ISSN 2709-2968
eISSN 2709-2976

VOLUME 6 ISSUE 2 2025

Journal of Interdisciplinary Approaches to Medicine

Al-Farabi Kazakh National University

The following article has been removed from publication for non-compliance with Publication Ethics: "THE CHOICE OF SURGICAL TACTICS FOR THE CORRECTION OF A HIATAL HERNIA IN PATIENTS WITH CHOLELITHIASIS COMBINED WITH GASTROESOPHAGEAL REFLUX» authors- Urokov Sh.T., Kholikov F.Y., Kenzhayev L.R., Khamroyev Kh.N. Bukhara State Medical Institute named after Abu Ali ibn Sino, Uzbekistan, Bukhara pages 14-18 Vol. 3 No. 2 (2022).

Proprietor of the Edition: Al-Farabi Kazakh National University
Editor-in-chief: G.Zh. Kapanova

Certificate № 17781-СИ Registered on July 4th, 2019 in the Ministry of Information and communications of the Republic of Kazakhstan

Journal of Interdisciplinary Approaches to Medicine is publishing two number in a year
website: https://appmed.kaznu.kz

The publisher is not responsible for the internal content of the magazine

Format 60x84/8. Offset paper.
Digital printing. Volume printer's 0,0 sheet.
Publishing house «Kazakh University»
Al-Farabi Kazakh National University
KazNU, 71 Al-Farabi, 050040, Almaty
Printed in the printing office of the Publishing house «Kazakh University».

IRSTI 76.29.07 https://doi.org/10.26577/appmed2025621

L.B. Kuanova[1], G.O. Zhienkulova[1], L.E. Eszhanova[2], J.A. Nugmanova[1*]

[1]CF «University Medical Center», Astana, Kazakhstan
[2]NCJSC «Astana Medical University», Astana, Kazakhstan
*e-mail: nugmanovajam@gmail.com

BRIDGING THE GAP: A CONCEPTUAL MODEL FOR TRANSITIONING NF1 PATIENTS FROM PEDIATRIC TO ADULT CARE IN RESOURCE-LIMITED SETTINGS

Abstract

Introduction: Neurofibromatosis type 1 (NF1) is a chronic autosomal dominant disorder requiring lifelong multidisciplinary oversight. International evidence shows that the transition from pediatric to adult care remains insufficiently standardized, despite the high risk of clinically significant complications during adolescence and early adulthood.

Materials and Methods: A systematic search was performed across PubMed, Scopus and Web of Science (2015–2025) using the keywords "Neurofibromatosis type 1 in adults," "transition care" and "clinical pathway NF1". English-language publications focusing on clinical and organizational aspects of transition were included.

Results: International recommendations emphasize early transition planning (starting at 14–16 years), risk-stratified follow-up, multidisciplinary surveillance, and structured transfer processes extending up to age 25. Key clinical risks during transition include tumor progression (e.g., plexiform neurofibromas, MPNST), neurocognitive impairments, vasculopathy, and skeletal deformities.

Discussion: The absence of established NF1 transition pathways in Kazakhstan may contribute to delayed diagnosis of complications and fragmented care. International practices highlight the necessity of coordinated, multidisciplinary management supported by structured planning, patient education, and continuity between pediatric and adult services. Implementation feasibility is influenced by resource constraints and limited specialist availability.

Conclusion: A stratified, structured transitional care model could improve early detection of NF1-related complications and strengthen continuity of care in Kazakhstan. Adoption of standardized transition pathways may enhance patient outcomes and support national rare disease strategies.

Keywords: patient care management, rare diseases, multidisciplinary care team, transitional care, care transition, neurofibromatosis type 1.

Introduction

Neurofibromatosis type 1 (NF1) is a chronic autosomal dominant disorder characterized by progressive multisystem involvement that require lifelong medical oversight [5, 15]. Despite significant global interest in improving outcomes for patients with rare genetic disorders, the transition from pediatric to adult healthcare services remains an underdeveloped and insufficiently standardized stage of care.

International studies emphasize that clinically significant complications are particularly common during the transitional period in patients with Neurofibromatosis Type 1. At this stage of life, there is an increased risk of developing malignant peripheral nerve sheath tumors, progressive skeletal deformities, chronic pain syndromes, pronounced cognitive impairments, and reproductive dysfunctions.

Studies indicate an important gap: practically applicable transition-of-care models specifically tailored to NF1 have not yet been developed [5, 25].

The aim of this review is to systematize the existing evidence on transitional care in NF1, identify key barriers and components of successful models, and evaluate their applicability in the context of healthcare systems with limited resources, including Kazakhstan.

Methodology

The previously reported lack of established transition-of-care models for NF1 served as the rationale for conducting a systematic literature search.

The search was performed across three major international databases – PubMed, Scopus, and Web of Science – for the period from 2015 to 2025. The following keywords and phrases were used: "Neurofibromatosis type 1 in adults," "transition care," and "clinical pathway NF1." Only English-language publications focusing on clinical and organizational aspects of the transition from pediatric to adult care, principles of multidisciplinary management, and risk stratification methods were included [5, 15, 25, 28]. In addition, official clinical protocols and guidelines from leading international organizations were reviewed, including the Children's Tumor Foundation (CTF) [6], EURORDIS [9], NHS England [20], the German NF1 competence network, and the NF Clinic Network (NIH, USA) [22].

This analysis aimed to synthesize international recommendations and evaluate their applicability within the healthcare system of the Republic of Kazakhstan. Based on these findings, an adapted conceptual model of transitional care was developed, incorporating recommended age stages, risk stratification, and the clinical transfer of patients from pediatric to adult services.

Review

The development of an adapted model of transitional care for NF1 in Kazakhstan requires integration of international practices with the specific characteristics of the national healthcare system. Given the rarity of NF1 and the limited experience in adult patient management, a stratified and structured approach to care coordination is essential [5].

