Complications among diabetic patients in critical care units

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Abstract
Diabetes mellitus has increased in most countries in the world. Affecting more than 415 million adults in the world. The eleventh most important cause of premature mortality in Egypt is diabetes mellitus. Diabetic patient when admitted to ICU nurses face several challenges that need careful attention. **Aim:** To assess the complications of diabetic patients in critical care units. **Research design:** A Descriptive research design was used in the present study. **Patients:** A convenient sample of critically ill adult patients who were admitted to ICU units (who were150 patient). They were diagnosed as diabetes mellitus or hyperglycemia their ages ranged between (18-60) years from both sex. **Setting:** ICU units at El-Mabara Hospital & Assiut University hospital include general& trauma &critical intensive care unit. **Tools: Tool I**: patient assessment sheet. Used to assess the studied patients regard the socio-demographic data and medical related data as base line data **Tool II:** Diabetes Severity Score (DISSCO). used to assess acute & chronic complication for diabetic patients. **Results:** complications include (DKA) affected 34% of patients on admission, however (33.3%) at discharge& hyperosmolar hyperglycemic syndrome (HHS) affected 28% of patients on admission, however (26.7%) at discharge. **Conclusion:** There is significant correlation between the onset of diagnosis and these acute complications. **Recommendations:** The study Recommends that more research studies to minimize complications of D.M in ICU such as diabetic ketoacidosis, hyperosmolar hyperglycemic syndrome and hypoglycemia.

Keywords: Intensive care unit& Diabetes Severity Score.

Introduction
Diabetes mellitus has increased dramatically in most countries in the world. Affecting more than 415 million adults in the world**.** Recently, it is estimated that the number of DM patients will increase from 171 million to 366 million between the years 2000 and 2030 **(Pickup & Sutton, 2008)**

Egypt will have at least 8.6 million adults with diabetes and will be the tenth largest population of diabetics in the world. The eleventh most important cause of premature mortality in Egypt is diabetes mellitus. It's responsible for 2.4% of all years of life lost. Also, diabetes is the six most important cause of disability burden in Egypt. It is associated with impaired quality of life **(Anees A, et al. 2020).**

Over world the last 4-year period, there have been 1283 admissions in ICU out of which 179 (13.95%) were established cases of DM, while 64 (4.99%) were diagnosed as diabetes after admission. A total of 497 patients (38.73%) had hyperglycemia (BS > 140 mg/dL) at one time or the other during the ICU stay, including the diabetic patients **(Roncon, et al. 2020).** Admission of DM patients in intensive care units (ICU) can be due to various acute complications attributable to DM (diabetic ketoacidosis, hyperosmolar coma, and hypoglycemia), or some other underlying pathology and co-morbidity.

Invariably, the associated co-morbidities are the decisive factors responsible for such critical admissions and DM is a secondary contributor or sometimes an accidental finding **(Cowan, 2019)**

Diabetic patient when admitted to ICU face several challenges include the following severe ischemic heart disease cerebral venous thrombosis, Myocardial infarction, Deep venous thrombosis, Acute gastric dilatation, gastritis, hyperglycemia, Cerebrovascular accident and sepsis in addition to respiratory failure, aspiration and acute renal failure **(Pal, et al.2020)**

Diabetic patient when admitted to ICU nurses face several challenges that need careful attention. Here are some of the potential issues that we encountered in our ICUs and their suggested mitigating plans. So, sharing them at this early stage is important. Nurses know that diabetic patients are at higher risk for problems such as infections, disturbed sensory perception and nutritional imbalances. Nurses can identify these problems early and provide the needed care such as restore the balance of fluids, electrolytes and the acid-base balance Correct/reverse abnormal metabolic functions ,Help manage the underlying cause of diabetes and the disease process ,Prevent diabetic complications and Educate patients about diabetes and how it affects the body, self-care and necessary treatments **(El-Rahman et al., 2018)**

Diabetic patient when admitted to the intensive care unit (ICU), insulin requirement is at its highest, and blood glucose remains high if not properly managed. Patients and care providers should focus together on how to optimize lifestyle from the time of the initial comprehensive medical evaluation, throughout all subsequent evaluations and follow-up, and during the assessment of complications and management of comorbid conditions in order to enhance diabetes care **(Amin & Doupis, 2018)** The current study will concern on the primary students to assess the complications of dialectic patients in critical care units. We will give attention to the acute complications that occur to the diabetics in the ICU like hypoglycemia, and DKA.

Significance of the study

According to hospital registry about 1660 patients diagnosed with diabetes mellitus in 2021, out of those cases, 184 patients were having diabetic foot **as a serious complication (Hospital record – Assiut University, 2022)**.

