

Knowledge, Attitudes and Practice of Internal Medicine Registrars at Soba University Hospital Toward Management of Hyperglycemia in Hospitalized Patients 2021

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Abstract

Background: Hyperglycemia is defined as blood glucose levels above 140 mg/dL during a fast and above 180 mg/dL two hours after a meal. **Objective:** To assess the knowledge, attitude, and practice of internal medicine registrars at Soba University Hospital toward the management of hyperglycemia in hospitalized patients. **Methodology:** It was a cross-sectional, single-center hospital-based study conducted at the internal medicine department at Soba University Hospital during the period from October 2021 to December 2021. Data was collected using a questionnaire filled out by the study participants. The data entry was in an Excel sheet. The data were analyzed by Statistical Package for Social Sciences (SPSS) Version 26. **Results:** A total of 41 internal medicine registrars participated in this study; 23 (56.1%) were females and 18 (43.9%) were males. According to years of practicing medicine, 19 (46.3%) internal medicine registrars had 3–5 years of practice, 12 (29.3%) registrars had less than 3 years of practice, and 10 (24.4%) registrars had more than 5 years of practice. Regarding the level of training of the participants, 16 (39%) registrars were R1, 16 (39%) registrars were R2, 5 (12.2%) registrars were R3, and 4 (9.8%) registrars were R4. 23 (56.1%) internal medicine registrars had an average level of knowledge with a mean score of 6.25 ± 0.51 out of ten; 11 (26.8%) internal medicine registrars had a high level of knowledge with a mean score of 8.45 ± 0.82 out of ten; and 7 (17.1%) internal medicine registrars had a low level of knowledge with a mean score of 4.29 ± 0.76 out of ten. 32 (78%) internal medicine registrars had a positive attitude with a mean score of 8.70 ± 0.55 out of ten, and 9 (22%) internal medicine registrars had a negative attitude with a mean score of 4.11 ± 0.69 out of ten. 21 (51.2%) internal medicine registrars had an average level of practice with a mean score of 6.38 ± 0.49 out of ten; 12 (29.3%) internal medicine registrars had a high level of practice with a mean score of 8.33 ± 0.65 out of ten; and 8 (19.5%) internal medicine registrars had a low level of practice with a mean score of 3.88 ± 1.36 out of ten. **Conclusion:** There was a statistically significant association between the level of knowledge and the level of practice (P -value = 0.003). There was no association between the overall KAP and demographic data (P -value > 0.05).

Keywords: Diabetes; Hyperglycemia; Endocrinology; Soba University Hospital; Napata College; Registrar Assessment; Internal Medicine

Introduction

Diabetes mellitus (DM) is a group of metabolic disorders characterized by hyperglycemia. It is associated with abnormalities in carbohydrate, fat, and protein metabolism, which results in chronic complications, including microvascular, macrovascular, and neuropathic disorders [1].

Hyperglycemia is defined as blood glucose greater than 140 mg/dL. A patient has impaired glucose tolerance, or pre-diabetes, with a fasting plasma glucose of 100 mg/dL to 125 mg/dL [2,3].

For the last two decades, the incidence rates of diabetes have been rising intensively in many parts of the world. Globally, approximately 422 million adults are living with DM. In 2010, 12.1 million people were estimated to

be living with diabetes in Africa, and this is projected to increase to 23.9 million by 2030 [5,6]. Evidence from observational studies indicates that development of hyperglycemia in critically ill patients is associated with an increased risk of hospital complications, mortality, and a higher total hospitalization cost [7-9]. The importance of hyperglycemia also applies to noncritically ill patients admitted to general medicine and surgery services. In such patients, the presence of hyperglycemia is associated with prolonged hospital stay, infection, disability after hospital discharge, and death [10-12].

According to the most recent guidelines from the American Diabetes Association (ADA), Insulin therapy should be initiated for treatment of persistent hyperglycemia in hospitalized patients starting at a threshold ≥ 180 mg/dL (10.0 mmol/L). Once insulin therapy is started, a target glucose range of 140–180 mg/dL (7.8–10.0 mmol/L) is recommended for the majority of critically ill and noncritically ill patients. More stringent goals, such as 110–140 mg/dL (6.1–7.8 mmol/L), may be appropriate for selected patients if they can be achieved without significant hypoglycemia.

Basal insulin or a basal plus bolus correction insulin regimen is the preferred treatment for noncritically ill hospitalized patients with poor oral intake or those who are taking nothing by mouth. An insulin regimen with basal, prandial, and correction components is the preferred treatment for noncritically ill hospitalized patients with good nutritional intake. Use of only a sliding scale insulin regimen in the inpatient hospital setting is strongly discouraged [13]. In light of the above, the assessment of knowledge, attitude and practice of internal medicine registrars towards inpatient management of hyperglycemia is highly important in implementing an updated recommendation.

Problem Statement

Diabetes and stress hyperglycemia are common occurrences in hospital settings and are associated with increase in-hospital complication, length of stay and mortality.

Hyperglycemia on the other hand, is associated with poor in-patient outcome and health care cost.

Justification:

Adequate knowledge about the guidelines for in-patient hyperglycemia management and adherence to their guidelines could help in reducing the morbidity and mortality associated with both hyper and hypo-glycemia.

Research Objectives:

General Objective: To assess the knowledge, attitude and practice of internal medicine registrars at Soba University Hospital toward the management of hyperglycemia in hospitalized patients.

Specific Objectives: To identify the reason behind not using the Basal-Bolus regimen in hospitalized patients.

To improve the adherence of internal medicine registrars to the last guideline in management of hyperglycemia in hospital.

Literature Review:

Definition

The term "hyperglycemia" is derived from the Greek hyper (high) + glykys (sweet/sugar) + haima (blood). Hyperglycemia is defined as blood glucose levels above 125 mg/dL during a fast and above 180 mg/dL two

hours after a meal. A patient's fasting plasma glucose level of 100 mg/dL to 125 mg/dL indicates impaired glucose tolerance, often known as pre-diabetes. If a patient's fasting blood glucose is more than 125 mg/dL, they are classified as diabetics [14,15].

