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Errors in diabetic insulin therapy and the vitality of proper precautions in Bangladesh: Real-life insights from the developing world

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ABSTRACT

Background: Insulin therapy errors can have life-threatening consequences in patients with diabetes. Given the increasing prevalence of diabetes and insulin therapy in Bangladesh, it is crucial to identify and prevent these errors. This study uses case-based clinical experiences to thematically analyze insulin therapy errors and propose preventive measures. The study aims to provide valuable insights into the challenges faced in managing insulin therapy in a developing country setting and the importance of involving various stakeholders. **Materials and Methods:** This is a qualitative research that used a case study approach to identify and analyze errors in insulin therapy in diabetic patients who had experienced adverse clinical consequences. The cases were thematically analyzed to generate insights into current global health problems resulting from erroneous insulin therapy. **Results:** The two case studies highlight potential risks of errors in insulin therapy, including poor glycemic control, complications, and death. The analysis also highlights the importance of careful monitoring, checks, and communication among health-care providers, patients, and pharmacists to prevent such errors. In addition, it emphasizes the need for education and awareness among patients and health-care providers to ensure safe and effective insulin therapy. **Conclusion:** Accurate insulin therapy is crucial for diabetes management and preventing adverse outcomes. Identified themes emphasize improved communication, education, and monitoring to minimize therapy errors. Insights from this study can inform policies and practices for better patient outcomes. Further research can identify the root causes and develop interventions to prevent errors, leading to improved quality of life for diabetics.

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Introduction

The incidence of diabetes is increasing rapidly worldwide, and a report by the International Diabetes Federation atlas in 2021 revealed that there are currently around 537 million people aged between 20 and 79 years with diabetes worldwide. The number is projected to increase to 643 million by 2030 and 784 million by 2045.^[1] In Bangladesh alone, there are approximately 13.1 million people with diabetes. Diabetes is one of the four primary noncommunicable diseases and causes approximately 500,000 deaths annually. Reasonable control of blood sugar levels can significantly reduce vascular complications and mortality in all forms of diabetes. In type 1 diabetes, insulin is essential. Around 50% of individuals with diabetes are between 40 and 59 years of age, and with the increasing prevalence of obesity and physical inactivity, type 2 diabetes is being detected in younger individuals. It is now clear that β -cell function progressively and relentlessly declines in type 2 diabetes regardless of interventions.^[2] As a result, it is unsurprising that a significant proportion of type 2 diabetes patients ultimately require insulin therapy to manage their blood sugar levels effectively.

Insulin is considered a high-alert medication (HAM), which means that mistakes with this medication, either in preparation or administration, can have very serious consequences.^[3,4] Hospitalized patients are particularly at risk of medication errors with insulin, which can lead to longer hospital stays.^[4] About 31% of patients with diabetes are treated with insulin, and a significant proportion of medication errors resulting in death within 48 h involve insulin therapy.^[5,6] From 2007 to 2011, there were over 97,000 emergency room visits annually related to insulin, with about one-third of these events resulting in hospitalization.^[7] The most common reason for insulin-related hypoglycemia was incorrect medication administration.^[8]

A large number of individuals with diabetes in Bangladesh are currently being treated with insulin, but a significant portion of those receiving insulin fail to reach their target glycated hemoglobin (HbA1c) levels.^[1] Mistakes in insulin therapy are a significant contributing factor in many cases, and preventing these errors is crucial to the success of treatment.^[9] Such errors can occur at every stage of the process, from the initial prescription to administration, and can have serious consequences including low or high blood sugar.^[3,4] The National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) defines medication error as “any preventable event that can cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health-care professional, patient, or consumer,” and avoiding such errors in insulin-treated patients is critical to the therapeutic success.^[10] Given the high prevalence of diabetes in Bangladesh, it is important to identify the types of errors that occur in insulin therapy and develop strategies to minimize them. This study shares case-based experiences and proposes preventive measures to overcome these barriers and achieve long-term glycemic control.

The aim of this study is to explore the real-life experiences of health-care providers and patients with insulin therapy in Bangladesh. We aim to identify common insulin therapy errors and the factors that contribute to them, as well as to highlight the importance of proper precautions in preventing these errors. This study will provide valuable insights into the challenges faced by health-care providers and patients in managing insulin therapy in a developing country setting and will inform the development of effective strategies to improve the safety and quality of insulin therapy for people with diabetes in Bangladesh. We also highlight the roles of different stakeholders including physicians, nurses, pharmacists, policymakers, regulatory bodies, patients, and the public in reducing this growing prevalence of insulin therapy errors.

