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Post Operative Diabetic Control: A Tailored Approach to Medication, Nutrition and Recovery

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ABSTRACT

Diabetes mellitus increases surgical complications risk, necessitating effective management before and after surgery to minimize postoperative complications and enhance surgical recovery. This study aimed to investigate the impact of a tailored approach to medication, nutrition, and diabetic self-management education and support (DSMES) activity on postoperative outcomes in diabetic patients undergoing surgery at a tertiary care hospital, Malappuram, Kerala.

A prospective interventional trial with 138 diabetic patients from orthopaedic and general surgery involved data collection on post-operative adverse events, medication use, nutritional control, and DSMES activities, including patient counselling, patient education handouts, individualized diet charts, and routine follow-up.

The study found that a significant portion of diabetic patients (55.8%) required multiple medications to control their blood sugar. A total of 14.5% of patients experienced adverse events, including delayed extubation (25%), delayed wound healing (40%), wound site infections (30%) and other site infections (5%). Strict adherence to a tailored diet plan was associated with shorter hospital stays ($p = 0.035$, chi square=10.325), less severity of adverse events ($p=0.000$, chi square=30.21), lower grade according to Calvien-Dindo classification with ($p=0.000$, chi square=30.21) and improved surgical recovery ($p = 0.000$, chi square=49.865).

Diabetes surgery patients may benefit from tailored medicine, nutrition, and DSMES activities because they will receive tight glycemic control and specialized diabetes diet, both of which are essential for a quicker and better surgical recovery. Additional investigation is required to ascertain and evaluate the DSMES program's efficacy as well.

Keywords: *Diabetes, Postoperative, Nutrition, DSMES, Glycemic control, Surgical recovery.*

1. INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder characterized by high blood sugar levels due to issues with insulin secretion or action. Type 1 diabetes occurs when beta cells destroy, while type 2 diabetes affects 90-95% of cases. Managing blood sugar levels is crucial as prolonged hyperglycaemia can lead to complications like cardiovascular disease, kidney damage, vision problems, nerve damage, and foot-related conditions. Achieving glycemic control, along with managing other health factors, helps prevent long-term complications and reduces healthcare costs. High HbA1c levels have been linked to increased mortality in clinical type 2 diabetes patients.[1]

Surgical procedures can disrupt glucose regulation, leading to hyperglycemia and increased risks of complications like postoperative sepsis, endothelial dysfunction, cerebral ischemia, and impaired wound healing. Effective glucose management during major surgeries can reduce these risks and improve patient outcomes.[2]

Diabetic patients face higher postoperative complications like infection, stroke, and mortality. Studies show no clear association between diabetes or preoperative glucose levels and perioperative morbidity or mortality, but hypoglycemia during the postoperative period increases risks of adverse events.[3] Long-term glycemic control and hyperglycemia severity

significantly impact postoperative complications and mortality. Elevated blood glucose can impair neutrophil function, increase reactive oxygen species, and cause cellular damage, while insulin management can reduce hospital complications. [4]

Surgical stress, including trauma, blood loss, and anesthesia, can exacerbate hyperglycemia by increasing insulin resistance and disrupting glucose metabolism. This can lead to complications like diabetic ketoacidosis and hyperglycemic hyperosmolar syndrome. Optimized blood glucose management can mitigate these risks, with effective therapeutic regimens reducing metabolic disturbances and postoperative complications.[5]

Perioperative hyperglycemia is a significant risk factor for complications and increased mortality. Studies suggest that glucose variability is a crucial marker for glycemic control. Short-term fluctuations can induce more oxidative stress than persistent hyperglycemia. Elevated glucose variability is linked to longer hospital stays, higher complications, and increased mortality. Consistent and stable glycemic management during the perioperative period is essential. [6]