Untreated hyperglycemia can result in numerous severe, sometimes fatal consequences, such as harm to the kidneys, heart, kidneys, nerves, eyes, and peripheral vascular system. Therefore, it is essential to properly and efficiently treat hyperglycemia in order to avoid disease complications and enhance patient outcomes [14,15].

Epidemiology

Over the past 20 years, there has been a significant rise in the incidence of hyperglycemia as a result of rising obesity, declining levels of physical activity, and an aging population. There is no difference in prevalence across genders. China, India, the US, Brazil, and Russia were the nations with the highest percentage of diabetes sufferers. Low- to medium-income households are more likely to have hyperglycemia [16, 17].

According to the Centers for Disease Control and Prevention's most recent data, there are around 84 million Americans with prediabetes and approximately 30.5 million Americans with diabetes. Over the next ten years, these figures are expected to rise dramatically [16, 17].

Etiology

Reduced insulin secretion, decreased glucose utilization, and increased glucose production are some of the factors that lead to hyperglycaemia. A balance between peripheral glucose absorption and utilization and hepatic glucose synthesis is known as glucose homeostasis. The primary modulator of glucose homeostasis is insulin [18, 19].

The following are some examples of secondary causes of hyperglycaemia: (1) endocrine diseases that cause peripheral insulin resistance, such as Cushing syndrome, acromegaly, and pheochromocytoma; (2) destruction of the pancreas due to chronic pancreatitis, hemochromatosis, pancreatic cancer, and cystic fibrosis; (3) use of medications, such as glucocorticoids, phenytoin, and estrogens, (4) Reactive as observed postoperatively or in critically ill patients; (5) complete parental nourishment and dextrose infusion; (6) gestational diabetes, which is known to occur in 4% of pregnancies and is mostly attributable to impaired insulin sensitivity [20].

Hyperglycemia is primarily caused by weight over 120% of the target body weight, a family history of type 2 diabetes, a presence of hyperlipidemia or hypertension, a history of gestational diabetes, or polycystic ovarian syndrome [20]. Other risk factors include being Native American, Hispanic, Asian American, Pacific Islander, or African American.

Pathophysiology

Hyperglycemia in type 1 diabetes patients is caused by a combination of genetic, environmental, and immunologic factors. These cause the demise of pancreatic beta cells and insulin insufficiency. Hyperglycemia occurs in patients with type 2 diabetes due to insulin resistance and irregular insulin secretion [21].

According to recent research, metabolic abnormalities such as type 2 diabetes mellitus enhance the risk of cognitive decline and Alzheimer's dementia. Alzheimer's dementia also increases the likelihood of developing

type 2 diabetes. Recent research has shown that these disorders are linked at both the clinical and molecular levels. Brain insulin resistance is associated to neuronal dysfunction and cognitive impairment in Alzheimer's disease, just as peripheral insulin resistance leads to type 2 diabetes [21].

Evaluation

When assessing a patient for hyperglycemia, the emphasis should be on the patient's cardiorespiratory, mental, and volume state. It is possible to acquire serum glucose at the bedside fast. Serum electrolytes are tested with the anion gap calculated, blood urea nitrogen and creatinine are measured, and a complete blood count is performed. A dipstick urine analysis measures the amount of glucose and ketones in urine. If serum bicarbonate levels are significantly low, arterial or venous blood gas testing may be required [22].

To evaluate whether the patient has developed type 2 diabetes, the patient must have the following results on these tests: A fasting plasma glucose level of 126 mg/dL or higher, a 2-hour plasma glucose level of 200 mg/dL or higher during a 75-g oral glucose tolerance test (OGTT), a random plasma glucose level of 200 mg/dL or higher in the presence of hyperglycemic symptoms, or a hemoglobin A1c level of 6.5% or higher [22].

Critical Care Setting

Several observational and prospective studies in hospitalized patients with and without diabetes have shown that hyperglycemia is an independent predictor of poor survival in critically sick patients [23-25]. These studies link hyperglycemia to an increased risk of inpatient problems, extended hospitalization, and death. Falciglia and colleagues conducted a retrospective cohort study of over 250,000 veterans admitted to various intensive care units (ICUs) and discovered that, in addition to inpatient hyperglycemia being an independent risk for mortality, hyperglycemia-related risk varies with admission diagnosis, such that individuals with cardiac diagnoses, sepsis, respiratory failure, and pulmonary embolism are at an increased risk for mortality [27].

More crucially, bigger, milestone studies found that stringent glycemic control following open-heart surgery and in the ICU with continuous insulin infusion (CII) dramatically reduced the probability of these bad outcomes [27-29]. Furnary conducted a nonrandomized prospective study on 3,554 diabetic patients who received coronary artery bypass grafts and were treated with either subcutaneous insulin (SCI) or CII for hyperglycemia. Compared to patients treated with SCI that had an average blood glucose of 11.9 mmol/L (214 mg/dL), patients treated with CII with an average blood glucose of 9.8 mmol/L (177 mg/dL) had significantly fewer deep sternal wound infections¹⁶ and a reduction in risk-adjusted mortality by 50%.¹⁸ A follow-up analysis in a subset of this study population revealed that patients with blood glucose levels >11.1 mmol/L (>200 mg/dL) had higher mortality than those with blood glucose levels <11.1 mmol/L (<200 mg/dL) (5.0% vs. 1.8%, $P < 0.001$) [28].

The Leuven SICU study could likely be considered the main randomized controlled trial (RCT) that set the stage for aggressive glycemic control in the critical care setting a decade ago. This study randomized 1,548 patients admitted to the surgical ICU (63% cardiac cases, 13% with diabetes, early parenteral nutrition use) to either conventional therapy to maintain target BG levels 10–11.1 mmol/L (180–200 mg/dL) or intensive therapy to maintain target blood glucose (BG) levels 4.4–6.1 mmol/L (80–110 mg/dL). Compared to patients in the conventional arm that had a daily BG average of 8.5 mmol/L (153 mg/dL), patients in the intensive arm with a daily, average BG of 5.7 mmol/L (103 mg/dL) had significantly less bacteremia, fewer antibiotic requirements,

lower length of ventilator dependency, and an overall 34% reduction in in-hospital mortality. When the data were further examined, it was found that in addition to the above benefits, those patients that had exposure to at least 5 days of treatment with CII also had significantly fewer ICU days and lower ICU mortality [27].