Materials and Methods

This is a qualitative research that used a case study approach to identify and analyze errors in insulin therapy in diabetic patients who had experienced adverse clinical consequences. These case studies were taken from our admitted patients and were narrated by the admitting physician. For the selection of case studies, specific inclusion and exclusion criteria were applied. Inclusion criteria encompassed diabetic patients who had experienced adverse clinical consequences directly related to errors in insulin therapy. The cases were chosen based on the severity and diversity of the errors, ensuring a comprehensive representation of the challenges associated with insulin therapy. Exclusion criteria involved cases where the errors were unrelated to insulin therapy or lacked sufficient documentation to support a thorough analysis. By employing these criteria, we aimed to focus on cases that provided valuable insights into the complexities of insulin therapy errors and their impact on patient outcomes. The patients were then included for our thematic analysis.

Analysis

After identifying the patients, we thematically analyzed the cases and used the generated insights to highlight the current global health problems resulting from erroneous insulin therapy. To identify and analyze themes, a systematic and rigorous approach was followed. Firstly, the two case studies were thoroughly examined, and relevant data, including textual descriptions, interview transcripts, and medical records, were carefully reviewed. Through a process of constant comparison and iterative analysis, key concepts and ideas emerging from the data were identified and organized into potential themes. These themes were refined and finalized through discussions among the researchers to ensure consensus and validity. Written informed consent was obtained from the patients, ensuring confidentiality and anonymity and avoiding any harm to the participants.

Results

Case-based clinical experience 1

This was a middle-aged woman who presented with uncontrolled type 2 diabetes mellitus for 6 months despite repeated attempts to escalate her insulin doses. The patient's clinical history for dietary and physical activity

patterns was inconsistent with poor glycemic control. We further probed into her potential errors in using insulin therapy and asked the patient to demonstrate insulin administration technique and to bring the prescribed insulin and syringe. We observed her taking the insulin of 40 IU/ml vial using a syringe made for 100 IU vial. This is shown in Figure 1 that was taken while encountering the patient. That was the error which occurred to the patient when she was receiving 2½ times lesser than the prescribed insulin. The patient reported the wrong dispensation syringe was supplied by the local pharmacy man.

Thematic analysis

As the patient was receiving a lesser dose of insulin, it would lead to chronic poor glycemic control and dreadful diabetic complications that would increase her risk of mortality and morbidity as well as put a financial constraint.

If her insulin doses are being continually uptitrated using a vial containing 40 IU/ml insulin and 100 IU/ml syringe and if after good glycemic control, the patient purchases the 40 IU syringe in place of 100 IU syringe, which she was supposed to buy at the first place, then the patient will start receiving 2½ times more doses than required to control her sugar. This will lead to a drastic reduction in blood sugar and may lead to the death of the patient.

Case-based clinical experience 2

A middle-aged diabetic man got admitted due to a diabetic foot ulcer. He was getting conservative care with regular dressing and antibiotics. He was taken care of by his nurse relative, who gave him all the necessary diabetic care including insulin injection. Suddenly, one of our clinical care physicians got a call from the hospital that the patient suddenly developed symptoms of hypoglycemia and his blood sugar was found to be 2.2 mmol/l. The patient was about to get into a hypoglycemic coma and eventually die. However, he was rapidly infused with 25% dextrose, which saved the patient. We asked the relative nurse to bring her insulin vial and syringe. To our surprise, we found him taking insulin (100 IU/ml) using the syringe of 40 IU/ml. The patient was supposed to get insulin in 20 + 20 + 16 (morning, afternoon, night) units; however, the patient was getting it in units of 50 + 50 + 40, which means 2½ folds more than the dose prescribed. On interviewing his relative, she said the pharmacy man had changed the syringe, which she did not take notice of.

