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**PROPER GLYCEMIC CONTROL OF ADULT DIABETIC
PATIENT IN PERIOPERATIVE NURSING CARE. A LIT-
ERATURE REVIEW.**

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ABSTRACT

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Name of thesis PROPER GLYCEMIC CONTROL OF ADULT DIABETIC PATIENT IN PERI- OPERATIVE NURSING CARE. A LITERATURE REVIEW.		
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<p>This study was purposed to gather and present comprehensive information related to nursing knowledge of patients' blood glucose regulation during perioperative treatment. The goal of this study was to fill the gaps in knowledge of perioperative nurses and ensure better outcomes for diabetic surgical patients.</p> <p>This research was conducted as a literature review. The method of this work was deductive content analysis. Research was focused on adult diabetic patients during their perioperative phase of treatment. Reliability was supported by utilizing scientific databases. The whole research process was simplified and represented in text and illustrations in order to preserve its transparency.</p> <p>The results of this study showed that proper and safe regulation of blood glucose levels during all perioperative phases of treatment ensured better postoperative outcomes for diabetic surgical patients. Finland is considered to possess significantly high amount of diabetic people and this amount increases continuously. It was assumed that the amount of elective surgeries experienced by this particular patient group would increase as well. Therefore, nurse's role in administration of appropriate glyceemic control remains valuable aspect of qualified patient care.</p>		
Key words Content analysis, diabetes, hyperglycaemia, perioperative, surgery		

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<p>Tämä työn päämääränä oli kerätä ja esittää kattavasti informaatiota liittyen sairaanhoitajien tietoon potilaiden verensokerin säätelystä perioperatiivisen hoidon aikana. Tämän tutkimuksen tarkoituksena oli täyttää aukkoja perioperatiivisten hoitajien tiedoissa ja taata parempia lopputuloksia diabetesta sairastaville kirurgisille leikkauspotilaille.</p> <p>Tutkimus toteutettiin kirjallisuus katsauksena. Työssä käytettiin metodina deduktiivista sisällön analyysiä. Tutkimus keskittyi aikuispotilaisiin, joilla on diabetes mellitus perioperatiivisen hoidon aikana. Luotettavuutta tuki tieteellisten tietokantojen käyttö. Koko haku prosessi yksinkertaistettiin ja esitettiin kirjoitettuna ja graafisesti, jotta sen läpinäkyvyys säilyisi.</p> <p>Tämän tutkimuksen tulokset osoittivat että sopiva ja turvallinen verensokeri tasojen kontrollointi jokaisessa perioperatiivisen hoidon vaiheessa takasi paremmat lopputulokset diabetesta sairastaville leikkauspotilaille. Suomessa on merkittävän suuri määrä diabeetikoita ja tämä määrän löydettiin nousevan jatkuvasti. Oletettavasti myös elektiivisten leikkausten määrä kyseisellä potilasryhmällä tulisi myös nousemaan. Näin ollen hoitajien rooli sopivan verensokeri tason säätelyssä pysyy arvokkaana asiana laadukkaassa potilaan hoitotyössä.</p>		
Asiasanat Diabetes, leikkaus, perioperatiivinen, sisällönanalyysi		

ABBREVIATIONS

BGL	Blood Glucose Level
BMI	Body Mass Index
DFU	Diabetic Foot Ulcer
DKA	Diabetic ketoacidosis
DM	Diabetes Mellitus
DO	Osteopath
ECG	Electrocardiogram
FPG	Fasting Plasma Glucose
GDM	Gestational Diabetes Mellitus
GLP-1	Glucagon-like peptide -1
HbA1c	Glycated Hemoglobin
HDL	High Density Lipoprotein
IM	Intramuscularly
IV	Intravenously
KCl	Potassium Chloride
KPSHP	Keski-Pohjanmaan Keskussairaala
MBO	Metabolic Syndrome
MD	Licensed Physician
MG/DL	Milligrams Per Deciliter
ML	Milliliters
ML/H	Milliliters Per Hour
ML/MIN	Milliliters Per Minute
MMOLS	Millimoles Per Litre
NaCl	Sodium Chloride
OR	Operating Room
OYS	Oulun Yliopistollinen Sairaala

PAD

Peripheral Arterial Disease

PACU

Post Operative Care Unit

WHO

World Health Organization

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1 INTRODUCTION

Diabetes mellitus (DM) is known for the public as a branch of diseases with general symptoms experienced as abnormally high level of blood glucose. It is not contagious, which means that it cannot be transferred among people through viruses or bacteria. There are three core types of DM distinguished nowadays: type one and type two along with gestational diabetes mellitus (GDM). It is estimated that nowadays there is approximately 382 million people with diabetes, among which around 46% of cases remain undiagnosed. Moreover, DM is considered to be enormous financial and health-related burden for any society and its inhabitants.

Currently the amount of diabetic people undergoing invasive treatment is constantly increasing. Therefore this study is purposed to gather and present comprehensive information that considers nursing knowledge of patients' blood glucose regulation during perioperative treatment. At the same time, the goal of this research was to improve the knowledge of perioperative nurses that would lead to better outcomes for diabetic surgical patients via administration of more qualified nursing care. This topic was chosen because of authors' personal interest and lack of accessible guidelines. It particularly focused on adult diabetic patients undergoing elective surgery.

Glycemic control is considered to be a significant contributor to postoperative outcomes of diabetic patients. In addition, untreated hyperglycemia was found to be the main cause of several post operative complications. In perioperative phase it is strongly associated with such complications as poor wound healing, higher risk of acquiring post-operative infections and increased require for pain medication. Acquired complications can result in extended hospital stay that demands serious financial aid from the government. Therefore, hyperglycaemia related risks considered on time may decrease prevalence of post-operative complications. It may significantly save hospital limited resources. Since the lack of vital information may

result in poor care administration and even lead to severe complications, the current ongoing research is focused on producing more precise and beneficial data. The researchers aimed to collect and produce well-balanced and organized study that was based on properly selected and reliable material for health care professionals.

2 PERIOPERATIVE CARE OF DIABETIC PATIENTS

2.1 Prevalence of diabetes

At the moment approximately 382 million people have diabetes and around 46% of this group remain undiagnosed. It is estimated that the disease continues to grow, rising over 592 million within 25 years. The age group involves people from 40 to 59 years old, and 80% are citizens of low or middle income countries. Currently the disease increases rapidly, while the second type of diabetes takes the first place. By the year 2035 the amount of people with type II DM will increase by 55%. In year 2013 diabetes caused 5.1 million deaths and it was estimated that every six seconds somebody dies because of diabetes. In addition to the above mentioned numbers, there is annually around 21 million GDM cases which accounts 17% of all births in 2013.(International Diabetes Federation 2013.)

Apart from global perspective, situation in Finland stays no less critical. For instance, Ilanne-Parikka, Rönnemaa, Saha & Sane (2015), claimed that currently around 350 000 of Finnish inhabitants have DM. Approximately 50 000 them were diagnosed with first type of DM, and the rest of the group had second type. Moreover, it has been investigated that the amount of type 1 DM will annually increase in numbers by 3%. The raise is based on the aging of Finnish population and gradually increasing expectancy of life. As a matter of fact, Diabetes Mellitus is clearly more common in Eastern than in Western Finland. It was highlighted that reasons behind proliferation of diabetes are similar in both developed and developing countries. Even though, the second type of diabetes is mostly associated with elderly people, during the last years it has become a great problem for teenagers as well. In addition, Finland has the highest incidence of diabetes all around the world. Unfortunately, the cause of the problem still remains under investigation. (Ilanne-Parikka et al. 2015, 10.)

2.2 Identifying undiagnosed diabetes preoperatively

Diabetes Mellitus is a group of metabolic diseases characterized by increased levels of glucose in the blood (hyperglycemia) resulting from defects in insulin secretion, insulin action, or both. There are several types of Diabetes Mellitus, such as type 1, type 2 and GDM. In addition, there is a variety of certain sub-types such as monogenic diabetes syndromes, diseases of exocrine pancreas and drug- or chemical-induced diabetes. (Standards of Medical Care in Diabetes 2015.) Nonetheless, this research focuses more on the first and second types of DM along with GDM as they are mostly encountered in perioperative nursing care.

Type 1 diabetes means that secretion of body insulin is insufficient which causes high blood glucose levels. It occurs due to the destruction of pancreatic β -islet cells as a result of autoimmune response. This results in destroyed ability of pancreas to produce insulin that is vital for the maintenance of normal glucose level. It usually starts before the age of 30 with rapid onset. It is assumed that person's genetics, immunity and environmental factors are most probable causes for triggering this type of diabetes. People suffering from this type of diabetes are in constant need of insulin, lack of which will eventually lead to inevitable death. (International Diabetes Federation 2013, 22.)

In comparison to DM type 1, majority of diabetic patients belong to second type of DM. It accounts between 90 to 95% of all cases. Alternatively to other types, people develop the disease after 30 years of age and in most of the cases they possess abdominal obesity. Unfortunately this type of diabetes is becoming more common among people of younger age, because of their high Body Mass Index (BMI). Type 2 DM can be characterized by such concepts as insulin resistance and impaired insulin secretion. Even though insulin secretion in the body is affected by the diabetes, there is still enough insulin secreted by pancreas needed for fat breakdown and production of ketone bodies. The majority of people do not even realize the presence of the disease. Around in 75% cases of the DM type II

are diagnosed accidentally. By this time the disease may have developed during many years and caused severe damage to person's health (Smeltzer, Bare, Hinkle, Cheever 2010, 1198-1199.)

