Received: 07 January 2025 / Accepted: 14 April 2025 / Published online: 30 April 2025

DOI 10.34689/SH.2024.27.2.007

UDC 616.61-78-008.64(574)

CURRENT STATUS AND ACHIEVEMENTS OF EXTRACORPOREAL HEMOCORRECTION IN KAZAKHSTAN: RECENT ACHIEVEMENTS AND CURRENT CHALLENGES

Ainamkoz K. Amanzholova[1,2], https://orcid.org/0000-0003-3847-5290

Marina A. Morenko[1], https://orcid.org/0000-0001-9553-3560

Gulzhan K. Besbayeva[2], https://orcid.org/0009-0008-9623-9142

Kseniya V. Shnaider[1], https://orcid.org/0000-0001-5527-2933

Dariga K. Koichubayeva[2], https://orcid.org/0009-0007-2989-9055

Assem U. Kurmangali[1], https://orcid.org/0009-0007-7990-705X

Bolat E. Bekishev[2], https://orcid.org/0000-0002-2116-3912

[1] NJSC "Astana Medical University", Astana, the Republic of Kazakhstan;
[2] CF UMC «Heart Center», Astana, the Republic of Kazakhstan.

Abstract

Topicality. This article represents information about the spread of extracorporeal hemocorrection methods, as well as the process of organization and introduction of modern extracorporeal hemocorrection technologies into the healthcare system of the Republic of Kazakhstan. Currently, in Astana, Kazakhstan, there is a Laboratory of Extracorporeal Hemocorrection on the basis of Corporate fund “University Medical Center” “Heart Center”.

Aim. To assess the current state of extracorporeal hemocorrection in Kazakhstan, to analyse the frequency of application of various methods, to identify key achievements and existing problems, and to propose possible solutions

Materials and methods of research. An analysis of extracorporeal hemocorrection techniques performed on patients who underwent cardiac surgery from 2017 to 2023 was conducted at the Corporate Fund "University Medical Center" Heart Center. Cases of plasmapheresis, hemosorption, and other extracorporeal therapy methods were identified.

Results and conclusion. Based on the presented analysis of the current state of the service of extracorporeal hemocorrection service in Kazakhstan, the cases and detailed analysis of the implementation of modern technologies and methods of extracorporeal therapy in the Corporate Fund University Medical Center “Heart Center” (Astana, Kazakhstan) are described. Attention is also focused on the shortcomings, significant gaps in the equipment of specialised centers and limited availability of these methods in regional medical institutions. In conclusion, recommendations are offered to improve the material and technical base, improve the qualifications of medical workers, and develop and implement national clinical protocols based on international standards.

Key words: *The Republic of Kazakhstan; extracorporeal hemocorrection, multiple organ dysfunction syndrome.*

For citation:

Amanzholova A.K., Morenko M.A., Besbayeva G.K., Shnaider K.V., Koichubayeva D.K., Kurmangali A.U., Bekishev B.E. Current status and achievements of extracorporeal hemocorrection in Kazakhstan: recent achievements and current challenges // *Nauka i Zdravookhranenie* [Science & Healthcare]. 2025. Vol.27 (2), pp. 53-61. *doi 10.34689/SH.2025.27.2.007*

Резюме

СОВРЕМЕННЫЕ ВЗГЛЯДЫ И ДОСТИЖЕНИЯ В ОБЛАСТИ ЭКСТРАКОРПОРАЛЬНОЙ ОЧИСТКИ КРОВИ В КАЗАХСТАНЕ: ДОСТИЖЕНИЯ ПОСЛЕДНИХ ЛЕТ И АКТУАЛЬНЫЕ ВЫЗОВЫ

Айнамкоз К. Аманжолова[1,2], https://orcid.org/0000-0003-3847-5290

Марина А. Моренко[1], https://orcid.org/0000-0001-9553-3560

Гульжан К. Besbayeva[2], https://orcid.org/0009-0008-9623-9142

Ксения В. Шнайдер[1], https://orcid.org/0000-0001-5527-2933

Дарига К. Койчубаева[2], https://orcid.org/0009-0007-2989-9055

Асем У. Курмангали[1], https://orcid.org/0009-0007-7990-705X

Болат Е. Бекишев[2], https://orcid.org/0000-0002-2116-3912

[1] НАО «Медицинский университет Астана», г. Астана, Республика Казахстан;
[2] «Центр сердца» UMC, г. Астана, Республика Казахстан.

Актуальность. В данной статье представлены сведения о распространении методов экстракорпоральной гемокоррекции, а также о процессе организации и внедрения новых технологий экстракорпоральной гемокоррекции в систему здравоохранения Республики Казахстан. В настоящее время в городе Астана, Казахстан, функционирует лаборатория экстракорпоральной гемокоррекции на базе Корпоративного фонда “University Medical Center” “Центр Сердца”.

Цель: Оценить текущее состояние экстракорпоральной гемокоррекции в Казахстане, проанализировать частоту применения различных методов, выявить ключевые достижения и существующие проблемы, а также предложить пути их решения.

Материалы и методы исследования Проведен анализ методов экстракорпоральной гемокоррекции у пациентов после кардиохирургических операций за период с 2017 по 2023 год на базе Корпоративного фонда “University Medical Center” (Центр Сердца).

