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Glycaemic control in male patients with type 2 diabetes mellitus while on diabetes specific enteral tube feeding formulas: Retrospective study

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Abstract

Background: Hyperglycaemia is one of the complications associated with enteral tube feeding that, can have a significant impact on the patients' clinical results as it is associated with an increase in length of hospitalization, mortality and morbidity.

Objectives: This retrospective study recognizes the critical importance of managing blood sugar levels in diabetic patients who require enteral tube feeding. This study aims to understand if diabetes-specific formulas are effective in reducing hyperglycaemia.

Methods: A retrospective study looking at patients who had a diagnosis of diabetes mellitus and received enteral tube feeding (diabetes-specific formulas). The collected variables included patient demographics, anthropometry, and glycaemic control measure. 2 different types of diabetes-specific formulas, feeding rate and other glycaemic control measure were analyzed.

Results: We had a total of 28 male patients, with an average age of 54 years, all diagnosed with type 2 diabetes mellitus and received diabetes-specific enteral tube feeding. All participants were on sliding scale insulin therapy, and most were overweight. They received either of the two different diabetes-specific formulas. The glucose range after initiating enteral feed was (6.15mmo/L, SD= 1.7517-14.15 mmol/L, SD= 5.5235) from both formulas.

Discussion: The recommended and desired blood glucose goal range in adult hospitalized patients receiving nutrition support is 7.8–10 mmol/L, the target glycaemic range was exceeded, most patients on both types of diabetes-specific formula had hyperglycaemia.

Conclusion: In conclusion, this study demonstrates the occurrence of hyperglycaemia during Enteral Tube Feeding in patients with diabetes despite being enterally fed diabetes-specific formulas whilst on insulin therapy.

Keywords: Type 2 Diabetes Mellitus; Enteral Tube Feeding; Diabetes-Specific Enteral Tube Feeding Formula; Blood Glucose; Hyperglycaemia

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1. Introduction

The development of diabetes often leads to many complications which may require enteral nutritional support. The provision of enteral feeds comes with its complications including hyperglycaemia which if not managed can have profound consequences for the patients in terms of clinical outcomes [1]. Hyperglycaemia related to nutrition support is associated with an increase in mortality and morbidity. It is estimated that hyperglycaemia has been noted in 22–46% of hospitalized patients [2]. It is mostly common in those receiving enteral nutrition or parenteral nutrition with and without diabetes [3]. In a study titled Nutrition Support of Adult Patients with Hyperglycaemia, ASPEN recommended a desired blood glucose goal range in adult hospitalized patients receiving nutrition support to be a target blood glucose goal range of 140–180 mg/dL (7.8–10 mmol/L) [4].

Several studies have proven that the use of diabetes-specific enteral tube feeding formulas is superior to using standard enteral tube feeding formulas in glycaemic control [2, 3, 4]. Diabetes Specific Formulas are high in monounsaturated fatty acids and contain low glycaemic-index carbohydrates along with dietary fiber to prolong the time required for glucose digestion and absorption [5]. DSF use has been shown to lower mean blood glucose, HbA1C, postprandial blood glucose levels, glycaemic variability, insulin requirements, and insulin resistance [6]. Furthermore, decreases in mortality, lengths of stay, health care costs, and risk of acquired infection in the ICU have not been well established [6]. But diabetes-specific formulas currently on the market which are slightly different from each other have not been thoroughly assessed for effectiveness.

Since it is known that hyperglycaemia in hospitalized patients is common and represents an important indicator of poor clinical outcomes and mortality [7].

The major goal of clinical diabetes management is to achieve and maintain optimum glycaemic control, thereby preventing or delaying associated long-term or acute complications [7]. This research focuses on the management of glycaemic control using different diabetes-specific enteral tube feeding formulas in a population of male patients diagnosed with Type 2 Diabetes Mellitus who received enteral tube feeding.

The objectives of this study are to assess the effectiveness of different diabetes-specific enteral tube feeding formulas in regulating blood glucose levels in male patients with Type 2 Diabetes Mellitus and to determine which of these formulas resulted in better glycaemic control of this patient population.