According to Smeltzer et al. (2010), Gestational Diabetes is referred as any degree of glucose intolerance that has begun during pregnancy. In comparison, Diabetes Care (2015), reveals that it is usually diagnosed during second or third trimester of pregnancy. This condition is based on the secretion of placental hormones which afterwards leads towards insulin resistance. The prevalence accounts for 14% of all pregnancies. Commonly, blood glucose levels return to normal levels after delivery, despite some women who have a high risk of developing type II DM later in their lives. (Diabetes Care 2015.)

2.2.1 Predisposing factors of diabetes

Poor theoretical background of health care providers may lead to adverse outcomes of patient care. Concurrently, insufficient diagnose of DM among patients is correlated to higher risk during admission. As many hospitals experience lack of comprehensive guidelines, it may result in administration of insufficient glycemic control which in turn causes the higher risk of morbidity and infection. (Association of Surgeons of Great Britain and Ireland 2012.) Therefore, the nurse should possess sufficient knowledge about risk factors of DM that may be applied during perioperative practice.

There are certain factors predisposing the onset of Diabetes Mellitus. Among risk factors are the age over 45 years, obesity, Body Mass Index over 27, especially abdominal obesity, family history of diabetes, smoking and stress. Equally, hypertension, High Density Lipoprotein (HDL) level that is less than 35 mg/dL or delivery

of a newborn weighting more than four kilograms are essential reasons to consider. (Smeltzer et al. 2010, 1197-1198.)

Almost all of these previously mentioned symptoms can separately cause diabetes, but the combination of such conditions as abdominal obesity, hypertension, low HDL levels, increased plasma glucose and high serum triglycerides are together differentiated as a metabolic syndrome (MBO). MBO in turn causes insulin resistance which results in increased amount of glucose in blood as pancreas cannot produce enough insulin. Approximately 80% of Finnish citizens with DM type II have MBO and one third of people with DM type I have this condition (Ilanne-Parikka et al. 2015, 79.) In addition, ethnicity and race play a vital role in developing of diabetes. For example, in the United States of America, people originating from African, Hispanic, Asian Americans or Pacific Islanders are exposed to DM in higher rates than the rest of the population. (Smeltzer et al. 2010, 1198-1197.)

2.2.2 Significance of blood glucose regulation

It is crucial to diagnose possible diabetes on time, as it will prevent severe health complications, improve person overall wellbeing and decrease perioperative morbidity and mortality rates. When diabetes is suspected, there is a certain path the patient and the doctor should undertake. (Scobie 2014, 12.) Fasting plasma glucose (FPG) level of non-diabetic person is considered to be ≤ 6 millimoles per litre (mmol/l). Hence, impaired fasting glucose is the first clinical manifestation of diabetes. In case of glucose being ≥ 7 mmol/l after eight hours of fasting, the person can be diagnosed as a diabetic. Another possible way to diagnose is performing glucose tolerance testing. In this case a person is given a drink containing 75g of glucose. (Ilanne-Parikka et al. 2015, 13-14.)

Interpretation of the test is based on the glucose level after two hour break. The response of > 11.1 mmol/l refers to diabetes. Normal value in this test remains below 7,8 mmol/l. (Ilanne-Parikka et al. 2015, 13-14.) In 2009 World Health Organization (WHO) accepted that diabetes can be confirmed also from glycated hemoglobin (HbA1c) sample, which investigates how much glucose is attached to red blood cell protein. The greater the amount of blood glucose approximately is, the bigger is the percentage of HbA1c. Normal value is below or accounts for 6.5%. (Scobie 2014, 12-14.)

2.2.3 Possible diabetic complications leading to surgery

It has been proven that diabetes activates the variety of different changes in human organism that are induced by altered glucose balance. There is a possibility to prevent at least half of all comorbid diseases if blood sugar is maintained within recommended values. Moreover, adequate treatment of DM is essential in order to maintain good quality of life. Hence, the diabetic person must have permanent care relationship with the diabetes specialist nurse and the physician. In addition to above listed facts, diabetic patient should take prescribed medication regularly, consume reasonable amount of food and make healthy lifestyle modification. Regular monitoring of blood glucose levels, blood pressure, weight, condition of feet and mouth is expected from the diabetic person. Undoubtedly, health care system assists patients in the management of the disease. However, it is important that the person participates in his own treatment. (Ahonen, Blek-Vehkaluoto, Ekola, Partamies, Sulosaari & Uski-Tallquist 2012, 573, 577.)

Patients with DM require different elective surgeries or procedures, also depending on comorbid illnesses they suffer from. For instance, angioplasty, bypass surgery, amputations (toes, feet), eye surgeries (such as cataract removal, repair of retinal detachment, vitrectomy), carpal tunnel decompression and in some cases emergency surgeries are the most common. These operations require thorough

planning preparations and in some instances acute care is needed. Moreover, person's overall health has to be in a good physical condition which enables a positive surgical outcome. Generally, preliminary medical check-up has to be initiated before a person with DM undergoes any surgical operation. In addition, assessment of the DM is based on clinical diagnostics and how stable the blood sugar levels are. (Dunning 2009, 260-261.)

Diabetes can cause numerous health complications, while diabetic foot ulcer (DFU) is considered to be one of the most difficult ones to experience. It affects approximately 15% of diabetic patients. Moreover, such condition is associated with infections, neuropathy and ischemia that become chronic and recurrent and even may eventually disturb person mental health. In variety of cases, benign foot ulcer may lead to lower limb amputation after certain period of time. It was estimated, that around 38% of all amputations are strongly connected to DM. In addition to DFU that may cause amputation, DM triggers vasculopathy, immunopathy and neuroarthropathy. (Singh, Pai, Yuhhui 2013.)

Variety of health complications triggered by DM cause impaired blood supply to patient extremities, especially lower limbs. For instance, another important risk factor for amputations and ulcerations is peripheral arterial disease (PAD). It is a consequence of atherosclerosis in peripheral arteries, eventually leading to blockage of distal arteries and arterioles, hampering blood circulation and deprivation of tissues' sufficient supply of oxygen and nutrients. This disease diminishes wound healing and can eventually lead to gangrene. (American Diabetes Association. 2003.)

2.2.4 Risk of perioperative complications

Diabetes can cause the need for several surgical procedures and diabetic correlated morbidity is higher than among non-diabetic people. In addition, surgery and anaesthesia affect different metabolic and endocrine responses that contain the releasing of counter-regulatory hormones and glucagon, which will lead to insulin resistance, hyperglycemia, gluconeogenesis and neutrophil malfunctioning. Moreover, surgical operation activates a stress response that develops endocrine, metabolic and long-term symptoms. Stress generates hyperglycemia, which in turn causes insulin resistance. Without control this stress raises the risk for diabetic (DKA) and other complications. (Vann 2009 & Burton, Nicholson, Hall 2004.)

Stress during surgery and induced anaesthesia impact different physiological processes in patient organism. Especially involved are cardio-vascular and metabolic systems along with fluid and electrolyte levels that in turn have a direct impact on patient health. For instance, there is a rise in a cardiac output, heart rate, blood pressure and elevated oxygen demand. In addition to above mentioned, levels of sodium and water are declined and there is a high blood level or hyperglycemia. Wound infections, decreased amount of urine and hypotension are not less common features of surgery-induced stress and anesthesia combination. All of these conditions are correlated with a high risk for postoperative complications. (Singh 2003.)

Obesity is related to the functional risk and to the metabolic consequences of surgery. This needs to be taken into consideration when a patient is placed on the operating table. The functional residual capability and expiratory reserve volume in the respiratory system may be weakened because of the weight on the chest wall and the shifting of diaphragm. In a case of the severe overweight obstructive sleep apnea and hypoventilation occur. Those can lead the patient to have aspiration pneumonia. Several cardiac changes will increase the risk of heart failure and insufficient oxygenation in tissues. The risk for pressure ulcers grow significantly

because of weight and the low activity level expose a patient in danger of having venous stasi and emboli. The need for nutritional treatment may be overlooked in overweight persons which can cause protein deprivation because protein and carbohydrates are mostly used as energy sources instead of fat. Hyperglycemia hinders white cell function and increases coagulability. (Dunning 2009, 261-280.)

2.3 Perioperative phase of treatment

As this thesis is focused on glycemic control of perioperative patients with DM, it is suitable to define each of these stages and the role of different medical workers during each phase of the treatment process. As it was mentioned previously, perioperative phase is further subdivided into three main subparts. Preoperative care includes three different stages, which are pre, intra and postoperative phase. Preoperative phase starts when the decision from surgical intervention is made and it ends when patient is brought into the operating room (OR). The intraoperative phase begins with patient lying on the operating room table and this phase ends when he is transferred to postanesthesia care area. This place literally begins the postoperative phase and it will end with a follow-up evaluation in a clinical environment or patient discharge. Characteristically, each phase contains several activities that nurses perform according to the nursing process guide. (Collaborative Care Guidelines for Perioperative Nurses. 2013)

2.3.1 Roles of medical personnel in the operating room

As this thesis concentrates its attention on glycemic control of perioperative diabetic patients, it is reasonable to show nurse's role as integral part of surgical team. In addition, co-operation and teamwork are highly respected during this phase of treatment. Successful teamwork in turn will ensure better patient outcomes. Usually, the operation team includes surgeons, anaesthesia personnel, nurses, technicians and other professionals participating in surgery. Within the limits of this thesis, the term "nurse" was referred as health care professional that provides care to diabetic patients within their perioperative stage of treatment, starting with preparation to surgical procedure and finishing with postsurgical care. (WHO 2008.)

The circulating nurse, who is a qualified registered nurse, coordinates the care of the patient in the operating room. The circulator assists on the patient positioning, prepares the patient's skin for operation, manages surgical specimens while anticipating the needs of the surgical team and documents the intraoperative events. When the surgical team uses evidence-based practices which are tailored to the specific case, it will result in optimum patient care and improved postoperative outcomes. In this leadership role the circulating nurse manages the operating room while protecting the patient's safety and health by monitoring the tasks of the surgical team. (Goldman 2008, 5-8.)