Результаты. По результатам представленного анализа современного состояния службы экстракорпоральной гемокоррекции в Казахстане, описаны случаи и детальный анализ внедрения современных технологий и методов экстракорпоральной терапии в Корпоративного фонда “University Medical Center” “Центр Сердца” (Астана, Казахстан). Также акцентировано внимание на недостатках, значительных пробелах в оснащении специализированных центров и ограниченной доступности этих методов в региональных медицинских учреждениях. В заключение предложены рекомендации по улучшению материально-технической базы, повышению квалификации медицинских работников, а также разработке и внедрению национальных клинических протоколов, основанных на международных стандартах.

Ключевые слова: *Республика Казахстан; экстракорпоральная гемокоррекция, синдром полиорганной недостаточности*.

Для цитирования:

Аманжолова А.К., Моренко М.А., Бесбаева Г.К., Шнайдер К.В., Койчубаева Д.К., Курмангали А.У., Бекишев Б.Е. Современные взгляды и достижения в области экстракорпоральной очистки крови в Казахстане: достижения последних лет и актуальные вызовы // Наука и Здравоохранение. 2025. Vol.27 (2), С.53-61. *doi 10.34689/SH.2025.27.2.007*

Түйіндеме

ҚАЗАҚСТАНДАҒЫ ЭКСТРАКОРПОРАЛЬДЫ ТҮЗЕТУ САЛАСЫНДАҒЫ ЗАМАНАУИ КӨЗҚАРАСТАР МЕН ЖЕТІСТІКТЕР: СОҢҒЫ ЖЫЛДАРДАҒЫ ЖЕТІСТІКТЕР ЖӘНЕ ӨЗЕКТІ СЫН-ҚАТЕРЛЕР

Айнамкоз К. Аманжолова[1,2], https://orcid.org/0000-0003-3847-5290

Марина А. Моренко[1], https://orcid.org/0000-0001-9553-3560

Гульжан К. Besbayeva[2], https://orcid.org/0009-0008-9623-9142

Ксения В. Шнайдер[1], https://orcid.org/0000-0001-5527-2933

Дарига К. Койчубаева[2], https://orcid.org/0009-0007-2989-9055

Асем У. Курмангали[1], https://orcid.org/0009-0007-7990-705X

Болат Е. Бекишев[2], https://orcid.org/0000-0002-2116-3912

[1] «Астана медицина университеті», Астана қ., Қазақстан Республикасы;
[2] UMC «Жүрек орталығы», Астана қ., Қазақстан Республикасы.

Өзектілігі. бұл мақалада экстракорпоралды гемокоррекция (ЭКГК) әдістерін талдау нәтижелері, сондай-ақ Қазақстан Республикасының Денсаулық сақтау жүйесінде ЭКГК жаңа технологияларын ұйымдастыру және енгізу процесі туралы ұсынылған. Қазіргі уақытта Астана, Қазақстан қаласында "Heart Center" Corporate Fund University Medical Center базасында экстракорпоралды гемокоррекция зертханасы жұмыс істейді.

Зерттеудің мақсаты. Қазақстандағы экстракорпоралды гемокоррекцияның қазіргі жағдайын бағалау, әртүрлі әдістердің қолдану жиілігін талдау, негізгі жетістіктер мен өзекті мәселелерді анықтау, сондай-ақ оларды шешу жолдарын ұсыну.

Зерттеу материалдары мен әдістері. Зерттеу 2017–2023 жылдар аралығында "University Medical Center" Қорының (Жүрек орталығы) базасында кардиохирургиялық отадан кейінгі пациенттерге қолданылған экстракорпоралды гемокоррекция әдістерін талдауға негізделген. Плазмаферез, гемосорбция және басқа да экстракорпоралды терапия әдістерінің қолданылу жағдайлары анықталды және олардың клиникалық нәтижелерге әсері бағаланды.

Нәтижелер мен қорытындылар. Қазақстандағы экстракорпоралдық гемокоррекция қызметінің қазіргі жай-күйіне ұсынылған талдау нәтижелері бойынша "Heart Center" Corporate Fund University Medical Center (Астана, Қазақстан) - де экстракорпоралдық терапияның қазіргі заманғы технологиялары мен әдістерін енгізудің қызметінің нәтижелері мен егжей-тегжейлі талдауы. Сондай-ақ, мамандандырылған орталықтардың негізін қалаудағы

кемшіліктерге, елеулі олқылықтарға және өңірлік медициналық мекемелерде осы әдістердің шектеулі қолжетімділігіне назар аударылды. Ұсынымдарға сәйкес материалдық-техникалық базаны арттыру, медицина қызметкерлерінің біліктілігін арттыру, сондай-ақ халықаралық стандарттарда негізгі ұлттық клиникалық хаттамаларды әзірлеу және енгізу жөніндегі ұсынымдар.

