



**APPLICATION OF INSULIN MEDICATION MANAGEMENT TO IMPROVE
BLOOD GLUCOSE STABILITY IN PATIENTS WITH TYPE I DIABETES
MELLITUS**

Aji Setya Guna Darma, Idramsyah*

Department of Nursing, Poltekkes Kemenkes Bengkulu, Jl. Indragiri Pd. Harapan No.3, Padang Harapan,
Gading, Bengkulu 38225

*idramsyah@poltekkesbengkulu.ac.id

ABSTRACT

People with type 1 diabetes mellitus need insulin therapy to maintain blood glucose stability and improve their quality of life. Nurses have an important role in insulin medication management interventions to achieve therapeutic goals. Objective: This study aims to provide an overview of the application of evidence-based practice nursing activities for developing insulin medication management interventions to improve blood glucose stability in patients with type I diabetes mellitus. Method: This descriptive case study uses a nursing process approach carried out on one young person with type 1 diabetes mellitus at the Regional General Hospital (RSUD) Dr. M Yunus Bengkulu. The nursing process is carried out for three days while the patient is treated in the internal medicine room. Data were collected through interviews and observation. Results: Nursing activities started with assessing the patient's nutritional and fluid needs and continued to data analysis. The analyzed data shows that >80% of the major and minor data are listed in the nursing diagnosis guidelines, namely the Indonesia Nursing Diagnostic Standards (SDKI). From the data obtained, the diagnosis that can be raised is the instability of blood glucose levels with the criteria of nursing outcomes of the level of knowledge with increased expectations. On the last day of the nursing evaluation, there was an increase in the level of knowledge from moderate to increase in the respondents. Conclusions: Applying nursing activity development to insulin medication management intervention effectively achieves blood glucose stability in patients with type 1 diabetes mellitus.

Keywords: blood glucose; diabetes mellitus; insulin therapy; medication management

How to cite (in APA style)

Darma, A. S. G., & Idramsyah, I. (2024). Application of Insulin Medication Management to Improve Blood Glucose Stability in Patients with Type I Diabetes Mellitus. *Indonesian Journal of Global Health Research*, 6(S5), 79-86. <https://doi.org/10.37287/ijghr.v6iS5.4211>.

INTRODUCTION

Diabetes Mellitus (DM) type 1 is a condition with absolute insulin deficiency or insulin-dependent diabetes mellitus (IDDM). Absolute insulin deficiency experienced will result in chronic hyperglycemia during fasting or even after meals (Tai et al., 2021; Zhang et al., 2020). People with type I DM are represented as individuals with a thin body shape, young age but experiencing a loss of pancreatic β cell function of more than 90% (Bielka et al., 2024). People with type 1 DM will be given insulin therapy from the moment they are diagnosed (Boonpattharatthiti et al., 2024). In the nursing care process, the administration of insulin therapy is a collaborative intervention. Meeting the body's proper insulin needs is the goal of therapy so that blood glucose stability is achieved (Boonpattharatthiti et al., 2024; Haddadi et al., 2021). Life expectancy of people with type 1 diabetes increases along with improvements in diabetes management (Golding et al., 2024).

Adherence to insulin therapy is essential to achieve reasonable glycemic control (Boonpattharatthiti et al., 2024) and effectively prevent the development of diabetes complications (Farsaei et al., 2014). The availability of several new types of insulin therapy significantly allows for flexibility in dosage timing and dosage (Wilson & Castle, 2020). This flexibility certainly affects the adherence and accuracy of insulin therapy (Boonpattharatthiti et al., 2024). Nurses' role in managing insulin therapy medication is vital (Indramsyah & Novira, 2023). Nurses must carry out various measures, such as monitoring, observation, education, and therapeutic, to achieve the goals of insulin therapy. The achievement of the therapeutic goals needs to pay attention to several things related to insulin storage, insulin injection location and technique (Wilson & Castle, 2020), as well as monitoring the therapy's response and side effects (Farsaei et al., 2014).