Furthermore, uncontrolled blood glucose level considered a predispose and interacting with other risk factors, might modulate immune and inflammatory responses, thus predisposing patients to severe complications and possible lethal outcomes **(Leone et al, 2020).**

Patients at high risk of severe complications or death have several characteristics, including advanced age and male sex, and have underlying health issues, such as cardiovascular disease (CVD), obesity and/or type 1 diabetes mellitus (T1DM) or type 2 diabetes mellitus (T2DM). A few early studies have shown that diabetes mellitus complications among patients admitted to ICUs **(Aalaa et al, 2019).**

Clinical studies of patients with diabetes and/or uncontrolled hyperglycemia had a longer length of stay and markedly higher mortality than patients without diabetes or uncontrolled hyperglycemia **(Driver et al, 2020).**

So, the current study will concern on the primary students to assess the complications of dialectic patients in critical care units.

Aim of the study:
To assess the complications of diabetic patients in critical care units.

Research question:
What are the complications of diabetic patients in critical care units?

Patients and Method

Research design:
Descriptive research design was used in the present study.

Setting:
The present study was conducted in ICU units at El mobara Hospital and general intensive care unit, trauma intensive care unit, critical intensive care unit at Assiut University hospital.

Sample:
Convenient sample critically ill adult patients who were admitted to ICU units (who were 150 patients). They were diagnosed as diabetes mellitus or hyperglycemia their ages ranged between (18-60) years from both sex.

Study Tools:
Two tools were utilized to collect data in this study. They are developed by the researcher after passing through an extensive and relevant review of literature. The validity & reliability of these tools were revised by a panel of critical care nursing and medical experts.

Tool (I): patient assessment sheet:
This tool was developed by the researcher based on reviewing of the relevant literature and used to assess the studied patients regard the -demographic data and medical related data as base line data, it includes three parts:

Part 2: Medical data of the studied patients:
It includes the family, past and present history of diabetes mellitus, duration of diabetes diagnosis, use of anti-diabetic medications, date of admission, vital signs and LOS(Length of stay) .

Part 3: Laboratory assessment sheet which include: -
1- Random blood sugar.
2- Hg A1c at admission and discharge .
3- Arterial blood gases and electrolytes.

Tool (II) Diabetes Severity Score (DISSCO): adopted from Zghebi et al., (2020).
Diabetes Severity Score (DISSCO). used to assess acute & chronic complication for diabetic patients.

It includes two parts:
1. Diabetic related complications and renal disease Contains 13 questions with 24 points.
2. Cerebrovascular and cardiovascular disease 21 questions with 38 points.

It is a simple count of the total number of severity domains present for an individual, out of 34, by assigning hierarchical weighting to all domains in the overall score. The total score was 62 points.

Method:
This study where carried out through three phases:-

preparatory phase:
1. Official and non-official permission of carry out the study was taken from the responsible authorities general anesthesia and head in both ICU units at El mobara Hospital and General ICU at Assiut University hospital.

To participate in the study after exploration of the aims of the study.

2. Developing of the tool after reviewing the available literature concerning the topic of the study.

3. Content validity and reliability of the study tools was tested by jury of (5) experts in the field of the study (medicine and nursing).

4. The reliability of the devolved tools were done by using Cronbach's coefficient alpha test which were 0.85 for tool (**I**) was accepted.

5. A pilot study was conducted on 10% of total participants to verify reliability of the tool and then necessary modifications was done before actual data collection.

Ethical considerations:

1. Research proposal was approved from ethical committee in the faculty of nursing.

2. There is no risk for study subject during application of the research.

3. The study was follow common ethical principle in clinical research.

4. Written consent was obtained from patients or parents that were willing to participate in the study, after explaining the nature and the purpose of the study.

5. Patients will be assured that the data of this research was used only for the purpose of research.

6. Confidentiality and anonymity was assured.

7. Patients have the right to refuse to participate and withdraw from the study without any rational any time.

Phase (II): Data collection:

▪ Data were collected within 6 months starting from the beginning of June 2022 and the end of November 2022 The data collected from each patient was evaluated three times (at admission, during 5 day, at discharge) by using study tools.

▪ All newly admitted patients to the previously mentioned units was enrolled in this study.

▪ The researcher was assessed and observed patients who admitted to ICU and document as base line data on admission using Tool I (Part 1 and 2).

▪ The research was conducted on diabetic patients and diagnosed with diabetes mellitus.

▪ Each studied patients was assessed for presence of complications using tool (II).