Түйінді сөздер: *Қазақстан Республикасы; экстракорпоральды гемокоррекция, көп ағзалы жеткіліксіздік синдромы.*

Дәйексөз үшін:

Аманжолова А.К., Моренко М.А., Бесбаева Г.К., Шнайдер К.В., Койчубаева Д.К., Курмангали А.У., Бекишев Б.Е. Қазақстандағы экстракорпоральды түзету саласындағы заманауи көзқарастар мен жетістіктер: соңғы жылдардағы жетістіктер және өзекті сын-қатерлер // Ғылым және Денсаулық сақтау. 2025. Vol.27 (2), Б. 53-61 *doi 10.34689/SH.2025.27.2.007*

Introduction

Extracorporeal hemocorrection (ECHC) – is a group of modern therapeutic methods aimed at purification or correction of blood composition outside the patient's body using specialized equipment. These technologies are especially relevant in cases requiring the removal of toxins, excess fluids, excessive blood components, or restore the normal balance of segments. ECGC is widely used in intensive care, nephrology, cardiology, hematology and other medical specialties. The primary goal of these methods is to improve the patient's condition, reduce the toxic load on the body, and treat both chronic and acute diseases.

ECHC demonstrates significant potential for the rapid and direct removal of molecular substances and is often used as a life-saving measure in cases of organ failure and for the correction of metabolic and immunological disorders. Over the past fifty years, there have been radical changes in the technical support of efferent therapy procedures. The modernization of equipment and profound transformations of the devices themselves have significantly increased both efficiency and safety of the procedures performed. In this regard, it was of practical interest to review scientific sources devoted to in-depth analysis of the modern capabilities of extracorporeal hemocorrection in the treatment of various diseases and critical conditions.

The Extracorporeal therapeutic methods used in the Laboratory are based on the targeted intervention on the patient's blood in order to quantitatively and qualitatively change its cellular, protein, water-electrolyte, enzyme and gas composition.

On average, 19 million people die from circulatory system diseases annually worldwide, 52 thousand people die every day [1-2]. Cardiovascular diseases of atherosclerotic genesis are also the leading cause of sudden death accounting for 6.2 million sudden deaths in the world among individuals aged 30-70 years [3].

An analytical work was carried out to examine the epidemiology of chronic kidney disease in Kazakhstan and to forecast future trends in the prevalence and mortality of chronic kidney disease by 2030. According to the Global Burden of Disease it is expected that by 2040 chronic kidney disease will become the fifth most common cause of death [4].

Based on the results of this work, the incidence rate decreased markedly from 6365 per million population in 2014 to 4040 per million population in 2020. The prevalence changed from 10346 to 38287 cases per year and the mortality rate increased dramatically from 279 to 916 cases per year. The predicted mortality climbed from 17068 cases in 2020 to 37305 deaths in 2030 [4].

The aim of this article is also to describe the situation in Kazakhstan – focusing on the experience of single center, where the extracorporeal hemocorrection methods are actively used. To provide a wide range of anesthesiologists-resuscitators, nephrologists, cardiologists, cardiac surgeons, pediatricians, pulmonologists and doctors of other specialties, providing highly specialized medical care to patients with critical conditions and multiple organ dysfunction syndrome with the essential basic information about the achievements and effectiveness of the use of extracorporeal hemocorrection based on the experience of international and domestic studies. The article also specifically discusses the application in pediatric cardiology service, complications of extracorporeal hemocorrection in various conditions.

In modern conditions, extracorporeal hemocorrection is increasingly being introduced into clinical practice as one of the key treatment methods providing significant improvement of patients' condition. It has a wide range of indications: from acute kidney injury to pre-eclampsia and various infectious processes. Given the growing number of cases of this technology, its relevance and importance are constantly increasing, emphasizing the need for further research and optimization of extracorporeal therapy methods to enhance the effectiveness and safety of treatment.

Materials and Methods

Study Design and Setting

This study is based on a retrospective analysis of extracorporeal hemocorrection methods applied to patients who underwent cardiac surgery between 2017 and 2023. The research was conducted at the Corporate Foundation “University Medical Center” (Heart Center) in Astana, Kazakhstan. The study includes both clinical data and literature analysis to assess the implementation, effectiveness, and challenges of extracorporeal hemocorrection in post-cardiac surgery patients.

Patient Selection and Inclusion Criteria

The study included patients who:

- Had undergone cardiac surgery between 2017 and 2023 at the Heart Center.

- Received extracorporeal hemocorrection therapy, including plasmapheresis, hemoperfusion, and other methods.

- Had available medical records documenting the treatment, its indications, and outcomes.

Exclusion Criteria

Patients were excluded if:

- They did not receive extracorporeal therapy.
- Their medical records were incomplete or lacked sufficient data for analysis.
- They had severe comorbid conditions that could significantly influence treatment outcomes.

Data Analysis

The study involved a retrospective review of medical records to identify:

- Frequency and indications for extracorporeal therapy.
- Clinical outcomes associated with the use of plasmapheresis and hemoperfusion.
- Complications and challenges related to the application of these methods.
- Comparative effectiveness of different hemocorrection techniques.

Descriptive statistics were used to summarize patient demographics, treatment patterns, and clinical outcomes. Data were analyzed using mean values, standard deviations, and 95% confidence intervals. Significance testing was performed using the Student's t-test ($p < 0.05$) to assess differences between treatment groups. Correlation analysis was conducted to evaluate the relationship between hemocorrection therapy and patient outcomes. This methodology provides a comprehensive approach to evaluating the role of extracorporeal hemocorrection in post-cardiac surgery patients, integrating both clinical data and a systematic literature review.

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The research protocol was approved by the Institutional Review Board (IRB) of Astana Medical University based on Protocol No. 124 dated December 15, 2020. The study complies with international Good Clinical Practice (GCP) standards, the standards established by the Joint Commission International (JCI), the principles of scientific ethics (Declaration of Helsinki), and Order No. 248 of the Ministry of Health of the Republic of Kazakhstan dated December 11, 2020.