Nursing interventions that are currently widely carried out are still standard, especially in administering insulin therapy (PERKENI, 2021). Therefore, exposure and examples of appropriate insulin injection and storage techniques are needed. There have not been many research results that outline the development of insulin medication management interventions. In this study, the researcher tried to summarize several evidence-based nursing practices that can be applied to insulin therapy patients. Based on the above phenomenon, increasing the level of knowledge and skills is very important to increase the effectiveness of insulin injection medication and monitor treatment adherence. Therefore, this study aims to provide an overview of the application of nursing activity development in the standard insulin medication management intervention to improve blood glucose stability in people with type 2 diabetes.

METHOD

This case study aims to provide an overview of the application of nursing activities based on scientific evidence literature to develop standards for insulin medication management nursing interventions. This descriptive case study is qualitative research using a nursing process approach, which includes the stages of assessment, diagnosis, intervention, implementation, and evaluation. This case study was conducted on 1 participant with type 1 diabetes mellitus who was young and diagnosed less than two years old at the Regional General Hospital (RSUD) dr. M Yunus Bengkulu. The focus of nursing problems on disorders of nutritional and fluid needs is the instability of blood glucose levels by implementing Mediation management interventions. Treatment is carried out for one week in the treatment room. Anamnesa methods, interviews, observations, physical examinations, diagnostic examinations, and medical record tracing carried out data collection.

RESULTS

Assessment

A male patient named Mr. J is 24 years old, unmarried and Muslim. The patient is currently a student. The patient lives on Sumatra Street, Sukamerindu Village, Sungai Serut District, Bengkulu City. The results of the health history assessment are now in the emergency department (IGD) of dr. M. Yunus Bengkulu Hospital, escorted by family members on Saturday, February 17, 2024 at 11.00 WIB. The patient entered the emergency room with complaints of shortness of breath, weakness, headache, nausea, and vomiting. The results of the physical examination at the emergency room were blood pressure 108/79 mmHg, Pulse rate 86 x/min, Respiratory rate 25 x/min, Temperature 36.2°C, Laboratory examination results obtained blood sugar results (GDS) 565 Mg/dl, urea 45 Mg/dl, sodium 132 Mmol/L, potassium 4.0 Mmol/L, chloride 104 Mmol/L. The patient was diagnosed with diabetic ketoacidosis (KAD). After going through the emergency phase with the management of

diabetic ketoacidosis procedures, The patient then moved to Melati's infirmary, which focuses on internal medicine nurses.

The current disease history while in the internist inpatient room was assessed on the third day of treatment, Monday, February 19, 2024, at 09.00 WIB. The current assessment results were obtained: the patient said that he was weak and tired easily, had aches and pains in the lower extremities, the head was still dizzy and had a headache, sweating frequently, blurred vision, and a dry mouth. The results of the physical examination showed the patient still appeared weak, the level of consciousness was composed (CM) GCS 15 (E4 M6 V5), blood pressure 112/88 mmHg, pulse 94 x/min, respiratory rate 27 x/min, temperature 36.6°C GDS test result 422 mg/dl. Previous disease history was identified that the patient had DM disease for \pm 2 years; the patient said that he had never consumed or used medication to control blood glucose levels, and the patient also did not control food and physical activity properly. The family admitted that no other siblings had the same disease. The results of the assessment focused on nutritional and fluid needs. The patient stated that the frequency of eating three times a day and the type of food eaten was porridge. Patients can consume \pm 1 serving. The patient is able to drink mineral water, 600 cc/24 hours, and drinks by mouth.

Nursing Problems

The author established nursing problems based on the assessment results on nutritional and fluid needs disorders. In this case study, the nursing problem that was enforced was the instability of blood glucose levels. The patient was diagnosed with type 1 DM, so the etiology of this disease is pancreatic dysfunction.