Implementatlon phase:

▪ Assessed the diabetic patient according to the designed assessment sheet from first day of admission as base line data until the fifth day of the study by using three tools.

▪ The patient socio-demographic and clinical data including (age, sex, marital status, past history and risk factors) was obtained on admission.

▪ Hemodynamic state (Temperature, pulse, blood pressure and respiration) was assessed manually on admission, after five days and at discharge by the researcher.

▪ Continuous monitoring blood glucose daily for five days in morning, afternoon and night shift.

▪ Continuous monitoring arterial blood gases on first, third and fifth day.

▪ Assessed patient nutrition status by calculated total calories intake every 24 hour.

▪ Assessed complications of diabetic patient at admission and discharge by scale Diabetes Severity Score (DISSCO): adopted from **Zghebi et al., (2020)** It includes two parts; Diabetic related complications and renal disease Contains 13 questions with 24 points. Cerebrovascular and cardiovascular disease 21 questions with 38 points. It is a simple count of the total number of severity domains present for an individual, out of 34, by assigning hierarchical weighting to all domains in the overall score. The total score was 62 points.

Evaluation phase:-

Patients were evaluated daily for five days to determine complication occupy diabetic patient in intensive care unit.

Statistical analysis

The data were tested for normality using the Anderson-Darling test and for homogeneity variances prior to further statistical analysis. Categorical variables were described by **number and percent** (N, %), where continuous variables described by mean and standard deviation **(Mean, SD)**. compare between continuous variables by **t-test and ANOVA**. **Spearman Correlation** Used to Appear the Association between Length of hospital stay of the patient group with Complication .**A two-tailed p < 0.05** was considered statistically significant. All analyses were performed with the **IBM SPSS 20.0** software.

Results
Table (1): Sociodemographic data of studied group:

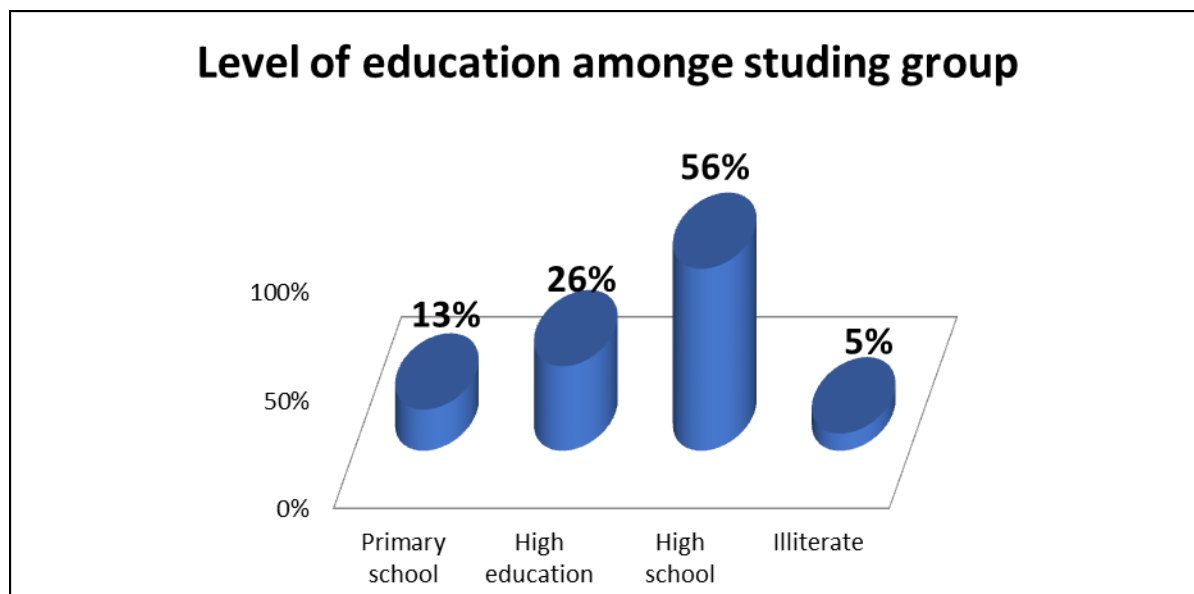| Age		
18 - < 30 years	25	17%
30 - < 40 years	35	23%
40 - < 50 years	25	17%
50 -60 years	65	43%
Mean ± SD	45.31 ± 3.77	
Sex		
Male	80	53%
Female	70	47%
Occupational status		
Not working	30	20%
Retired	25	17%
Employer	65	43%
House wife	20	13%
Student	10	7%
Residence		
Urban	79	53%
Rural	71	47%
Onset of diagnosis		
<1 years	64	42.7%
More than one year	86	57.3%
Length of stay	20.31 ± 2.77	