I. Historical overview

Until the early 1960s, methods of extracorporeal hemocorrection, specifically dialysis was not widely used, although it was in the focus of clinicians' attention as a method of treatment for renal failure. In the late 1950s, Dr W.N.Scribner began working on a program for acute dialysis at the University of Washington. In 1960 in Seattle, a patient in uremic coma was returned to near full life with the help of intermittent hemodialysis. However, this patient's kidney disease turned out to be chronic and irreversible, and he was sent home to die. This case led doctors to conclude that a long-term vascular access to the circulation was necessary to make intermittent hemodialysis a reality and prolong the patient's life [5].

The history of sorbents spans approximately two centuries. During this period, significant progress has been made through the development of aluminosilicates and porous carbons using modern synthetic polymeric materials. New advances in this field ensure the safe and effective use of sorbents in extracorporeal blood purification methods as well as in the treatment of certain clinical syndromes [6].

Hemoadsorption therapy is a method of extracorporeal detoxification aimed at removing toxins and other harmful substances from the blood with the help of adsorbents.

The initial stage (1950s-1960s): During this period, researches on the use of activated charcoal for blood purification began. However, issues with biocompatibility and blood cell damage limited the method's application.

Breakthrough in the 1970s: The development of new adsorbents with improved biocompatibility, such as porous carbon materials, led to the creation of the first hemoadsorption devices. These devices were used in clinical practice to treat poisoning and sepsis

1980s-1990s: The introduction of polymeric adsorbents such as polystyrene and polyacrylic resins expanded the range of substances that could be removed. The method became widely used in intensive care, especially in sepsis and multiple organ dysfunction.

Modern stage (2000s - present): Adsorbents aimed at removing specific molecules such as cytokines and endotoxins have been developed, which is particularly important in sepsis and severe inflammatory conditions. Modern devices such as CytoSorb are known for their highly safety and effectiveness.

Hemoadsorption is currently being actively investigated for the treatment of sepsis, autoimmune diseases and multi-organ failure. Further development of selective and effective adsorbents is expected to improve the efficacy of therapy.

Results

A detailed analysis of the implementation of modern technologies and methods of extracorporeal therapy was conducted at the Corporate Fund "University Medical Center" (Heart Center, Astana, Kazakhstan). Key achievements, existing challenges, and promising directions for the development of this field were identified. Special attention was given to the shortage of technical equipment in specialized centers, as well as the limited availability of extracorporeal therapy methods in regional medical institutions.

The study results are structured into the following sections:

1.1 Recent Achievements in Kazakhstan – An overview of the latest advancements in extracorporeal therapy that have been introduced into clinical practice.

1.2 Current Challenges – An analysis of existing issues, including equipment shortages, staffing concerns, and accessibility of methods across different regions.

1.3 Prospects for Development – Identification of promising directions for the further development and optimization of extracorporeal therapy in Kazakhstan, considering global experience and modern technologies.

1.1 Recent Achievements in Kazakhstan

The Corporate Fund "University Medical Center" "Heart Center" has established itself as a leading medical organization in the field of extracorporeal hemocorrection and renal replacement therapy since 2013. The laboratory functioning at this center offers a wide range of modern techniques aimed at improving the condition of patients with various cardiological diseases (Fig.1).

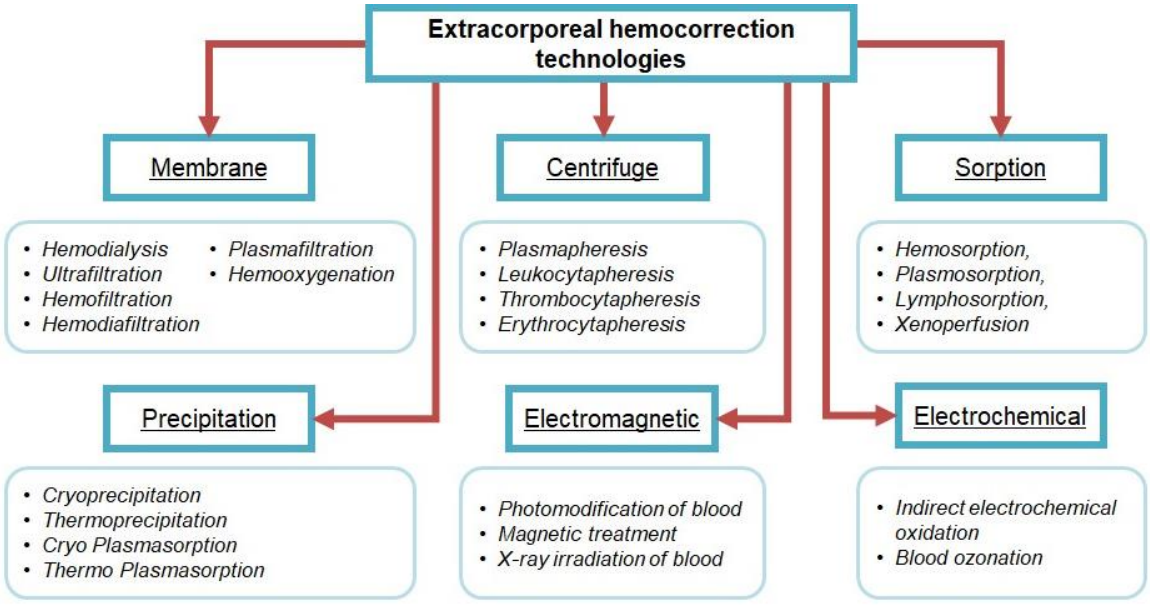

Figure 1. Methods of Extracorporeal Hemocorrection.