Tight glycemic control (TGC) is recommended as a standard approach in perioperative intensive care units (ICUs) to reduce mortality and morbidity in critically ill patients. However, studies on its benefits have produced mixed results. Perioperative hyperglycemia affects 20–40% of general surgery patients and up to 80% of cardiac surgery patients, contributing to delayed wound healing, surgical site infections, prolonged hospital stays, and complications. The optimal glucose target for postoperative management remains controversial. While some studies found no significant difference between TGC and conventional glycemic control (CGC), others, particularly in cardiac surgery patients, reported fewer postoperative complications with TGC. Given these conflicting findings, further research is needed to identify effective glycemic management strategies and improve outcomes in elective surgery patients. [7-9]

Diabetic patients experience more hospitalizations, longer stays, and higher medical costs than non-diabetic individuals. Consequently, perioperative glucose management focuses on several critical goals:

1. Reduction of morbidity and mortality
2. Avoidance of severe hyperglycemia or hypoglycemia
3. Maintenance of electrolyte and fluid balance
4. Prevention of ketoacidosis
5. Achievement of glycemic targets, such as blood glucose levels below 180 mg/dL for critically ill patients and below 140 mg/dL for stable patients. [10,11]

Surgical patients' blood glucose control, particularly preventing ketoacidosis, reduces mortality rates by 25.4%, especially for type 1 diabetes, and minimizes resource-intensive and costly treatment. [2]

Diabetes patients account for 15% of all surgical procedures, putting significant strain on healthcare systems. Despite heightened risks, perioperative management is often neglected, leading to adverse postoperative outcomes, health issues, and increased economic costs, including extended hospital stays. [12]

Diet is crucial for managing type 2 diabetes, impacting weight and metabolic control. Medical nutrition therapy offers a structured approach, but challenges remain like lack of nutrition training and time-consuming counseling. In developed countries, guidelines focus on macronutrient quality, avoiding processed foods, and promoting healthy dietary patterns, avoiding processed foods. [13]

2. MATERIAL AND METHODS

Study Design was a prospective interventional study conducted over a six-month period in the Orthopedics and General Surgery departments of a tertiary care teaching hospital, Malappuram, Kerala. The study included 138 diabetic patients undergoing surgery, randomly selected from those meeting the inclusion criteria. Patients undergoing surgery in the orthopedic and general surgery departments, with pre-operative or newly diagnosed diabetes mellitus has been included in to the study. Whereas, Non-communicative patients (ventilators, ICU), patients refusing research participation has been excluded from study.

Materials used upon the study were Patient data collection forms, Patient information leaflets (PIL), Blood glucose monitoring devices, Medication supplies and DSMES team resources. The study was approved by the Institutional Ethics Committee as per letter no KAS:ADM:IEC:0109AI:23 on November 27 2023 and informed consent was obtained from all participants.

Baseline data were collected on patient demographics, medical history, diabetes management, and preoperative blood glucose levels. As a part of DSMES team work appropriate patient counselling is provided, covering postoperative care, dietary adjustments, and the fundamentals of diabetes. The same is explained in a patient information leaflet (PIL), which is provided in their mother tongue. Afterwards, any postoperative adverse events and their management are recorded by the pus culture report. The patient's case record is used to assess postoperative diabetic medication. Frequent GRBS tracking is recorded,

and a weekly mobile follow-up is conducted to assess how the DSMES team's efforts have affected the post operative glycaemic control and surgical recovery.

A sample size of 138 was calculated using the Cochran formula with a 95% confidence level and a margin of error of ±7%. The estimated prevalence of diabetes in Kerala was 23.6% as of June 2023.

$$N = \frac{Z^2 P (1-P)}{E^2}$$

A sample size of 138 is used in our study with the following values:

