Review Article

The Effects of Blood Sugar, Electrolytes, and Blood Pressure on Postoperative Cognitive Dysfunction in Patients Candidates for General Surgery Under General Anesthesia: A Non-Systematic Review

Yazdan Dokht Ghaffari[1] | Naser Ghorbanian[1,*]

[1]Assistant Professor of Surgery, Department of General Surgery, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Instructor of Anesthesiology, Department of Anesthesiology and Operating Room, School of Allied Medical Sciences, Tabriz University of Medical Sciences, Tabriz, Iran

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Citation Y. D. Ghaffari, N. Ghorbanian. **The Effects of Blood Sugar, Electrolytes, and Blood Pressure on Postoperative Cognitive Dysfunction in Patients Candidates for General Surgery Under General Anesthesia: A Non-Systematic Review** . *Eurasian J. Sci. Technol.*, **2023**, *3*(3), 125-132.

https://doi.org/10.48309/ejst.2023.169928

Article info:
Submit: 2022-08-05
Revise: 2023-02-14
Accept: 2023-03-10
Checked for Plagiarism: Yes
Checked Language: Yes

Keywords:
Cognitive Disorders; Post-Operative, Blood Sugar; Electrolyte; Blood Pressure; General Anesthesia.

ABSTRACT

Introduction: Since general surgeries have a wide range of types of surgeries and the possibility of cognitive disorders in these patients is high and can increase mortality and complications after surgery, the present study was designed and conducted following the question that do changes in blood sugar, electrolytes, and blood pressure cause cognitive disorders in patients who are candidates for general surgery under general anesthesia, or not?
Methodology: This article was carried out by using a non-systematic and descriptive review method; the non-systematic method by searching without any restrictions in Web of Science, Google Scholar, Scopus, Medline, and PubMed by using keywords selected based on the mesh including: Blood sugar, glucose, hyperglycemia, hypoglycemia, general anesthesia, surgery, surgery general, pain, electrolyte, vitamin, blood pressure, cognitive impairment, post-surgery, and delirium were done.
Results: A total of 38 articles were found (12 articles related to the relationship between blood glucose and cognitive disorders, 13 articles about electrolytes and cognitive disorders, and 13 articles about blood pressure and cognitive disorders) and it was evaluated that these articles were published from 2005 (one article) to 2022.
Conclusion: The changes and fluctuations of blood sugar, electrolytes, and blood pressure during general anesthesia in patients who are candidates for general surgery are one of the important and fundamental factors in the occurrence of cognitive disorders after surgery. Therefore, preventive measures should be considered for all patients.

***Corresponding Author: Naser Ghorbanianb** (N_ghorbanian@yahoo.com)*

Introduction

In recent years, with science development, anesthesiology has been linked with psychology and neuroscience [1]. Research suggests that just as brain traumas can affect the patient's neuropsychological performance, surgery, and anesthesia are also possible factors for causing cognitive and behavioral problems. In this regard, they have reached important points about risk factors and solutions to reduce cognitive problems after the operation [2,3].

A patient who enters the operating room and undergoes surgery, has the possibility of suffering from various respiratory, cardiovascular, renal, and neuropsychological injuries at any moment [4]. Therefore, only fully alert and compassionate personnel can properly manage the patient's bedside so that not only the patient is not harmed during the surgery, but also the problems after the operation are reduced or eliminated [5,6].

Treatment centers that do not pay enough attention to the patient's neuropsychological risk factors and do not provide solutions [7], have increased the prevalence of cognitive problems after surgery in their patients and do not follow up on the complications after surgery in their patients. Hence, it is often necessary and important to reduce the risk factors and perform they do not see prevention and treatment solutions [8,9]. Cognitive problems can occur from one day after the operation and continue for weeks and even until the end of life. Two general categories of cognitive disorders are: Postoperative Delirium (POD) and Postoperative Cognitive Dysfunction (POCD) [10]. The characteristics of post-operative delirium include: Acute decrease in attention, concentration, failure to follow orders, poor verbal communication, presence of hypoactive or hyperactive movements [11,12].