The main procedures performed in the laboratory include:

- *Renal replacement therapy* is a method that replaces kidney function in cases of acute or chronic kidney failure. This is particularly relevant for critically ill patients.

- *Hemoadsorption (HA)* - a procedure to cleanse the blood of toxic substances using specialized sorbents. Various hemosorbents such as Jafron HA 330, HA 330 II, HA 280, BS 330, Cytosorb 300 are used in this laboratory to effectively remove metabolic products and toxins from the blood.

- *Membrane therapeutic plasma exchange* is a method where blood plasma is purified and replaced, which helps in autoimmune and inflammatory diseases.

- *Centrifugal plasmapheresis* - a procedure in which plasma is separated from blood cells under the action of centrifugal force, thereby reducing the levels of harmful immune complexes.

- *LPS-sorption (Alteco-sorber)* - a method aimed at removing lipopolysaccharides, which is especially important in septic conditions.

- *Highly selective high-volume plasma exchange (Evaclio)* - the latest method allowing effective plasma purification, used in difficult clinical situations.

The CF "UMC" "Heart Center" performs approximately 1,500 procedures annually, which demonstrates the effectiveness of the technologies offered (Fig.2). As the center is highly specialized and focuses on cardiac surgical procedures, including: LVAD (artificial mechanical left ventricular assist devices) are devices that help patients with severe heart failure, as well as heart and lung transplants. This approach successfully integrates extracorporeal treatment methods with advanced surgical technologies, which in turn contributes to a significant improvement in clinical outcomes, reducing overall mortality and enhancing the quality of life of patients. The laboratory's ongoing work on the introduction of innovative techniques and continuous professional development of medical staff are key factors in maintaining this high standard of treatment and care.

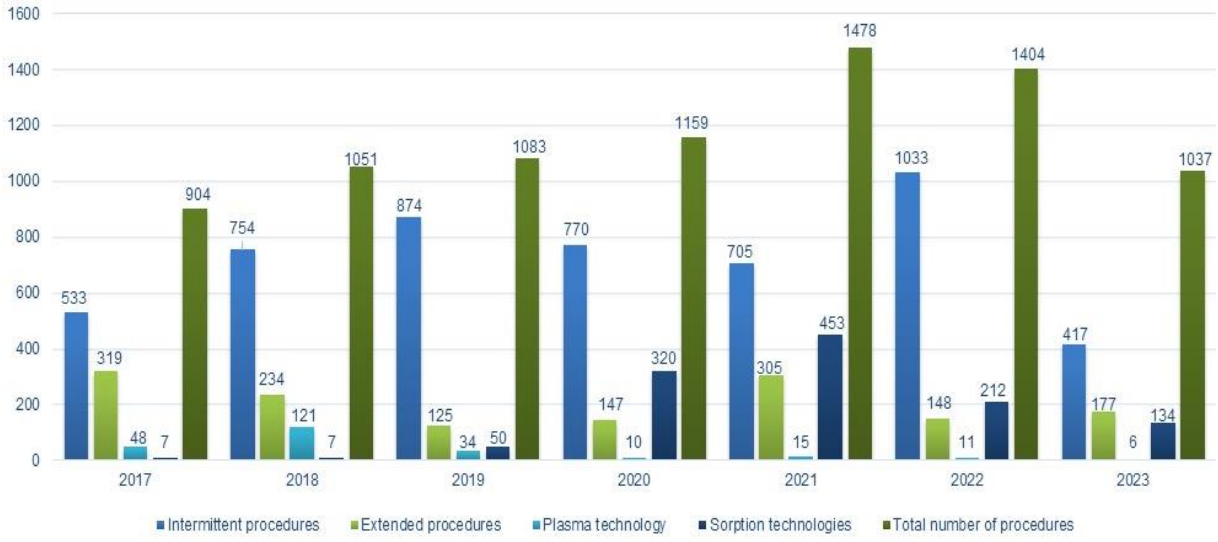

Figure 2. Annual number of procedures from 2017 to 2023.

Innovations in the field of medicine, particularly in cardiology and intensive care, continue to actively develop, which determines the implementation of new methods and technologies that improve the diagnosis and treatment of cardiovascular diseases, especially in adults and children following cardiac surgery. Also during this period an internal analysis was conducted on complications after cardiac surgeries and the most frequent of them was acute kidney injury: in 32% of cases after valve prosthesis or repair procedures, in 24% of cases after coronary artery bypass grafting (CABG) surgery. In 5% after Left Ventricular Assist Device (LVAD) implantation. The remaining cases are after aortic surgery, such as Supracoronary ascending aortic replacement surgery, aortic debranching, Bentall de Bono procedure, various interventional endovascular surgeries such as stent graft implantation, TAVI, MitraClip, as well as after heart and lung transplantation surgeries (Fig.3).