In the Republic of Kazakhstan, patients with Neurofibromatosis Type 1 (NF1) are followed in pediatric services until the age of 18, after which responsibility for care shifts to adult healthcare providers [24]. At the same time, international guidelines define a more flexible age range for the transition period – 14 to 25 years – taking into account the clinical course of NF1, the patient's level of psychosocial maturity, and the readiness of the adult care system [20, 25, 28].

In accordance with international guidelines, transition should not occur at a fixed age but rather as a gradual and structured process initiated as early as 14 years. Early engagement of the patient facilitates the development of self-management skills, awareness of disease-specific needs, and responsibility for adhering to treatment recommendations [20, 25, 28].

Although 18 years remains the legal threshold for transfer of care, the transition process may extend beyond this age, particularly for individuals with cognitive or behavioral impairments, psychiatric comorbidities, or complex clinical pathways, which are frequent among NF1 patients [25, 28]. Given the elevated risk of severe complications – such as malignant transformation of plexiform neurofibromas, neuro-oncological or vascular disorders, chronic pain, and cognitive deficits – international organizations, including EURORDIS [9], the Children's Tumor Foundation [6], and the NIH Neurofibromatosis Network [22], recommend maintaining elements of pediatric support and multidisciplinary surveillance until the age of 25.

Diagnostic criteria for Neurofibromatosis type 1 (NF1) are consistent for both pediatric and adult patients, although their clinical presentation often varies with age. In 2021, the American College of Medical Genetics and Genomics (ACMG), in collaboration with the NIH and international experts, revised the diagnostic framework [11]. The diagnosis is established when at least two characteristic clinical features are present: multiple café-au-lait macules (≥6, with a diameter of ≥5 mm in children and ≥15 mm in adolescents and adults), two or more neurofibromas of any type or at least one plexiform neurofibroma, axillary or inguinal freckling. Additional hallmarks are optic pathway glioma, two or more Lisch nodules, other iris abnormalities, or typical osseous lesions (e.g., sphenoid wing dysplasia). A confirmed pathogenic NF1 gene variant or a first-degree relative with a definitive diagnosis of NF1 is also considered sufficient for establishing the diagnosis [11].

Thus, transitional care represents a distinct and structured process rather than a simple continuation of pediatric management. A consolidated overview of international transitional care recommendations is provided in Table 1.

Tumor manifestations of NF1 represent a principal and the most serious complication during the transition period, constituting a primary challenge for timely surveillance and effective clinical management. The most common tumor manifestations include plexiform neurofibromas, optic pathway gliomas, pheochromocytomas, gastrointestinal stromal tumors, breast cancer in young women, and hematologic malignancies such as juvenile myelomonocytic leukemia [11, 21].

Table 1 – International Recommendations for NF1 Transitional Care

Source	Year	Key Provisions	Applicability
European Reference Network for Rare Neurological Diseases (ERN-RND) [5].	2022	• Early transition planning (starting at age 14) • Individual transition plan (patient passport, cognitive function assessment, family involvement) • Appointment of a transition coordinator	• Include the transition plan in the outpatient record • Assign a transitional care physician between ages 14–16
NICE (UK), DraftRecommendations [11, 20].	2023	• Annual follow-up for symptomatic adults • Multidisciplinary approach (dermatologist, neurologist, oncologist, etc.) • Written handover of medical records • Involvement of primary care provider	• Protocol for interlevel data transfer • Include family physician in thecare scheme
Austrian NF1 adult surveillance form [26].	2025	• Baseline assessment at the point of transfer • Consideration of neurocognitive and social risks • Tumor prevention measures	• Screening template for transition • Regional protocol development for women's health and cognitive assessment
ConsensusStatement (USA) [6, 28].	2018	• Continuity of care into adulthood • Regular evaluation of cognitive and psychiatric issues • Inclusion of specialists in pain management, orthopedics, and rehabilitation • Importance of adult NF1 centers	• Create a referral roadmap with an expanded care team • Localize specialized centers for rare diseases
Note – compiled by the author based on the source (ERN-RND, NICE (UK), Draft Recommendations, The Austrian NF1 adult surveillance form, Consensus Statement (USA))			

Beyond oncological risks, neurocognitive impairments represent a major source of morbidity. Many patients present with learning difficulties, attention deficit and hyperactivity disorder (ADHD), autism spectrum disorders, executive dysfunction, anxiety, and depression, which substantially affect quality of life and social integration [1, 7, 8, 10, 14, 18, 23].

Additional complications include vasculopathy, Moyamoya disease, skeletal deformities such as pseudarthrosis and sphenoid wing dysplasia, scoliosis, and reduced bone mineral density [2, 4, 12, 16, 19]. Collectively, these findings highlight the necessity of dynamic surveillance involving multidisciplinary teams [27, 29].

The infrastructure of the proposed model incorporates multiple layers designed to strengthen continuity of care. At the national level, the establishment of a Coordination Center is proposed, which will provide methodological leadership, maintain the national registry, and organize multidisciplinary consultations, including telemedicine services. This center would also lead professional training, guideline development, and integration with international networks.

Regional centers, located in multi-profile provincial hospitals, are intended to manage patients with low- to moderate-risk profiles, conduct regular assessments, and collaborate with the national center for complex clinical cases. These centers also serve as transitional hubs, preparing pediatric patients for transfer to adult services, managing digital patient passports, and coordinating support of patients.

A digital transitional care passport is proposed as a central tool to ensure continuity. This electronic document consolidates diagnostic history, imaging, genetic results, care coordinators' notes, and follow-up schedules, and facilitates communication across healthcare levels. Additional components of the model include structured physician training programs, integration of psychosocial services, and partnerships with patient advocacy organizations.