A similar study was conducted by the same study group in the medical ICU setting (18% with diabetes), and during this trial, although the mean daily BG in the intensive arm of 6.2 mmol/L (111 mg/dL) was just above the targeted range (4.4-6.1 mmol/L; 80-110 mg/dL), these patients experienced less ICU and total hospital mortality after 3 days of treatment with CII [29]. Based on the excellent morbidity and mortality results, these two trials indicated a glycemic target in the ICU of 4.4-6.1 mmol/L (80-110 mg/dL) [30, 31].

Hyperglycemia treatment goals include the elimination of symptoms and the reduction of long-term consequences. Glycemic management in type 1 diabetic patients is achieved with a varied insulin regimen combined with good nutrition. Patients with type 2 diabetes are treated with diet and lifestyle changes in addition to medicines. Type 2 diabetes can also be controlled with oral glucose-lowering medications. Patients with hyperglycemia should be evaluated for sequelae such as retinopathy, nephropathy, and cardiovascular disease [32].

Treatment aims to decrease the following consequences associated with hyperglycemia: (1) renal and eye damage by regulating blood pressure and reducing hyperglycemia. (2) ischemic heart disease, stroke, and peripheral vascular disease by controlling hypertension, hyperlipidemia, and quitting smoking. (3) Reduce the risk of metabolic syndrome and stroke by controlling body weight and hyperglycemia [32].

Patients with hyperglycemia and confirmed type 2 diabetes should be referred to an endocrinologist. Metformin is the medicine of choice for lowering hyperglycaemia, unless there are contraindications. In addition, certain patients may need insulin therapy in conjunction with other medications [32].

Complications of Hyperglycaemia

The cause of stress hyperglycaemia is multifactorial, likely due to a combination of acute illness, medical treatments, and patient predilection that in turn leads to a physiologic rise in counter-regulatory hormones, activation of the inflammatory cascade, and oxidative stress (Table 1) [33,34].

Hormone	Effect
Cortisol	↑ skeletal muscle IR, ↑ lipolysis → substrate for ↑ gluconeogenesis
Epinephrine	↑ skeletal muscle IR, ↑ gluconeogenesis and glycogenolysis, ↑ lipolysis, ↓ insulin secretion
Norepinephrine	↑ gluconeogenesis (at high levels), ↑ lipolysis
Glucagon	↑ gluconeogenesis and glycogenolysis
Growth hormone	↑ skeletal muscle IR, ↑ gluconeogenesis, ↑ lipolysis

Table 1: Counter-regulatory hormones and mediators of inflammation associated with stress hyperglycaemia [35].

Inflammation mediators	Effect
Tumor necrosis factor Interleukin-1 Interleukin-6	↑ skeletal and hepatic IR

* **IR = insulin resistance; TNF = tumor necrosis factor.**

Counter-regulatory hormones including cortisol and adrenaline have a deleterious impact on carbohydrate metabolism by increasing peripheral insulin resistance, increasing hepatic gluconeogenesis and glycogenolysis, and lowering insulin production [35, 36]. Elevated levels of inflammatory mediators and proinflammatory transcription factors have also been linked to hyperglycemia. TNF-alpha and the cytokine interleukin 1 are examples of inflammatory mediators that impede post-receptor insulin signalling [33, 37].

Inflammation, platelet aggregation, apoptosis, and endothelial dysfunction are associated with the activation of proinflammatory transcription factors such as NFκB and activator protein-1 [38,39]. Finally, reactive oxygen species produced by oxidative stress during acute illness and hyperglycemia contribute to increased hyperglycemia through damage to lipids, proteins, and DNA [36, 40]. Importantly, investigators have observed that several of the hormonal and proinflammatory abnormalities associated with stress hyperglycemia revert to normal following insulin treatment and hyperglycemia resolution [40].

Insulin suppresses counter-regulatory hormones, pro-inflammatory transcription factors, and may even inhibit the generation of reactive oxidative species [41,42]. Contrary to early literature that suggested insulin directly increases the risk of cardiovascular events, 49 subsequent studies have shown that hyperinsulinemia is simply a marker of underlying insulin resistance syndromes (i.e., metabolic syndrome and diabetes), which are associated with increased cardiovascular morbidity and mortality [43]. In fact, insulin can reverse variables such as vasoconstriction, lipolysis, overproduction of free fatty acids, platelet aggregation, and inflammation which increase cardiovascular risks [41,]. Thus, guided treatment of significant hyperglycemia and the use of insulin in the inpatient setting appear to be tools for decreasing the risks associated with increased morbidity and mortality associated with hyperglycemia.

Prevention of Complications

To avoid problems of hyperglycemia, the following preventive methods are recommended: (1) Schedule yearly eye exams with an ophthalmologist; (2) monitor hemoglobin A1c levels every 3-6 months; (3) check urinary albumin levels every 12 months; (4) examine the feet at each clinic visit; (5) keep blood pressure under 130/80 mmHg; and (6) begin statin therapy if the patient has hyperlipidemia [32].

Some individuals have increased glycemic fluctuation in their blood sugars throughout the day, as well as variability at the same time on different days, resulting in frequent episodes of hypoglycemia and hyperglycemia. These patients require constant monitoring by an endocrinologist, as well as a treatment strategy designed to lower both risks or, at the very least, maintain one while reducing the other [32].

Prognosis

Individuals with hyperglycemia's prognosis is determined by how well their blood glucose levels are regulated. Chronic hyperglycemia can lead to serious life- or limb-threatening consequences. A better prognosis can be achieved with lifestyle adjustments, regular physical activity, and dietary alterations. Individuals who maintain

euglycemia have a significantly better prognosis and higher quality of life than those who remain hyperglycemic. Hyperglycemia consequences are almost often irreversible. Countless research has demonstrated that untreated hyperglycemia reduces longevity and lowers quality of life. Thus, an aggressive lowering of hyperglycemia must be initiated, and patients must be closely followed. Studies suggest that one should try to achieve an A1C level of less than 7%. However, controlling blood sugars too tightly can result in hypoglycemia which is not well tolerated by elderly individuals who already may have a pre-existing cardiovascular disease [45].