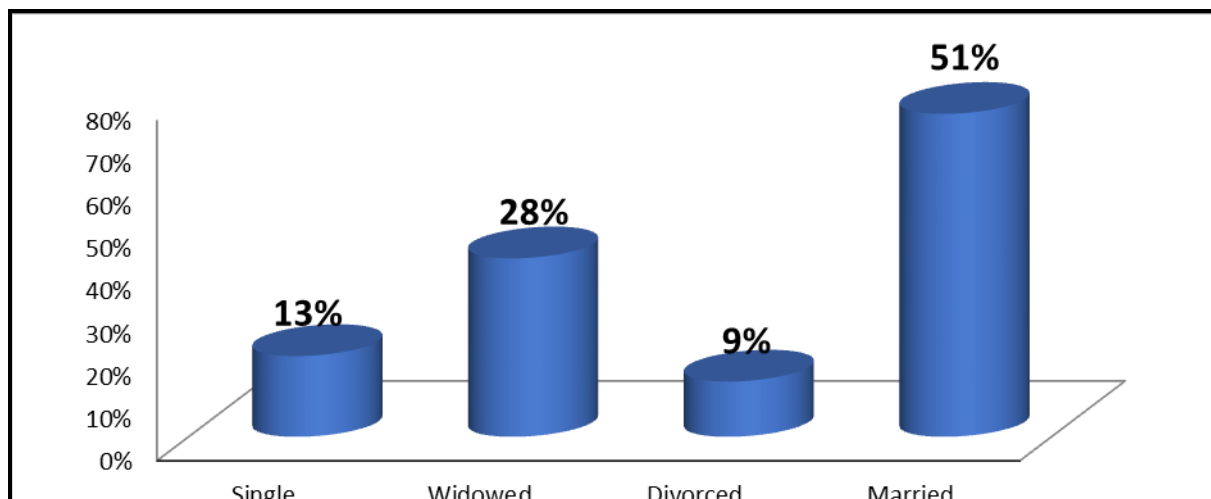**Figure (1): Level of education among studied group**

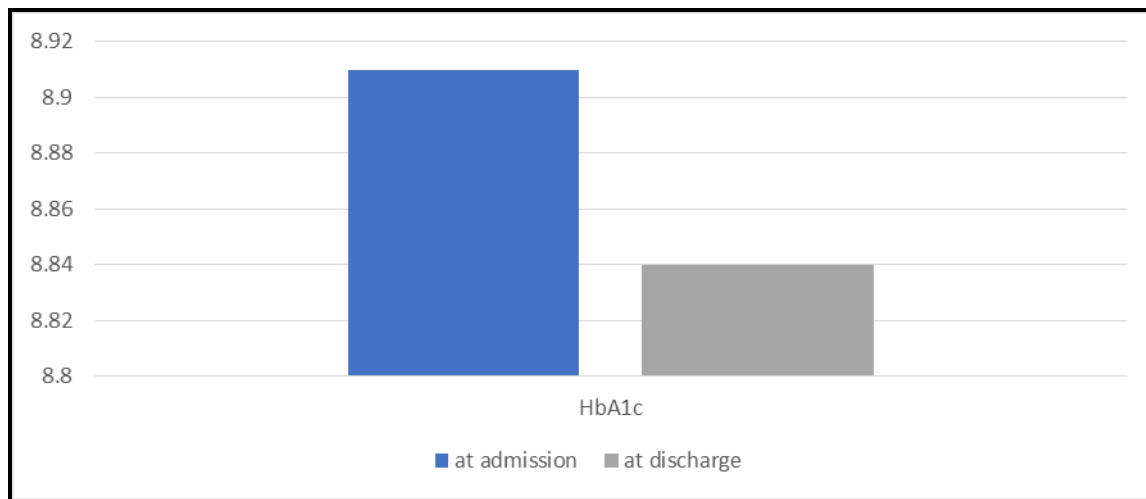**Figure (2): Marital status among studied group**