Nursing Intervention

The expected nursing goal is that after nursing actions are carried out for 3x24 hours, it is hoped that the level of knowledge of the Indonesian nursing output standards will increase. The criteria for measuring results are habits according to recommendations increase, habits of explaining knowledge about a topic increase, behaviour according to knowledge increases, wrong understanding of problems decreases, and habits improve—formulation of nursing plans. The Indonesian nursing intervention standard is medical management. Observational nursing activities, including identification of the use of drugs according to prescriptions; identification of drug expiration dates; identification of knowledge and ability to undergo treatment programs; monitoring the effectiveness and side effects of drug administration; monitoring signs and symptoms of drug poisoning; serum blood monitor (e.g. electrolytes, prothrombin), if necessary; compliance monitors undergo treatment programs.

Nursing activities that are austere include facilitating changes in treatment programs, if necessary; providing visual and written sources of information on treatment programs; and Facilitating patients and families to adjust their mindset due to treatment programs. Educational nursing activities include teaching patients and families how to administer drugs (dose, storage, route, and time of administration) and how to handle or reduce side effects if they occur. It is recommended that a health worker be contacted if side effects occur.

Nursing Implementation

Nursing was implemented for three days in the internal medicine room. In this case study, the author applies actions and conducts formative evaluations. In the observational nursing action carried out on the patient, the nurse identifies and re-evaluates the insulin class and insulin name with the therapy provided by the doctor in the integrated hospital notes. The results of the patient's identification were obtained from regular short-acting insulin brand Novorapid

with a dose of 3x16 units and Sansulin brand long-acting insulin 1x12 units. The nurse also directly checked the expiration date of Novorapid insulin, which is November 10, 2027, and the expiration date of Sansulin, January 22, 2028. Nurses identify the patient's and family's knowledge of the insulin used. The nurse also identified the patient's ability to self-inject insulin. The results showed that patients did not understand the main goals of insulin therapy and how insulin could help improve the patient's quality of life. There are also still mistakes in the ability of patients and families to inject insulin. The patient stores insulin in the refrigerator and injects it into the abdomen and upper right arm (deltoid). Patients and families have not yet known the mistakes they have made.

In implementing the treatment program, nurses monitor insulin administration's effectiveness and side effects by checking blood glucose levels. Nurses used the Morisky Medication Adherence Scale-8 item (MMAS-8) questionnaire to monitor patient compliance while undergoing a treatment program. The compliance evaluation results obtained an MMAS-8 score, which is a score of 4 with a low compliance level category. In therapeutic nursing, actions are carried out on the patient, namely, providing sources of information related to the insulin treatment program. Encouraging patients and families to inject insulin independently, the nurse explained, practised, and implemented Self-Injectable Insulin Storage Temperature (SIIST). SIIST is essential in the management of insulin for diabetic patients who inject independently. In nursing, educational actions teach patients and families how to manage insulin injections, starting from applying insulin doses according to the dose. Explain to the patient that used insulin should be stored at average room temperature, around 15°C to 30°C, and not at hot or cold temperatures in the refrigerator. However, insulin that has never been opened or as a stock should be stored in a refrigerator of 2°C to 8°C. The nurse explained to the patient that it is best to avoid putting insulin in a hot car when travelling long distances. Also, avoid the occurrence of insulin clotting conditions. The nurse also taught that if there is a change in the colour and texture of insulin, it should not be used again.

Nurses educate and practice injecting insulin into adipose tissue at a 90° angle. The area of insulin injection can be done in the abdomen about one finger outside the umbilicus. The area of the back arm with a lot of adipose tissue is not in the upper arm near the deltoideus muscle. Insulin injection in the quadriceps is either for insulin administration with a slower action (long-acting) or insulin injected into the patient at night. Injections in the buttocks area have prolonged absorption and should be used for long-acting insulin or insulin the patient gives at night.