Postoperative and Rehabilitation Care

Hyperglycemia is frequent after surgery. High blood sugars after surgery are related with increased perioperative problems, hence goal blood sugar levels should be controlled between 140 and 180 mg/dL. Multiple teams care for postoperative patients during their hospital stay, necessitating the development and implementation of multidisciplinary procedures to treat hyperglycemia and reduce perioperative and postoperative complications [46].

Enhancing Healthcare Team Outcomes

Diabetes management is extremely complex and time-consuming. A newly diagnosed patient can easily get overwhelmed, resulting in noncompliance with therapy and irreparable problems. Patients and family members must collaborate closely with primary care physicians, endocrinologists, dieticians, and diabetic educators to obtain optimal therapy outcomes and avoid complications. Home health nurse services for disease management have been found to improve outcomes in the first few weeks and should be used whenever possible [47].

Previous Studies

Isnani et al, conducted a case control study Philippines 2021; determined the knowledge, attitudes and practices (KAP) of health care providers at the Philippine General Hospital towards hypoglycemia among non-critically ill patients using a validated, self-administered survey tool. The validated KAP survey tool yielded a low overall mean score of 12.56 ± 2.11 in the knowledge domain although high scores (4.88 ± 1) were noted for knowledge on management of hypoglycemia. In terms of attitude, majority (99.31%) of respondents believed that fewer hypoglycemia events correlate to better clinical outcomes and are willing to adopt a nurse-driven protocol. Most respondents (52.8%) employed correct practices in hypoglycemia management. The FGDs identified the perceived facilitators and barriers to hypoglycemia management. There is a gap in knowledge and practices in managing hypoglycemia among health care providers which needs to be addressed further with education and training. Nevertheless, health care providers have a positive attitude towards having a standard hypoglycemia protocol that will contribute greatly to its implementation in the clinical area [48].

A case control study done by **De la Cruz et al**, in Philippines 2019; determined the beliefs and attitudes towards diabetes of rural health care providers in Aklan, Philippines using the Diabetes Attitude Scale 3 (DAS-3) and to determine factors associated with it. Rural health care providers showed an overall mean positive attitude score of 3.5 using the DAS-3 questionnaire. In decreasing order, mean scores of participants according to subscale is as follows: "Need for Special Training in Education" (4.13) > "Autonomy of diabetes for patients" (3.70) > "Psychosocial Impact of Diabetes" (3.60) > "Value of Tight Glucose Control" (3.14) and "Seriousness of Type 2 Diabetes" (3.09). Physicians have the highest mean scores consistently in all subscales compared to other

health care providers. Among the different factors considered, educational attainment ($p=0.005$) and work position ($p<0.001$) were found out to affect attitude score of health care providers. Their study has shown that the majority of the rural health care providers believe in the need for special training of healthcare providers, psychosocial impact of diabetes and patient autonomy in diabetes self-care. However, the majority still do not strongly believe in the seriousness of diabetes and the benefits of tight sugar control. Educational attainment and work position are the consistent factors that impact diabetes-related attitude; therefore, the need to strengthen continuous medical education among health care providers [49].

In the USA 2016; **Beliard et al**, who assessed knowledge and perceptions of health care workers regarding optimal care for patients with hyperglycemia and identify commonly perceived barriers for the development of a hospital-wide education program. Approximately 50% of questions about best clinical practices were answered correctly. Correct responses varied across disciplines (n, mean + standard deviation [SD]), that is, physicians (n ¼ 112, 53% + 26%), nurses (n ¼ 43, 52% + 35%), pharmacists (n ¼ 20, 64% + 23%), dietitians (n ¼ 5, 48% + 30%), and patient care assistants (n ¼ 12, 38% + 34%). Most health care workers perceived hyperglycemia treatment to be very important and that sliding scale insulin was commonly used because of convenience but not efficacy. Knowledge regarding hyperglycemia management was suboptimal across a sample of health care workers when compared to clinical best practices. Hyperglycemia management was perceived to be important but convenience seemed to influence the management approach more than efficacy. Knowledge, perceptions, and barriers seem to play an important role in patient care and should be considered when developing education programs prior to implementation of optimized glycemic protocols [50].

Another study, conducted in Spain 2012; by **Biagetti et al**, who assessed resident physician' attitudes toward inpatient hyperglycemia, barriers to achieve optimum control, and impact on them of an insulin training program. Twenty-five interns completed the questionnaire. Glycemic control was considered "very important" in all admission situations, but was only considered "very important" in conventional hospitalization by 36% of interns. Most of these felt "comfortable" using sliding scales, but not with the basal/bolus regimen, which was the least commonly used. Perception of number of well-controlled patients and comfort and use of basal/bolus therapy increased at six months, but use of "sliding scales" remained high. The greatest difficulty reported for adequate management of hyperglycemia was the lack of knowledge. Most residents are aware of the importance of adequate glycemic control, but cannot achieve it because of inadequate knowledge. The insulin training program led to an improved perception and applicability of basal-bolus insulin regimens. However, despite all efforts, use of sliding scales remains high. Training programs should emphasize management of hyperglycemia [51].