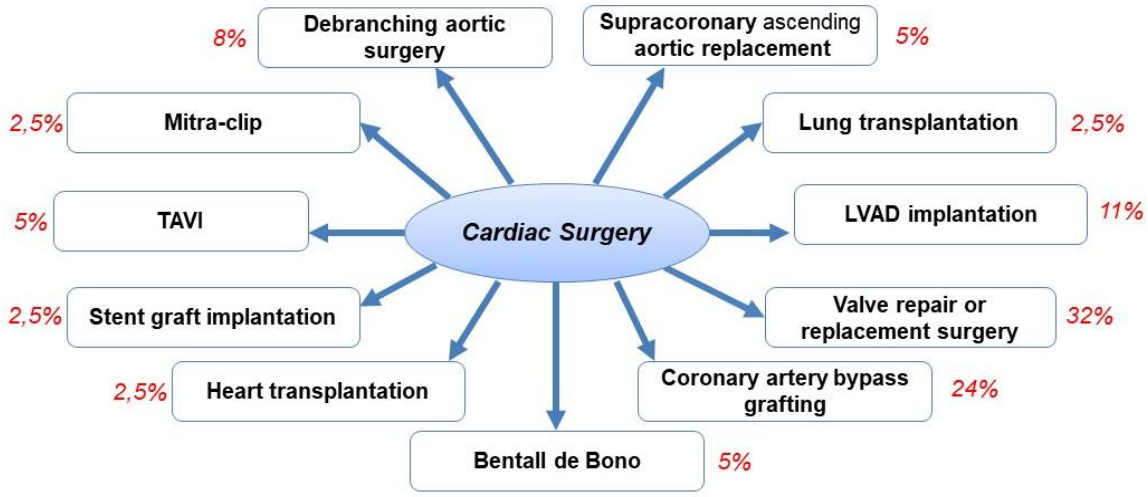

Figure 3. Types of cardiac surgeries after which Acute kidney injury developed.

Recently, there has been an increase in the use of apheresis techniques for extracorporeal removal of circulating lipoproteins. This is particularly important for the treatment of patients with atherosclerosis where it is necessary to reduce blood lipid levels, especially low-density lipoprotein (LDL) and lipoprotein(a). The introduction of techniques such as Direct adsorption of lipoproteins (DALI), Cascadeflo, Heparin-induced extracorporeal low-density lipoprotein (LDL) precipitation (HELP) and Evaflux can significantly improve patients' lipid profiles and reduce risks associated with cardiovascular diseases.

Apheresis is a collective term for a group of methods of extracorporeal hemocorrection, which are based on the removal (or separation) of specific fractions or components from the blood. Dialysis technologies (hemodialysis, hemofiltration, hemodiafiltration, ultrafiltration) do not refer to apheresis.

Currently, there are three different principles used for removing LDL and/or Lp(a) particles from the blood: Precipitation, Filtration, Adsorption.

According to the mechanism, apheresis is divided into 2 groups:

1 - for whole blood perfusion – These methods are simpler to use.

2 - for plasma perfusion and therefore require a plasma separation stage, i.e. separation of plasma from blood cells.

This year, we performed 10 lipoprotein apheresis (DALI) procedures on 4 patients. First patient B., 15 years old, was diagnosed with familial hypercholesterolemia (FH) on the background of xanthomatosis: multiple skin xanthomas on the buttocks and back of the right hand. The patient regularly received cascade plasma filtration, with 6 procedures per year. After cascade plasma filtration in 3 months: cholesterol level – 16.35 mmol/l, High-density lipoprotein (HDL) – 0.8 mg/dl, Low-density lipoprotein (LDL) – 14.35 mg/dl. The patient was on long-term medication therapy: rosuvastatin/ezetimibe (Rosulip Plus) at a dose of 20 mg/10 mg once per day. According to the guidelines, taking into account the severe condition of the child, refractoriness to therapy with rosuvastatin/ezetimibe (20/10 mg/day), in connection with the activity of the main diagnosis, the DALI procedure was performed. The principle of this technique is the electrostatic interaction between positively charged apolipoprotein B100 and negatively charged polyacrylic acid (covalently bound), which facilitates the binding of LDL, VLDL, and lipoprotein (a) to the adsorber. During the period of hospitalization, 2 procedures were performed, with a 1-week interval. The patient tolerated all procedures well (Tab.1).

Additionally, 34 year old male patient, was diagnosed with Stage 2 Arterial hypertension, dyslipidemia, secondary hypertriglyceridemia. The Comprehensive laboratory investigations of the patient are showen on the table (Tab.2).

The problem of acute kidney injury (AKI) in children after cardiac surgery remains a significant challenge. Modern technologies such as renal replacement therapy (RRT), hemodialysis with filtration (Hemodiafiltration/Hemofiltration) and hemoadsorption are becoming increasingly relevant in the treatment of this pathology. These approaches help not only in the elimination of toxic metabolites, but also in the normalisation of fluid -electrolyte balance, which is essential for the health and morphological stability of organs. Given the high prevalence of AKI (40-60% among high-risk

groups) after paediatric cardiac surgery, new protocols have been developed and implemented to minimise the risks. These protocols include comprehensive monitoring, the use of innovative techniques to maintain hemodynamic stability pre- and postoperatively, as well as specialized approaches to ventilation and oxygenation during intervention.

Table 1.

Comprehensive laboratory investigations of the patient (15 y.o.)