The scrub nurse provides supplies and sterile instruments to the surgeon during the operation. In addition, this includes performing of surgical hand scrub, arranging the sterile stable, preparation of sutures, ligatures and special equipment (for example, laparoscope). The scrub nurse anticipates which instruments and supplies will be required. In addition to above mentioned, such non-technical skills as communication, teamwork, situation awareness, leadership, and proper decision-making are extremely important to develop. Those are applied on practice in order

to provide high quality care that is aimed to improve overall performance of surgical team and significantly benefit patient outcomes. (Mitchell & Flin 2008.)

Although this research is written from a nursing point of view, it is essential for nurses to realize the surgeon role in the operating room. This ensures that every worker performs their own role in the multiprofessional team. The surgeon is the one who performs the surgical procedure and heads the rest of the team. Surgeon is a licensed physician (MD), osteopath (DO), oral surgeon (DDS or DMD), or podiatrist (DPM) who is specially trained and qualified. An anaesthesiologist is a physician who is educated in the art and science of anaesthesiology. He will assess the patient before the operation, select the anaesthesia and administer it. Furthermore, he performs the intubation if needed, copes with technical problems that are related to the administration of anaesthetic agent while supervising the patient's condition during the operation. (Smeltzer et al. 444-445.)

Before the operation, the anaesthesiologist or anaesthetist visits the patient in order to perform an assessment, give information and answer possible questions that patient may have. The topics that are discussed are recognized as anatomic abnormalities that could make airway management challenging, possible previous reactions to anesthetic medication and type of anesthetic agent that will be administered. Later, when the patient comes into the operation room, the anesthetist or anaesthesiologist assesses the patient overall condition immediately before administering any anaesthesia. Finally, when anesthetic agent is administered, the patient's airway is maintained through oral intubation, intranasal intubation or a laryngeal mask airway. During the operation, the anesthetist or anaesthesiologist monitors patient's overall condition and all his vitals. (Smeltzer et al. 444-445.)

3 RESEARCH QUESTION

Information obtained from this study will provide comprehensive and well-organized data based on delivering effective and qualified care for adults with DM. The authors made a decision to narrow the question consistently in order to produce well-organized and current information that reflects the nursing point of view. In general, this study reviews the previously conducted research concerning the topic and utilizes the most relevant sources about role of nurse during proper glycemic control in perioperative patient's care. Moreover, this study considers hyperglycaemia as another important subject that is closely connected to the literature review. As a result, this study is meant to improve the knowledge of nursing care professionals which may result in improved quality of nursing care received by diabetic patients undergoing surgical procedure.

The question posed by this literature review is the following:

1. What do nurses have to know about the significance of blood sugar regulation during the perioperative phase of treatment?

4 METHODOLOGY

In order to provide latest information on the topic concerning blood glucose control of diabetic perioperative patient the authors decided to choose the literature review as a suitable method. There were certain limitations, which formed the frame that would shape the research and data collection process. In addition, strict criteria were set for the sources that could be used and those same parameters defined how search was performed in various databases. All of these aforementioned facts would guarantee that the research is valid and up to date.

4.1 Literature review and sources

According to Burns & Grove (2011), literature review gathers the contemporary theoretical and scientific knowledge related to specific problem that enables to combine what is widely accepted and still unknown at that moment. It assists professionals in keeping current progress in their work by means of constantly searching the available updated literature on topics related to their specific interest. Literature reviews used in conduction of this survey should be based on scientifically proved knowledge. Published studies supply a baseline for the studied dilemma. Previously mentioned reviews demonstrate currently existing information on the research question, assist in recognition of gaps in this current survey, and offer existing study as a baseline to utilize already approved information in order to broaden the particular subject. The range of literature review has to be wide enough to present the research problem and include only the most appropriate sources for the studied subject. Sources used by the researchers have to be concurrently related and prevailing. (Burns & Grove 2011,189-190.)

There are two predominant types of sources that were previously mentioned in the literature review guidelines. They are theoretical and empirical. Empirical means that the framework knowledge which is developed from a research is data-based and reliable. In this literature only scientifically approved databases available from Centria University of Applied Sciences were preferred. Primary sources are referred as data-based publications written by one or multiple authors who have organized the research. In addition, primary source is written by an author who has refined the theory or conceptual content. In contrary, secondary source quotes or compiles information from the primary source. In this literature review primary sources were utilized. The main challenge with secondary sources stands for another author's interpretation which can be biased or misunderstood. Therefore secondary sources were excluded from this work. Finally, this theoretical literature review contained concept analyses, theories, models and conceptual frameworks that overlap previously chosen dilemma of perioperative blood glucose monitoring. (Burns & Grove, 2011, p. 188-189.)

4.2 Data Collection

The collection of data relevant to this literature review was performed comprehensively. In the beginning of the working process, the main keywords related to the chosen topic were identified as diabetes, hyperglycaemia, perioperative and surgery. As a result, this research was conducted subsequently based on above mentioned words. The data collection was performed by the means of scientific journal databases such as Science Direct, SAGE journals online, EBSCO and Terveystietti. Information found was strictly time-limited and varying between years 2009 to 2015. The search of sources was performed in English and Finnish respectively. Furthermore, information collected was focused on the nursing role of proper glycemic control adjustment during perioperative patient care. This study had several limitations. First, adult people suffering from first and second type of DM who used insulin were selected. Second, administration of perioperative nursing care associated with elective surgeries was also highlighted in this literature

review. The detailed process of data collection of this study is represented below in the Table 1.

TABLE 1. Inclusion and exclusion criteria for information selection.

Inclusion criteria	Exclusion criteria
Scientific evidence-based literature	Not reliable sources
Articles published within the period from 2009 to 2015	Articles published before 2009
Studies available in free full text	Studies without full text
Articles written in English and Finnish	Articles written in other languages
Literature concentrating on nursing and patient's point of view	Literature aimed at other health care professionals or relatives
Studies relevant to this literature review	Studies not relevant to this literature review
Studies concerned on nurses role in perioperative management of glycemic control regarding insulin dependent adult patients with DM type 1 and 2 included	Studies, concerned other age groups, other types of DM or not-related phases of care

Based on the inclusion/exclusion criteria, the authors performed data search using the chosen keywords. Table 2 represents the final results of the performed search. Altogether, the authors received 14 reliable sources that afterwards were utilized in order to create the proper answer for the chosen study question. During the process of inquiry, the authors faced a need to adjust chosen keywords, so

enough information would be acquired. In some cases, the combination of chosen keywords was used. However, sometimes only one key word that responds to the research question was used.

TABLE 2. Results of data search and selection.

DATABASE	KEY WORDS	FINDINGS	CHOSEN
EBSCO host	Diabetes, peri-operative	99	5
Sage Premier	Diabetes, peri-operative, hyperglycemia	426	2
Science Direct	Diabetes, peri-operative, hyperglycemia	428	5
Terveysportti	Diabetes, leikkaus	215	1
Suomen Lääkäri-lehti	Diabetes, leikkaus		1

4.3 Reliability and Validity

Reliability and validity are integral parts of any nursing research. They are exactly those methods of data collection and tools applied within scientific study that assist in omitting prejudice and bias that may arise during actual data collection. Presence of reliable and valid data determines the credibility of research findings acquired by the researchers afterwards. (Moule & Goodman 2009, 184-186,349). Krippendorff (2004) claims that reliable data remains steady regardless of variations undergone during research process. Accuracy, precision and stability are the main components of reliability (LoBiondo-Wood & Haber, 345.) According to Lo-

Biondo-Wood & Haber (2006), validity is a research instrument that accurately measures what was intended by the researchers. Validity of certain content analysis is obvious when the result of the research can confront conclusions of newer studies, opposing theories, considerations or separately accessible information.

Validity defines whether the tool used in the collection of information is accurate and performs desired mission, while reliability is identified as consistency of applied in the research tool (Moule & Goodman 2009, 184-186,349.) The reliability of this literature review was maintained by the means of choosing evidence-based updated sources that strictly depended on established inclusion/exclusion criteria. Additionally, all the sources were gained from scientific databases. Validity of this study was assured as all of the articles included in content analysis correctly responded to the chosen question.

4.4 Content Analysis

The research method for this thesis was content analysis. It is reliable and valid scientific tool that is used for the production of conclusions that can be duplicated from other texts. Content analysis has its own conduction process. (Krippendorf 2004, 18.) By the time the data needed for further performance of literature review is successfully gathered, organized and divided according to the study needs, it becomes significantly easier to choose the most appropriate sources from the whole collected data. Furthermore, the work is recommended to be started dealing either with textual or visual data first. Content analysis was chosen to become the next step in obtaining the key aspects from already gathered information. It was advised that the researcher may use more appropriate and suitable ways of subsequent levels of data organization. (Moule & Goodman 2009,349.)

As conducted search provided the authors with large number of pages, it became relatively challenging to process the whole data manually. Therefore, the authors applied the specific technique of content analysis in practice. This technique varies significantly depending on the researcher's own preference. This type of data retrieval and handling was closely connected to Miles and Huberman's way of analyzing through interpreting and conclusion-making which is based on using key words and reading transcripts of data. (Moule & Goodman 2009, 349.) First, the whole gathered data was highlighted and coded according to the main idea. Consequently, the most appropriate information was reconnected in-between and reorganized into separate categories: pre-, intra- and postoperative phase. During the next step, the authors simplified the original sentences and compacted them even into smaller word combinations. It allowed in keeping the precise and clear idea that supported the original data content. The researchers have represented the process of content analysis in order to maintain research transparency.

TABLE 3. Description process of the content analysis: preoperative phase of treatment.