Khan et al, conducted a study in Saudi Arabia 2010; assessed the Knowledge Attitude and Practice (KAP) of MOH Primary Health Care Physician in the management of Type 2 Diabetes Mellitus (DM). The mean of overall KAP score ($\pm$ SD) for all the respondents were 66.59 ± 8.82 (Maximum 100). Male physicians scored better than the females physicians (66.90 , $P=.018$ Vs 64.67 , $P=.018$) and the same was true with the rural physicians who scored higher (68.65 ± 10.19 , $P=.003$) than the urban physicians (65.34 ± 7.36 , $P=.003$). The main weakness of knowledge was on epidemiology of Diabetes Mellitus (DM). 28.3 % (n=28) of physicians didn't know the correct diagnostic criteria of Type 2 DM and only 34.7% physicians knew the correct angle of

insulin injection. 86.8% (n=86) of the physicians did not agree that Diabetic Self-Management Education (DSME) is an essential part of diabetic care. The mean overall KAP score was significantly higher for physicians with 1-5 years of experience (70.16 , $P < .05$) than those with more than 5 years of practice ($P < .05$). This difference was found in all the segments of KAP. Overall KAP score of those GPs who had a copy of Clinical practice guidelines (CPG) in their clinic was 70.90 ± 10.94 which was higher than KAP Score of those GPs who did not have a copy of CPG (65.10 ± 7.01 , $P = .005$). Checking patients' ability to manage their diabetes, checking blood pressure, eye exam, lipids, serum creatinine, baseline ECG, chest X ray and serum electrolyte were the best followed tests while foot exam and urinary protein were performed more often than recommended in the guideline. Serum HbA_{1c} was the most delayed test. Their study explored several aspects of diabetes related KAP of Ministry of Health appointed GPs and identified the need for improvement in their knowledge, attitude and practices for treating Type 2 DM patients [52].

In the USA 2007; **Cook et al**, developed insight into resident physician attitudes about inpatient hyperglycemia and determine perceived barriers to optimal management. Of 70 resident physicians from various services, 52 completed the survey (mean age, 31 years; 48% men; 37% in first year of residency training). Most respondents indicated that glucose control was "very important" in critically ill and perioperative patients but only "somewhat important" in non-critically ill patients. Most residents indicated that they would target a therapeutic glucose range within the recommended levels in published guidelines. Most residents also said they felt "somewhat comfortable" managing hyperglycemia and hypoglycemia and using subcutaneous insulin therapy, whereas most residents (48%) were "not at all comfortable" with use of intravenous administration of insulin. In general, respondents were not very familiar with existing institutional policies and preprinted order sets relating to glucose management. The most commonly reported barrier to management of inpatient hyperglycemia was lack of knowledge about appropriate insulin regimens and how to use them. Anxiety about hypoglycemia was only the third most frequent concern. Most residents acknowledged the importance of good glucose control in hospitalized patients and chose target glucose ranges consistent with existing guidelines [53]

Research Methodology:

Study design: It was a cross-sectional single center hospital-based study. **Study area:** The study was conducted at the internal medicine department at Soba University Hospital. **Study duration:** This study was conducted during the period from October 2021 to December 2021. **Study population:** All internal medicine registrar who are to Soba university hospital during the study period. **Inclusion criteria:** i) Internal medicine registrar at Soba university hospital. ii) Accepted to participant in this study. **Exclusion criteria:** i) Not fulfilling the including criteria above. ii) Refuse to participate in the study.

Sample size and sampling technique: Since the number of internal medicine registrars fulfilling the study criteria is limited, so, total coverage method was applied. Expected number is 35. **Data collection tools and methods:** Data was collected using a questionnaire (Google Form) filled by the study participants. The question was designed by the researchers and revised by the supervisors to fulfill to study objectives.

Study variables: Dependent variables, patient, level of knowledge, practice, and attitude. Independent Variables, sociodemographic data (gender and level of training).

Data analysis and interpretations: The data entry was in an excel sheet. Data were analyzed by Statistical Package for Social Sciences (SPSS) Version 26. The data was calculated as percent, and frequencies and then presented in Tables and Figures. The chi-square test was used for categorical variables and to find associations among them. Statistically, $P \leq 0.05$, was considered a significant difference.

Ethical consideration: Written ethical clearance and approval for conducting this research was obtained from Soba University Hospital Research Center. Carefully the concept of the study was explained to participant and written informed consents was taken. Participant had the right to withdraw at any time without any deprivation from health care. Confidentiality and secrecy were maintained by using serial code; data will be used only of the purpose of study

Results:

A total of 41 internal medicine registrars participated in this study; 23 (56.1%) were females and 18 (43.9%) were males. In so far as the number of years of practicing medicine; 19 (46.3%) internal medicine registrars had 3–5 years of practice, 12 (29.3%) registrars had less than 3 years of practice, and 10 (24.4%) registrars had more than 5 years of practice [Figure 1].

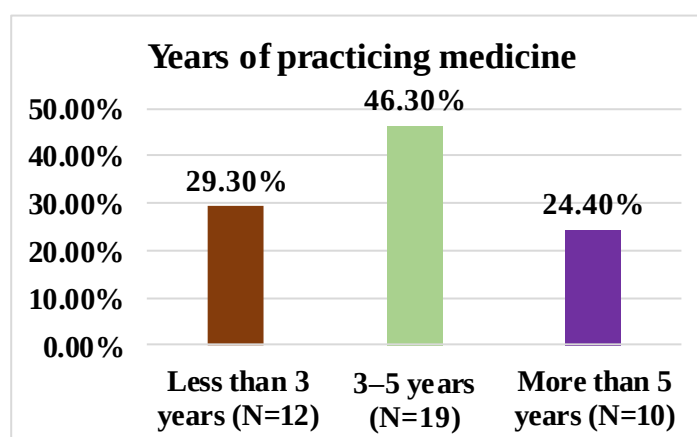


Figure 1: Distribution of the participants according to their years of practicing medicine in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Regarding the level of training of the participants, 16 (39%) registrars were R1, 16 (39%) registrars were R2, 5 (12.2%) registrars were R3, and 4 (9.8%) registrars were R4 [Table 2].

Level in training	Frequency	Percent
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Table 2: Distribution of the participants according to their level in training in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

R1	16	39%
R2	16	39%
R3	5	12.2%
R4	4	9.8%
Total	41	100%

Most of the participants 30 (75%) responded no to the question, “Do you know the guidelines of the American Diabetes Association for diabetes care in the hospital?” while 10 (25%) registrars responded yes [Table 3].