E value 0.07 P value 22.8757 Z value 0.95

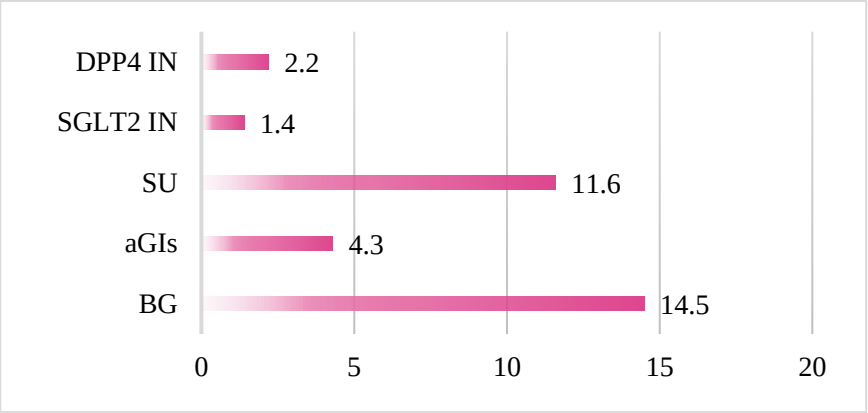
The collected data were compiled using Microsoft excel and were presented in figures. The data were analyzed using Statistical Package for Social Sciences (SPSS)software. The result was expressed as percentage or proportion either as a pictorial representation in the form of bar diagram and pie chart. Chi-square analysis and paired t-tests were employed to evaluate the association between the intervention and postoperative outcomes.

3. RESULT & DISCUSSION

A total of 138 patients were enrolled in the study. 57.2% subjects from orthopaedic department and rest from General surgery. 53.6% of females were included in the study and most of them were of the age between 40-60 years old. About 46.4% of the total population were males around the age of 50 years old. Type 2 diabetes is more prevalent than type 1, and the risk increases with age, particularly after 45. As the body becomes resistant to insulin, making it difficult to effectively use it. The highest percentage of patients fell within the 45-55 and 66-75 age groups. The results align with the study conducted by Yan, Zihui et al. [14] Some among were having only T2DM and 74.6% of them were having it along with other health conditions.

The study reveals that 66.7% of diabetic patients manage their diabetes without insulin, suggesting successful management through lifestyle changes or oral medications. However, almost 30% rely on insulin therapy, and a small minority require multiple units, potentially indicating more severe cases. Post operative diabetic pharmacotherapy were analysed and thus found that Metformin is the most common single drug OHA, prescribed for 14.5% of patients. Other single OHA include sulfonylureas (SU), alpha-glucosidase inhibitors (aGIs), SGLT2 inhibitors (SGLT2 IN), and DPP-4 inhibitors (DPP4 IN) the result similar with study conducted by Lin, Chao-Shun, et al. [3]

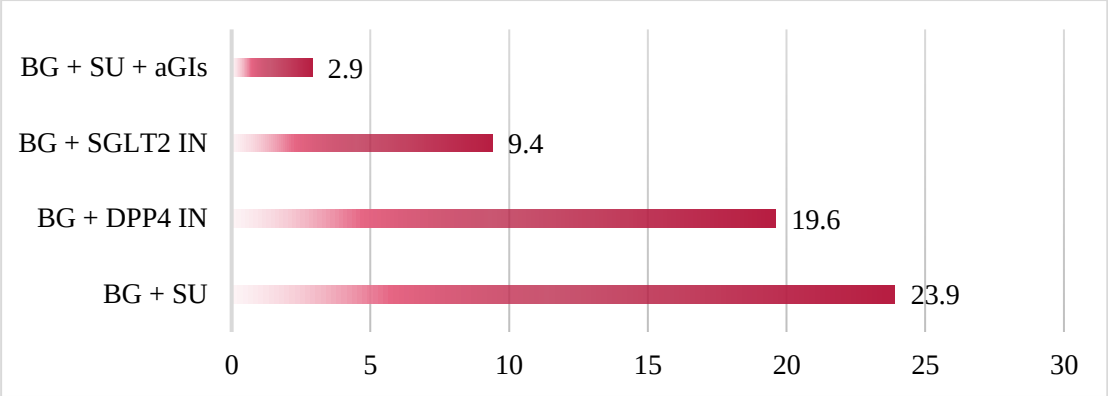
Fig.1: Distribution of patients taking single OHA class of drug.