2. Methods and Materials

This was a retrospective study looking at patients who had a diagnosis of diabetes mellitus and received enteral tube feeding (nasogastric) during their hospital stay from January to December of 2023. Clinical coding was used to provide a list of patients. Data was collected from the online Hospital Database (Cerner) with the help of the clinical coding department. The study population for this retrospective study was obtained from the clinical notes database list of male patients who had been diagnosed with Type 2 Diabetes Mellitus (T2DM) and who received enteral tube feeding (ETF) in 2023 while admitted at Hazm Mebaireek General Hospital, currently a male-only facility. The collected variables included patient demographics, anthropometry, and glycaemic control measures. Data was collected over a period of one year.

3. Results

Table 1 Frequency distribution formulas and feeding method

	Frequency	**Percent**
Enteral Feed Adult Diabetic Formula		
Formula A	19	67.9
Formula B	9	32.1
Method Bolus/Continuous		
Continuous	28	100

We had a total of 28 male patients mean (range) age: 54 (18-55) years, all were diagnosed with type 2 diabetes mellitus and received diabetes-specific enteral tube feeding as part of their medical care during admission. All Diabetic patients on enteral feeds were on insulin therapy (sliding scale). The average BMI was 25.5 kg/m2 which classifies most patients as being overweight.

Table 1 above shows the frequency distribution for enteral feed and shows that all feeds were administered continuously. As shown in Table 1, most participants were on Formula A while 32.1% received Formula B, which further indicates that all participants in Formula A and B were on continuous feeding.

They received either of the 2 different diabetes-specific formulas, at the HMGH facility, Formula A (Glucerna 1.0) or Formula B (Nutrison Advanced Diason 1.0) as shown in Table 2 below. Patients were initiated at a low rate, and the enteral feed gradually increased to the maximum rate as calculated by the Dietitians. The duration of feed ranged from twenty hours to 24 hours over a 24-hour period. Both formulas are known to be used as Diabetes Specific Formulas with some differences, Formula A can be best described as a fiber- and fat-containing formula with reduced carbohydrates designed to help minimize blood glucose response in patients with hyperglycaemia. It provides 34.3% of total calories as carbohydrates, which is very different from Formula Bs 45% of calories as carbohydrates. Formula B on the other hand provides 38% of total calories from Fats, which is significantly lower than Formula As 49.1% of total Energy from Fats.

Table 2 Diabetes Specific Formulas

Diabetic Specific Formulas		**Formula A (Glucerna 1.0)**	**Formula B (Nutrison Advanced Diason 1.0)**	***Percentage Difference***
Nutrients	Unit	per 100ml	per 100ml	%
Energy	kcal	100	103	2.95%
Protein	g	4.18	4.3	2.83%
Carbohydrate	g	8.14	11.3	32.51%
Sugars	g	2.1	2.3	9.09%
Fat	g	5.4	4.2	25%
Fibre	g	1.44	1.5	4.08%

ASPEN recommended a blood glucose goal range of 140–180 mg/dL (7.8–10 mmol/L) [4]. The target glycaemic range was achieved in some cases but most patients on either enteral tube feeding formula had hyperglycaemia, necessitating titration of the insulin dose (sliding scale). The average minimum glucose score after initiating enteral feed was (M= 6.15, SD= 1.7517) and the mean maximum glucose after initiating enteral feed was (M= 14.15, SD= 5.5235). Lastly the mean HbA1C% score was found to be (M= 7.457, 1.8161) all measured after admission.

Table 3 below shows the descriptive summary for various variables used in this research. According to the results the average BMI score is (M= 25.598, SD= 5.1698), 95% CI (23.593, 27.602) and the mean glucose as (M= 9.596, SD= 5.6583).