Nursing Evaluation

The evaluation results of Mr. J's third meeting showed that his level of knowledge had increased. Patients and families can explain again and immediately practice related insulin injection techniques appropriately. The patient can determine and indicate the exact area of insulin injection. The patient's blood glucose evaluation results were stable starting from the second day, with an average blood glucose of 165 gr/dl. A follow-up plan was conducted for an MMAS-8 evaluation two months after the intervention.

DISCUSSION

Type 1 diabetes mellitus is expected at less than 30 years (Bielka et al., 2024). In this case study, patients were diagnosed with DM at 22. The occurrence of DM at an early age is not only caused by genetic or autoimmune factors. Still, it is also aggravated by high lifestyle behaviours of consuming sugar and lack of physical activity (Soelistijo, 2021). In this case study, genetic and autoimmune factors could not be identified from the assessment results in

patients and families because they were related to limited information and family knowledge. However, it was identified that the patient had a lazy lifestyle of exercise. Unstable blood glucose conditions or unstable blood glucose are nursing problems that are often found in people with diabetes, both Type 1 and Type 2 (Bielka et al., 2024). Blood glucose instability is a condition in which a person can experience excess blood glucose or even a lack of blood glucose (Golding et al., 2024). In this case study patient, symptoms of excess blood glucose were found that led to acute complications in the form of diabetic ketoacidosis (Zarse et al., 2024). When the body experiences excess blood glucose and cells experience a shortage of materials to carry out metabolism (Zarse et al., 2024), the body will use a reserve energy source, namely ketone bodies (Golding et al., 2024). Ketone bodies that increase and are acidic cause acidosis (Fukao et al., 2014).

Pengontrolan kadar glukosa darah dapat tercapai dengan baik dengan mengaplikasikan 4 pilar DM (Webber, 2013). Pilar tersebut terdiri dari edukasi, perencanaan makan, latihan jasmani dan intervensi farmakologis (PERKENI, 2021; Soelistijo, 2021). Berdasarkan 4 pilar DM tersebut, salah satu intervensi yang paling efektif pada DM tipe 1 yaitu pemberian terapi Insulin (Wilson & Castle, 2020). Blood glucose level control can be adequately achieved by applying the four pillars of DM (Webber, 2013). These pillars include education, meal planning, physical exercise and pharmacological interventions (PERKENI, 2021; Soelistijo, 2021). Based on the four pillars of DM, Insulin therapy is one of the most effective interventions for type 1 DM (Wilson & Castle, 2020). Patient adherence to insulin medication management can be evaluated using the Morisky Medication Adherence Scale-8 item (MMAS-8) instrument (Martinez-Perez et al., 2021). MMAS-8 is also used to assess patient compliance during medication (Saibi et al., 2020). This instrument was developed and perfected by Donald Morisky and his colleagues. MMAS-8 is simple, practical and accurate enough to be used directly on patients and does not require much time (Gumilas et al., 2021). However, the disadvantage is that it requires patient honesty and correct patient understanding of questions (Martinez-Perez et al., 2021). In the results of this case study, the patient's MMAS-8 score of only 4 indicates that the patient's adherence to the insulin regimen is very lacking.

Based on the results of the nursing process, it can be seen that the cause of blood glucose instability and low patient compliance is due to a lack of understanding of insulin therapy (Skriver et al., 2023). The level of patient skill in injectable insulin can be improved through the Self-Injectable Insulin Simulation Tool (SIIST) (Astuti, 2023). Patients are still not suitable for the technique of self-storage and injection of insulin. So that nurses apply SIIST (Huang & Hung, 2018). SIIST is concerned with the storage and temperature management of the insulin to be used, which is crucial to ensure the effectiveness and safety of the treatment (Bahendeka et al., 2019). Controlling diabetes with insulin injection is an effective treatment for hyperglycemia (Boonpattharatthiti et al., 2024), but it has a high failure rate and is quite expensive (Sophausvaporn et al., 2023). So that the maximization of the use of insulin injections can be improved (Simamora et al., 2021). Optimal diabetes self-management requires cooperative action from patients (Botero et al., 2021) to increase the effectiveness of medication management in the form of SIIST use skills (Putri et al., 2023).