The source	The original sentence	Simplified sentence	Final version
5. Holt 2012	Therefore, it is essential that accurate assessment of the patient is undertaken before surgery to identify possible complications.	Preoperative patient assessment is done in order to detect complications.	Patient assessment
2. Rutan & Sommers 2012	When evaluating a patient's blood glucose level, it is important to know whether the patient is taking any antidiabetic medications.	History of antidiabetic medication will give nurse understanding of patient's blood glucose goals.	Antidiabetic medication evaluation
2. Rutan & Sommers 2012	If so, knowledge of the last dose, onset, peak, and duration of that medication can give the nurse insight into the direction that the blood glucose level is like-	Acquired knowledge about patient's diabetic history assist in prediction of further glycemic	Evaluation of earlier blood glucose levels.

	ly to follow.	control.	
2. Rutan & Sommers 2012 9. Boreland, Scott-Hudson, Hetherington, Frussinety & Slyer 2015.	Furthermore, patients who have central visceral obesity are particularly prone to insulin resistance. DM, obesity, high preoperative serum glucose levels (> 200 mg/dL or 11.1 mmol/l), and female gender are among the risk factors for surgical site infection following CABG surgery.	Central visceral obesity increases risk of insulin resistance. In addition, acute pain, loss of blood, and long surgery may lead to low glucose disposal. Risk of surgical site infections was correlated with preoperative DM, obesity, high preoperative serum glucose levels and female sex.	Identifying of possible risks of hyperglycemia
2. Rutan & Sommers 2012	Patients without known diabetes can demonstrate symptoms that should alert the perioperative nurse to the risk of hyperglycemia or developing perioperative hyperglycemia. This symptoms may include somnolence, fruity breath, itchy skin, and confusion.	Nurse should be able to observe for high blood glucose symptoms. They are fruity breath, itchy skin, confusion and sleepiness.	Distinguishing of obvious hyperglycemia symptoms
2. Rutan & Sommers 2012	Identifying factors that can compound stress hyperglycemia is an important part of nursing assessment, judgment, and perioperative care. Corticosteroids, catecholamines, anabolic agents, and other medications increase blood glucose levels.	Certain meds increase BG levels, such as corticosteroids, catecholamines and anabolic agents.	Spotting of hyperglycemia-inducing medication

The next step in this content analysis included numbering of all chosen articles. The authors once more checked all the articles for detection of any similarities or controversial ideas among them. Every time the similar ideas were noticed the

authors wrote the article number in the below presented Table 4. It was the beneficial tool that simplified the performing of data processing and provided an enormous contribution into researcher's time management. As a result, the researchers reorganized the gathered data into the answer that was presented as a graph model (see APPENDIX 1).

TABLE 4. Process of data division into subcategories.

Pre-operative phase	Intraoperative phase	Postoperative phase
Patient assessment/10,2,1,5	Blood glucose monitoring/6,1,2,14,12,8	Monitoring of vital signs/2
Antidiabetic medication evaluation/2	Adjustment of insulin infusion rate/6,8,9	Blood glucose monitoring at regular intervals/2,1,14,12,8,9
Evaluation of earlier blood glucose levels/2	Avoiding too tight glycemic control/13,1,8	Discontinuation of iv-insulin infusion/6,5,9
Identifying of possible risks of hyperglycemia/2,1	Realize severity of surgery and hyperglycemia/13	Beginning of subcutaneous insulin/6,8
Distinguishing of obvious hyperglycemia symptoms/2	Consider individual target glucose levels/10	Awareness of possible risks of hyperglycemia/2,1,4
Spotting of hyperglycemia-inducing medication/2	Confirmation of equipment availability/1	Alertness to hyperglycemia risks/2,1,9,4
Evaluation of recent blood tests/1	Affirming presence of required insulin/1	Awareness to hyperglycemia complications/2,1,12,5,9
Obtaining blood glucose sample/3,2,14,12,10,8,5,4		Alertness to complications caused by hyperglycemia/1
Starting intravenous insulin glucose infusion/6		Patient counseling for insulin self-care/13,10
Nurse expertise and knowledge/5,8 Good cooperation among perioperative staff/1,2,5 Commitment to work/1,13 Patient safety based on glycemic control/12		

5 ETHICS

Any nursing research is based on honesty and integrity. The first ethical step usually includes the identification of the proper study topic that ends with the publication of the study. All the parts of conducted research should be supported with ethical background that is reinforced by the current presiding codes and concepts. At the same time, ethical codes and regulations which are referred as the guide in different parts of the research methodology have undergone significant changes. Hence, the sources concerning ethical background need to be valid and updated as well. However, along with ethics, every study has its own risks and benefits to overcome. It is possible to reach the balance between them by evaluating the amount of advantages and risks beforehand. In order to reach the optimal outcome the researcher should try to decrease existing risks and increase the benefits. (Burns & Grove 2009, 184.)

At one hand, the aim of this research was to produce thorough scientific material which can be archived only by reliable conduct, publication of good quality survey and proper reporting. On the other hand, healthcare professionals who are critically appraising published studies, inspecting studies for their own cause or conducting their own research have to be cautious to acknowledge whether the rights of research participants or subjects are guarded in the process. These human rights were preserved as the rights to self-determination, privacy, anonymity and confidentiality, proper treatment and defence from discomfort and harm. (Burns & Grove 2009, 189-190.)

There were also limitations in this scientific research just as moral and ethical issues and problems of complexity of human being. First of all, moral limitations mean that research cannot offer answers to questions that are dependent on human values. Human complexity results in individuality and originality of the human

being in personality, social life, values and health status. In addition, general limitations result from the fact that virtually every research contains inaccuracies. However, when composing this literature review only reliable sources were used while unreliable or biased were successfully discarded from the survey. In addition, there were two researchers who conducted this literature review. The workload was divided equally between both the participants and co-operation and teamwork was respected while conducting this research. The authors stayed objective and focused directly on the chosen subject.

6 RESULTS

6.1 Glycemic control in preoperative care

This literature review included 14 articles after careful search and exclusion process. Authors had a specific frame when data analysis was conducted. All gained data was organized according to three different categories. They were pre-, intra-, and postoperative phases of patient care. First, all the articles utilized in this literature review were numbered in order to facilitate the processing of gathered data. After the process of grouping and division of information, the results were divided according to three above listed phases of care that adult diabetic patient undergoes before surgery. Particularly, this content analysis was focused on nurse's role in patient's glycemic control during administration of perioperative care.

During this content analysis it was revealed that diabetic patients and patients with a risk for hyperglycemia require preoperative nursing evaluation. In order to clarify that Kittelson (2009) defines hyperglycemia as a typical reaction caused by critical illness and metabolic stress that induces inflammation, susceptibility to infection and multi-organ dysfunction. Specifically, blood glucose levels increase due to bodily injury and stress associated with surgical interventions. In the past, high blood glucose levels were treated only if the result was over 200 milligrams per deciliter (mg/dl) or (11.1 mmol/l). Such condition is known as diabetes of injury (Rutan & Sommers 2012.) In addition, Lee et al. (2013), Rutan & Sommers (2012), Kittelson (2009), and Holt (2012) mentioned the importance of preoperative patient assessment. This evaluation primarily includes the assessment of patient metabolic status and corresponding co-morbidities. For example, these additional disorders may include cardiovascular disease, peripheral and autonomic neuropathy or nephropathy.

Another important aspect of nursing assessment is the identification of factors causing hyperglycemia. For instance, central visceral obesity increases the risk of insulin resistance. Hence, the nurse should be able to observe high blood glucose symptoms. They are fruity breath, itchy skin, confusion and sleepiness (Lee et al. 2013, Rutan & Sommers 2012, Kittelson 2009, and Holt 2012.) Moreover, Jämsen et al. (2012) also mentions that if the patient is well-educated about his disease and its connection to surgical complications, he may become more motivated to pay attention to personal lifestyle habits and his diabetic treatment.

Other important findings concerned patient's medication self-care. Rönnemaa (2015) reveals that it is important that a diabetic person undergoing surgery knows how he has to proceed with his medication before arriving to the hospital. If the patient has not received any guidelines beforehand, he is advised to contact the particular ward. In addition, Rutan & Sommers (2012) reminded that information concerning the history of the patient's antidiabetic medication will give the nurse the understanding of the patient's blood glucose goals. Moreover, it is important to identify certain medication that are known to increase BG levels, such as corticosteroids, catecholamines and anabolic agents (Rutan & Sommers 2012). Furthermore, Kittelson (2009) mentions the importance of becoming familiar with the patient's laboratory results. The nurse should obtain baseline blood glucose levels and focus on plasma glucose, pH, creatinine, blood urea nitrogen and electrolytes. (Kittelson 2009.)

As a matter of fact, patient's glycemic control can be improved already in the preoperative phase. It is suggested to improve the blood glucose levels before elective surgery is performed. The amount of HbA1c should be less than 9,0% or, if possible, below 8,0%. Fasting blood glucose levels and those before meals should be around 5-10 mmol/l and levels after food consumption have to be less than 12mmol/l (Rönnemaa 2015.) Before the scheduled surgery the glucose balance should be at least on satisfactory levels. Moreover, initial blood glucose test is compulsory for all patients no matter of existing diseases. HbA1c is taken as

well. If the result is more than 9%, the nurse contacts the doctor.(Rönnemaa 2015.)

Equally important is that the surgery may also be postponed due to high BGL. In addition, acute pain, loss of blood, and long surgery may lead to low glucose disposal. (Rutan& Sommers 2012.) However, Jämsen et al (2012) and Rollins, Varadhan, Dhatariya and Lobo (2015) claim, that HbA1c is not a sign of possible surgical infection risk afterwards. Moreover, Rönnemaa (2015) recommends that in a case of the major operation a diabetic person is admitted to the ward one day before the operation and in majority of the cases a physician who induces the anaesthesia will meet the patient. There are two alternative ways to treat surgical patient who receives insulin treatment. Most common one is that insulin is not taken as subcutaneous injection on morning of surgery, but rather as insulin and glucose intravenous (IV) infusion. (Rönnemaa 2015.)