The delirium prevalence is from 3 to 50% depending on the number of risk factors that the patient has. Postoperative delirium will be associated with a delay in discharge and the possibility of increased mortality and decreased cognitive level in the future [13,14]. Cognitive dysfunction is likely to appear in the patient from days to months after surgery and has symptoms such as: Attention disorder, memory, concentration, poor verbal communication, personality disorder or change, aggressiveness, depression, unwillingness to disability in movement, and work, etc. [15,16].

Studies have suggested risk factors that should be considered in the evaluation and treatment measures before surgery [17,18]. The more risk factors the patient has, the more likely he/or she will be affected by the above disorders. Therefore, efforts to reduce risk factors and implement solutions can reduce the probability of POCD occurrence [19]. These risk factors include: Sick and critical patients, old age, especially over 70 years, low level of cognitive function before surgery, low level of awareness and education, dementia and Alzheimer's, history of neurological or psychological disorders, hypoalbuminemia, general weakness, or prolonged dehydration. Metabolic disorders, history of smoking, psychoactive substances, movement disorder, abnormal electrolytes, infection and inflammation, history of cardiac, thoracic, orthopedic, and general surgeries [20-22].

Since general surgeries have a wide range of types of surgeries and the possibility of cognitive disorders in these patients is high and can increase mortality and complications after surgery. The present study was designed and carried out following the question of whether the changes do blood sugar, electrolytes, and blood pressure cause cognitive disorders in patients who are candidates for general surgeries under general anesthesia, or not?