ADA Guidelines	Frequency	Percent
Yes	10	25%
No	30	75%
Total	40	100%
Missing	1	-

More than half of the 22 (53.7%) registrars defined

Table 3: The response of the participants to do you know the guidelines of American diabetes association for diabetes care in the hospital? in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=40).

hyperglycemia among hospitalized patients as a blood glucose of more than 200 mg/dl, 14 (34.1%) defined registrars hyperglycemia in hospitalized patients as a blood glucose of more than 180 mg\dl, 4 (9.8%) defined registrars hyperglycemia in hospitalized patients as blood glucose more than 140 mg\dl, and 1 (2.4%) defined registrar hyperglycemia in hospitalized patients as blood glucose more than 125 mg\dl [Table 4].

Table 4: The definition hyperglycemia in hospitalized patients by the registrars in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Hyperglycemia =	Frequency	Percent
125 mg\dl	1	2.4%
140 mg\dl	4	9.8%
180 mg\dl	14	34.1%
200 mg\dl	22	53.7%
Total	41	100%

Nearly two-thirds 27 (65.9%) of participants stated that HbA1c level should be done for any patient with hyperglycemia if not done within the last three months, and 14 (34.1%) of participants stated that HbA1c level should not be done for any patient with hyperglycemia if not done within the last three months [Figure 2].

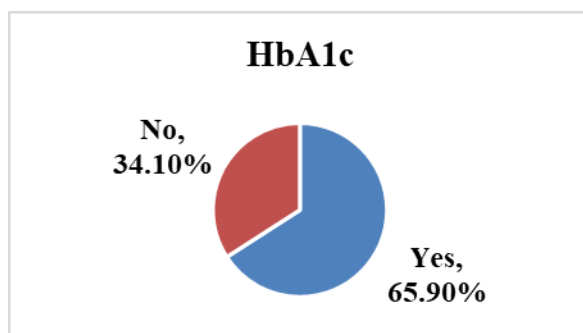


Figure 2: The knowledge of participants about HbA1c in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Regarding the insulin therapy, 14 (34.1%) of the participants stated that it should be initiated for persistent hyperglycemia if it is more than 200 mg/dl, 14 (34.1%) of the participants stated that it should be initiated for persistent hyperglycemia if it is more than 250 mg/dl, 10 (24.4%) of the participants stated that it should be initiated for persistent hyperglycemia if it is more than 180 mg/dl, and 3 (7.3%) of the participants stated that it should be initiated for persistent hyperglycemia if it is more than 140 mg/dl [Table 5].

Insulin therapy	Frequency	Percent
140 mg/dl	3	7.3%
180 mg/dl	10	24.4%
200 mg/dl	14	34.1%
250 mg/dl	14	34.1%
Total	41	100%

Table 5: The knowledge of participants about insulin therapy in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

In terms of the targeted glucose range for the majority of patients, 26 (63.4%) internal medicine registrars said it's 140–180 mg/dl, 13 (31.7%) internal medicine registrars said it's 110–140 mg/dl, and 2 (4.9%) internal medicine registrars said it's 180–200 mg/dl [Table 6].

Target range	Frequency	Percent
110–140 mg/dl	13	31.7%
140–180 mg/dl	26	63.4%
180–200 mg/dl	2	4.9%
Total	41	100%

Table 6: The knowledge of participants about targeted glucose range in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

If the patient is not on a regular diet, monitoring of blood glucose is recommended every 4–6 hours, according to the statement of 33

Table 7: The knowledge of participants about monitoring of blood glucose for patient who are not on regular diet in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41). www.ijrp.org

(80.5%) internal medicine registrars saying every -10 hours, 7 (17.1%) internal medicine registrars, and 1 (2.4%) internal medicine registrar saying every 10–12 hours [Table 7].

RBG every	Frequency	Percent
4–6 hours	33	80.5%
8-10 hours	7	17.1%
10-12 hours	1	2.4%
Total	41	100%

About two-thirds 26 (63.4%) of the participants stated that if the patient is on intravenous insulin, blood glucose is recommended every 2 hours, 8 (19.5%) of the participants stated that it every 8 hours; and 7 (17.1%) of the participants stated that every 4 hours [Table 8].

RBG every:	Frequency	Percent
2 hours	26	63.4%
4 hours	7	17.1%
6 hours	8	19.5%
Total	41	100%

Table 8: The knowledge of participants about the recommendation of blood glucose among patient on intravenous insulin in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

The majority of the participants 39 (95.1%) registrars stated that the treatment regimen should be reviewed and changed if a blood glucose level of less than 70 mg/dl is documented, 35 (85.4%) registrars stated that the use of a sliding scale insulin regimen in the inpatient hospital setting is strongly unrecommended, 29 (70.7%) stated that basal or basal-bolus correction insulin regimen is the preferred treatment for non-critically ill patient with poor oral intake, and 27 (65.9%) registrars stated that in the critical care setting, intravenous insulin infusion is recommended [Table 9].

Variables	Yes	No
Basal or basal bolus correction insulin regimen is the preferred treatment for non-critically ill patient with poor oral intake	29 (70.7%)	12 (29.3%)

Table 9: The knowledge of participants about infusion and treatment regimen in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Use of sliding scale insulin regimen in the inpatient hospital setting is strongly recommended	6 (14.6%)	35 (85.4%)
In the critical care setting intravenous insulin infusion is not recommended	14 (34.1%)	27 (65.9%)
The treatment regimen should be reviewed and changed if a blood glucose level of less than 70 mg/dl is documented	39 (95.1%)	2 (4.9%)

According to the level of knowledge of internal medicine registrars about hyperglycemia, 23 (56.1%) internal medicine registrars had an average level of knowledge with a mean score of 6.25 ± 0.51 out of ten, 11 (26.8%) internal medicine registrars had a high level of knowledge with the mean score of 8.45 ± 0.82 out of ten, and 7 (17.1%) internal medicine registrars had a low level of knowledge with the mean score of 4.29 ± 0.76 out of ten. The overall level of knowledge is average, with a mean score of 6.66 ± 1.51 out of ten [Table 10].