The age-related structure of the transitional period in NF1 involves the sequential implementation of four key stages aimed at ensuring continuity of care and supporting patients in their adaptation to the adult healthcare system.

The first stage – Early Preparation (12–14 years) – includes an initial discussion with the patient and their family, as well as education about the disease and forthcoming changes in healthcare organization.

During the Active Preparation stage (14–17 years), a transition coordinator is appointed, and a systematic assessment of the patient's self-management skills and engagement in their own care is conducted.

The third stage – Transfer (18–19 years) – is characterized by joint visits with pediatric and adult specialists and the handover of the full medical record, which facilitates the establishment of a stable relationship with the adult care provider.

The final stage – Post-Transition Follow-up (20–25 years) – focuses on the patient's adaptation within the adult care system, monitoring of treatment adherence, and timely identification of risk factors associated with NF1.

In addition to age-based staging, the model introduces a three-tiered risk stratification system to guide the intensity of follow-up and level of care required.

Patients classified as Low Risk, characterized by exclusively cutaneous manifestations, can be safely followed at the regional level.

The Moderate Risk group includes patients with stable PNF, cognitive impairment, or hypertension. For these individuals, referral to a specialized regional center is recommended, along with periodic neuroimaging every 1–2 years and multidisciplinary follow-up involving neurologists, dermatologists, oncologists, psychologists, and other specialists [17].

Conclusion

This review emphasizes the importance of structured transitional care in Neurofibromatosis Type 1, highlighting early preparation, risk-based management, and multidisciplinary support as essential elements.

For Kazakhstan, the proposed stratified model offers a practical framework to improve continuity of care.

The model has the potential to enhance early detection of complications, ensure smoother transfer from pediatric to adult services. Implemented within the framework of the national rare disease strategy, it could serve as a pilot initiative to strengthen patient outcomes and quality of life.

Gratitude, conflict of interest

Funding: The authors declare that they did not receive any financial support or funding from any organization for the submitted work.

Acknowledgements: No additional contributions or institutional support were received.

Conflicts of Interest: The authors declare no other relationships or activities that could appear to have influenced the submitted work.

References

1. Acosta, M. T., Gioia, G. A., & Silva, A. J. (2006). Neurofibromatosis type 1: New insights into neurocognitive issues. Current NeurologyandNeuroscienceReports, 6, 136–143. https://doi.org/10.1007/s11910-996-0036-5

2. Barreto-Duarte, B., Andrade-Gomes, F. H., Arriaga, M. B., Araújo-Pereira, M., Cubillos-Angulo, J. M., & Andrade, B. B. (2021). Association between neurofibromatosis type 1 and cerebrovascular diseases in children. PLOS ONE, 16, e0241096. https://doi.org/10.1371/journal.pone.0241096

3. Bergqvist, C., Servy, A., Valeyrie-Allanore, L., Ferkal, S., Combemale, P., Wolkenstein, P., & NF France Network. (2020). Neurofibromatosis 1 Frenchnationalguidelinesbasedonanextensiveliteraturereviewsince 1966. *Orphanet Journal ofRareDiseases, 15*(1), 37. https://doi.org/10.1186/s13023-020-1310-3

4. Boulanger, J. M., &Larbrisseau, A. (2005). Neurofibromatosis type 1 in a pediatric population. Canadian Journal ofNeurological Sciences, 32, 225–231. https://doi.org/10.1017/s0317167100004017

5. Carton, C., Evans, D., Blanco, I., Friedrich, R., Ferner, R., Farschtschi, S., ... Wagner, A. (2023). ERN GENTURIS tumour surveillance guidelines for individuals with neurofibromatosis type 1. EClinicalMedicine, 56, 101818. https://doi.org/10.1016/j.eclinm.2022.101818

6. Children's Tumor Foundation. (2023). Annual Report 2022. https://www.ctf.org/news/childrens-tumor-foundation-annual-report-2022

7. Descheemaeker, M. J., Plasschaert, E., Frijns, J. P., &Legius, E. (2013). Neuropsychological profile in adults with neurofibromatosis type 1. Journal of Intellectual Disability Research, 57, 874–886. https://doi.org/10.1111/j.1365-2788.2012.01648.x

8. Doser, K., Andersen, E., Kenborg, L., Dalton, S. O., Jepsen, J. R., Kroyer, A., Ostergaard, J., Hove, H., Sorensen, S., Johansen, C., Mulvihill, J., Winther, J., & Bidstrup, P. (2020). Clinical characteristics and quality of life in adults with neurofibromatosis 1. *American Journal of Medical Genetics Part A, 182*, 1704–1715. https://doi.org/10.1002/ajmg.a.61627

9. EURORDIS. (2024). Activity Report 2024. https://www.eurordis.org/publications/activity-report-2024

10. Ferner, R. E., Hughes, R. A. C., & Weinman, J. (1996). Intellectual impairment in neurofibromatosis 1. Journal of the Neurological Sciences, 138, 125–133. https://doi.org/10.1016/0022-510x(96)00022-6

11. Gutmann, D. H., Ferner, R. E., Listernick, R. H., Korf, B. R., Wolters, P. L., & Johnson, K. J. (2017). Neurofibromatosis type 1. Nature Reviews Disease Primers, 3. https://doi.org/10.1038/nrdp.2017.4

12. Heervä, E., Koffert, A., Jokinen, E., Kuorilehto, T., Peltonen, S., Aro, H., Aho, H., & Peltonen, J. (2012). A controlled register-based study of 460 NF1 patients. *Journal of Bone and Mineral Research, 27*, 2333–2337. https://doi.org/10.1002/jbmr.1685