DALI	On admission	After the end of the first procedure	1 day after the first procedure	3 days after the first procedure	7 days after the first procedure	After the end of the second procedure	1 day after the second procedure
Cholesterol, mg/dL	599,5	294,3	359,6	364,33	446,5	182,1	218,74
Triglycerides, mg/dL	107,9	70,3	185,1	101,39	115,9	59,3	88,37
LDL, mg/dL	511,2	225,5	274	277,27	378,2	140,7	160,98
HDL, mg/dL	32,2	25,9	29,7	57,94	33,8	29,7	37,72
Lp(a), g/l	3,6	2,8					2,2

Table 2.

Comprehensive laboratory investigations of the patient (34 y.o.)

Analysis	On admission	11.10	12.10	13.10	14.10	15.10	16.10	17.10	23.10
ApoA (1.04 - 2.02)	1.65	1.33	1.44	-	0.86	1.46	1.54	0.93	0.85
ApoB (0.66 - 1.44)	1.16	0.49	0.60	-	0.32	0.41	0.45	0.47	0.50
LP(a) (0.00 - 30.00)	42.86	16.02	23.50	-	18.59	32.49	57.63	72.30	
Total cholesterol (0.00 - 200.00)	277.47	136.10	154.10	141.86	68.37	70.61	68.30	69.30	214
Triglyceride mg/dL <150	1250	970	1103	495	476.50	220.80	202.00	146.50	348
HDL (0.00 -100.00)	23.42	17.40	17.90	28.38	21.93	25.36	25.60	29.00	51
LDL (0.00 - 50.00)	139	15	17.70	91.03	36.86	38.91	18.70	23.30	42

An analysis was conducted on the frequency of AKI during the perioperative period in young children with congenital heart disease at CF “UMC” “Heart Center” from 2017 to 2023 (Fig.4).

During this period, 55 renal replacement therapy (RRT) procedures were performed, which included the placement of double-lumen dialysis catheters, of which: hemodiafiltration on the Multifiltrate device - 25 procedures, hemodialysis Sled -1 procedure, hemodiafiltration on the OMNI device - 3 procedures, hemoadsorption therapy with Cytosorb 300 - 9 procedures. hemoadsorption therapy with HA 330 (septic) - 8 procedures, hemoadsorption therapy with HA 330 II (hepatic) - 4 procedures.

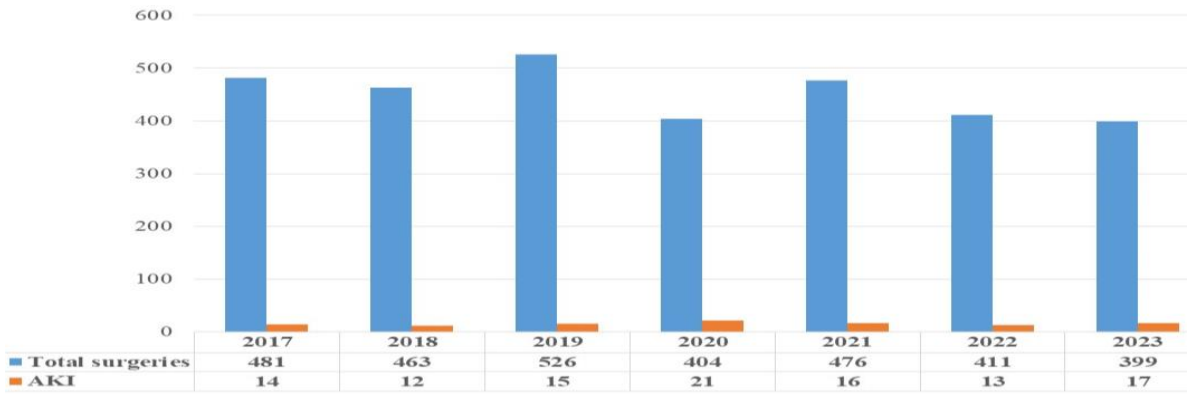

Figure 4. The frequency of AKI during the perioperative period in young children with congenital heart disease after cardiac surgeries.

This comprehensive approach highlights the versatility of extracorporeal therapies tailored to address critical conditions such as sepsis, hepatic failure, and AKI in pediatric patients with congenital heart defects after cardiac surgeries.

The development and implementation of new technologies and methods of extracorporeal hemocorrection and therapy require further research in this area. It is essential to evaluate not only the efficacy but also the safety of the applied technologies, as well as their impact on patients' quality of life. Empirical data obtained as a result of clinical trials will enable the optimization of treatment approaches, increasing survival rates and improving postoperative recovery outcomes in children at risk of developing multiple organ dysfunction syndrome, as well as in patients with atherosclerosis (Pic.1).

Picture 1. Extracorporeal hemocorrection procedures at the CF "University Medical Center" "Heart Center".

1.2 Current challenges

The progressive pace of extracorporeal hemocorrection in Kazakhstan highlights several key problems that require thorough analysis and resolution. The first concern to focus on is the quality of patient care. Medical institutions face various difficulties in providing high-quality medical services, which negatively affects the final result of treatment and patient satisfaction. These challenges are rooted in the lack of modern technology and equipment, as well as insufficient funding and resources.