Level of knowledge	Frequency	%	Score
Low	7	17.1%	4.29 ± 0.76
Average	23	56.1%	6.25 ± 0.51
High	11	26.8%	8.45 ± 0.82
Total	41	100%	6.66 ± 1.51
The overall level of knowledge is average			

Table 10: Level of knowledge about hyperglycemia in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Score 5 and less is low, score 6-7 is average, and score 8-10 is high.

The prescription of the basal-bolus correction regimen for inpatients who are not on a regular diet by internal medicine registrars: sometimes 16 (39%), frequently 10 (24.4%), always 7 (17.1%), rarely (12.2%), and never 3 (7.3%) [Table 11].

Prescription of basal bolus	Frequency	%
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Table 11: The frequency prescription basal bolus correction regimen for inpatient who are not on regular diet in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Always	7	17.1%
Frequently	10	24.4%
Sometimes	16	39%
Rarely	5	12.2%
Never	3	7.3%
Total	41	100%

The prescription of SSI for hospitalized patients with hyperglycemia and not on a regular diet (NG feeding, pre-surgical NPO) by internal medicine registrars: rarely 16 (39%), sometimes 13 (31.7%), always 5 (12.2%), frequently 4 (9.8%), and never 3 (7.3%) [**Table 12**].

Frequency of SSI prescription:	Frequency	%
Never	3	7.3%
Rarely	16	39%
Sometimes	13	31.7%
Frequently	4	9.8%
Always	5	12.2%
Total	41	100%

Table 1: The frequency of prescription SSI for hospitalized patients with hyperglycemia and not on regular diet (NG feeding, pre-surgical NPO) in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

According to the level of practice of internal medicine registrars about hyperglycemia, 21 (51.2%) internal medicine registrars had an average level of practice with a mean score of 6.38 ± 0.49 out of ten, 12 (29.3%) internal medicine registrars had a high level of practice with the mean score of 8.33 ± 0.65 out of ten, and 8 (19.5%) internal medicine registrars had a low level of practice with the mean score of 3.88 ± 1.36 out of ten. The overall level of practice is average, with a mean score of 6.46 ± 1.72 out of ten [**Table 13**].

Level of practice	Frequency	%	Score
Poor	8	19.5%	3.88 ± 1.36
Average	21	51.2%	6.38 ± 0.49
Good	12	29.3%	8.33 ± 0.65
Total	41	100%	6.46 ± 1.72
The overall level of practice is average			

*Score 5 and less is poor, score 6-7 is average, and score 8-10 is good.

Table 2: Level of practice about hyperglycemia in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

More than half of the participants (56.1%) strongly agreed that the engagement of an endocrinological consultant in the management of inpatient hyperglycemia is important: 12 (29.3%) of the participants agreed; 4 (9.8%) participants neither agreed nor disagreed; 1 (2.4%) of the participants disagreed; and 1 (2.4%) of the participants strongly disagreed. [**Table 14**].

Engagement of endocrinological consultant in management of inpatient hyperglycemia	Frequency	%
Strongly agree	23	56.1%
Agree	12	29.3%
Neither agree nor disagree	4	9.8%
Disagree	1	2.4%
Strongly disagree	1	2.4%
Total	41	100%

Table 3: The thought of the participants if the engagement of endocrinological consultant in the management of inpatient hyperglycemia is important in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

More than one-third 15 (36.6%) of the participants strongly disagree that adherence to guidelines in the management of inpatient hyperglycemia will result in improved outcomes and reduce both complications and hospital stays: 12 (29.3%) of the participants strongly agreed, 9 (22%) of the participants strongly disagreed, 4 (9.8%) of the participants neither agreed nor disagreed, and 1 (2.4%) of the participants agreed [Table 15].

Adherence to guidelines in management of inpatients hyperglycemia	Frequency	Percent
Strongly agree	12	29.3%
Agree	1	2.4%
Neither agree nor disagree	4	9.8%
Disagree	9	22%
Strongly disagree	15	36.6%
Total	41	100%

Table 4: The thought of the participants if the adherence to guidelines in management of inpatients hyperglycemia will result in improved outcome and reduced both complications and hospital stay in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Nearly one-third (31.7%) of the participants disagreed that it is important to document the occurrence of fasting blood glucose between 100-126 mg/dL and/or random blood glucose between 40-200 mg/dL in discharge documents for patients without a preadmission diagnosis of diabetes, 11 (26.8%) of the participants strongly disagreed, 4 (9.8%) of the participants strongly agreed, 6 (14.6%) of the participants neither agreed nor disagreed, and 3 (7.3%) of the participants were agreed [Table 16].

Documentation of RBG	Frequency	%
Strongly agree	8	19.5%
Agree	3	7.3%
Neither agree nor disagree	6	14.6%
Disagree	13	31.7%

Table 5: The thought of the participants it is important to document the occurrence of fasting blood glucose between 100-126 mg/dL and/or random blood glucose between 40-200 mg/dL in discharge documents for patients without a preadmission diagnosis of diabetes in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Strongly disagree	11	26.8%
Total	41	100%

In this study, 11 (26.8%) of the participants strongly disagreed that it is important to treat blood glucose levels between 180-220 mg/dL in a perioperative setting, 10 (24.4%) of the participants agreed, 9 (22%) of the participants disagreed, 8 (19.5%) of the participants neither agreed nor disagreed, and 3 (7.3%) of the participants were strongly agreed [Table 17].

Treatment of elevated RBG levels	Frequency	Percent
Strongly agree	3	7.3%
Agree	10	24.4%
Neither agree nor disagree	8	19.5%
Disagree	9	22%
Strongly disagree	11	26.8%
Total	41	100%

Table 6: The thought of the participants it is important to treat the blood glucose levels between 180-220 mg/dL in perioperative setting in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

According to the attitude of internal medicine registrars about hyperglycemia, 32 (78%) internal medicine registrars had a positive attitude with a mean score of 8.70 ± 0.55 out of ten, and 9 (22%) internal medicine registrars had a negative attitude with the mean score of 4.11 ± 0.69 out of ten. The overall attitude is a positive attitude, with a mean score of 7.10 ± 1.92 out of ten [Table 18].