6.2 Intraoperative phase

Rönnemaa (2015) suggests that the same surgical operations can be implemented both to patients with diabetes and to non-diabetic patients. However, as it was highlighted, the results of surgery are dependent on blood glucose balance and possible lifestyle changes (Rönnemaa 2015.)According to Coan, Schlinkert, Beck, Haakinson, Castro, Schlinkert &Cook (2013), intraoperative blood glucose monitoring was insufficiently conducted in comparison to pre-and postoperative phases of care. However, as it is stated by Lee et al. (2013), target blood glucose levels should be set individually. As a result, it might postpone appropriate management of hyperglycemia that leads to excess BGL after surgery.

In the contrary, Rönnemaa (2015) noted that the management of diabetes during the surgery depends on what type of diabetes the patient has, its treatment and what kind of operation is planned. The management of blood glucose during surgery varies between different hospitals. Common practise is that anaesthesiologist will give instructions on diabetes treatment for the whole perioperative time (Rönnemaa 2015). At the same time, Rutan & Sommers (2012) warn that tight glycemic control performed earlier produced hypoglycemia that further triggered negative patient outcomes. In addition to tight glycemic control, Kittelson (2009) reminds that hypoglycemia may arise from poor nutrition of the patient during perioperative phase of treatment.

Furthermore, Rönnemaa (2015) claims that mildly high blood sugar levels are usually not dangerous during surgery. Aforementioned author also discusses two different methods on how to organize patient's glycemic control. Most common option is that insulin is not taken as subcutaneous injection on morning of the surgery, but rather as insulin and glucose IV infusion. There exist various methods for medication dosing as well. Quite common one is to give 5% glucose 120 milliliters per hour (ML/H) (or alternatively 10% glucose 60ml/h) and half the amount of insulin that patient is consuming daily, diluted to 500 milliliters (ML) of Sodium Chloride (NaCl) that is infused 30ml/h. Blood glucose is followed hourly, and infusion speed is alternated if needed. Another, more older method is to give half of the needed morning insulin portion, then start a 5% glucose infusion and follow glucose rates hourly. Short acting insulin is given intramuscularly (I.M.) if necessary. (Rönnemaa 2015.)

What is more important, Rönnemaa (2015) claims that in a case of the patient with type two diabetes who is treated with evening insulin and tablets, tablets are given as it is previously prescribed. In addition, aforementioned glucose and insulin infusion can be administered in the morning, when the amount of three fourths of evening insulin is diluted to 500ml of NaCl. When the glucose and insulin are given simultaneously as infusion, the serum's potassium content can decrease significantly. For this reason the potassium can be added in advance to glucose infu-

sion. When 10% infusion is used, 10 mmol/l of potassium chloride (KCL) is added. Potassium rates need to be followed every two to four hours during the infusion (Rönnemaa 2015.)

6.3 Postoperative treatment

Kittelson (2009), Rutan & Sommers (2012) and Sadoskas, Suder, & Wukich (2015) describe how diabetic and non-diabetic patients are prone to experience abnormal glucose levels during the surgery and may experience poor surgery outcomes. Majority of authors mentioned that untreated hyperglycemia causes post-operative complications, namely Kittelson (2009), Rutan & Sommers (2012), Shah, Apsey, Stearns, Schlinkert, Seifert, & Cook (2014), Holt (2012) and Boreland, Scott-Hudson, Hetherington, Frussinetty & Slyer (2015). In those articles they have described about how surgical patients are exposed to the greater risk of hyperglycemia and complications triggered by it. Among those are infection, morbidity, mortality and the length of stay at hospital. Increased blood glucose may lead to impaired wound healing as well. In addition, diabetic patients are prone to cardiac arrhythmia, cerebral vascular accidents and acute renal failure (Kittelson 2009; Rutan & Sommers 2012; Shah et al. 2014; Holt 2012 and Boreland et al. 2014.)

Furthermore, Sadoskaset al. (2015), mentioned how peripheral neuropathy, HbA1c $\geq 8\%$, fasting serum glucose ≥ 140 mg/dL (7.8 mmol/l) and history of DM more than 10 years increase the risk of postoperative hyperglycemia. Moreover, Jämsen et al. (2012) stated that stress hyperglycemia can occur during the surgery and reach its peak during the two postoperative days. In case diabetes is treated poorly, it will result in the higher risk of stress hyperglycemia. However, Vilatoba-Chapa (2014), identified hyperglycemia as ≥ 140 mg/dL (7.8 mmol/l), while other studies define it as ≥ 200 mg/dL (11.1 mmol/l). According to the study, patients who have undergone liver transplantation quite commonly develop hyperglycemia. However, high blood glucose levels did not seem to increase the risk for

postoperative complications that might be triggered by absolutely different factors (Vilatoba-Chapa 2014.)

Rutan & Sommers (2012), Kittelson (2009), Kwon, Thompson, Dellinger, Yanez, Farrohi, & Flum (2013), Shah et al.(2014), Boscolo, Barvais, Engelman, & Fery (2014) and Boreland et al.(2015) support the same idea to monitor blood glucose and vital signs with all patients in the post operative care unit (PACU). Still, blood glucose needs to be measured more often than usually, as the stress caused by the operation can increase the need for insulin. Moreover, Rönnemaa (2015) reveals that post-operative phase blood glucose is measured every one to two hours and Jämsen et al. 2012 stated that if the patient has undergone severe surgery, his blood glucose should be monitored four to six times a day. It is not recommended to target blood glucose level that is less than 6.1 mmol/l in postoperative phase of care (Rönnemaa 2015 & Jämsen et al. 2012.)

Furthermore, severe hypoglycaemia in post-operative phase can be very dangerous as it is not possible to notice its symptoms during and after anaesthesia (Rönnemaa 2015.) In addition, Holt (2012) states that insulin is classified as “high alert medication” as its inappropriate administration may cause double risk of creating harmful consequences to the patient. It was found that the effect of morphine is decreased due to the patient’s hyperglycemia. It results in higher dose of morphine needed in order to decrease postoperative pain (Holt 2009). Jämsen et al., (2012) believes that acute pain increases insulin resistance likewise. Therefore nurses should possess enough knowledge in order to manage potential complications.

As it was mentioned in article written by Rönnemaa (2015), when the patient is able to eat, it is safe to return to subcutaneously injected insulin. When a patient is able to measure his own blood glucose and eat, it is time for him to take once again responsibility of his own insulin treatment. Proper glycemic control ensures successful patient transfer onwards with desired glucose levels. By the time of dis-

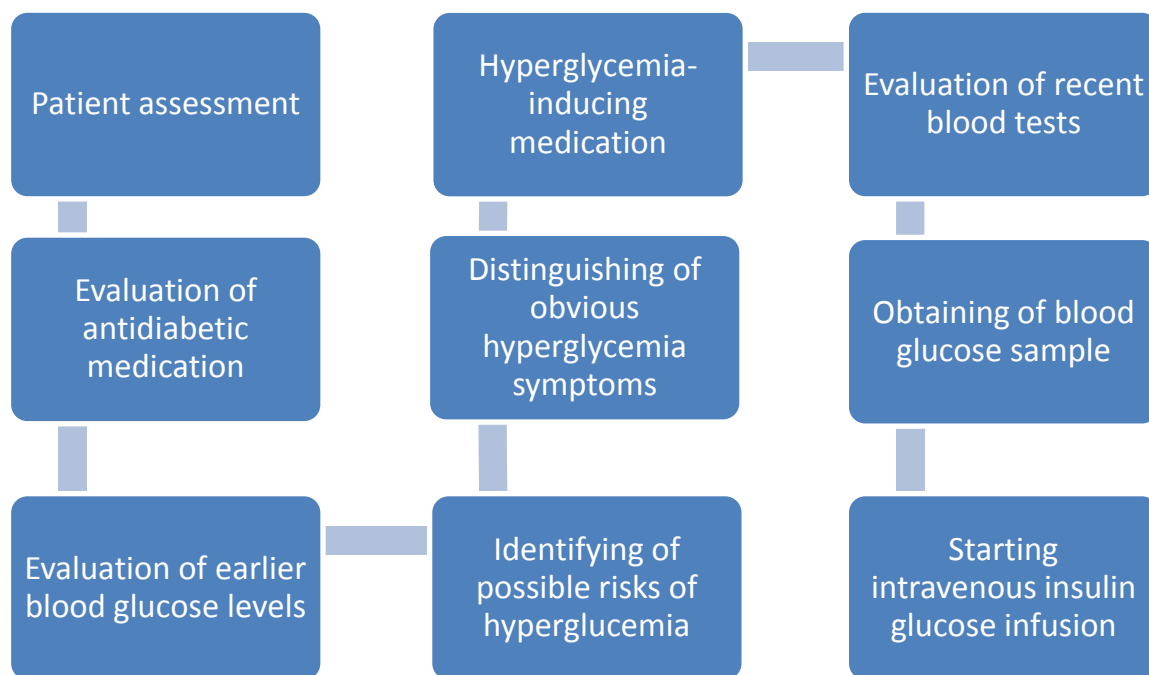
charge patient should be educated about the impact of hyperglycemia on his health (Rönnemaa 2015.) In addition, the patient is consulted about conditions that require further medical attention (Rutan & Sommers 2012.) Moreover, Shah et al. (2014) concludes that blood glucose levels should be monitored carefully at each phase of perioperative care treatment. It gives the opportunity to notice extreme alterations in glucose levels. Inadequate glycemic control during any phase of the perioperative treatment is a risk factor for poor patient outcomes.