13. Hirbe, A. C., Dehner, C. A., Dombi, E., Eulo, V., Gross, A. M., Sundby, T., Lazar, A. J., &Widemann, B. C. (2024). Contemporaryapproachtoneurofibromatosistype 1–associatedmalignantperipheralnervesheathtumors. *ASCO Educational Book, 44*(3), e432242. https://doi.org/10.1200/EDBK_432242

14. Hyman, S. L., Shores, E. A., & North, K. N. (2006). Learning disabilities in children with neurofibromatosis type 1. DevelopmentalMedicine& Child Neurology, 48, 973–977. https://doi.org/10.1017/s0012162206002131

15. Iasella, M. P., Ruttens, D., Hompes, D., Vandecaveye, V., Sciot, R., Deroose, C., Douchy, T., Decramer, T., Jacobs, S., Denayer, E., Van Calenbergh, F., Legius, E., & Brems, H. (2025). Close follow-up of patients with neurofibromatosis type 1. *Cancers, 17*(8), 1306. https://doi.org/10.3390/cancers17081306

16. Kaas, B., Huisman, T. A. G. M., Tekes, A., Bergner, A., Blakeley, J. O., & Jordan, L. C. (2013). Spectrum and prevalence of vasculopathy in pediatric neurofibromatosis type 1. Journal of Child Neurology, 28, 561–569. https://doi.org/10.1177/0883073812448533

17. Karwacki, M. W., Wysocki, M., Perek-Polnik, M., &Jatczak-Gaca, A. (2021). Coordinatedmedicalcareforchildrenwithneurofibromatosistype 1 andrelatedRASopathiesinPoland. *Archivesof Medical Science, 17*(5), 1221–1231. https://doi.org/10.5114/aoms.2019.85143

18. Lausdahl, S., Handrup, M. M., Rubak, S. L., Jensen, M. D., & Ejerskov, C. (2022). Transition to adult care in young patients with neurofibromatosis type 1. Orphanet Journal ofRareDiseases, 17. https://doi.org/10.1186/s13023-022-02356-z

19. Monroe, C. L., Dahiya, S., & Gutmann, D. H. (2017). Dissecting clinical heterogeneity in NF1. Annual Review ofPathology, 12, 53–74. https://doi.org/10.1146/annurev-pathol-052016-100228

20. National Institute for Health and Care Excellence. (2016). Transition from children's to adults' services (NG43). https://www.nice.org.uk/guidance/ng43

21. National Institute for Health and Care Excellence. (2022). Selumetinib for treating symptomatic and inoperable plexiform neurofibromas (HST20). https://www.nice.org.uk/guidance/hst20

22. National Institute of Neurological Disorders and Stroke. (2025). Neurofibromatosis. https://www.ninds.nih.gov/health-information/disorders/neurofibromatosis

23. Payne, J. M., Haebich, K., MacKenzie, R., Walsh, K. S., Hearps, S., Coghill, D., Barton, B., Pride, N., Ullrich, N., Tonsgard, J., Viskochil, D., Schorry, E., Klesse, L., Fisher, M., Gutmann, D., Rosser, T., Packer, R., Korf, B., Acosta, M., Bellgrove, M., & North, K. (2021). Cognition, ADHD symptoms, and functional impairment in NF1. *Journal of Attention Disorders, 25*, 1177–1186. https://doi.org/10.1177/1087054719894384

24. Приказ Министра здравоохранения Республики Казахстан от 15 декабря 2020 г. № ҚР ДСМ-264/2020. (2020). https://adilet.zan.kz/rus/docs/V2000021820

25. Romanized: PrikazMinistrazdravookhraneniyaRespubliki Kazakhstan ot 15 dekabrya 2020 goda № KR DSM-264/2020. (2020). O vneseniiizmeneniy i dopolneniy v pravilaokazaniyameditsinskoipomoshchi v Respublike Kazakhstan [OrderoftheMinisterofHealthcareofthe Republic of Kazakhstan No. KR DSM-264/2020: Amendmentstomedicalcareregulations]. Adilet. https://adilet.zan.kz/

26. Radtke, H. B., Berger, A., Skelton, T., & Goetsch Weisman, A. (2023). Neurofibromatosis type 1: Transition to adult care. Pediatric Health, Medicine and Therapeutics, 14, 19–32. https://doi.org/10.2147/phmt.s362679

27. Sunder-Plassmann, V., Azizi, A. A., Farschtschi, S., Gruber, R., Hutterer, M., Ladurner, V., Röhl, C., Welponer, T., Bergmeister-Berghoff, A.-S. (2025). Neurofibromatosis type 1 adult surveillance form for Austria. *Wiener klinischeWochenschrift, 137*(3), 487–494. https://doi.org/10.1007/s00508-024-02443-0

28. Uusitalo, E., Leppävirta, J., Koffert, A., Suominen, S., Vahtera, J., Vahlberg, T., Pöyhönen, M., Peltonen, J., & Peltonen, S. (2015). Incidence and mortality of neurofibromatosis. *Journal of Investigative Dermatology, 135*, 904–906. https://doi.org/10.1038/jid.2014.465

29. White, P. H., & Cooley, W. C. (2018). Supporting the health care transition from adolescence to adulthood in the medical home. Pediatrics, 142. https://doi.org/10.1542/peds.2018-2587

30. Wolkenstein, P., Zeller, J., Revuz, J., Ecosse, E., &Leplège, A. (2001). Quality-of-life impairment in neurofibromatosis type 1. Archives of Dermatology, 137, 1421. https://doi.org/10.1001/archderm.137.11.1421

Information about authors:

L.B. Kuanova – Doctor of Medical Sciences, Professor, Head of the Neurology Residency Program, Neurologist at CF «University Medical Center» (Astana, Kazakhstan).