Level of attitude	Frequency	Percent	Score
Negative	9	22%	4.11 ± 0.69
Positive	32	78%	8.70 ± 0.55
Total	41	100%	7.10 ± 1.92
The overall level of attitude is positive			

*Score 5 and less is negative, score 6-10 is positive.

Table 7: Level of attitude about hyperglycemia in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

There was a statistically significant association between the level of knowledge and level of practice (P-value = 0.003), while there was no statistically significant association between the level of knowledge and the level of attitude (P-value = 0.434) [Table 19].

Variables	Level of knowledge				P-value
	Low	Average	High	Total	

Table 8: The association between the level of knowledge and (level of practice and attitude) in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Practice	Poor	5	1	2	8	0.003*
	Average	2	13	6	21	
	Good	0	9	3	12	
Attitude	Negative	2	4	3	9	0.434
	Positive	5	19	8	32	

*Statistically significant

There was no association between the level of knowledge and demographic data (P-value > 0.05) [Table 20].

There was no association between the level of practice and demographic data (P-value > 0.05) [Table 21].

There was no association between the level of attitudes and demographic data (P-value > 0.05) [Table 22].

Demographic data		Level of knowledge				p-value
		Low	Average	High	Total	
Gender	Male	4	11	3	18	0.39
	Female	3	12	8	23	
Years of practice	<3 years	3	4	5	12	0.29
	3-5 years	3	11	5	19	
	>5 years	1	8	1	10	
Training	R1	4	9	3	16	0.53
	R2	3	9	4	16	
	R3	0	2	3	5	
	R4	0	3	1	4	

Table 20: The association between the level of knowledge and demographic data in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Demographic data		Level of practice				p-value
		Low	Average	High	Total	
Gender	Male	4	8	6	18	0.75
	Female	4	13	6	23	
Years of practice	<3 years	4	5	3	12	0.69
	3-5 years	3	10	6	19	
	>5 years	1	6	3	10	

Training	R1	6	5	5	16	0.26
	R2	1	11	4	16	
	R3	0	3	2	5	
	R4	1	2	1	4	

Table 10: The association between the level of practice and demographic data in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Demographic data		Level of attitude			P-value
		Negative	Positive	Total	
Gender	Male	5	13	18	0.73
	Female	4	19	23	
Years of practicing medicine	<3 years	2	10	12	0.11
	3-5 years	6	13	19	
	>5 years	1	9	10	
Level in training	R1	2	14	16	0.42
	R2	3	13	16	
	R3	3	2	5	
	R4	1	3	4	

Table 9: The association between the level of attitudes and demographic data in the study of the knowledge, attitudes and practice of internal medicine registrars at Soba University Hospital toward management of hyperglycemia in hospitalized patients 2021 (n=41).

Discussion

Isnani and colleagues [48] and Biagetti and colleagues [51] both reported that most of the respondents were female; these demographics were similar to our study.

The mostly represented demographic of our participants had 3-5 years of practice, followed by less than 3 years, and the least represented were those with 5+ years of practice. In Khan and colleagues' study [52], (40.2%) of the participants had experience with basal/bolus insulin protocol, this was not in line with our findings, where our number were far less.

Within this study, 53.7% of our participants defined hyperglycemia as blood glucose levels exceeding 200 mg/dl, while 34.1% defined it as blood glucose levels exceeding 180 mg/dl, 9.8% defined it as blood glucose levels exceeding 140 mg/dl, and 2.4% defined it as blood glucose levels exceeding 125 mg/dl. Hyperglycemia is defined as blood glucose levels above 125 mg/dL during a fast and above 180 mg/dL two hours after a meal. A patient's fasting plasma glucose level of 100 mg/dL to 125 mg/dL indicates impaired glucose tolerance, often known as pre-diabetes. If a patient's fasting blood glucose is more than 125 mg/dL, they are classified as diabetics [14,15].

Beliard and colleagues reported that knowledge regarding hyperglycemia management was suboptimal across a sample of health care workers when compared to clinical best practices. [50]. Based on the level of practice of internal medicine registrars regarding hyperglycemia, as determined by the study, the average mean score amongst our participants was 6.46 ± 1.72 out of 10, indicating an average overall level of practice.

Internal medicine registrars' attitudes towards hyperglycemia varied: (78%) had a positive attitude. Compared to the data reported by Isnani and colleagues whose respondents had positive attitudes toward clinical impact, healthcare delivery and cost, managing hypoglycemia, and adhering to a standard protocol [48]. There was no association between the level of knowledge and demographic data (P -value > 0.05). In the same study, the mean overall knowledge scores of respondents differed significantly across age groups (12.56 ± 2.11 ; $p < 0.001$), professions (13.2 ± 1.96 ; $p < 0.001$), number of years in service/training (12.28 ± 1.7 ; $p = 0.028$), and highest educational attainment (13.15 ± 1.93 ; $p < 0.001$) [48].

There was a statistically significant association between the level of knowledge and level of practice (P -value = 0.003), while no statistically significant association between the level of knowledge level of attitude was established (P -value = 0.434).

According to **De la Cruz et al**, physicians have the highest mean scores consistently in all subscales compared to other health care providers. Educational attainment ($p=0.005$) and work position ($p<0.001$) were found out to affect attitude score of health care providers [49].

Conclusion:

The overall KAP in this study revealed an average score of 6.66 ± 1.51 out of 10, indicating an average level of overall knowledge, average mean score of 6.46 ± 1.72 out of 10 indicates an average overall level of practice, and the attitude is positive, with a mean score of 7.10 ± 1.92 out of 10. Most internal medicine registrars acknowledged the importance of good glucose control in hospitalized patients and chose target glucose ranges consistent with existing guidelines. There was a statistically significant association between the level of knowledge and level of practice (P -value = 0.003). There was no association between the overall KAP and demographic data (P -value > 0.05).

Recommendations:

- There is a gap in knowledge and practices in managing hypoglycemia among health care providers in Sudan which needs to be addressed further with education and training.
- Educational attainment and work position are the not factors that impact diabetes-related attitude; therefore, the need to strengthen continuous medical education among internal medicine registrars.

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