Hyperglycemia control is compulsory through the whole perioperative process, no matter whether the patient has diabetes or not. Previously, there was the lack of improvements aimed at perioperative care of diabetic patients and generally accepted guidelines were not created. Lack of perioperative glycemic control can result in poor patient safety (Shah et al. 2014). Furthermore, cooperation between surgical team and the medical consultants is needed in order to improve patient's glycemic control and post operative outcomes (Kittelson 2009; Rutan & Sommers 2012.) In conclusion, patient safety based on proper glycemic control along with sufficient knowledge and experience combined with good cooperation within multi-professional team are crucial aspects of perioperative patient care.

7 CONCLUSIONS

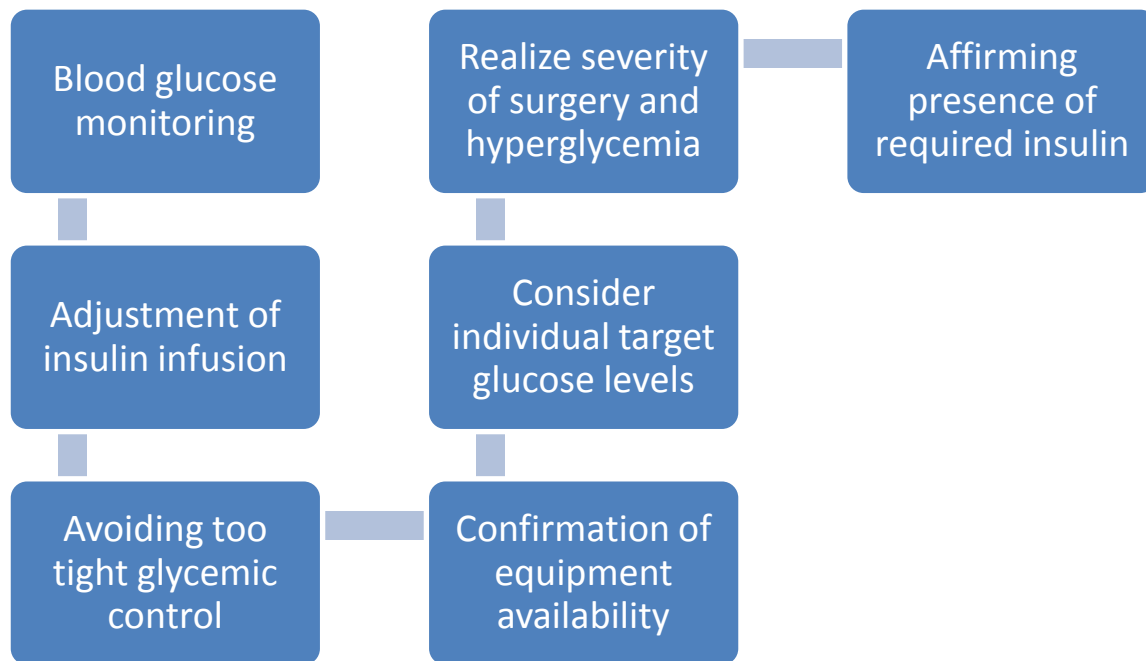
This study presented material related to perioperative nursing care of adult diabetic patients. The results are demonstrated as written text that is further organized into the graph (see APPENDIX 1). Findings of this literature review included 14 evidence-based articles connected to the study topic. First, database search was conducted. All gathered articles were numbered in order to ease the process of organizing final results. Second, these articles were analyzed, relevant information was coded and organized into sub-groups. Original sentences were simplified and further divided into three main categories: pre-, intra-, and postoperative.

One of major themes in preoperative phase that was found in the utilized articles was blood glucose level measuring before the onset of operation. Proper patient assessment played also a vital role at this stage. It usually included evaluation of earlier blood glucose levels and evaluation of current anti-diabetic medication. The evaluation of recent blood tests and spotting of hyperglycemia inducing were also conducted. Moreover, identifying of possible risks of elevated blood glucose was revealed in couple of articles. Finally, intravenous insulin infusion was usually started at this phase. The researchers created a summary of nursing duties in preoperative care of adults with diabetes and showed it in Graph 1.



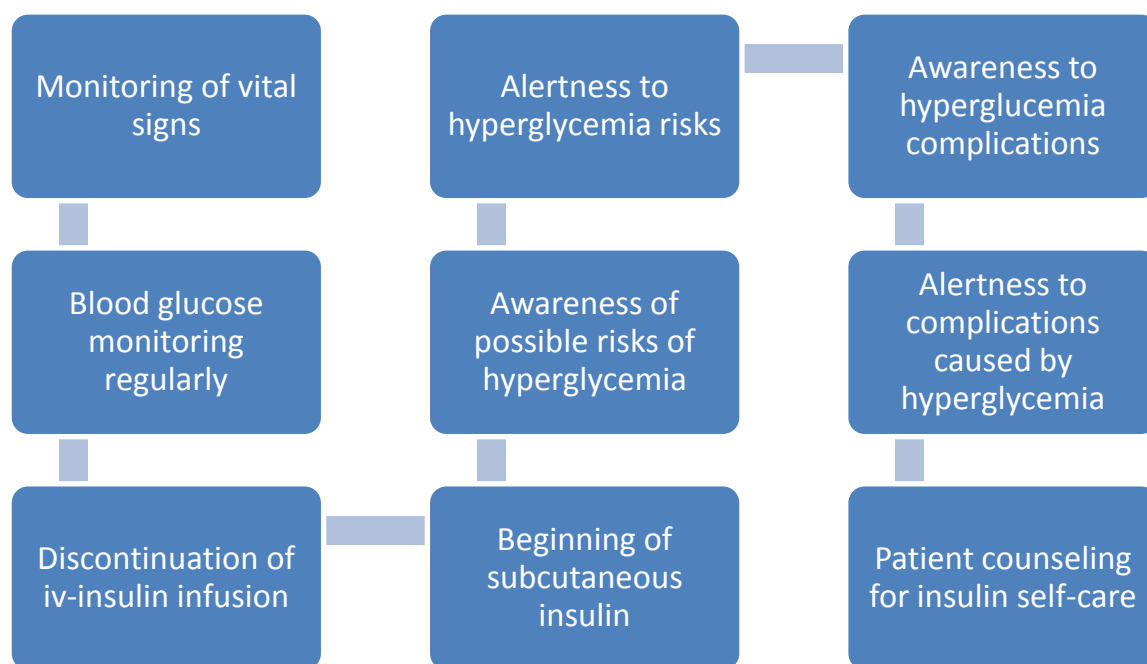
GRAPH 1. Nursing path in preoperative glycemic control of the diabetic patient.

During the intraoperative phase the monitoring of blood glucose was considered to be very important. The adjustment of infusion rate should also be taken into consideration. Individual glucose target levels should be considered as well. Avoiding of too tight glycemic control is recommended. In addition, the confirmation of required insulin and needed equipment is completed by the perioperative nurse. Furthermore, the nurse should understand the correlation between the severity of surgery and how it affects the patient's glycemic level. All the results obtained are represented in below given Graph 2.



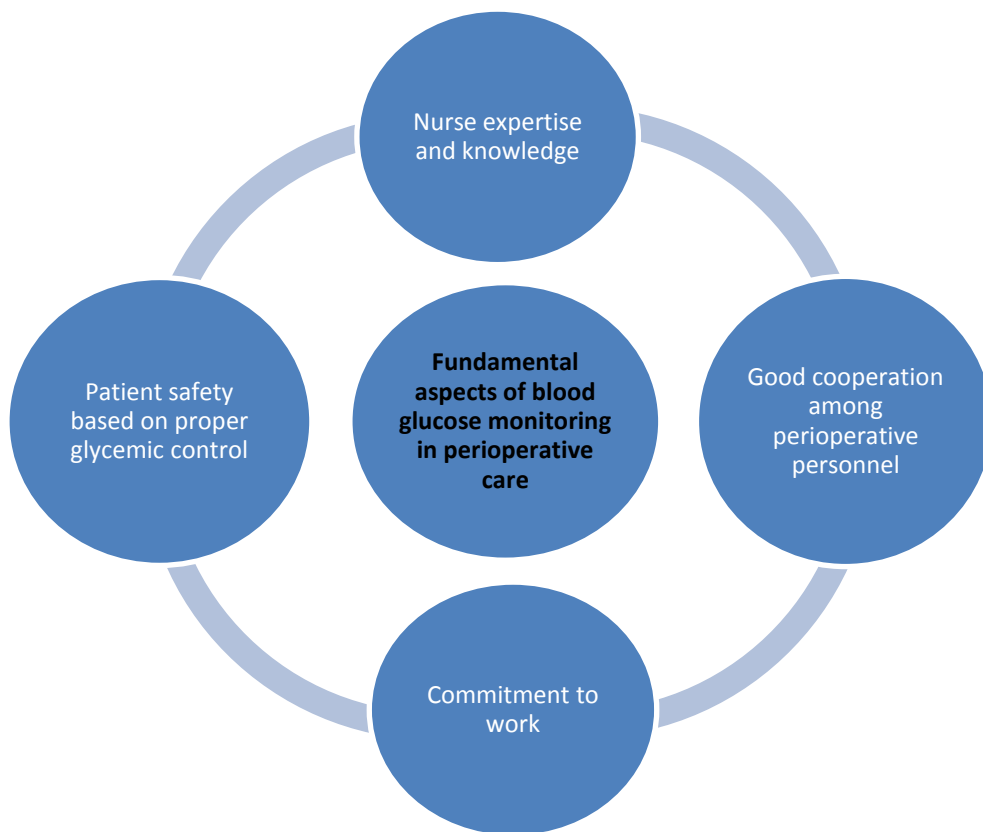
GRAPH 2. Nursing path during intraoperative glycemic control of adult diabetic patient.

