ISNN 3030-3907

2026
MAY
ISSUE - 5
VOLUME - 5

DEVELOPMENT OF SCIENCE

scientific journal



Development of science

Ilmiy jurnal

MAY 2026
Issue - 5, VOLUME - 5

ISSN 3030 -3907

Ilmiy jurnal OAK rayosatining 2024 yil 27 sentabrdagi 361-son qaroriga asosan 02.00.00 kimyo fanlari hamda 2025 yil 12 fevral 367- son qaroriga asosan 05.00.00 texnika fanlari bo‘yicha falsafa doktori (PhD) va fan doktori (DSc) ilmiy darajasiga talabgorlarning dissertatsiya ishlari yuzasidan dissertatsiyalari asosiy ilmiy natijalarini chop etish tavsiya etilgan milliy ilmiy nashrlar ro‘yxatiga kiritilgan.

BOSH MUHARRIR:
Temirov Alisher Hoshim o‘g‘li – texnika fanlari falsafa doktori (PhD),Dotsent.
TAHRIRIYAT KENGASH RAISI:
Fozilov Sadriddin Fayzullayevich – texnika fanlari doktori, professor
TAHRIRIYAT KENGASH A’ZOLARI

TEXNIKA FANLARI/ TECHNICAL SCIENCES/ ТЕХНИЧЕСКИЕ НАУКИ

Bozorov G‘ayrat Rashidovich
Buxoro Davlat Texnika Universiteti, professor
Abdurahmonov Olim Rustamovich
Buxoro Davlat Texnika Universiteti, professor
Adizov Bobur Zamirovich
O‘zbekiston Respublikasi Fanlar akademiyasi Umumiy va noorganik kimyo instituti, professor
Hayitov Ruslan Rustamjonovich
Buxoro Davlat Texnika Universiteti, professor
Jumayev Qayum Karimovich
Buxoro Davlat Texnika Universiteti, professor.
Berdiyev Dorob Murodovich
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti, professor
Maxmudov Rafiq Amonovich
Buxoro Davlat Texnika Universiteti, professor.
Tilloyev Lochin Ismatilloyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Raxmonov Qahramon Sanakulovich
Buxoro Davlat Texnika Universiteti, dotsent.
Barakayev Nusratullo Rajabovich
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti, professor.
Jo‘rayev Xayrullo Fayziyevich
Buxoro Davlat Texnika Universiteti, professor.
Panoyev Erali Rajabboyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Ataullayev Sherzod Nabiullyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Murodov Malik Negmurodovich
Buxoro Davlat Texnika Universiteti, dotsent.
Axmedova Ozoda Bahronovna
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti.
Safarov Bahri Jumayevich
Buxoro Davlat Texnika Universiteti, dotsent.
Xaydarov Axtam Amonovich
Buxoro Davlat Texnika Universiteti, dotsent.
Safarov Jasur Alijon o‘g‘li
Buxoro Davlat Texnika Universiteti, dotsent.

KIMYO FANLARI/ CHEMICAL SCIENCES/ ХИМИЧЕСКИЕ НАУКИ

Axmedov Voxid Nizomovich
Buxoro Davlat Texnika Universiteti, professor
Umarov Baqo Bafoyevich
Buxoro Davlat Universiteti, professor
Kodirov Abduaxad Abduraximovich
Qarshi davlat Universiteti, professor
Qurbonov Mingniqul Jumagulovich
Qarshi davlat Universiteti, dotsent
Turemuratov Sharibay Naurizbaevich
O‘zbekiston Respublikasi Fanlar akademiyasi Qoraqalpog‘iston bo‘limi Bosh ilmiy kotibi, professor
Tursunov Kaxor Shonazarovich
Qarshi davlat Universiteti, professor
Do‘stov Hamro
Buxoro Davlat Texnika Universiteti, professor
Panoyev Nodir Shavkatovich
Buxoro Davlat Texnika Universiteti, dotsent.
Olimov Bobur Bahodir o‘g‘li
Buxoro Davlat Texnika Universiteti, dotsent.
Kasimov Sherzod Abduazimovich
Termiz Davlat Universiteti, professor.
Aliqulov Rustam Valiyevich
Termiz Davlat Universiteti, professor
Tropov Xamza Tursunovich
Samarqand Davlat Universiteti, professor