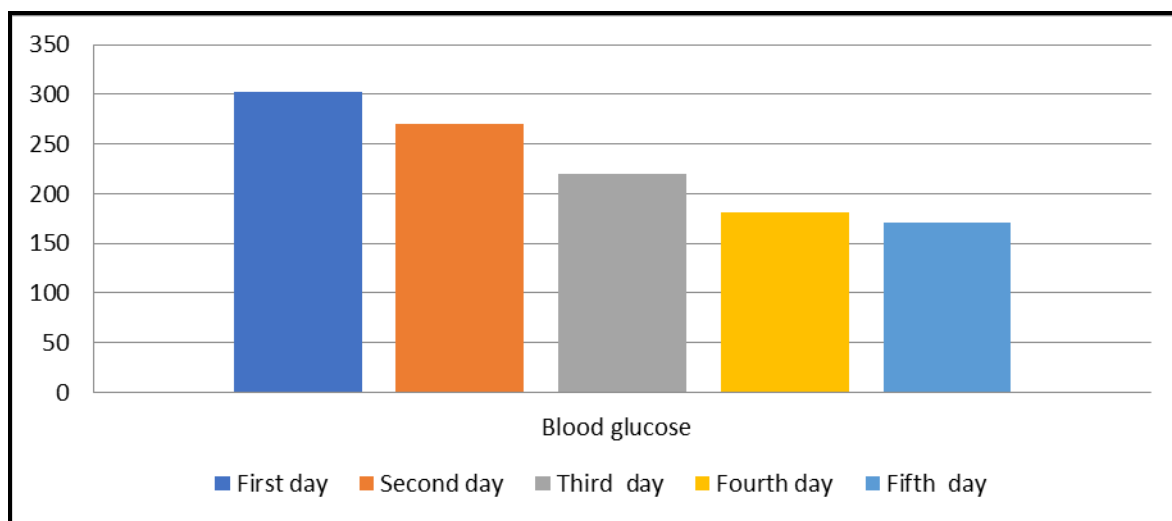**Figure (3): HbA1c results among studied group.**

Figure (4): Blood glucose results among studied group.

Table (2): Blood gases and electrolytes among studied group.

PH	First day	7.36 ± 0.08
	Third day	7.26 ± 0.06
	Fifth day	7.16 ± 0.05
P value		**0.03**
PCO2	First day	30.21 ± 2.12
	Third day	28.26 ± 1.61
	Fifth day	27.14 ± 0.83
P value		**0.001**
HCO3	First day	15.25 ± 1.09
	Third day	12.25 ± 0.94
	Fifth day	11.07 ± 0.8
P value		**0.001**
K+	First day	4.13 ± 0.36
	Third day	4.25 ± 0.35
	Fifth day	4.4 ± 0.51
P value		0.85
Na+	First day	136.39 ± 8.56
	Third day	139.28 ± 10.81
	Fifth day	140.47 ± 11.94
P value		**0.01**
Ionized calcium (mmol/l)	First day	1.17 ± 0.13
	Third day	1.18 ± 0.11
	Fifth day	1.2 ± 0.11
P value		0.46

Table (3): Diabetic related complications and renal disease score among studied group.

Diabetic related complications and renal disease				
	At admission		**At discharge**	
	No.	**%**	**No.**	**%**
Diabetic neuropathy	133	88.7%	133	88.7%
Foot ulcer and Charcot foot	56	37.3%	56	37.3%
Gangrene	32	21.3%	32	21.3%
Amputation	24	16%	24	16%
Diabetic retinopathy	59	39.3%	59	39.3%
Laser Therapy(including laser photocoagulation)	19	12.7%	19	12.7%
Low vision, blindness	57	38%	57	38%
Diabetic nephropathy	96	64%	96	64%
Albuminuria	48	32%	48	32%
ESRD(End Stage Renal Disease)	50	34%	50	34%
Hypoglycemia	22	15%	19	12.7%
DKA (Diabetic ketoacidosis)	51	34%	50	33.3%
HHS (hyperosmolar hyperglycemic syndrome)	42	28%	40	26.7%
Total degree	7.49 ± 8.34		7.19 ± 8.24	

Figure (5): Percentage distribution of diabetic crisis at admission and discharge among studied group