G.O. Zhienkulova – Candidate of Medical Sciences, Oncologist-Hematologist, Coordinator of the Oncology Day Hospital Department at CF «University Medical Center» (Astana, Kazakhstan).

L.E. Eszhanova – Candidate of Medical Sciences, Professor, Head of the Department of Neurology at Astana Medical University (Astana, Kazakhstan).

J.A. Nugmanova (corresponding author) – Resident-Neurologist at CF «University Medical Center» (Astana, Kazakhstan).

IRSTI 76.29.39 https://doi.org/10.26577/appmed2025622

Y.P. Ziyayev*, M.N. Tillyashaykhov, S.M. Dzhanklich

Practical Medical Center of Oncology Tashkent, Uzbekistan
*e-mail: docziyaev1@gmail.com

THE IMPACT OF PESTICIDES ON CANCER INCIDENCE AMONG CHILDREN IN UZBEKISTAN: A SURVEY STUDY

Abstract

Introduction: The spread of malignant diseases is a serious problem in Uzbekistan. Recent data suggest a possible link between pesticide exposure and an increase in cancer rates. Pesticides are used in the cultivation of a wide range of agricultural crops. In Uzbekistan, 249 different plant protection products are permitted. They contain various active ingredients, 59 of which are recognized as highly hazardous pesticides.

Research objective: To study the effect of pesticides on the development of malignant neoplasms in children.

Results: The survey shows that a significant number of patients (63 out of 93) live near agricultural fields, indicating a potential risk of pesticide exposure to health. Approximately 30% of respondents reported the use of pesticides in nearby fields. This may be an important environmental factor influencing the development of malignant neoplasms in children. Patients were diagnosed with 28 different types of cancer. Leukemia and brain cancer were the most commonly diagnosed types of cancer among the study participants, which is consistent with international studies that have established a link between pesticide exposure and these types of malignant neoplasms.

Conclusions: The results of this survey indicate a probable correlation between pesticide exposure and cancer incidence in children in Uzbekistan, highlighting the need for stricter control of pesticide use and more comprehensive clinical and epidemiological studies to confirm these results.

Keywords: malignant neoplasms (MN), cancer incidence, pesticides, childhood cancer, environmental exposure, agrochemicals, pediatric oncology.

Introduction

The spread of malignant neoplasms (MN) is a serious problem in Uzbekistan. In 2024, the number of newly diagnosed cases of malignant neoplasms in children aged 0 to 17 was 827. The incidence rate of MN in children was 6.4 per 100,000 of the child population.The leading types of cancer were: hemoblastoses (36.0%), brain and spinal cord tumors (19.7%), MN of bones and joints (8.1%), MN of connective and soft tissues (7.5%), kidney malignancies (4.7%), retinoblastoma (3.9%), and retroperitoneal malignancies (3.0%), which together accounted for 83.0% of all newly diagnosed malignancies in children

Pesticides are used in the cultivation of a wide range of agricultural crops, including cotton and grains (the most common crops), as well as vegetables, fruits, berries, flowers, tobacco, fruit and ornamental trees and shrubs, and forest plantations. A total of 249 different products are approved for use as plant protection products in Uzbekistan. They contain various active ingredients, 59 of which are classified as highly hazardous pesticides and included in the list of particularly hazardous pesticides (PAN). In addition, 34 of them are banned in other countries, according to the PAN summary report [3, 5, 7]. Uzbekistan has created a database of laws and regulations, , governing the production, use, harm, and liability of individuals and legal entities, as well as the rational management of chemicals, including registration, licensing, and prevention of the accumulation of hazardous chemicals (primarily pesticides) in the country.

A meta-analysis published in 2019 on the impact of pesticides in the home and the risk of leukemia in children and adolescents showed a positive association between exposure to pesticides in the home and the development of leukemia in children [8].

Another study suggests that the risk of sarcoma was increased in some agricultural jobs involving pesticides, with differences depending on the histological subtype. Increased risks were observed among cattle farmers who had been working for more than 10 years, especially if they were involved in animal care and building disinfection, greenhouse production, and field vegetable growing [4, 6, 9].

The study aims to identify a possible link between pesticide exposure and cancer incidence among chil-

dren. The results of the study will allow for some changes in pesticide use, thereby reducing the risk of cancer in children.

Research objective

To study the effect of pesticides on the occurrence of malignant neoplasms in children.

Materials and methods:

The study was conducted in the form of a survey. Ninety-three out of 108 patients participated in the survey (15 patients did not consent to participate). All patients were treated at the Taskin hospice between 2022 and 2024.The survey was conducted by two coordinators during a telephone conversation. After obtaining verbal consent to use personal data and record the telephone conversation, the assistant began the survey. Recordings of all conversations related to the project were stored on the working group's personal computer.

A questionnaire was developed that included 12 questions:

Full name
Date of birth
Place of residence
Diagnosis
Stage of disease
Date of diagnosis
Medical facility
Presence of agricultural fields near place of residence
Occupation of guardians
Direct involvement in field work
Use of pesticides in the fields
Condition of the patient at the time of the survey

Personalized information was collected, including: data on the diagnosis according to the International Classification of Diseases, 10th Revision (ICD-10), age, gender, date of diagnosis, clinical stage of the disease according to the international classification, as well as the current condition of the patient according to the rules for registering malignant tumors. Relevant criteria for the impact of pesticides on patients with malignant neoplasms were also collected, such as: the presence of agricultural fields near the patient's place of residence, the occupation of caregivers, the patient's participation in field work, and the use of pesticides on agricultural fields, if any.

Research results:

Based on the study material, 37 patients (39.8%) were women and 56 (60.2%) were men. When studying the place of residence of the patients, it was found that most of them, 72 (77.4%), were rural residents, and 19 (20.4%) were urban residents.