IQTISODIYOT FANLARI/ ECONOMICS/ ЭКОНОМИЧЕСКИЕ НАУКИ

Nizamov Aslitdin Badreddinovich
Buxoro Davlat Texnika Universiteti, professor.
Boboyev Akmal Choriyevich
Buxoro Davlat Texnika Universiteti, professor.
Ergashxojayeva Shaxnoza Djasurovna
Toshkent davlat iqtisodiyot universiteti, professor
Saidaxmedova Nodira Ilxomovna
Toshkent davlat iqtisodiyot universiteti, professor
Muxsinov Bekzod Toxirovich
Buxoro Davlat Texnika Universiteti, dotsent.
Shakarov Qulmat Ashirovich
Renessans ta'lim universiteti,dotsent.
Jumaeva Zulfiya Qayumovna
Buxoro Davlat Texnika Universiteti, dotsent.
Norova Salomat Yusupovna
Buxoro Davlat Texnika Universiteti, dotsent.
Avezova Shaxnoza Maxmudjonovna
Buxoro Davlat Texnika Universiteti, dotsent.
Jalilov Jamshid G‘anijonovich
Toshkent davlat iqtisodiyot universiteti, dotsent
Xasanova Gulruh Djumanazarovna
Buxoro Davlat Texnika Universiteti, dotsent.

PEDAGOGIKA FANLARI/ PEDAGOGICAL SCIENCES / ПЕДАГОГИЧЕСКИЕ НАУКИ

Siddiqova Sadoqat G‘afforovna
Buxoro Davlat Texnika Universiteti, dotsent.
Zoyirov Erkin Xalilovich
Buxoro Davlat Texnika Universiteti, DSc, professor
Gaffarov Feruz Hasanovich
Puchon Universiteti, *professor*
Ruziyev Davron Yuldashevich
Buxoro Davlat Universiteti, professor
Muradova Firuza Rashidovna
Buxoro Davlat Texnika Universiteti, professor.
Yunusova Gulandon Samiyevna
Buxoro Davlat Texnika Universiteti, professor.
To‘xtayeva Zebo Sharifovna
Buxoro Davlat Texnika Universiteti, professor.
Navro‘zova Gulchixra Nigmatovna
Buxoro Davlat Texnika Universiteti, dotsent.
Uzoqova Laylo Polvonovna
Buxoro muhandislik – texnologiya instituti, dotsent.
To‘raqulova Marjona Qiyom qizi
Buxoro Davlat Texnika Universiteti, dotsent.
Muradova Zarina Rashidovna
Buxoro Davlat Texnika Universiteti, dotsent.
Murodov Sanjar Aslonovich
Buxoro Davlat Texnika Universiteti, dotsent.
Shodiyev Jahongir Jo‘raqulovich
Buxoro Davlat Texnika Universiteti, dotsent
Gaffarov Laziz Hasanovich
Buxoro muhandislik – texnologiya instituti, dotsent.

Tahririyat a’zolarning to‘liq ro‘yxati jurnalning www.devos.uz saytida keltirilgan.

Tahririyat hay’ati a’zolarining tarkibini o‘zgartirish hamda qo‘shimcha kiritish yoki tahririyat a’zoligidan chiqarish bosh muharrir tomonidan amalga oshiriladi.

ISSN 3030-3907

Development of science ilmiy jurnali 2024 yil 15 aprel kuni №256445 sonli guvohnoma bilan Davlat ro‘yxatidan o‘tgan.

To‘plam elektron ko‘rinishda (pdf formatida) mualliflarga taqdim etiladi. To‘plamga kiritiladigan maqolalarning mazmuni, ulardagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligiga hamda har qanday fikr - mulohazalarga mualliflarning o‘zlari mas’ul hisoblanadilar. Talablarga javob bermaydigan maqolalar to‘plamga kiritilmaydi. Tashkiliy qo‘mita maqola matnini qisqartirish, qisman tuzatish kiritish, seksiyalarga joylashtirish huquqiga ega.

ISSN 3030-3907

MODERN CHALLENGES IN HEMOTRANSFIOLOGY: BLOOD GROUPS AND THEIR CLINICAL SIGNIFICANCE

Asatullayev Rustam Bahtiyorovich
Assistant of the Department of "Languages" of Samarkand State Medical University
Murodullayeva Rukhshona Jasur qizi
Student of the 103rd group of the Faculty of Pediatrics of Samarkand State Medical University

Abstract. Hemotransfusiology, as a critical branch of clinical medicine, plays a central role in ensuring safe and effective blood transfusion practices. Despite significant advancements, modern challenges persist, particularly in the understanding and application of blood group systems. This article explores the clinical significance of major blood group systems, including ABO blood group system and Rh factor, and highlights contemporary issues such as transfusion compatibility, alloimmunization, rare blood types, and emerging technologies. The study emphasizes the importance of precise blood typing, cross-matching, and immunohematological screening in reducing transfusion-related complications.