Metformin is usually preferred as the best choice due to its advantage over other hypoglycaemia like, increased safety profile, decreased LDL cholesterol increased HDL cholesterol, reduce platelet aggregation, effective in individual with insulin resistant and does not cause weight gain. Sulfonyl urea is the second preferable class of OHA , it reduces microvascular risk

and promote increase systemic bioavailability of insulin. Alpha glucosidase inhibitor prescribed may be due to its enhanced effect in controlling post prandial blood sugar. GLP-1 agonist least preferred in this study population which may be attributed to its high cost. Many patients need multiple medications (combination therapy) to manage their blood sugar effectively. The most common pairing is metformin with a sulfonylurea medication (BG + SU), used by nearly a quarter of patients (23.9%) in this study

Fig.2: Distribution of patients taking combination OHA



This likely reflects type 2 diabetes being a progressive disease. As beta cells that produce insulin weaken over time, stronger treatment plans combining multiple medications become necessary to maintain good blood sugar control.

Most patients rely on either soluble insulin (50%) or biphasic isophane insulin (26.1%) for managing blood sugar spikes and providing sustained control. Other insulin types, such as glargine (5.8%) and aspart (2.1%), are less frequent and may be reserved for specific patient needs

Table.1 : Distribution of patients taking INSULIN

Type of insulin	Class of Insulin	Frequency (n)	Percentage (%)
Biphasic isophane Insulin	IA + SA	36	26.1
Soluble Insulin	SA	69	50
Glargine Insulin	LA	8	5.8
Aspart Insulin	RA	3	2.1

Almost half (47.8%) of the studied diabetics manage their blood sugar with just one type of medication (monotherapy) or insulin alone. The rest require a combination of medications (combination therapy) to effectively control their blood sugar. The study reveals 18.8% of drug-related problems (DRPs) due to drug interactions.

The study looked at surgery outcomes in diabetic patients, most (85.5%) had no complications, suggesting good blood sugar control can lead to successful surgeries with minimal issues. However, some patients (14.5%) did experience complications after surgery including Wound site infection (n=6), Delayed extubation (n=5), Delayed wound healing (n=8) and other site infection (n=1). Most of the patients didn't experience any complications (AEs) after surgery. But for those who did, the timing varied. Lin et al. [3] A small percentage (around 4.3%) had AEs within the first week, with some happening within the first day. There were also AEs reported much later, with about 6.5% occurring after 2 months.

17 out of 20 patients experienced adverse events after surgery treated with conservative treatment and others needs surgical treatment. Additionally, it's also shows that the majority of these patients (with adverse events) had GRBS levels exceeding 200mg/dL. Study suggest that conservative management is preferred for 75% of post-operative adverse events whenever possible. However, rest of the adverse events needed surgical intervention necessary for their complications, such as severe wound infections. Categorized adverse events (AEs) using the Clavien-Dindo classification, indicating that higher grades indicate more serious complications. Grade I AEs are the least severe, often requiring no intervention, while Grade II AEs require medical intervention, such as additional medications or hospitalization. Grade III AEs require significant medical intervention, potentially including surgery or prolonged hospitalization.

Table.2: Classification and distribution of Post operative adverse events based on Calvien- Dindo classification

C – D Classification	AE	Frequency (n)	Percentage (%)
GRADE I	Delayed Extubation	5	3.6
GRADE II	Delayed Wound healing	8 + 2	7.2
	Wound site infection		
GRADE III	Wound site infection	4 + 1	3.6
	Other site infection		
Nil		118	85.5
Total		138	100.0

The study reveals the severity of adverse events (AEs) experienced by patients. Mild AEs (3.6%) were minimally concerning, while moderate AEs (7.2%) were more noticeable and required additional medication or hospital stay. Severe AEs (3,6%) were the most severe, requiring significant medical intervention, potentially including surgery or extended hospitalization. The study highlights the importance of following a recommended diabetic diet plan after surgery. Most patients (74%) adhered to the plan, while some did so occasionally. Only a small percentage (7%) disregarded the diet plan altogether.

An assossiation between a patient's adherence to dietary recommendations and their length of hospital stay were ruled out with a chi-square test results (chi-square = 10.325, p-value = 0.035). This suggests that following the recommended diet plan may be associated with shorter hospital stays.

Table.3: Follow up patterns of diet with length of hospital stay.