The age distribution of patients was as follows: most patients in the study group were 2 years old (10.8%), 4 years old (8.6%), and 11 years old (7.5%), The average age of patients was 9.23± 2.3.16.1% of patients had brain tumors, 12.9% had hemoblastoses, and 10.8% had malignant neoplasms of bones and joints. It should be noted that the structure of morbidity in the study group is similar to the national structure.

After studying the distribution of the above diseases by stage, it was noted that 57.0% of patients were in stages III-IV, 9.7% were in stage I, and 33.3% were in stage II

The study included patients who were diagnosed between 2017 and 2024. Most of the patients in the study were diagnosed in 2023 (47.3%) and 2022 (26.9%). It is worth noting that a total of 39.8% of patients died. At the same time, 100% mortality was recorded in patients diagnosed in 2019 and 2020 (Table 1).

Table 1 – Distribution of study patients by date of diagnosis and mortality

Date of diagnosis	Number of patients		Mortality	
	Absolute number	%	abs. number	%
2017	2	2.2	0	0
2018	2	2.2	1	50
2019	1	1.1	1	100.0
2020	1	1.1	1	100.0
2021	9	9.7	5	55.6
2022	25	26.9	13	52.0

Continuation of the table

Date of diagnosis	Number of patients		Mortality	
	Absolute number	%	abs. number	%
2023	44	47.3	13	29.5
2024	9	9.7	3	33.3
Total:	93	100.0	37	39.8

Most patients (67.7% – 63 patients) lived near agricultural fields, while 30 patients (32.3%) did not have fields near their homes. It is worth noting that, of the 63 subjects, 24 (38.1%) were agricultural workers and were directly involved in this activity (Table 2). It should also be noted that 30 (30.1%) of the subjects responded that they themselves use various types of pesticides in their work.

Table 2 – Distribution of patients by the presence of agricultural fields near their place of residence and their parents' occupation

No agricultural fields near the patient's place of residence		There are agricultural fields near the patient's place of residence	
30	32.3	63	67.7
Of these, agricultural workers are employed:		**Of these, agricultural workers:**	
Mother	1 (3.3%)	All family members	11 (17.5%)
		Father	9 (14.3%)
		Mother	4 (4.8%)
		Brother	1 (1.6%)

Conclusions:

The survey involved 93 patients, mainly from rural areas where agricultural practices, including the use of various pesticides, are widespread. The data show that 67.7% of respondents lived near agricultural fields, and 26.9% had family members working in these fields. The study revealed that the vast majority of patients were from rural areas (77.4%). This is another direct link between cancer incidence and pesticide exposure.Approximately 30% of the study participants (30 out of 93) reported using pesticides while working in agricultural fields. This may be an important environmental factor affecting health.

The survey results show that 28 different types of cancer were recorded among the patients. Leukemia and brain cancer were the most commonly diagnosed types of cancer among the subjects, which is consistent with international studies that have established a link between pesticide exposure and these types of malignant neoplasms.

The results of this survey indicate a probable correlation between pesticide exposure and cancer incidence in children, highlighting the need for stricter control of pesticide use , more comprehensive clinical and epidemiological studies to confirm these results, and the development of effective cancer prevention strategies in Uzbekistan.

References

State departmental reporting forms of the Ministry of Health of the Republic of Uzbekistan "Information on malignant neoplasms" – form No. 7 for 2024[Gosudarstvennyevedomstvennyeotchetnyeformy MZ RUz "Svedeniya o zabolevaniyahzlokachestvennyminovoobrazovaniyami" – forma №7 za2024 g.]

2. Tillyashajhov M.N., Ibragimov SH.N., Dzhanklich S.M. "The state of oncological care for the population of the Republic of Uzbekistan in 2024," 2025. [Tillyashajhov M.N., Ibragimov SH.N., Dzhanklich S.M. "The state of cancer care for the population of the Republic of Uzbekistan in 2024," 2025..

3 .Bassil KL, Vakil C, Sanborn M, Cole DC, Kaur JS, Kerr KJ. Cancer health effects of pesticides: systematic review. Can Fam Physician. 2007 Oct;53(10):1704-11. PMID: 17934034; PMCID: PMC2231435.

4. Gunier RB, Kang A, Hammond SK, Reinier K, Lea CS, Chang JS, Does M, Scelo G, Kirsch J, Crouse V, Cooper R, Quinlan P, Metayer C. A task-based assessment of parental occupational exposure to pesticides and childhood acute lymphoblastic leukemia. Environ Res. 2017 Jul;156:57-62. doi: 10.1016/j.envres.2017.03.001. Epub 2017 Mar 19. PMID: 28319818; PMCID: PMC5466848

5. Hyland C, Gunier RB, Metayer C, Bates MN, Wesseling C, Mora AM. Maternal residential pesticide use and risk of childhood leukemia in Costa Rica. Int J Cancer. 2018 Sep 15;143(6):1295-1304. doi: 10.1002/ijc.31522. Epub 2018 Apr 26. PMID: 29658108; PMCID: PMC6099525.

6. Renier M, Busson A, Boulanger M, Piel C, Pons R, Tual S, Amadéo B, Meryet-Figuiere M, Marcotullio E, Clin B, Baldi I, Lebailly P; AGRICAN Group. Agricultural exposure and risk of soft tissue sarcomas and gastrointestinal stromal sarcoma in the AGRIculture and CANcer (AGRICAN) cohort. Int J Cancer. 2022 Jun 1;150(11):1792-1803. doi: 10.1002/ijc.33936. Epub 2022 Jan 29. PMID: 35048371.

7.Turner MC, Wigle DT, Krewski D. Residential pesticides and childhood leukemia: a systematic review and meta-analysis. Cien Saude Colet. 2011 Mar;16(3):1915-31. doi: 10.1590/s1413-81232011000300026. PMID: 21519680.