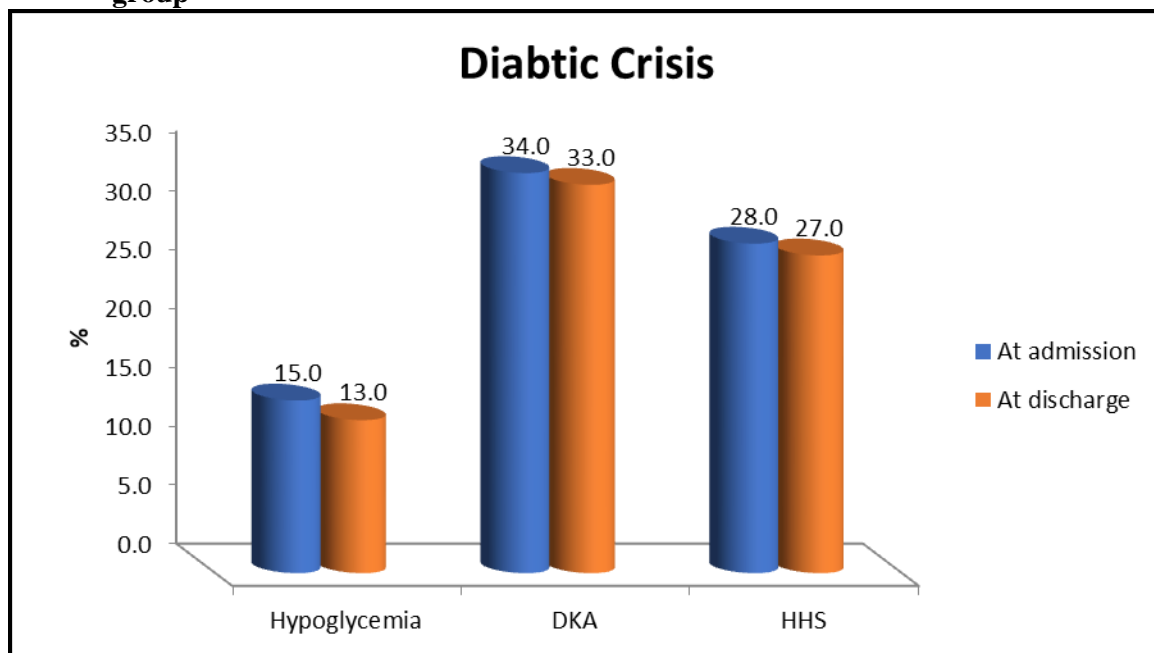**Figure (5): Diabetic crisis**

Table (4): Cerebrovascular and cardiovascular disease score among studied group

|	At Admission	
	No	**%**
Hypertension admission	117	78.0
Hyperlipidemia	35	23.3
Stable angina	55	36.7
MI (Myocardial Infarction)	18	12.0
Heart valve disease	33	22.0
Heart valve intervention	34	22.7
Endocarditis	34	22.7
Coronary artery interventions	29	19.3
Cardiac arrest	54	36.0
AF(Atrial Fibrillation)	40	26.7
Pacemaker	13	8.7
HF(Heart Failure)	24	16.0
ICD(Implantable Cardioverter Defibrillation)	26	17.3
PVD(Peripheral Vascular Disease)	74	49.3
Cardiomyopathy	75	50.0
Pericardial disease	49	32.7
Myocarditis	25	16.7
CHD(Coronary Heart Disease)	19	12.7
TIA(Transit Ischemic Attack)	21	14.0
Carotid artery events	114	76.0
Stroke	31	20.7
Total Degree	**10.32±11.94**	
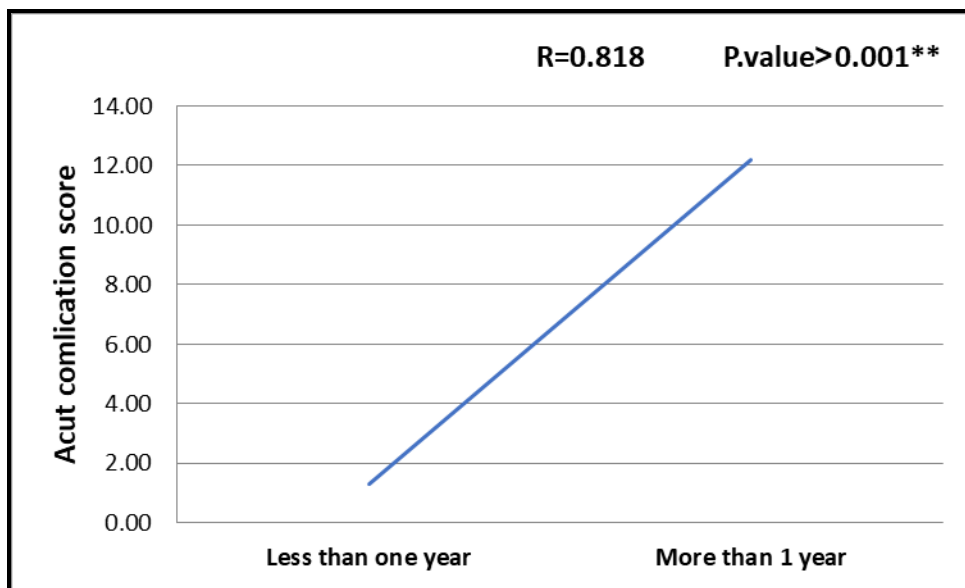
Figure (6): Correlation between Onset diagnosis of diabetes mellitus (less than one year & more than one year) with acute complication