Insulin storage that has been opened or is in use is an average room temperature of around 15°C to 30°C (PERKENI, 2021) because this is a constant temperature that will not damage the structure of insulin proteins (Bahendeka et al., 2019; PERKENI, 2021). If insulin is stored at too hot or frozen temperatures, there will be damage to the structure of insulin proteins, and its effectiveness will decrease (Bahendeka et al., 2019). In this case study, it was identified

that the patient stored insulin that had been opened or after use was stored at refrigerator temperature. This condition causes the insulin that the patient injects to decrease in effectiveness, so the goal of insulin therapy is not achieved. The patient was identified while at home, giving insulin injections to inappropriate areas. The patient admitted that from the beginning, he was taught to inject insulin into the upper arm of three fingers under the shoulder joint or in the deltoideus area. Experts recommend administering insulin to the adipose area (Wilson & Castle, 2020), so that the right location on the arm is the back of the upper arm where there is a lot of adipose tissue (Bahendeka et al., 2019; PERKENI, 2021). In addition, insulin can also be administered to the abdominal area and front thighs (Bahendeka et al., 2019; PERKENI, 2021).

Blood glucose stability is one of the indicators of the success of diabetes mellitus management (Golding et al., 2024) in addition to the stability of High-Density Lipoprotein (HDL) levels (PERKENI, 2021). Blood glucose control in DM patients can be achieved by ranging from lifestyle changes (Ahuja & Gupta, 2020), oral anti-hyperglycemic drugs to insulin (Schaper et al., 2020; Wang et al., 2022). After the intervention on the second to third days, the patient's blood glucose test results were stable, averaging 165 gr/dL. Patients and families are happy with achieving blood glucose stability (Indramsyah & Novira, 2023).

CONCLUSION

The role of nurses in the management of insulin medication is vital. Evaluation of patient compliance needs to be carried out to achieve the goal of therapy. Nursing actions that are educational, monitoring, therapeutic and collaborative need to be carried out appropriately by updating information from the latest research results. The application of interventions related to storage techniques, injection methods, injection areas and the accuracy of insulin injection dosage has a vital role in achieving blood glucose stability. The results of this research are expected to directly improve the quality and professionalism of education and nursing practitioners and patients.

REFERENCES

- Ahuja, A., & Gupta, J. (2020). Diabetes Silent Killer: Medical focus on Food Replacement and Dietary Plans Antimicrobial activity of herb View project. September. <https://doi.org/10.15515/abr.0976-4585.11.5.128135>
- Bahendeka, S., Kaushik, R., Swai, A. B., Otieno, F., Bajaj, S., Kalra, S., Bavuma, C. M., & Karigire, C. (2019). EADSG Guidelines: Insulin Storage and Optimisation of Injection Technique in Diabetes Management. *Diabetes Therapy*, 10(2), 341–366. <https://doi.org/10.1007/s13300-019-0574-x>
- Bielka, W., Przekaz, A., Molęda, P., Pius-Sadowska, E., & Machaliński, B. (2024). Double diabetes—when type 1 diabetes meets type 2 diabetes: definition, pathogenesis and recognition. *Cardiovascular Diabetology*, 23(1), 1–13. <https://doi.org/10.1186/s12933-024-02145-x>
- Boonpattharatthiti, K., Saensook, T., Neelapajit, N., Sakunrag, I., Krass, I., & Dhippayom, T. (2024). The prevalence of adherence to insulin therapy in patients with diabetes: A systematic review and meta-analysis. In *Research in Social and Administrative Pharmacy* (Vol. 20, Issue 3). Elsevier Inc. <https://doi.org/10.1016/j.sapharm.2023.11.009>