Keywords: hemotransfusiology, blood groups, ABO system, Rh factor, transfusion compatibility, alloimmunization, clinical significance.

Annotatsiya. Gemotransfuziologiya klinik tibbiyotning muhim sohasi sifatida qon quyish jarayonlarining xavfsiz va samarali amalga oshirilishini ta’minlashda asosiy rol o‘ynaydi. So‘nggi yutuqlarga qaramay, qon guruhlari tizimlarini tushunish va amaliyotda qo‘llash bilan bog‘liq zamonaviy muammolar saqlanib qolmoqda. Ushbu maqolada asosiy qon guruhlari tizimlari, jumladan ABO blood group system va Rh factor ning klinik ahamiyati tahlil qilinadi hamda transfuzion moslik, alloimmunizatsiya, noyob qon guruhlari va zamonaviy texnologiyalar kabi muammolar yoritiladi. Tadqiqot qon guruhini aniq aniqlash, kross-match qilish va immunogematologik skriningning transfuzion asoratlarni kamaytirishdagi muhimligini ta’kidlaydi.

Kalit so‘zlar: gemotransfuziologiya, qon guruhlari, ABO tizimi, Rh omil, transfuzion moslik, alloimmunizatsiya, klinik ahamiyat.

Аннотация. Гемотрансфузиология как важная отрасль клинической медицины играет ключевую роль в обеспечении безопасного и эффективного переливания крови. Несмотря на значительные достижения, сохраняются современные проблемы, связанные с пониманием и применением систем групп крови. В данной статье рассматривается клиническое значение основных систем групп крови, включая ABO blood group system и Rh factor, а также освещаются такие актуальные вопросы, как

трансфузионная совместимость, аллоиммунизация, редкие группы крови и современные технологии. Подчеркивается важность точного определения группы крови, проведения перекрестной пробы и иммуногематологического скрининга для снижения осложнений, связанных с переливанием крови.

Ключевые: гемотрансфузиология, группы крови, система ABO, резус-фактор, трансфузионная совместимость, аллоиммунизация, клиническое значение.

INTRODUCTION.

Hemotransfusiology represents a vital domain of modern clinical medicine, concerned with the safe collection, testing, storage, and transfusion of blood and its components. Over the past century, this field has undergone substantial transformation, largely due to the discovery and clinical application of major blood group systems, most notably the ABO blood group system and the Rh factor. These breakthroughs significantly reduced the risks associated with blood transfusion and established the scientific foundation for compatibility testing.

Despite these advancements, hemotransfusiology continues to face complex challenges in contemporary healthcare settings. Blood group antigens, which are inherited and expressed on the surface of erythrocytes, play a decisive role in determining immunological compatibility between donor and recipient. Any mismatch between these antigens can provoke severe immune responses, including acute hemolytic transfusion reactions, which may be life-threatening. Therefore, accurate identification of blood groups and careful cross-matching remain indispensable components of clinical practice.

In addition to the classical ABO and Rh systems, more than 30 other blood group systems have been identified, each contributing to the complexity of transfusion medicine. The increasing diversity of patient populations, the prevalence of chronic diseases requiring repeated transfusions, and the emergence of rare blood phenotypes further complicate donor-recipient matching. These factors elevate the risk of alloimmunization and necessitate more sophisticated diagnostic and screening approaches.

Moreover, the growing demand for blood products in surgical procedures, trauma care, oncology, and obstetrics continues to challenge healthcare systems worldwide. Ensuring both the safety and availability of blood supplies requires not only technological innovation but also effective organizational strategies and ethical considerations. Consequently, understanding the clinical significance of blood groups is not merely a theoretical issue but a practical necessity that directly influences patient outcomes.

ISSN 3030-3907

In this context, the study of modern problems in hemotransfusiology, particularly those related to blood group systems and their clinical implications, remains highly relevant. It provides critical insights into improving transfusion safety, optimizing patient management, and advancing the overall quality of medical care.

METHODS. The methodological framework of this study is based on a qualitative analytical approach combining systematic literature review and comparative evaluation of clinical practices in hemotransfusiology. Relevant data were collected from peer-reviewed scientific articles, international clinical guidelines, and authoritative textbooks in transfusion medicine and immunohematology. Particular emphasis was placed on publications addressing the clinical application and challenges of major blood group systems, including the ABO blood group system and the Rh factor.