The post operative phase of glycemic control is not less important as the two previous phases. Monitoring of vital signs at regular intervals was connected to post-operative phase. However, it is crucial in all phases of perioperative care. Discontinuation of iv-insulin is performed at this point and subcutaneous insulin is begun. The nurse should be aware of possible complications caused by hyperglycemia. Lastly, the nurse should provide patient counseling concerning insulin self-care. Graph 3 represents brief description of blood glucose regulation postoperatively.



GRAPH 3. Nursing path during postoperative glycemic control of adult diabetic patient.

After completing this literature review the authors have noticed specific similarities in all the phases of perioperative care that are demonstrated below in Graph 4. These aspects are crucial in performing successful nursing care. All of these stages required expertise and knowledge from the perioperative nursing staff. Also, good cooperation among perioperative team was highlighted in order to achieve better patient outcomes. Commitment to work was also deemed to be important aspect in perioperative nursing practice. Finally, patient safety dependant on proper glycemic control performed by the nurse is essential in order to provide adequate nursing care that will ensure positive patient outcomes.



GRAPH 4. Fundamental aspects of perioperative blood glucose monitoring.

8 DISCUSSION

Diabetes Mellitus is extremely common disease all over the world and especially in Finland. As the Finnish population with diabetes is becoming older, the amount of people requiring surgical intervention increases annually. Therefore there is an increased need for updated guidelines for nursing care of diabetic perioperative patients. Based on above listed facts, the purpose of this study was to present updated and reliable information on glycemic control of adult diabetic patients undergoing elective surgery. This study represented the nursing point of view regarding selected topic. The goal was to gather relevant information in order to create comprehensive and replicable results.

In the beginning of the study process, the authors conducted research in Theseus thesis database, in order to find out whether this topic had been studied earlier. No results were found. Subsequently, during the process of the investigation the researchers did not find any specific guidelines that would refer to perioperative nursing care of adult diabetic patients. Furthermore, several sources used to describe the theory behind perioperative care of Diabetes Mellitus state, that there is not enough written and verified guidelines for health care professionals. Moreover, several health care professionals from hospitals of Keski-Pohjanmaan Keskussairaala (KPSHP) and Oulun Yliopistollinen sairaala (OYS) were contacted in order to gather official Finnish sources. However, no generally approved protocols were found. This in turn may result in insufficient provision of glycemic control which may lead to escalated morbidity and mortality risks among the patients.

As a result, the lack of data triggered the conduction of this literature review. Several scientific databases were used in order to acquire evidence-based information that is suitable for further utilization. Nonetheless, as this research was conducted in Finland, reliable Finnish sources were preferable. All the sources supported role

of the nurse in perioperative glycemic control. However, there is still need for further research in order to create well-organized and comprehensive protocols that are applicable in the Finnish health care system. Based on the findings acquired during the conduction of this research, general guidelines for Finnish perioperative nurses should be created in the future.

This study was conducted as a literature review, as it allowed researchers to gather relevant and up-to-date information that could be further reorganized into comprehensive information packet. It was the most appropriate method to answer the introduced study question and assisted the researchers to identify possible gaps in current perioperative care of diabetic patients that could be studied in the future. Deductive content analysis was chosen to be appropriate method which allowed the researchers to analyze information in the most convenient way. This method gave the researchers an opportunity to act without restrictions while organizing the gained data. Researchers verified by the time this literature review was planned that general guidelines related to this topic were not followed in Finnish hospitals. Therefore, it was assumed to collect available data from various reliable sources.

After conducting this literature review the information presented can be used subsequently within perioperative health care settings. Perioperative registered nurses were chosen to be the target group for this study. The language chosen for this literature review was considered to be English. Therefore it can be beneficial to foreign nurses or nursing students along with Finnish nurses who have at least moderate English language skills. They can successfully apply acquired information on practice. In addition, nurses have an important role in ensuring that chain of care functions smoothly. For this reason, nurses need to understand the importance of proper glycemic control during all phases of perioperative treatment. Appropriately applied information from this literature review may ensure better outcomes for diabetic surgical patients. In addition to previously mentioned, quality of care may lead to significantly improved patient outcomes afterwards.

Finally, as researchers experienced personal interest in the chosen topic, they were satisfied with result they acquired. As both researchers would like to gain experience in perioperative field of work, this literature review provided them with useful knowledge that could be applied in practice. The researchers became particularly familiar with the process of qualified glycemic control provision to adult diabetic patients undergoing elective surgery. Lastly, researchers acquired experience on conducting scientific nursing research that can be applicable in future studies.

Moreover, the researchers understood the importance and benefit in overall nursing science and its development after conducting this literature review. It was first experience in researchers' practice that was found to be challenging and interesting at the same time. In addition, the process of this study was found to be time consuming. Proper time management was critical in the preparation of this study. The funds spent on conducting this study were considered to be minimal. Researchers did not receive any financial support for the conduction of this study. The work of nursing scientists who published articles utilized in this study was highly respected. The majority of sources were foreign. However, reliable and up-to-date Finnish articles were also obtained and included in this research. The results acquired after the conduction of this study covered the research question precisely.

As a conclusion, based on the statistics both worldwide and in Finland, the amount of diabetic people is dramatically increasing all the time. As a consequence, the amount of diabetic patients undergoing invasive procedures will be increasing at the same time. That is why proper glycemic control and opportune avoidance of hyperglycemia are needed in order to provide qualified nursing care and improve postoperative results of diabetic patients after their invasive treatment.

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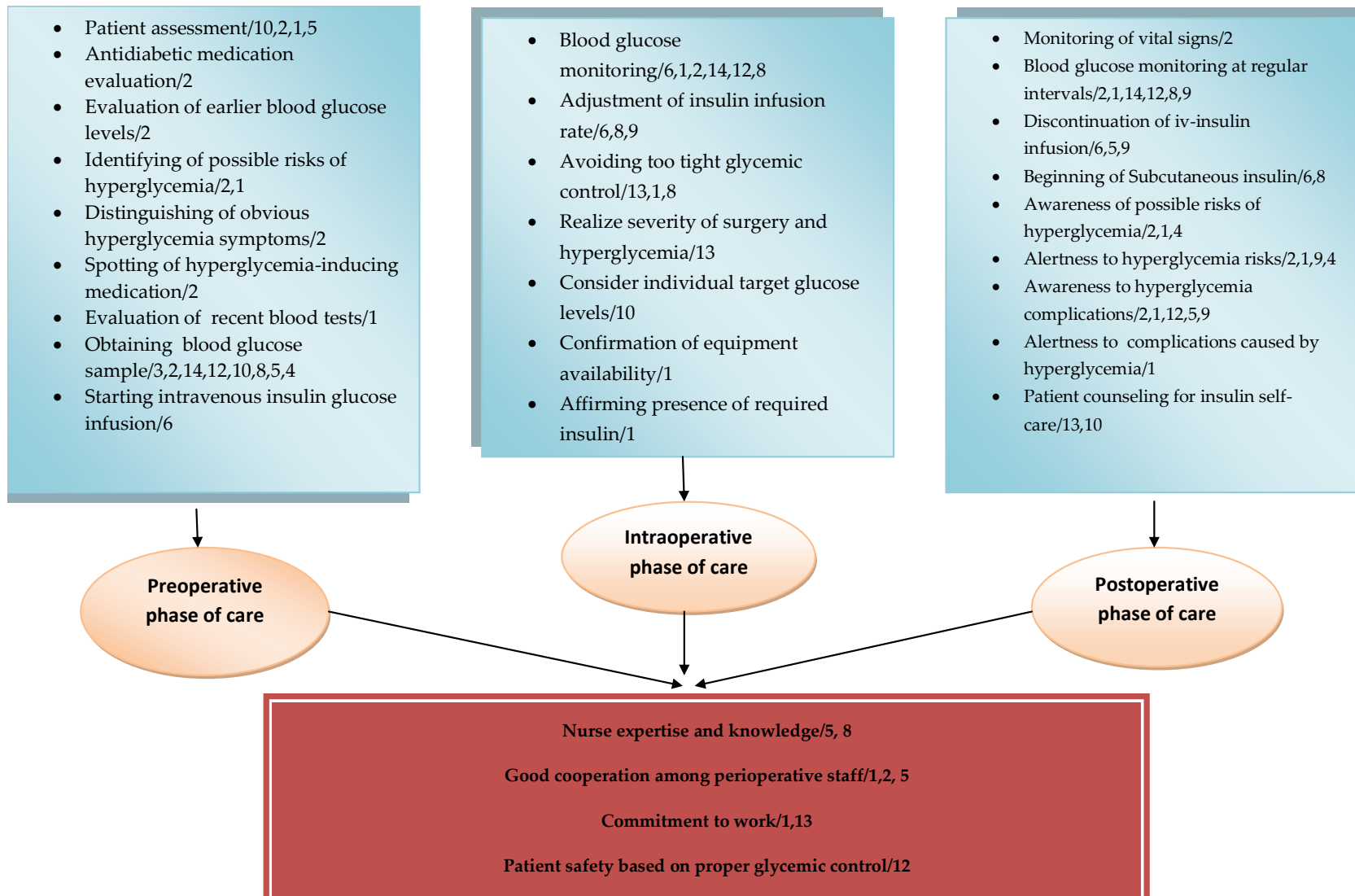
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GRAPH 5. Nursing care of adult diabetic patient perioperatively

TABLE 3. Description process of this content analysis: preoperative phase of treatment