Table 3 Descriptive summary

		BMI	**Glucose/ Glu Random (mmol/l)**	**Minimum Glu POC after initiating enteral feed (mmol/l)**	**Maximum Glu POC after initiating enteral feed (mmol/l)**	**HbA1C%**
N	Valid	28	28	28	28	28
	Missing	0	0	0	0	0
Mean		25.598	9.596	6.15	14.15	7.457
95% CI	Lower	23.593	7.402	5.471	12.008	6.753

	Upper	27.602	11.79	6.829	16.292	8.161
Median		25.15	7.95	5.95	12.1	7.05
SD		5.1698	5.6583	1.7517	5.5235	1.8161
Percentiles	25	21.225	6.525	5.25	10.4	6.125
	50	25.15	7.95	5.95	12.1	7.05
	75	29.645	9.325	6.625	16	7.775
IQR		8.42	2.8	1.375	5.6	1.65

Before conducting further analysis, a test for normality was carried out to assess the distribution of key variables in the study; Table 4 below shows the results of the tests. Normality was assessed using the Shapiro-Wilk tests at a .05 level of significance. From the table BMI score for the participants was found to be normally distributed $W = 0.975$, $p = 0.719$; the lowest glucose after initiating enteral feed was also found to be normally distributed $W = 0.931$, $p = 0.064$. The highest glucose after initiating enteral feed, random glucose, and HbA1C% scores were found not to be normally distributed with $p > .05$.

Table 4 Test for normality

	Kolmogorov-Smirnova			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
BMI	0.114	28	0.2	0.975	28	0.719
Glucose/ Glu Random (mmol/l)	0.3	28	0	0.725	28	0.001
Lowest Glu POC after initiating enteral feed (mmol/l)	0.193	28	0.009	0.931	28	0.064
Highest Glu POC after initiating enteral feed (mmol/l)	0.211	28	0.003	0.819	28	0.001
HbA1C%	0.227	28	0.001	0.861	28	0.002

3.1. Comparison of Maximum and Minimum Glucose after initiating Formula A & B

A Wilcoxon signed rank test was carried out to examine the highest and lowest glucose scores after initiating enteral feed for participants with formulas A and B. The results of the test are presented in Table 5 below. From the table, the mean lowest glucose POC for participants is ($M= 6.15$, $SD= 1.5717$) and the median is 5.95; for the highest glucose POC is ($M= 14.15$, $SD= 5.235$) and a median of 12.1. The Wilcoxon rank test yielded a significant result $Z = -4.623$, $p < .001$. The results indicate there is a significant difference in the median glucose POC at the lowest and highest points.

Table 5 Wilcoxon ranked test for formula A and B

	Descriptive Statistics				**Wilcoxon Signed Ranks Test**	
	N	**Mean**	**SD**	**Median**	**Z**	**p-value**
Lowest Glu POC after initiating enteral feed (mmol/l)	28	6.15	1.7517	5.95	-4.623	< .001
Highest Glu POC after initiating enteral feed (mmol/l)	28	14.15	5.5235	12.1		

Figure 1 below is a bar chart showing the mean minimum and maximum glucose POC after initiating enteral feeds A and B. The figure depicts that maximum glucose POC after initiating Formula A is slightly higher compared to that of Formula B, whilst the lowest glucose at the point of care after initiating both formulas seems almost the same, no episodes of hypoglycaemia were recorded during the study period.