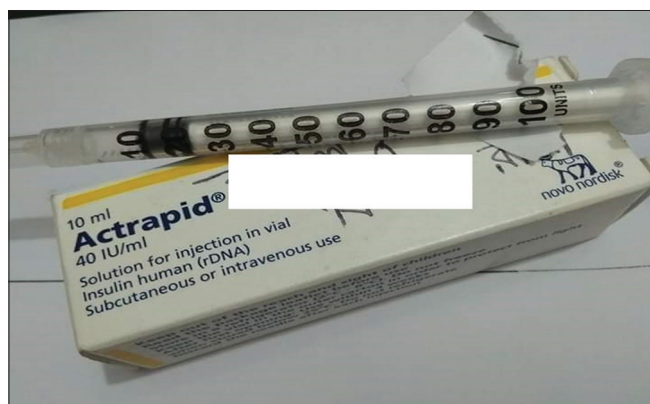


Figure 1: Patient using incorrect insulin syringe (40 IU/ml vial with 100 IU syringe)

Thematic analysis

First, this patient had adverse clinical consequences of insulin therapy errors. The patient developed symptoms of hypoglycemia due to an error in insulin therapy as he was receiving an increased dose of insulin that would lead to severe hypoglycemia, which could have resulted in death if not treated promptly. Second, there was a miscommunication and lack of understanding. The relative nurse was unaware of the difference in insulin dosages and units, and the error occurred due to miscommunication between the pharmacy and the patient. Third, the error was discovered only after the patient was taken to the hospital, highlighting the importance of careful monitoring and checks to prevent adverse clinical consequences. Fourth, the quick action taken by the clinical care physician and the infusion of dextrose saved the patient's life, highlighting the critical role of health-care providers in managing adverse clinical consequences. Fifth, the need for education and awareness is reflected in this case. The error in insulin therapy was due to a lack of understanding of the different insulin dosages and units, highlighting the need for education and awareness to prevent such errors.

Discussion

Effective management of diabetes through insulin therapy requires the identification and correction of potential errors, which can help remove barriers to successful treatment. Patients' compliance and long-term adherence to insulin therapy can be negatively affected by pain following an injection, which can be minimized or avoided by proper injection technique. Proper injection techniques can also improve compliance, especially when patients require multiple daily injections.^[11] Studies have shown that adopting proper injection techniques and regularly assessing injection sites can lead to significant reduction in HbA1c levels in as little as 3 months, which is equivalent to the antihyperglycemic potency of many oral agents.^[12]

The thematic analysis of the case studies highlights the adverse clinical consequences of errors in insulin therapy and the need for careful monitoring and checks to prevent such errors. The cases also highlight the importance of thorough investigation into potential errors and the role of health-care providers and local pharmacies in ensuring correct insulin administration.

One of the key themes that emerged from the thematic analysis is the adverse clinical consequences of insulin therapy errors. The case studies highlight the serious impact that errors in insulin therapy can have on patient health, including uncontrolled diabetes and even life-threatening hypoglycemia. These consequences underscore the need for careful monitoring and checks to prevent errors in insulin therapy and ensure that patients receive the correct dose of insulin. Another important theme is the role of health-care providers and local pharmacies in ensuring correct insulin administration. The cases highlight the importance of thorough investigation into potential errors, as well as the critical role of health-care providers in quickly identifying and treating adverse clinical consequences. The cases also highlight the role

of local pharmacies in dispensing the correct insulin and syringes, and the need for clear communication between pharmacies and patients to prevent errors. The cases also highlight the need for patient education and awareness regarding insulin therapy. The patients in the cases did not have a clear understanding of the different insulin dosages and units, and this lack of knowledge led to errors in insulin administration. To prevent such errors, it is important to educate patients about insulin therapy and the importance of accurate dosing and administration. Literary sources have consistently shown that insulin usage has been linked to a higher rate of medication errors than any other type of drug. Studies found insulin was responsible for a significant portion of harmful medication errors.^[13,14] The Pennsylvania Patient Safety Authority also found that a significant number of reported medication errors involved HAMS, with insulin products accounting for a significant proportion.^[15] The most frequent types of medication errors associated with insulin were drug omission (accounting for 24.7% of incidents), followed by wrong drug (13.9%) and wrong dose/overdose (13%).^[14] More than half of the reported events (52%) resulted in patients receiving an incorrect or no dose of insulin, including cases of missed doses, incorrect doses (over or under), extra doses, and incorrect infusion rates.^[16] These types of medication errors could have significant implications for glycemic control. In another study conducted in India, other common errors associated with insulin therapy were reported.^[16] Here, we discuss some of the potential errors that occur related to insulin therapy.