The selection criteria for sources included scientific relevance, recency, and methodological rigor. Studies focusing on transfusion compatibility, alloimmunization, hemolytic reactions, and rare blood group identification were prioritized. Both retrospective and prospective clinical studies were analyzed to evaluate real-world transfusion outcomes and complications associated with blood group incompatibility.

In addition, a comparative method was employed to assess traditional serological techniques versus modern molecular diagnostic approaches, such as genotyping and automated cross-matching systems. This allowed for the identification of advantages, limitations, and practical implications of each method in clinical settings.

The study also incorporated case-based analysis to highlight common and complex scenarios in transfusion practice, including multi-transfused patients and individuals with rare antigen profiles. Data synthesis was conducted through thematic categorization, focusing on key issues such as diagnostic accuracy, immunological risks, and technological advancements.

Overall, this methodological design ensures a comprehensive evaluation of current challenges in hemotransfusiology and provides a reliable basis for discussing the clinical significance of blood group systems.

RESULTS. The findings of this study confirm that accurate identification and compatibility assessment of blood group systems remain the cornerstone of safe transfusion practice. The ABO blood group system continues to be the primary determinant of transfusion compatibility, as even minor mismatches within this system can result in rapid intravascular hemolysis and severe clinical consequences. Individuals with blood group O were observed to have a broader

ISSN 3030-3907

donor capacity for red blood cells, while group AB individuals demonstrated universal recipient characteristics under controlled conditions.

The role of the Rh factor, particularly the D antigen, was identified as the second most critical factor in transfusion medicine. Rh incompatibility was strongly associated with alloimmune responses, especially in cases involving repeated transfusions or pregnancy. Clinical data indicate that failure to account for Rh status significantly increases the risk of hemolytic disease of the fetus and newborn, as well as delayed hemolytic transfusion reactions.

The analysis also revealed that alloimmunization represents a major and growing challenge. Patients receiving chronic transfusion therapy—such as those with hematological disorders—demonstrated a higher incidence of antibody formation against non-ABO antigens. This significantly complicates future transfusions by narrowing the pool of compatible donor blood and increasing the likelihood of adverse reactions.

Furthermore, rare blood group phenotypes were identified as a critical issue in transfusion practice. Individuals with uncommon antigen combinations often face delays in receiving compatible blood, particularly in emergency situations. The lack of comprehensive donor registries and limited availability of rare blood units exacerbate this problem.

Another key finding relates to the persistence of technical and human errors in transfusion procedures. Despite the implementation of standardized protocols, errors in labeling, sample handling, and cross-matching continue to contribute to preventable transfusion complications. These findings highlight the need for stricter quality control systems and continuous professional training.

In addition, the study demonstrates that modern molecular diagnostic techniques, including genotyping, provide significantly higher accuracy in blood group determination compared to traditional serological methods. These technologies are particularly beneficial in complex clinical cases, such as patients with multiple antibodies or recently transfused individuals where serological testing may be unreliable.

Overall, the results indicate that while foundational knowledge of blood group systems remains essential, the increasing complexity of clinical scenarios requires integration of advanced diagnostic tools, improved transfusion protocols, and enhanced donor management strategies to ensure patient safety.

DISCUSSION. The findings of this study highlight that modern hemotransfusiology operates at the intersection of classical immunohematology and rapidly advancing biomedical technologies. While the foundational importance of the ABO blood group system and the Rh factor remains unchanged, the increasing complexity of clinical cases exposes limitations in traditional

ISSN 3030-3907

transfusion practices. In particular, reliance solely on serological typing is no longer sufficient in patients with multiple transfusions, autoimmune conditions, or rare antigen profiles.

One of the central issues emerging from the results is the growing prevalence of alloimmunization. This phenomenon reflects an adaptive immune response to foreign erythrocyte antigens and significantly complicates transfusion therapy. From a clinical standpoint, alloimmunization necessitates extended antigen matching beyond ABO and Rh systems, especially for chronically transfused patients such as those with hemoglobinopathies. Failure to implement such strategies increases the risk of delayed hemolytic transfusion reactions, which are often underdiagnosed due to their subtle and progressive nature.

Another important aspect is the clinical challenge posed by rare blood groups. The globalization of populations and increased migration have introduced a broader spectrum of blood group variants into healthcare systems. As a result, local donor pools are often insufficient to meet the needs of patients with uncommon phenotypes. This underscores the importance of establishing international rare donor registries and enhancing cooperation between blood banks. Without such measures, delays in obtaining compatible blood may lead to critical outcomes in emergency medicine.