Table (5): Correlation between Length of hospital stay of the patient group with Complication

Pearson Correlation		
	Length of hospital stay	
	R	**P**
Hypertension	0.67	**0.001**
Hyperlipidemia	**0.199**	**0.049**
Stable angina	0.122	**0.006**
MI(Myocardial Infarction)	0.28	**0.094**
Cardiomyopathy	0.680	**0.001**
Pericardial disease	**0.19**	**0.049**
myocarditis	0.12	**0.006**
CHD(Coronary Heart Disease)	0.2805	**0.094**

A total of 150 cases diagnosed with diabetes were described in the current study. Relevant socio-demographic data of studied cases are summarized in distribution of studied group according to their characteristics.

Table (1): The mean age was 45.31 ± 3.77 with majority of cases aged between 50 -60 years, More than half of participant (53%) were male., A percent of 42.7% of patients had an onset of diagnosis less than one year, and 57.3% of patients had been diagnosed since more than one year ago. The average Length of stay was 20.31 ± 2.77.

Figure (1): Shows level of education the highest percentage was for high school (56%), the lowest percentage was for Illiterate (5%).

Figure (2): Shows Marital status, the highest percentage was for Married (51%), the lowest percentage was for divorced (5%).

Figure (3): Shows HbA1c. decreased at discharge in comparison to admission.

Figure (4): Shows that there were high significant difference between First day, Second day, Third day, Fourth day and Fifth day as regard Blood glucose.

Table (2): Shows that PH at First day of admission was 7.36 ± 0.08, Third day was 7.26 ± 0.06, Fifth day was 7.16 ± 0.05. There was statistically significant decrease in PH tending forward to acidosis. There was statistically significant decrease in PCO2 that refers into acidotic change. HCO3 at First day was 15.25 ± 1.09, Third day was 12.25 ± 0.94, Fifth day was 11.07 ± 0.8. There was statistically significant decrease in PH tending forward to acidosis.

There was significant increase in Na+ values at first day, Second day and Fifth day as regard Na+. Ionized calcium (mmol/l) at First day was 1.17 ± 0.13, Third day was 1.18 ± 0.11, At Fifth day was 1.2 ± 0.11, however, this change is not statistically significant. K+ was at First day 4.13± 0.36, and was

at third day 4.25± 0.35, Fifth day 4.4 ± 0.51; however, this change is not statistically significant.

Table (3): Shows that as regard Diabetic related complications and renal disease score among studied group. The most common complication was diabetic neuropathy which represented 88.7% of patients. Hypoglycemia, as an acute complication, affected 15% of patients on admission, however at discharge 12.7% only of patients suffered from hypoglycemia.

Figure (5): Shows Diabetic Ketoacidosis (DKA) affected 34% of patients on admission, however at discharge 33.3% only of patients suffered from DKA. Hyperosmolar hyperglycemic syndrome (HHS) affected 28% of patients on admission, however at discharge 26.7% only of patients suffered from HHS. There was a highly significant in Percentage distribution of diabetic crisis at admission and discharge among studied group.

Table (4): Shows that as regard Cerebrovascular and cardiovascular disease score among studied group. The most common complication was hypertension which represented 78% patients.

Figure (6): Shows that there was a highly significant correlation between onset of diagnosis of diabetes mellitus (less than one year& more than one year   and acute complication of diabetic patients.

Table (5): Shows that there was a statistically significant correlation between Length of hospital stay of the patient group with Complication. Patients with hypertension, hyperlipidemia, stable angina, cardiomyopathy, myocarditis, and pericardial disease had prolonged hospital stay. There was statistically significant correlation between these comorbidities and hospital stay. There was no statistically significant correlation between Coronary Heart Disease or Myocardial Infarction with length of hospital stay.

Discussion

Diabetes has many acute complications which are frequently present at the time of diagnosis, indicating a significant delay between the onset of diabetes and its identification. Long-term physical complications are common among those who survive critical illness.**(Abdulaziz Radhi, 2022)** Patients in the intensive care unit (ICU) who have hyperglycemia have a higher chance of developing renal failure, polyneuropathy, and death from their injuries.**(Alharbi et al., 2022).** In this study was aimed to assessment of the complications of diabetic patients in critical care units. We evaluated acute complications in newly diagnosed patients and longstanding diabetes mellitus.