Prescription errors

Unclear or misread prescriptions and lack of proper explanation regarding injection techniques and storage can often result in unfavorable outcomes for patients, their families, and health-care providers. In busy diabetic clinics, many prescriptions are written in handwriting that is difficult to read, leading to misinterpretations and dangerous consequences. For instance, patients have been hospitalized due to severe hypoglycemia after using 30 U of insulin instead of 3 U, and 100 U instead of 10 U, due to misinterpretation of the prescription. To avoid these harmful consequences, it is advisable that practitioners refrain from using the abbreviation “u” to indicate the number of units while prescribing insulin. Instead, using clear, standardized terminology is recommended. In addition, using nonstandard abbreviations such as “BD” (for before dinner) can lead to confusion among nurses and other community health-care workers. Hence, it is suggested that a different abbreviation be used instead.

Inappropriate storage conditions

It is crucial to follow the precise storage instructions provided by the insulin manufacturer. Insulin pens, unused cartridges, and vials should be stored in a refrigerator between 2°C and 8°C until their expiration date.^[17] Freezing insulin can cause it to become unusable, and storing it in a deep freezer can affect its bioavailability. Pens should not be stored with needles attached to avoid clogging and insulation leaks. People with diabetes

living in rural or remote areas without access to refrigerators should be aware that insulin can be stored for about 4 weeks at temperatures below 30°C. If there is no refrigerator, insulin should be stored in a cool, dark, and well-ventilated place away from direct sunlight. Unused vials should be placed in a clean plastic bag, secured properly, and stored in an open bottle or pot filled with water. An alternative option for these patients is a modified “zeer pot” that uses evaporative cooling with water or wet sand for insulin storage. Like all medications, insulin should be kept out of reach of children.

Maintaining insulin during travel

Insulin storage is a crucial issue for patients who frequently travel, as temperature changes can impact its effectiveness. When traveling, insulin should be kept in insulated bags or thermos flasks to prevent exposure to temperatures exceeding 30°C.^[17] It is best to keep insulin in carry-on luggage when traveling by plane to avoid exposure to extreme temperatures, especially freezing.

Improper dosing

In Bangladesh, the availability of both U-40 and U-100 insulin vials and syringes can increase the risk of dosing errors if patients are not informed and trained on how to use them properly when starting insulin therapy. Patients should be educated that U-100 vials require U-100 syringes, while U-40 vials require U-40 insulin syringes. However, in Bangladesh, patients commonly use U-40 vials and syringes. In Case 1, a patient experienced high blood sugar levels despite increasing the insulin dose, and it was later discovered that the patient was using a U-40 NPH vial with a U-100 syringe, resulting in 2.5 times lesser dose than the dose prescribed. Other common mistakes include failing to resuspend premixed or cloudy insulins before administering a dose. Improper mixing of split-dose regimens can also alter the chemical and pharmacological properties of insulin, leading to unwanted changes in blood sugar levels. To minimize these errors, patients must be properly informed and educated on the correct administration techniques and preparation methods for insulin therapy.

Errors in insulin injection technique

To properly inject insulin into subcutaneous fat, it is recommended to lift the skin and insert the needle at a 90° angle, especially in thin individuals where the distance from skin to muscle is expected to be short.^[18] Injections can also be done at a 45° angle. Advances in technology now allow for the use of shorter needles (4, 5, or 6 mm), reducing the risk of intramuscular injection and preventing intradermal delivery. However, poor technique can result in intradermal injections, which are not recommended due to discomfort and the potential for hyperpigmented patches and increased risk of insulin allergy. For optimal insulin absorption and to avoid lipodystrophy, rotating the injection site is crucial. Overuse in one location can lead to lipohypertrophy, which can cause irregular and delayed insulin absorption in some patients. The injection site should be divided into quadrants for the abdomen or halves for the thighs, buttocks, and arms, with each

used once a week and spaced 1–2 cm apart to avoid damage to the same spot.^[19] Before injecting, it is important to check for preexisting lipodystrophy, infection, or bruises and choose an alternative site if any are found.

Reducing insulin therapy errors requires the efforts of multiple stakeholders, including health-care providers, patients, pharmacists, pharmaceutical companies, policymakers, and health-care organizations. By collaborating and working together, multiple stakeholders can help reduce insulin therapy errors and improve patient outcomes. We discuss the potential roles of each stakeholder below.

The role of physicians

The case studies highlight the critical role of physicians in identifying and treating adverse clinical consequences of errors in insulin therapy. The prompt action of the clinical care physician in the first case saved the patient from life-threatening hypoglycemia. This underscores the importance of continuous monitoring of patients receiving insulin therapy and the need for health-care providers to be vigilant in identifying potential errors. Physicians can also play a crucial role in educating patients about insulin therapy, including the importance of accurate dosing and administration, and in thoroughly investigating potential errors in insulin therapy.

