-diabetic agents pose a significant threat to patient safety, particularly in the context of the growing prevalence of diabetes and the complexity of diabetes management. To improve patient safety include promoting medication self-management, encouraging timely reporting of medication errors and adverse drug events, and fostering a culture of safety within healthcare systems. Physicians, nurses, and pharmacists as the primary providers of patient education and support, play a crucial role in empowering patients to actively participate in their medication management and report any safety concerns. A clinical pharmacist can have a significant impact on the quality of patient care, early diagnosis, and prevention of medication errors.

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Conflict of interest

The authors declare no conflict of interest.

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