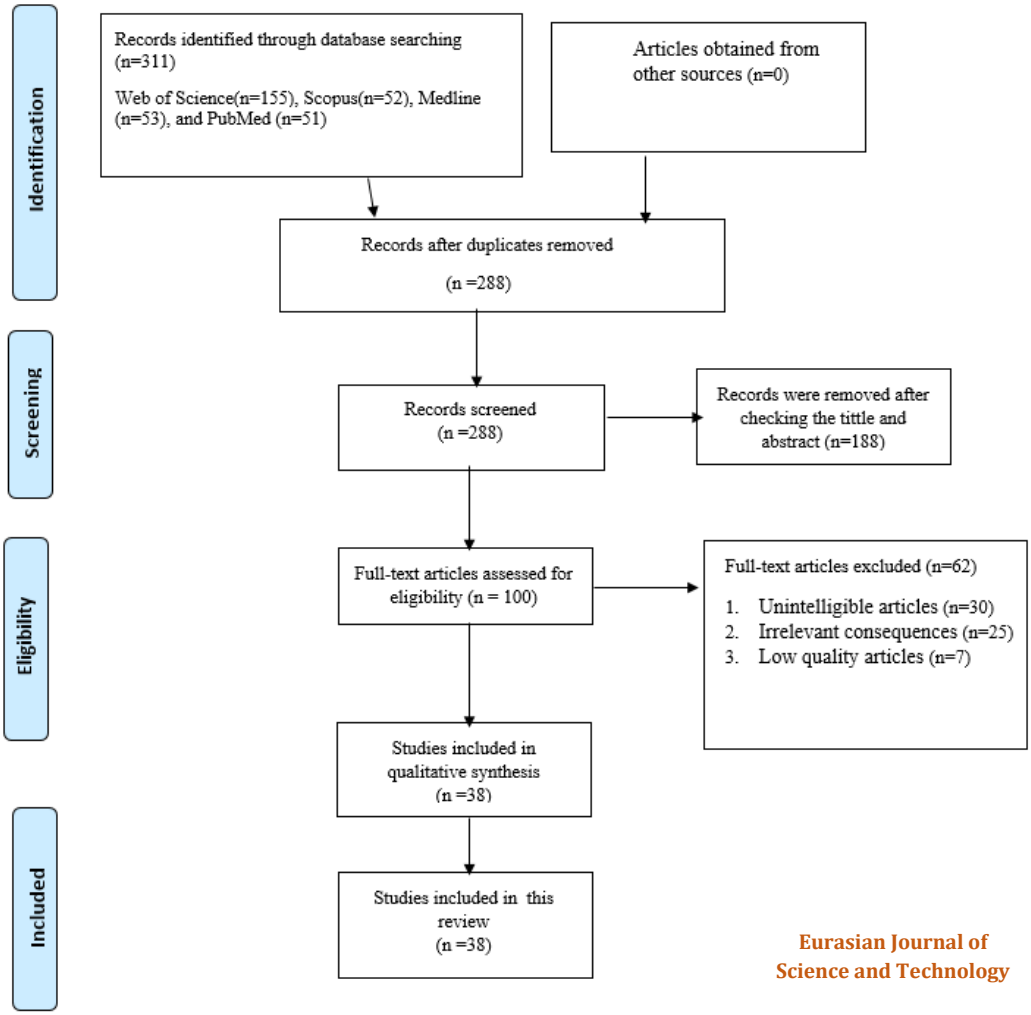
Method

This article was conducted in a non-systematic review method; the non-systematic method by searching without any restrictions in Web of Science, Google Scholar, Scopus, Medline, and PubMed by using keywords selected based on the MESH including: Blood sugar, glucose, hyperglycemia, hypoglycemia, general anesthesia, surgery, general surgery, pain,

electrolytes, vitamins, blood pressure, cognitive disorders, after surgery, and delirium were done. Through this method, 311 articles were obtained that were selected by reviewing the titles and abstracts of articles related to the pain management after cesarean section. The search was continued using known sources in the primary search and the option of similar articles in PubMed. All the selected articles were reviewed independently by two authors, and then the aspects raised in this review were determined and the draft version was prepared and edited.

Results

A total of 38 articles (12 articles related to the relationship between blood glucose and cognitive disorders, 13 articles about electrolytes and cognitive disorders, and 13 articles about blood pressure and cognitive disorders) were found and evaluated. These articles were published from 2018 to 2022 (Flowchart 1).



Flowchart 1 The process of the studies reviewed in this review

Discussion

Blood Sugar

It is recommended to maintain the blood sugar between 100 and 180 during surgery. Since glucose is one of the most important molecules in the energy production of brain cells, its decrease and increase can have inappropriate effects, especially in sensitive patients [4]. Hypoglycemia is associated with a decrease in

neurons' activity and a severe delay in waking up from anesthesia. Hyperglycemia increases the POCD possibility by producing inflammatory factors and metabolic reactions, especially in patients with brain damage [23].

In patients who have had severe physical and mental pain and stress before the operation [24], or for any reason during the operation, due to the hormones release such as cortisol, catecholamine's, growth, and thyroid, they have an increase in the blood glucose level. The insulin release and the reduction of the cells sensitivity to insulin (insulin resistance) are decreased [25]. In these conditions, the hyperglycemia possibility and the complications occurrence resulting from it increases, especially in sensitive patients. Therefore, attention should be paid to the level of anesthesia, analgesia, physical and mental stress of the patient, and the use of drugs [26].

Since some patients may be malnourished and some others have not eaten for several hours before the procedure in addition to NPO [3] they may directly or indirectly suffer from changes in the metabolic system, and therefore, neuropsychological changes[27]. In the first 24 hours of starvation, the body supplies blood glucose with the glycogenolytic mechanism [28]. In the next 24 hours, it goes to lipolysis and gluconeogenesis [29]. In the third 24 hours, it goes to cytogenesis and gluconeogenesis (delayed) [29].