The source	The original sentence	Simplified sentence	Final version
5. Holt 2012	Therefore, it is essential that accurate assessment of the patient is undertaken before surgery to identify possible complications.	Preoperative patient assessment is done in order to detect complications.	Patient assessment
2. Rutan & Sommers 2012	When evaluating a patient's blood glucose level, it is important to know whether the patient is taking any antidiabetic medications.	History of antidiabetic medication will give nurse understanding of patient's blood glucose goals.	Antidiabetic medication evaluation
2. Rutan & Sommers 2012	If so, knowledge of the last dose, onset, peak, and duration of that medication can give the nurse insight into the direction that the blood glucose level is likely to follow.	Acquired knowledge about patient's diabetic history assist in prediction of further glycemic control.	Evaluation of earlier blood glucose levels.
2. Rutan & Sommers 2012 9. Boreland, Scott-Hudson, Hetherington, Frussinety & Slyer 2015.	Furthermore, patients who have central visceral obesity are particularly prone to insulin resistance. DM, obesity, high preoperative serum glucose levels (> 200 mg/dL or 11.1 mmol/l), and female gender are among the risk factors for surgical site infection following CABG surgery.	Central visceral obesity increases risk of insulin resistance. In addition, acute pain, loss of blood, and long surgery may lead to low glucose disposal. Risk of surgical site infections was correlated with preoperative DM, obesity, high preoperative serum glucose levels and female sex.	Identifying of possible risks of hyperglycemia
2. Rutan & Sommers 2012	Patients without known diabetes can demonstrate symptoms that should alert the perioperative nurse to the risk of hypoglycemia.	Nurse should be able to observe for high blood glucose symptoms.	Distinguishing of obvious hyperglycemia symptoms

	lycemia or developing perioperative hyperglycemia. This symptoms may include somnolence, fruity breath, itchy skin, and confusion.	They are fruity breath, itchy skin, confusion and sleepiness.	
2. Rutan & Sommers 2012	Identifying factors that can compound stress hyperglycemia is an important part of nursing assessment, judgment, and perioperative care. Corticosteroids, catecholamines, anabolic agents, and other medications increase blood glucose levels.	Certain meds increase BG levels, such as corticosteroids, catecholamines and anabolic agents.	Spotting of hyperglycemia-inducing medication
1. Kittelson 2009.	This requires reviewing and interpreting the patient's laboratory results (eg, plasma glucose, pH, creatinine, blood urea nitrogen (BUN), electrolytes).	It is important become familiar with patient's laboratory results. Nurse should focus on plasma glucose, pH, creatinine, blood urea nitrogen and electrolytes.	Evaluation of recent blood tests
3. Coan, Schlinkert, Beck, Haakinson, Castro, Schlinkert & Cook 2013	This analysis has lead to the formation of an institutional multidisciplinary team empowered to standardize the care of outpatients with diabetes undergoing elective surgical procedures to include the need for preoperative medical evaluation (lacking in many of our patients) and a requirement to obtain HbA1c measurement.	Obtaining of preoperative blood glucose sample is found to be compulsory.	Obtaining blood glucose sample
6. Rönnemaa, 2015	Tavanomaisin käytäntö on se, että leikkausaamuna ei enää oteta ollenkaan insuliinia ihonalaisena pistoksena, vaan aloitetaan glukoosin ja insuliinin infuusio laskimoon.	Most common one is that insulin is not taken as subcutaneous injection on surgery morning, but rather as insulin and glucose iv- infusion.	Starting intravenous insulin glucose infusion

13. Jämsen, Helminen, Nevalainen, Viitanen, Vähävuori & Korpi- Hyövähti 2012	Potilaalle tulee kertoa glukoosiaineenvaihdunnan häiriöiden sekä diabeteksen hoitotasapainon vaikutuksesta leikkaukskomplikaatioiden riskiin. Leikkauksen onnistumiseen kohdistuvat odotukset voivat motivoida potilasta kiinnittämään enemmän huomiota elintapatekijöihin ja diabeteksen hoitoon.	If patient is well-educated about own disease and it's connection to surgical complications, he may become more motivated to pay attention on own lifestyle habits and own diabetic treatment.	Patient education of own glycemic control
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TABLE 4. Review process of the study

AUTHORS, YEAR, TOPIC	STUDY PURPOSE	STUDY METHOD	MAIN RESULTS OF THE STUDY
1. Kittelson, K. 2009. Glycemic Control: A Literature Review with Implications for Perioperative Nursing Practice. AORN Journal, volume 90, no 5, 714-726.	Hyperglycemia should be controlled by perioperative nurses during perioperative process.	Literature review	Perioperative hyperglycemia is common among surgical patients. It increases risk of complications. Perioperative glycemic control reduces this poor outcomes.
2. Rutan, L., & Sommers, K. 2012. Hyperglycemia as a Risk Factor in the Perioperative Patient. AORN Journal, volume 95, no 3, 352-361.	To define whether hyperglycemia associated with risk factors in perioperative patient.	Literature review	Perioperative nurses should closely monitor patient's blood glucose levels while watching for hyperglycemia signs during all perioperative phases of care.
3. Coan, K., Schlinkert,A., Beck, B., Haakinson, D., Castro, J., Schlinkert ,R. & Cook, C. 2013. Perioperative Management of Patients with Diabetes Undergoing Ambulatory Elective Surgery. Journal of Diabetes Science and Technology, volume 7, issue 4, 983-989.	Determination of frequency of perioperative glucose monitoring, changes in glucose control, treatment of intraoperative hyperglycemia.	Retrospective review	There is lack of sufficient blood glucose monitoring intraoperatively and lack of guidelines for perioperative glucose monitoring.
4. Sadoskas, D., Suder, N. & Wukich, D. 2015. Perioperative Glycemic Control and the Effect on Surgical Site Infections in Diabetic Patients Undergoing	Detection whether hyperglycemia increased SSI rates in elective diabetic patients	Clinical research	Diabetic patient have higher risk of postoperative complications than non-diabetic people. Severe hyperglycemia causes nu-

Foot and Ankle Surgery. Clinical Research, volume 20, no 10, 1-7.			merous postoperative complications.
5. Holt, P. 2012. Pre and Post-Operative Needs of Patients with Diabetes. Nursing Standard 26, no 50, 50-56.	Effects of anesthesia and surgery on blood glucose control.	Review	Management of diabetic patient is important in order to prevent complications as hypoglycemia, infection, and postoperative pain.
6. Rönnemaa, T. 2015. Leikkaukset ja Diabetes. Terveystietä.	Impact of diabetes on surgery and its outcome.	Review	Results of surgery are affected by blood glucose balance and possible organ changes.
7. Rollins, K., Varadhan, K., Dhatariya, K., Lobo, D. 2015. Systematic Review of the Impact of HbA1c on Outcomes Following Surgery in Patients with Diabetes Mellitus. Clinical Nutrition, 30, 1-9.	Establish relationship between long-term preoperative glycemic control and postoperative complications.	Systematic review	Elevated preoperative HbA1c was not associated with increased postoperative morbidity or mortality in diabetic patients.
8. Boscolo, M., Barvais, L., Engelmann, E. & Fery, F. 2014. Perioperative Management of Hyperglycemia: the Diabetologist's Point of View. Acta Anaesthesiologica Belgica, vol 65, 167-174.	How to manage hyperglycemia	Review	Hyperglycemia increases morbidity and mortality. Suggests certain glucose target levels.
9. Boreland, L., Scott-Hudson, M., Hetherington, K., Frassinetti, A. & Slycer, J. 2015. The Effectiveness of Tight Glycemic Control on Decreasing Surgical	Effects of tight glycemic control with continuous insulin infusion.	Systematic review/meta analysis	Keeping blood glucose levels below 200mg/dL can reduce risk of postoperative surgical site infection.

Site Infections and Readmission Rates in Adult Patients with Diabetes Undergoing Cardiac Surgery: A Systematic Review. Heart & Lung, vol 30, 1-11.			
10. Lee, G., Wyatt, S., Walker, K. & Stoney, R. 2013. A Study of a Pre-Operative Intervention in Patients with Diabetes Undergoing Cardiac Surgery. Collegian, vol. 21, 287-293.	To determine whether specialist consultation is beneficial for type 2 diabetic patients.	Quantitative study of 24 patients undergoing cardiac surgery.	Potential benefit in the acute optimization of diabetes treatment before elective cardiac surgery.
11. Vilatoba-Chapa, M. 2014. Hyperglycemia in Liver Transplantation: A Frequent Event or Risk Factor? Revista de Gastroenterologia de Mexico, vol 79 (3), 159-160.	To determine whether hyperglycemia a risk factor in liver transplantation surgery.	Retrospective and observational study.	Hyperglycemia does not increase risk for postoperative complications.
12. Shah, M., Apsey, H., Stearns, J., Schlinkert, R., Seifert, K. & Cook, C. 2014. Guidelines to Improve Perioperative Management of Diabetes Mellitus: An Example of a Successful Quality Initiative. Diabetes Management, 4(4), 327-337.	To assess the impact of perioperative guidelines for diabetic patients undergoing elective surgery.	Quality improvement project.	Insufficient glycemic control in any phase of perioperative care is associated with poor patient outcomes.
13. Jämsen, E., Helminen, H.,	To describe management of	Review	Blood glucose levels should be closely moni-

<p>Nevalainen, P., Viitanen, H., Vähävuori, H. & Korpi-Hyövälti, E. 2012. Kirurgisen Potilaan Hyperglykemian Hoito. Suomen Lääkärilehti, vol 45, 3297-3303.</p>	<p>hyperglycemia during surgery.</p>		<p>tored with all surgical patients. Hyperglycemia is associated with postoperative complications.</p>
<p>14. Kwon, S., Thompson, R., Dellinger, P., Yanez, D., Farrohi, E. & Flum, D. 2013. Importance of Perioperative Glycemic Control in General Surgery. A Report from the Surgical Care and Outcomes Assessment Program. Annals of Surgery, vol 257, 8-14.</p>	<p>To determine connection between hyperglycemia and insulin administration during colon/rectal and bariatric operations.</p>	<p>A retrospective cohort study</p>	<p>Perioperative monitoring of blood glucose and insulin administration in patients with high blood glucose levels are important quality targets.</p>