The role of nurses

Nurses play a critical role in reducing errors related to insulin therapy. Nurses can educate patients on proper insulin injection techniques, including selecting the appropriate injection site, using the right insulin vial with an appropriate syringe, rotating the site to avoid lipodystrophy, and using the correct angle and needle length. Nurses can work with other members of the health-care team, such as physicians and pharmacists, to develop and implement best practices for insulin therapy, including protocols for managing insulin doses and avoiding medication errors.

The role of pharmacies

The case studies highlight the role of local pharmacies in dispensing the correct insulin and syringes, and the need for clear communication between pharmacies and patients to prevent errors. Pharmacies must take extra care to ensure that the correct insulin and syringes are dispensed to patients, and that patients receive clear instructions and information about their medication. Pharmacies can also play a role in educating patients about insulin therapy, including the importance of accurate dosing and administration.

The role of regulatory bodies

Regulatory bodies play an important role in ensuring the safety and efficacy of insulin therapy and preventing errors in insulin administration. Regulatory bodies can set standards for insulin therapy, monitor the performance of health-care providers and pharmacies, and enforce penalties for noncompliance with

regulations. In addition, regulatory bodies can work with other stakeholders, including health-care providers and pharmacies, to develop and implement strategies to prevent errors in insulin therapy.

The role of policymakers

Policymakers have a critical role in shaping the health-care landscape and addressing global health problems, including those resulting from errors in insulin therapy. Policymakers can develop and implement policies and programs aimed at improving insulin therapy, including the promotion of patient education and awareness, development of safe and effective insulin therapy protocols, and monitoring and enforcement of regulations.

The role of patients

Patients have a key role in ensuring their own safety and health when receiving insulin therapy. Patients must be educated about insulin therapy, including the importance of accurate dosing and administration, and they must be vigilant in monitoring their own health and reporting any adverse consequences. Patients must also work with health-care providers and pharmacies to ensure the correct dispensation of insulin and syringes.

The role of the public

The public has a crucial role in raising awareness and understanding of the importance of insulin therapy and the consequences of errors in insulin administration. The public can support initiatives aimed at improving insulin therapy, including patient education and awareness campaigns, and they can advocate for policies and programs aimed at preventing errors in insulin therapy. In addition, the public can work with other stakeholders, including health-care providers, pharmacies, and policymakers, to promote the safe and effective use of insulin therapy.

Limitations

Despite the valuable insights gained from this study, several limitations should be acknowledged. Firstly, the sample size of the case studies was relatively small, which may limit the generalizability of the findings to a broader population. The cases selected were based on specific inclusion criteria and focused on diabetic patients who had experienced adverse clinical consequences due to errors in insulin therapy. Therefore, caution should be exercised when extrapolating the results to different patient populations or health-care settings. Furthermore, although efforts were made to ensure a rigorous thematic analysis process, there is a possibility of potential biases in the interpretation and identification of themes. The subjective nature of qualitative analysis and the reliance on researchers' judgments may introduce inherent biases. It is important to acknowledge the potential influence of researcher subjectivity on the identified themes. These limitations highlight the need for future research with larger sample sizes and diverse populations to validate and expand upon the findings of this study.

Conclusion

The study aimed to highlight the errors in insulin therapy and their adverse clinical consequences. Through our thematic analysis of case studies, we identified several contributing factors to these errors, including incorrect insulin administration techniques, improper dosing and storage, and dispensation errors. It is crucial to note that these errors are not only the patients' responsibility, but also the responsibility of various stakeholders, including physicians, paramedics, pharmacies, regulatory bodies, and policymakers. The health-care system must work collaboratively to minimize such errors and prevent their negative consequences on patients. We hope that this study will raise awareness among health-care professionals and the public about the importance of correct insulin therapy. Regular education and training programs for patients and health-care providers, as well as rigorous quality control measures by pharmacies could help reduce the frequency of these errors.

In addition, we recommend that further research be conducted to better understand the root causes of insulin therapy errors and the consequences of these errors, with the ultimate goal of improving diabetes care and patient outcomes. By doing so, we can work toward ensuring that patients receive safe, effective, and optimal insulin therapy, leading to improved health and quality of life.

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Conflicts of interest

There are no conflicts of interest.

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