- Botero, J. F., Vásquez, L. M., Blanco, V. M., Cuesta, D. P., Ramírez-Rincón, A., Bedoya, J., & Palacio, A. (2021). The effectiveness of a comprehensive diabetes program for glycemic control and adherence, and the selection of candidates for sensor-augmented insulin pump therapy. *Endocrinología, Diabetes y Nutrición (English Ed.)*, 68(10), 735–740. <https://doi.org/10.1016/j.endien.2021.12.002>
- Farsaei, S., Radfar, M., Heydari, Z., Abbasi, F., & Qorbani, M. (2014). Insulin adherence in patients with diabetes: Risk factors for injection omission. *Primary Care Diabetes*, 8(4), 338–345. <https://doi.org/10.1016/j.pcd.2014.03.001>
- Fukao, T., Mitchell, G., Sass, J. O., Hori, T., Orii, K., & Aoyama, Y. (2014). Ketone body metabolism and its defects. *Journal of Inherited Metabolic Disease*, 37(4), 541–551. <https://doi.org/10.1007/s10545-014-9704-9>
- Golding, J. A., Yong, E. S. T., Hope, S. V., Wright, J. E., Levett, T. J., & Chakera, A. J. (2024). Type 1 diabetes and frailty: A scoping review. *Diabetic Medicine*, 41(8), 1–16. <https://doi.org/10.1111/dme.15344>
- Gumilas, N. S. A., Harini, I. M., Samodro, P., & Ernawati, D. A. (2021). Mmas-8 score assessment of therapy adherence to glycemic control of patients with type 2 diabetes mellitus, tanjung purwokerto, Java, Indonesia (October 2018). *Southeast Asian Journal of Tropical Medicine and Public Health*, 52(3), 359–370.
- Haddadi, D., Rosolowsky, E., Pacaud, D., McKeen, J., Young, K., Madrick, B., Domaschuk, L., Sargious, P., Conroy, S., & Senior, P. A. (2021). Revision of Alberta's Provincial Insulin Pump Therapy Criteria for Adults and Children With Type 1 Diabetes: Process, Rationale and Framework for Evaluation. *Canadian Journal of Diabetes*, 45(3), 228–235.e4. <https://doi.org/10.1016/j.cjcd.2020.08.097>
- Huang, H. T. D., & Hung, S. T. A. (2018). Investigating the strategic behaviors in integrated speaking assessment. *System*, 78, 201–212. <https://doi.org/10.1016/j.system.2018.09.007>
- Indramsyah, I., & Novira, D. (2023). Studi Fenomenologi Persepsi Pasien dan Keluarga tentang Luka Kaki Diabetes. *Health Information: Jurnal Penelitian*, 15(3), e970. <https://doi.org/10.36990/hijp.v15i3.970>
- Martinez-Perez, P., Orozco-Beltrán, D., Pomares-Gomez, F., Hernández-Rizo, J. L., Borrás-Gallen, A., Gil-Guillen, V. F., Quesada, J. A., Lopez-Pineda, A., & Carratala-Munuera, C. (2021). Validation and psychometric properties of the 8-item Morisky Medication Adherence Scale (MMAS-8) in type 2 diabetes patients in Spain. *Atencion Primaria*, 53(2), 101942. <https://doi.org/10.1016/j.aprim.2020.09.007>
- PERKENI. (2021). *Pedoman Petunjuk Praktis Terapi Insulin Pada Pasien Diabetes Mellitus 2021*. Pb Perkeni, 1–70.
- Putri, H. L., Malini, H., & Maisa, E. A. (2023). Utilization Of Educational Videos In Increasing Knowledge And Skills Of Insulin Pen Injection In Type 2 Diabetes Mellitus Patients : Literature Review. 7, 616–625.
- Saibi, Y., Romadhon, R., & Nasir, N. M. (2020). Kepatuhan Terhadap Pengobatan Pasien Diabetes Melitus Tipe 2 di Puskesmas Jakarta Timur. *Jurnal Farmasi Galenika*