The discussion also emphasizes the role of technological innovation in addressing these challenges. Molecular typing methods, including DNA-based genotyping, offer a more precise and comprehensive identification of blood group antigens. Unlike traditional serology, these techniques are not affected by recent transfusions or the presence of autoantibodies, making them particularly valuable in complex diagnostic scenarios. However, their widespread implementation is limited by cost, infrastructure requirements, and the need for specialized personnel, especially in low-resource settings.

In addition to technological factors, human and organizational elements remain significant contributors to transfusion-related risks. Errors in patient identification, sample labeling, and blood administration continue to be reported even in well-regulated systems. This indicates that improving transfusion safety is not solely a matter of scientific advancement but also of system-level optimization, including staff training, digital tracking systems, and strict adherence to protocols.

Ethical considerations further complicate the landscape of hemotransfusiology. Ensuring equitable access to safe blood transfusion services remains a global challenge. In many regions, shortages of voluntary donors and inadequate screening procedures increase the risk of transfusion-transmitted

ISSN 3030-3907

infections. Addressing these disparities requires coordinated public health strategies, awareness campaigns, and policy-level interventions.

CONCLUSION. In summary, the discussion demonstrates that although the core principles of blood group compatibility are well established, modern hemotransfusiology faces multifactorial challenges that demand integrated solutions. Advancements in molecular diagnostics, expansion of donor databases, and improvement of clinical protocols must be combined with organizational efficiency and ethical responsibility to enhance the safety and effectiveness of transfusion practices.

In conclusion, hemotransfusiology remains a critically important field in modern medicine, where the accurate understanding and application of blood group systems are essential for ensuring patient safety. The central role of the ABO blood group system and the Rh factor continues to define the fundamental principles of transfusion compatibility. However, contemporary clinical practice demonstrates that these systems alone are not sufficient to address the growing complexity of transfusion medicine.

The increasing incidence of alloimmunization, the clinical challenges associated with rare blood group phenotypes, and the persistence of technical and human errors highlight the need for a more advanced and integrated approach. Modern diagnostic technologies, particularly molecular typing methods, provide significant improvements in accuracy and safety, yet their accessibility and implementation remain uneven across healthcare systems.

Furthermore, the rising global demand for blood products, combined with limitations in donor availability, underscores the necessity of strengthening blood donation systems and enhancing international collaboration. Ensuring safe transfusion practices is not only a scientific and clinical issue but also an organizational and ethical responsibility.

Ultimately, improving outcomes in hemotransfusiology requires a multifaceted strategy that integrates advanced technology, rigorous clinical protocols, continuous professional training, and effective public health policies. Only through such a comprehensive approach can the risks associated with blood transfusion be minimized and the full therapeutic potential of this life-saving intervention be realized.

REFERENCES

1. Harmening, D. M. (2019). *Modern Blood Banking & Transfusion Practices*. F.A. Davis Company. 624 pages, pp. 45–78.
2. Klein, H. G., & Anstee, D. J. (2014). *Mollison's Blood Transfusion in Clinical Medicine*. Wiley-Blackwell. 944 pages, pp. 123–160.

ISSN 3030-3907

3. Daniels, G. (2013). *Human Blood Groups*. Wiley-Blackwell. 568 pages, pp. 210–245.
4. World Health Organization. (2022). *Blood Safety and Availability*. Online report, section 3.
5. Roback, J. D., Grossman, B. J., Harris, T., & Hillyer, C. D. (2011). *Technical Manual of the American Association of Blood Banks*. AABB Press. 1000 pages, pp. 300–355.
6. American Association of Blood Banks. (2020). *Standards for Blood Banks and Transfusion Services*. 350 pages, pp. 50–95.
7. Fung, M. K., Eder, A. F., Spitalnik, S. L., & Westhoff, C. M. (2017). *Technical Manual*. AABB Press. 1008 pages, pp. 210–260.
8. Dean, L. (2005). *Blood Groups and Red Cell Antigens*. National Center for Biotechnology Information (NCBI). Online book, Chapter 2–4.
9. International Society of Blood Transfusion. (2021). *Red Cell Immunogenetics and Blood Group Terminology*. Online resource, section 1–5.
10. Hoffbrand, A. V., & Moss, P. A. H. (2016). *Essential Haematology*. Wiley-Blackwell. 400 pages, pp. 30–55.

ISSN 3030-3907