8. Van Maele-Fabry G, Gamet-Payrastre L, Lison D. Household exposure to pesticides and risk of leukemia in children and adolescents: Updated systematic review and meta-analysis. Int J Hyg Environ Health. 2019 Jan;222(1):49-67. doi: 10.1016/j.ijheh.2018.08.004. Epub 2018 Sep 26. PMID: 30268646.

9. Wigle DT, Turner MC, Krewski D. A systematic review and meta-analysis of childhood leukemia and parental occupational pesticide exposure. Environ Health Perspect. 2009 Oct;117(10):1505-13. doi: 10.1289/ehp.0900582. Epub 2009 May 19. PMID: 20019898; PMCID: PMC2790502.

Information about authors:

Y.P. Ziyayev – Medical Doctor, Head of Palliative Treatment Department Republican Specialized Scientific Practical – Medical Center of Oncology and Radiology (Tashkent, Uzbekistan).

M.N. Tillyashaykhov – Doctor of Medical Sciences, Professor, Director of The Republican Specialized Scientific Practical – Medical Center of Oncology and Radiology (Tashkent, Uzbekistan).

S.M. Dzhanklich – PhD, Head of the Cancer Registry Department Republican Specialized Scientific Practical – Medical Center of Oncology and Radiology (Tashkent, Uzbekistan).

IRSTI 76.29.39 https://doi.org/10.26577/appmed2025623

U.D. Usmonov

Andijan State Medical Institute, Andijan, Uzbekistan
Military Medical Academy of the Armed Forces of the Republic of Uzbekistan, Tashkent, Uzbekistan
e-mail: udusmonov@gmail.com

EFFECTIVENESS OF A NEW METHOD OF PROVIDING FIRST AID FOR NON-GUNSHOT WOUNDS TO SOFT TISSUE

Abstract

Introduction: This study evaluates a novel pre-hospital care method for non-gunshot soft tissue injuries using a multi-stage antiseptic gel. The aim is to reduce pain, local inflammation, and postoperative complications, addressing a key need in emergency and military medicine.

Materials and Methods: A comparative analysis included a main group (164 patients treated with the multi-stage gel protocol and trained junior staff) and a comparison group (291 patients treated with standard protocols). Groups were matched for injury type, absence of bone damage, surgical conditions, and injury severity. A subgroup of 49 military personnel was analyzed for microbiological outcomes and simulation-based training impact.

Results: The main group experienced reduced pain during the first 3–5 days post-injury and fewer postoperative complications. Preoperative sterile wound cultures were higher (57.7% vs. 13.0%) and postoperative complications lower (15.4% vs. 47.8%) compared to the comparison group.

Discussion: Integrating multi-stage antiseptic treatment with simulation training enhanced early infection control and wound healing, demonstrating practical value, especially in field and resource-limited settings.

Conclusion: The proposed protocol effectively reduces pain and complications, improving early infection management and continuity of care in emergency and military medicine.

Keywords: pre-hospital care, non-gunshot wounds, infection control, simulation training, military medicine.

Introduction

In contemporary armed conflicts, the primary causes of injuries are firearms, artillery shells, landmines, and explosive devices. However, despite the lower incidence of non-gunshot injuries, their nature and consequences remain highly significant. Among non-gunshot injuries, soft tissue damage represents one of the most prevalent types of trauma both in wartime and peacetime. These injuries include stab and cut wounds caused by knives or shrapnel, blunt trauma from impacts or falls, burns of varying severity, and others [1,9].

In military conflicts, soft tissue injuries constitute a substantial proportion of combat-related trauma, with various studies reporting incidences of up to 60% of all cases. In modern military engagements, non-gunshot soft tissue injuries among service members typically result from road traffic accidents, falls from heights, collisions with military equipment, and other mechanical forces. These injuries may be either open or closed and can resemble gunshot wounds in their nature and severity. In peacetime, soft tissue injuries are also widespread: according to medical institution statistics, they account for up to 40% of visits to emergency departments, underscoring their significance for the healthcare system [2,4,16].

The organization of surgical care for non-gunshot soft tissue injuries among military personnel at the initial stages of medical evacuation is a crucial aspect in ensuring timely treatment, preserving lives, and increasing the likelihood of full recovery. This process encompasses a range of organizational, surgical, and evacuation measures aimed at minimizing complications and preventing disability. Timely surgical care for non-gunshot soft tissue injuries during early medical evacuation stages is an essential component of the military medical support system. It reduces mortality and disability rates, expedites recovery, and facilitates the return of service members to duty. Achieving maximum efficiency requires the integration of modern medical technologies, strategic planning, and highly qualified personnel [5,6,11]

Traditional methods of first aid, which primarily involve mechanical wound treatment and the use of standard antiseptic solutions, often do not provide

adequate protection against infectious complications–particularly in cases of deep and extensive tissue damage–even when rapid transport to a medical facility is available.

Therefore, the search for and development of new approaches and agents capable of minimizing the risk of wound infection and other complications remains highly relevant, both in civilian and military medicine (in both peacetime and wartime). Modern challenges necessitate the use of flexible, mobile solutions, adaptive technologies, and highly skilled personnel, making this field a priority in military medical practice.

Materials and Methods

Within the clinical phase of the study, the effectiveness of a novel method for providing initial pre-medical care for non-gunshot soft tissue injuries using an antiseptic gel was assessed.

The main study group comprised 164 patients treated using the proposed method, which involved multistage application of the antiseptic gel: at the pre-medical care stage, during surgical wound debridement, and throughout postoperative dressing changes. Additionally, in a subgroup of military personnel, the main group was supported by specialized simulation-based training for junior medical staff, conducted according to field surgical care standards. The comparison group consisted of 291 patients who received care according to traditional protocols, without the use of the antiseptic gel or trained personnel.