The second significant challenge is the limited access to these services, especially for the population living in remote and rural areas. The uneven distribution of medical facilities and the lack of specialized centers in the regions create serious barriers for patients in need of extracorporeal hemocorrection, leading to an increase in the number of cases of inadequate medical care and a deterioration in the health of the population. This situation requires the development of strategies to improve an access to medical services and enhancing the quality of health services for all segments of the population, regardless of geographical location.

Thus, despite the achievements made in the field of extracorporeal hemocorrection in Kazakhstan, the healthcare system faces serious challenges related to the quality of services and access to treatment. To ensure effective and equitable medical care, a comprehensive solution to the above problems is needed, including infrastructure development, training of medical personnel and reform of the healthcare system as a whole.

To ensure effective and equitable medical care, comprehensive solutions are needed. These include the development of infrastructure, the training of medical personnel, and the reform of the healthcare system as a whole.

The establishment of multidisciplinary teams including cardiologists, nephrologists, cardiac surgeons and pediatricians also plays an crucial role in the overall success of patient treatment and rehabilitation in a modern medical facility.

1.3 **Prospects for Development**

To date, extracorporeal hemocorrection has shown encouraging results in the treatment of various diseases, including autoimmune disorders and conditions related to lipoproteins.

Evidence of successful application of these methods is provided by numerous cases showing significant improvements in patient outcomes. For example, one of the successful application of HA 280 adsorber for a patient with LVAD.

Patient A., a 25-year-old female, diagnosed with congenital heart disease CHD: perimembranous ventricular septal defect (VSD), Eisenmenger syndrome. The patient underwent Bilateral lung transplantation under cardiopulmonary bypass, VSD repair with autopericardium, and central extracorporeal membrane oxygenation (ECMO) placement (aorta-right atrium) in march 2017. She also suffered from segmental fibroatelectasis of the middle lobe of the right lung, pneumocele of the lower lobe of the left lung, moderate subvalvular pulmonary artery stenosis, and

residual VSD. Complication of the main disease: Acute pulmonary allograft rejection, respiratory failure type 1, community-acquired right upper lobe pneumonia. The patient was admitted with symptoms of pneumonia. Given the diagnosis of right upper lobe pneumonia, a combined antimicrobial therapy regimen was initiated (meropenem 3.0 g/day, moxifloxacin 400 mg/day, caspofungin 50 mg/day, then amphotericin 50 mg/day, valganciclovir 900 mg/day). Fibrobronchoscopy with bronchoalveolar lavage was performed, there were no visual signs of active infectious process, and tests for infections were negative.

However, taking into account the results of allo-sensitization (Class I - negative, Class II - positive at 77%), pulse therapy with methylprednisolone was administered, followed by three procedures of hemoadsorption therapy with adsorber HA 280 adsorber. The therapy resulted in significant clinical improvement (reduction of dyspnea, improvement of overall well-being and better appetite). On control allo-sensitisation showed a marked reduction in sensitization levels (Class I - negative, Class II - positive at 9%) (Tab.3).

Table 3.

The results of allo-sensitization tests.

Date of blood sampling	Method	Result	Specific antibodies
03.05.2022.	Luminex MIX Singl.Ag	Class II – 77% MFI $_{max}$ – 4916.03	Class II DQ7, DQ4, DQ2, – DR103, DR17, DR53, DR8, DR1, DR18.
18.05.2022.	Luminex MIX Singl.Ag	Class II – 9 % MFI $_{max}$ – 7570,61	Class II DQ4, DQ2, DQ9, – DQ8, DQ9, DQ8, DQ7.

A key aspect of further development of extracorporeal hemocorrection is the training of medical personnel. The education of specialists working in the field of hemocorrection should be focused on improving their professional skills and deepening their knowledge of modern methods and technologies of treatment. The quality of training plays a crucial role in ensuring the safety and effectiveness of procedures. It is essential to implement standardized educational programs, as well as regular advanced training courses, which will enable doctors to stay up-to-date with the latest achievements and practical guidelines in the field of extracorporeal medicine. Ensuring this process contributes not only to improving the quality of medical services provided, but also to increasing the level of trust on the part of patients in the methods of extracorporeal hemocorrection treatment.

Conclusion

This article represented an analysis of the current state of the extracorporeal hemocorrection service in Kazakhstan, including existing opportunities and key achievements. It is noted that the country has implemented modern technologies such as plasmapheresis, hemoadsorption and other methods of extracorporeal therapy, which allowed to expand the range of care provided to patients with various diseases.

However, significant gaps remain, including inadequate equipment of specialized centers, lack of trained personnel and limited accessibility to these methods in regional healthcare facilities. The development of this service requires further work in the following areas: improving the material and technical resources, enhancing the qualifications of specialists, and developing and implementing national clinical protocols based on international guidelines.

Overall, despite the existing difficulties, significant successes have been achieved in the field of extracorporeal hemocorrection, and Kazakhstan has the potential for further advancement in this area.

Conflict of Interest. *The authors declare that they have no conflict of interest.*

Contribution of authors. *All authors were equally involved in the writing of this article.*

Funding: *No funding was provided.*

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Corresponding Author:
Amanzholova Ainamkoz Kutzhanovna - PhD in Medicine, NpJSC «Astana Medical University», Astana, Kazakhstan.
Address: Astana, Kazakhstan**,** 010000, Turan street 38.
E-mail: aainamkoz7@gmail.com
Phone: +7 707 426 53 24