- (Galenika Journal of Pharmacy) (e-Journal), 6(1), 94–103.
<https://doi.org/10.22487/j24428744.2020.v6.i1.15002>
- Schaper, N. C., van Netten, J. J., Apelqvist, J., Bus, S. A., Hinchliffe, R. J., & Lipsky, B. A. (2020). Practical Guidelines on the prevention and management of diabetic foot disease (IWGDF 2019 update). *Diabetes/Metabolism Research and Reviews*, 36(S1), 1–10.
<https://doi.org/10.1002/dmrr.3266>
- Simamora, S., Sarmadi, Mona Rahmi Rulianty, & Ferawati Suzalin. (2021). Peduli Penggunaan Insulin. *Dinamisia : Jurnal Pengabdian Kepada Masyarakat*, 5(3), 638–644.
<https://doi.org/10.31849/dinamisia.v5i3.4823>
- Skriver, L. K. L., Nielsen, M. W., Walther, S., Nørlev, J. D., & Hangaard, S. (2023). Factors associated with adherence or nonadherence to insulin therapy among adults with type 2 diabetes mellitus: A scoping review. *Journal of Diabetes and Its Complications*, 37(10), 108596. <https://doi.org/10.1016/j.jdiacomp.2023.108596>
- Soelistijo, S. (2021). Pedoman Pengelolaan dan Pencegahan Diabetes Melitus Tipe 2 Dewasa di Indonesia 2021. Global Initiative for Asthma, 46. www.ginasthma.org.
- Sophausvaporn, P., Boonhong, J., & Sahakitrungruang, T. (2023). The Prevalence of Diabetic Peripheral Neuropathy in Youth with Diabetes Mellitus. *Annals of Pediatric Endocrinology and Metabolism*, 28(1), 20–25.
<https://doi.org/10.6065/apem.2244092.046>
- Tai, C.-H., Hsieh, T.-C., Lee, R.-P., & Lo, S.-F. (2021). Prevalence and Medical Resource of Patients with Diabetic Foot Ulcer: A Nationwide Population-Based Retrospective Cohort Study for 2001–2015 in Taiwan. *International Journal of Environmental Research and Public Health*, 18(4), 1891. <https://doi.org/10.3390/ijerph18041891>
- Wang, H., Li, N., Chivese, T., Werfalli, M., Sun, H., Yuen, L., Hoegfeldt, C. A., Elise Powe, C., Immanuel, J., Karuranga, S., Divakar, H., Levitt, Na. A., Li, C., Simmons, D., & Yang, X. (2022). IDF Diabetes Atlas: Estimation of Global and Regional Gestational Diabetes Mellitus Prevalence for 2021 by International Association of Diabetes in Pregnancy Study Group's Criteria. *Diabetes Research and Clinical Practice*, 183, 109050. <https://doi.org/10.1016/j.diabres.2021.109050>
- Webber, S. (2013). International Diabetes Federation. *Diabetes Research and Clinical Practice*, 102(2), 147–148. <https://doi.org/10.1016/j.diabres.2013.10.013>
- Wilson, L. M., & Castle, J. R. (2020). Recent Advances in Insulin Therapy. *Diabetes Technology & Therapeutics*, 22(12), 929–936. <https://doi.org/10.1089/dia.2020.0065>
- Zarse, E., Knoll, M. M., Halpin, K., Thompson, M., Williams, D. D., Tallon, E. M., Kallanagowdar, G., & Tsai, S. (2024). Recognizing Complications in Youth With Diabetes Admitted With Diabetic Ketoacidosis Versus Hyperglycemic Hyperosmolar State. *Journal of Pediatric Health Care*. <https://doi.org/10.1016/j.pedhc.2023.12.012>
- Zhang, Y., Lazzarini, P. A., McPhail, S. M., van Netten, J. J., Armstrong, D. G., & Pacella, R. E. (2020). Global disability burdens of diabetes-related lower-extremity complications in 1990 and 2016. *Diabetes Care*, 43(5), 964–974. <https://doi.org/10.2337/dc19-1614>