Type II diabetes, as well as other forms of diabetes such as gestational diabetes mellitus, can develop into an acute condition known as **diabetic ketoacidosis** (DKA). Symptoms include **hyperglycemia** (blood glucose levels over 250 mg/dL), metabolic acidosis (pH 7.3 and serum bicarbonate 15 mEq/L), an elevated anion gap, and the presence of ketone bodies in the blood or urine.**(Lucero & Chapela, 2018) Lucero et al.**, analyzed three cases with DKA admitted to the ICU. Their Na+, K+, pH, HCO2 were comparable with our patients. They had reasons for this complication including pregnancy, the usage of sodium-glucose cotransporter 2 (SGLT-2) inhibitors, and dehydration.**(Lucero & Chapela, 2018) We agree with these results**, as in our study DKA affected more than one third of patients on admission, however at discharge only one third of our patients suffered from DKA. This increased ratio may be attributable to cardiac diseases comorbidities which affected our patients greatly. These results can show the effect of medical care including nursing care to the patients.

In a study of **Duca et al., (2019).** They investigated 1396 patients <20 years with newly diagnosed Type 1 Diabetes (T1D) with follow-up of 13 years after diagnosis. They found that DKA upon diagnosis was related not only with worse glycemic control (higher HbA1c levels) but also with a worsened glycemic trajectory beyond the first year of illness. These results persisted even after controlling for socioeconomic (household income and insurance status), treatment-related (glucose monitoring frequency and insulin regimen), and demographic (sex, race/ethnicity, and age at diagnosis) variables associated with DKA and long-term glycemic control. their findings add that diabetic ketoacidosis (DKA) at diagnosis of type 1 diabetes is more than simply an acute complication; it is also a risk factor for deteriorating glycemic control over the long term.**(Duca et al., 2019) These results confirm our data.** We found a statistically significant correlation between onset of diagnosis and acute complication of diabetic patients which included Diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic syndrome (HHS), and hypoglycemia. More than one half of our patients had been diagnosed since more than one year ago. There was a highly significant correlation between onset of diagnosis of diabetes mellitus and acute complication of diabetic patients. These results agree with **(Duca et al., 2019).**

Regarding **hypoglycemia**, researchers have observed that both high and low blood sugar levels are highly correlated with poor outcomes in the critically ill. Critically ill patients who were subjected to a network meta-analysis to compare the

risks of hypoglycemia and death from achieving various glycemic control objectives. They investigated 36 randomized studies and found that tight glycemic control did not affect mortality in critically ill patients one way or the other, but it did raise the risk of hypoglycemia and severe hypoglycemia by almost a factor of five compared to light or very mild glycemic control.**(Yamada, Shojima, Noma, Yamauchi, & Kadowaki, 2017)** According to this research, **there is acceptance with our results.** Hypoglycemia, as an acute complication, affected sixth of our patients on admission, however at discharge less than one sixth of patients suffered from hypoglycemia. These concerns are related to medical and nursing care provided to our patients.

Concerning hyperosmolar hyperglycemia, HHS affected more than one quarter of our patients on admission, however at discharge less percent of patients suffered from HHS. **These data agree with Lotter, Lahri, & van Hoving, 2021.** They reported less than one tenth of cases of all diabetic crises (n = 96 for DKA, 48.7%; n = 45 for simple hyperglycemia, 22.8%; n = 44 for severe hypoglycemia, 22.3%; n = 12 for hyperglycemic shock, 6%). Those presenting with DKA were much younger than the median age of 48. (36 years).**(Lotter, Lahri, & van Hoving, 2021)**

In the intensive care unit, the American Diabetes Association suggests aiming for a blood glucose level of 140–180 mg/dL. When blood sugar levels remain above 180 mg/dL for more than two days, an insulin infusion may be necessary to bring them down. **(Echouffo-Tcheugui & Garg, 2017)**

In this study have points of strength including powerful sample size with two comparable groups. We correlated between onset of diagnosis and acute complications. This is considered of novel data to the literature. We have detailed follow-up for patients regarding the complications. Our results are limited by the design and the sample characteristics. We need more studies to assure the results.

Conclusion
In this study there is high rate of acute complications that occur to diabetic patients which leads them to be admitted in the ICU. These complications include DKA, HHS, and hypoglycemia. There is significant correlation between the onset of diagnosis and these acute complications.

Recommendation
1. Elevated rates of acute complications indicate the need to diabetic care strategies to lessen the complications. As reported in this study.

2. Provide good clinical care including medical and nursing care provided to diabetic emergencies has a significant role in decreasing those complications.
3. The study recommend enhancing medical and nursing staff for the care of diabetics.

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