Diet follows ?	Length of stay			Total	Chi square	p value
	< 5 days	5- 10 days	>10 days			
Yes	61	30	11	102	10.325	0.035
No	5	5	0	10		
Intermediately	5	13	8	26		
Total	40	79	19	138		

The results suggests a strong link between following dietary recommendations and the likelihood of experiencing severe adverse events. Patients who adhered to their diets had a significantly lower frequency of severe adverse events compared to those who did not (chi-square = 30.211, p-value = 0.000) Shohat, N et al. [6]

Table.4 Follow up patterns of diet with Severity of adverse events.

Diet follows?	Severity				Total	Chi square	p value
	Mild	Moderate	Nil	Severe			
Yes	2	8	16	0	26	30.211	0.000
No	0	0	10	0	10		
Intermediately	3	2	92	5	102		
Total	5	10	118	5	138		

A chi-square test reveals a highly statistically significant association (chi-square = 30.21, p- value = 0.000) with patients who adhered to their diets had a significantly lower occurrence of Grade III (major) complications compared to those who did not.

Table.5: Follow up patterns of diet with Calvien-Dindo classification

Diet follows ?	C- D CLASSIFICATION				Total	Chi square	p value
	Grade I	Grade II	Grade III	Nil			
Yes	2	8	0	16	26		
No	0	0	0	10	10		
Intermediately	3	2	5	92	102		0.000
Total	5	10	5	118	138	30.21	

The results also suggest a strong correlation between blood sugar levels and the likelihood of experiencing complications after surgery. Notably, patients with blood sugar levels exceeding 200 mg/dL had a significantly higher frequency of adverse events compared to those in the normal range (chi-square = 44.138, p-value = 0.000)

Table:6: GRBS with occurrence of post operative adverse events.

GRBS (mg/dL)	AE (YES/NO)		Total	Chi square	p value
	NO	YES			
<140	22	0	22	44.138	0.000
141 – 200	78	3	81		
>200	18	17	35		
	118	20	138		

A chi-square test was conducted, revealing a highly statistically significant association between GRBS and Time of recovery (chi-square = 13.888, p-value = 0.001). Patients taking combination therapy were those majorly having an uncontrolled stage of diabetes mellitus and they subsequently experience longer time for surgical recovery as compared to patients taking monotherapy.

Table.7: Time of recovery with type of diabetic pharmacotherapy

Type of Therapy	Recovery			Chi square	p value
	After 2mo	Within 1mo	Within 2mo		
Combination Therapy	8	45	19	13.888	0.001
Mono Therapy	0	58	8		

A chi-square test revealed a significant association (chi-square = 49.865, p-value = 0.000) between those patients who followed the diet had a substantially higher proportion recovery within one month compared to those who did not.

Table.8: Follow-up pattern of Diet with time of recovery

Diet follows ?	Recovery			Total	Chi square	P value
	Within 1mo	Within 2mo	After 2mo			
Yes	88	14	0	102	49.865	0.000
No	5	5	0	10		
Intermediately	10	8	8	26		
	103	27	8	138		

All statistical procedures were performed using Statistical Package for Social Sciences (SPSS) 20.0.A p value of <0.05 is statistically significant, and p value <0.001 was obtained by Chi square t test implying highly statistically significant.

4. CONCLUSION

The study investigates the impact of Diabetes Self-management Education and Support (DSMES), an individualized diet plan, and medication on surgical outcomes for diabetic patients. 138 patients undergoing orthopaedic or general surgery participated in a prospective interventional trial. Data was collected on pre-operative and post-operative diabetes management, adverse events, medication administration, dietary regulation, and patient education and support activities provided under DSMES. The study found that maintaining glycaemic control during the perioperative period improves surgical outcomes. Patient. The study suggests that personalized medication, nutrition, and DSMES activities can lead to faster and better surgical recovery for diabetic surgery patients. Further research is needed to determine the long-term effects and improve treatment approaches, as well as assess the effectiveness of the DSMES initiative. Future research directions include investigating the long-term impact of this combined management approach, developing more individualized treatment approaches, and evaluating the specific contribution of DSMES to surgical success in diabetic patients.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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