These patients generally have the following symptoms: Neurological disorders, nerve and muscle disorders, delay in wound healing, delay in thermoregulation, prone to mitral and vasovagal prolapse, respiratory disorders due to respiratory muscle weakness, low lung compliance, digestive disorders, anemia, lack of vitamins and minerals, and mood disorders [30,31]. In these patients, it is useful to investigate and carry out these solutions: the hypoglycemia correction, hypomagnesemia, hypocalcemia, deficiency of vitamins E, B, D, and K, (there is a possibility of bleeding during the operation, which requires intravenous injection of this vitamin. However, you should be careful of its allergic reactions.), hypothermia, anemia, atelectasis, insufficient breathing, muscle weakness after surgery, pressure ulcers, hypophosphatemia, hypokalemia (avoid hypoventilation), cardiac arrhythmias, etc. According to some studies, inhaled anesthetics can have a greater effect on causing hyperglycemia during surgery than propofol or the epidural method.

Electrolytes

In studies, there is a significant relationship between electrolyte disorders and Alzheimer's, dementia and depression [34]. Hyponatremia is associated with neurological changes and increased mortality and morbidity and POCD. In patients with brain surgery and brain tumors and injuries, the possibility of aberrant ADH syndrome and the secretion of natriuretic peptide, both of which cause hyponatremia, should be kept in mind [35,36]. Neuropsychological diseases increase the hyponatremia possibility, and some drugs used by them also have the same effect [37].

Neuropsychological patients, children, and women are more sensitive to hyponatremia. Rapid correction of hyponatremia or hypernatremia also increases the possibility of neurological damage. Hyponatremia, hypokalemia, hypomagnesemia, and hypophosphatemia can increase the incidence of POCD [38]. Hypokalemia and hyperkalemia, in combination with acid and base disorders, and changes in tissue circulation, can aggravate tissue damage. One of the most important risk factors of electrolyte disorders is lack of water consumption and dehydration [39]. Before surgery, patients do not drink anything for at least eight hours and this issue provides the basis for dehydration [40]. Severe dehydration in patients may indicate non-standard and inappropriate patient care. Diagnosing dehydration in patients can be challenging because the physical symptoms of dehydration, which include weight loss, skin turgor reduction, dryness of the mucous membrane, and some other symptoms and lead to the dehydration diagnosis in adults, may be elderly people should not be seen. Therefore, it is important to monitor dehydration in other ways [41].

Several attempts have been made to determine the most reliable method of dehydration assessment that can be used for different population groups, but so far the superiority of none of these methods has been proven [42]. Of course, in recent years, saliva secretion has attracted the interest of researchers due to the ease of collection and the similarity of saliva water and ion concentration to extracellular fluid as an indicator of water deficiency. Likewise, changes in water and electrolyte balance are often associated with changes in the biomarkers concentration that are sometimes used to measure hydration status [43]. High blood urea nitrogen and creatinine may indicate an imbalance of fluids and electrolytes. The blood concentration caused by dehydration may lead to an increase in the level of blood components including other osmotic active molecules [44]. Sodium is an extracellular ion and the main determinant of extracellular osmolality, and its homeostasis is closely related to water, and as a result of chronic lack of fluids, its relative amount increases. Therefore, hypernatremia naturally produces a thirst response to restore water balance [45].

Blood Pressure

A change of more than 30% of the normal mean arterial pressure, during anesthesia and surgery, can increase the mortality and morbidity after the operation [46]. The duration of hypotension and hypertension and their severity during anesthesia and the cause of these two complications can indicate the severity of the problems caused by them after the operation [47]. In addition to acute kidney injury, myocardial damage, and tissues sensitive to ischemia, cognitive damage with hypotension and hypertension can occur after surgery [48].

The probability of damage caused by hypotension and hypertension is higher in these people: Ischemia of kidney, heart, and brain tissues, elderly patients, with cardiovascular disorders, anemias, with extensive bleeding, severe respiratory patients, or other pathological diseases [49]. Hypotension usually occurs after spinal and epidural anesthesia [50]. Despite the fact that body tissues have self-regulation and regulate tissue perfusion, sometimes the tissue self-regulation is mildly to severely disturb and the tissue undergoes changes in perfusion and even damage [51].