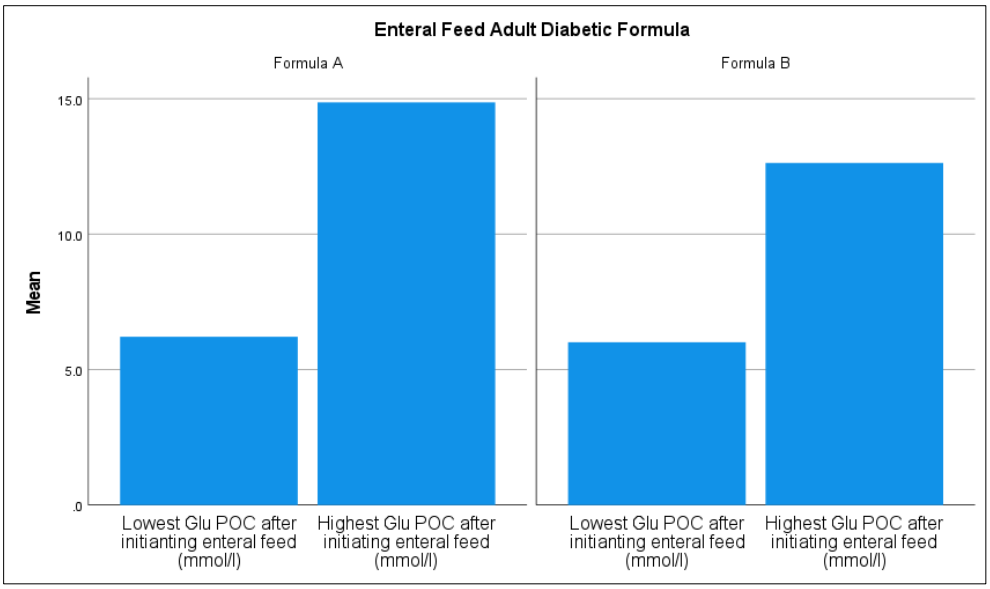

Figure 1 Mean lowest and highest glucose POC formula A and B

4. Discussion

This study assessed glycaemic control during ETF in patients with type 2 diabetes whilst on 2 different diabetes-specific formulas. From our data, we revealed the ability of the feeds to prevent hypoglycaemia in most cases, and slight hyperglycemia was noted from cases on either feed. There is a scarcity of published data on glycemic control during ETF, and previous similar studies also highlighted how difficult it was to achieve the glycaemic target range, with most patients on ETF having suboptimal glucose control [7].

Glycaemic control during ETF is faced with a multitude of challenges, namely intercurrent illnesses and treatments, feed interruptions, and feed changes [8]. There were no exceptions in this study. Nevertheless, the focus was rather more on the type of feed that the patients received, and how glycaemic control during ETF fared.

The classification of diabetes-specific enteral tube feeding formulas as being superior to using standard enteral tube feeding formulas in glycaemic control prompted our interest in identifying a superior diabetes-specific formula amongst the ones that are currently being used [1].

DSFs are high in monounsaturated fatty acids and contain low glycaemic-index carbohydrates along with dietary fiber to prolong the time required for glucose digestion and absorption [5]. The Formulas that we compared, and their effect of glycaemic control are Formula A (Glucerna 1.0) and Formula B (Nutrison Advanced Diason 1.0) both of which resulted in hyperglycaemia requiring insulin titration.

In general, DSF has less carbohydrate content, but more fat and fiber content compared to the standard formulas, and this produces slower gastric emptying, slower nutrient assimilation, and less glucose rise [9]. There are several studies that are still being performed to assess the optimal feed constituents and optimal insulin regimen to aid glycaemic control during ETF of diabetic patients, they all acknowledge that glycaemic control is difficult to achieve in patients with diabetes during ETF [7].

This study has its limitations, one is that it is a retrospective study with a small group of patients on only 2 different diabetes-specific formulas. Hence results may not be generalizable without larger studies. We also did not collect data concerning intercurrent illnesses, insulin dosages, the use of steroids, or other causes of uncontrolled hyperglycemia. Prospective studies are required to assess ETF-induced hyperglycaemia in patients who have diabetes.

Abbreviations

- T2DM: Type 2 Diabetes Mellitus
- ENTF: Enteral Tube Feeding
- DSETFF: Diabetes Specific Enteral Tube Feeding Formula

- ETFF: Enteral Tube Feeding Formulas
- BG: Blood Glucose
- IR: Insulin Requirements
- BMI: Body Mass Index
- HbA1c: Hemoglobin A1c

5. Conclusion

In conclusion, this study demonstrates the difficulty in achieving recommended optimal glycaemic control during ETF in patients with diabetes while on diabetes-specific formulas. The prevalence of hyperglycaemia necessitates more studies relating to diabetes-specific formulas or adjustments of the recommended and desired blood glucose goal range in adult hospitalized patients receiving nutrition support is 7.8–10 mmol/L who are diabetic, and probably the formulation of optimal feed constituents and optimal insulin regimens to aid glycemic control during ETF of diabetic patients.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interests.

Statement of ethical approval

The study design and operationalization adhered to the principles of respect, justice and confidentiality stipulated in the 2013 Declaration of Helsinki Good Clinical Practice. Also, in line with the laws and regulations of the Ministry of Public Health in Qatar, the study protocol was approved by HMC's Medical Research Center (MRC).

Statement of informed consent

The researchers will maintain anonymity of the participants by not including their personal details on the data collection tool.

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