Self-regulation disorder in the brain (which is sometimes associated with excessive permeability of the blood-brain barrier or its disorder) can be present in the following cases: Diabetes mellitus, chronic hypertension, obstructive sleep apnea, heavy smoking, hypercapnia, patient position during surgery, neuropathy, changes in the autonomic system, vasodilators, inhaled anesthetics (unlike sevoflurane), head trauma, brain tumors, multiple sclerosis, chronic nutrition with high saturated fatty acids, schizophrenia, and psychological problems including severe depression [52,53].

The times that hypotension occurs during anesthesia include: Deepening anesthesia, anesthetic and non-anesthetic drugs with vasodilatory effect, occurrence of cardiac shocks (inability of the heart to pump blood), hemorrhagic shock (hemorrhage, hypovolemia, and perfusion loss), shock anaphylactic (allergic reaction to medicine or surgical materials or blood), septic shock (reaction to toxins and microorganisms), heart and vascular failure, head positions, immediately after induction of anesthesia, especially in patients who take antihypertensive drugs [54].

Among the times when hypertension occurs are: Lightening of the anesthesia depth and waking up, pain during surgery, lack or end of the effect of muscle relaxants, not receiving antihypertensive medication before surgery, cardiovascular disorders, hypoxia, disorders electrolyte, specific malnutrition, etc. Severe hypertension for more than 10 minutes, especially in sensitive patients, will increase the possibility of cardiovascular, cognitive, and cerebrovascular problems after the operation. Severe hypotension for more than 10 minutes, especially in a sensitive patient, may cause cardiovascular and renal problems, ischemia of sensitive tissues, cognitive problems, air, blood, amniotic, and fat micro emboli. Therefore, continuous care of hemodynamics and correct analysis of the patient's condition, investigation

and implementation of solutions to prevent post-operative accidents are part of the obvious duties. Deliberate hypotension is usually used in surgeries where the surgical field is small and bleeding in this field makes the surgeon unable to see [55].

To create this method, instead of increasing the anesthetics dose, its depth, and elevated head positions, these drugs can be used: Magnesium infusion with propofol, remifentanil, and propofol infusion, nitroglycerin, propofol infusion, clonidine (about 3 micrograms per kilogram) about 30 minutes before induction of anesthesia), the combination of hypotension method with the method of using topical vasoconstrictors, coronet and lidocaine sprays 10%, and oxymetazoline drops in the surgical site. In these conditions, we should be careful not to put the patient in dehydration and hypovolemia because it will greatly increase the complications of hypotension. It is useful to recommend the use of multivitamins and neuroprotectants before and after surgery and exercise after surgery to reduce complications. In blood pressure control, systemic vascular resistance and cardiac output should be concerned.

Sometimes the mean arterial pressure does not change much. However, the cardiac output is low and systemic vascular resistance is increased [56]. In the prone position, there is an increase in intrathoracic pressure, a decrease in left ventricular compliance, a decrease in venous return, especially in the inferior vena cava towards the right ventricle, a decrease in cardiac output, and an increase in systemic vascular resistance. In laparoscopy, mean arterial pressure decreases after the anesthesia induction, but blood pressure increases after gas enters the abdomen, which in obese patients, pneumoperitoneum pressure, causes a decrease in cardiac output without changing mean arterial pressure [57]. Therefore, attention should be paid to the condition of the heart and also the condition of the patient's blood vessels [58].

Conclusion

The changes and fluctuations of blood sugar, electrolytes, and blood pressure during the general anesthesia in patients who are candidates for general surgery are one of the important and fundamental factors in the occurrence of cognitive disorders after surgery. Therefore, preventive measures should be concerned for all patients.

ORCID

Yazdan Dokht Ghaffari
https://orcid.org/0000-0002-8189-4397
Naser Ghorbanian
https://orcid.org/0000-0003-4426-0229

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