Comparative evaluation accounted for the homogeneity of included patients based on key criteria: type of injury (penetrating or non-penetrating), absence of bone damage, similarity in conditions of transport and surgical management, exclusion of complicated medical histories, and comparable severity and localization of injuries. This approach ensured the reliability of the outcomes in analyzing the efficacy of the proposed method.

Additionally, a subgroup of 49 military personnel with non-penetrating injuries (23 in the comparison group and 26 in the main group) was included in the study. Within this subgroup, the microbiological profile of wounds, frequency of complications, and the effectiveness of the implemented simulation training program were analyzed separately. The training program focused on developing skills in initial surgical wound debridement, dressing application, gel administration, and the use of triage and microbiological vigilance protocols in field conditions. Thus, the main group demonstrated not only pharmacological but also organizational and tactical advantages in early infection control of the wound surface.

The most common type of injury in both groups was stab-incised wounds, identified in 67 patients (40.9%) in the main group and in 125 patients (43.0%) in the comparison group. These were followed in frequency by incised wounds, recorded in 25.0% and 27.1% of patients, respectively. Puncture wounds were observed in 26 patients (15.9%) in the main group and in 36 (12.4%) in the comparison group. Lacerations occurred in 14.0% of the main group and 14.8% of the comparison group, indicating an almost identical frequency. Chop wounds, the rarest injury type, were registered in 7 patients (4.3%) in the main group and in 8 (2.7%) in the comparison group.

Among civilian patients, who constituted the majority in both the main group (86.0%) and the comparison group (91.1%), injuries were primarily due to domestic, occupational, or road traffic accidents. In contrast, injuries among military personnel–accounting for 14.0% of the main group and 8.9% of the comparison group–were mainly sustained in field conditions during exercises, training, or tactical operations.

Analysis of injury localization showed a predominance of upper limb injuries in both study groups: 57 patients (34.8%) in the main group and 98 (33.7%) in the comparison group. Lower limb injuries ranked second in frequency: 28.0% (n=46) in the main group and 29.9% (n=87) in the comparison group. Torso injuries were documented in 48 (29.3%) and 79 (27.1%) patients, respectively. Head and neck injuries were the least frequent: 13 patients (7.9%) in the main group and 27 (9.3%) in the comparison group.

Thus, injury conditions among civilians were predominantly caused by peacetime trauma factors, while those among military personnel were associated with tactical field environments. These differences determine the specifics of microbial contamination, injury depth, and treatment outcomes, which must be considered when analyzing the clinical effectiveness of first aid methods.

The analysis was conducted across the full sample–164 patients in the main group and 291 in the comparison group. The primary assessment focused on the dynamics of key indicators reflecting wound healing progression and quality. Upon admission, pain intensity, as measured by the Visual Analog Scale (VAS), was comparable between the groups: 4.23 ± 1.23 points in the main group and 4.10 ± 1.21 in the comparison group ($p > 0.05$). The analysis in-

cluded the frequency of positive and sterile cultures at key stages: upon injury and during surgical intervention. Microbial wound contamination was monitored in stages, taking into account clinical dynamics.

Statistical processing of study data and objective evaluation were performed using parametric and non-parametric methods depending on data type and distribution [3,7,8,10,12–14,17–19]. For quantitative variables, the mean, standard deviation (SD), and sample size (n) were calculated. Prior to comparing quantitative data between groups, distribution characteristics were assessed. The choice of statistical tests was justified by evaluating conformity to normal distribution. While the Shapiro–Wilk test could be used for small samples, independent sample analysis in this study employed the Student's t-test. For comparing mean values between two independent groups (main and control), Student's t-test for independent samples was applied (with Welch's correction if variance equality was not assumed). Results are presented as mean ± SD with p-values, where $p < 0.05$ was considered statistically significant. For categorical data, Pearson's chi-square test was used to compare proportions. When necessary, for 2×2 tables, degree of freedom (df=1) corrections were applied. For multicomponent comparisons, chi-square tests with df >1 were used. For visual representation, bar charts were employed with mean and SD indicators, significance annotations (p-values, χ^2, df) above the graphs, internal labels showing values within the bars, and color differentiation of main and control groups for clarity

Results and Discussion

On the first day following inpatient medical care, a statistically significant difference in pain intensity between the groups was observed. In the main group, the mean pain score was 2.79 ± 1.27 points, whereas in the comparison group it was 3.09 ± 0.91 points ($p < 0.01$). This difference was attributed to the specific effects of the antiseptic gel used, which exhibited not only antimicrobial properties but also a pronounced local analgesic effect due to its active components, thereby contributing to a rapid reduction in pain intensity. This effect was further enhanced when the gel was applied during dressing changes after surgical intervention.

By the third day, pain intensity in the main group was significantly lower than in the comparison group (1.07 ± 0.98 points versus 1.79 ± 0.92 points, respectively; $p < 0.001$). Although pain levels decreased in both groups, the reduction was more pronounced in the main group, likely due to the gel's efficacy in suppressing inflammatory responses and accelerating regenerative processes in the wound. This trend persisted on the fifth day, with pain intensity remaining markedly lower in the main group (0.59 ± 0.54 points) compared to the comparison group (1.20 ± 0.82 points; $p < 0.001$). The sustained reduction in pain throughout the observation period supports the pronounced and prolonged effectiveness of the new first aid method, which fosters favorable conditions for rapid wound healing and tissue recovery.

Analysis of the presence of pain over time using the chi-square (χ^2) test revealed no significant changes in patient distribution regarding the presence or absence of pain from day 1 to day 3 ($\chi^2 = 1.069$; $p = 0.301$). Despite the continued gradual decrease in average pain intensity, the proportion of patients experiencing any level of pain remained relatively stable. However, in the final observation phase (from day 3 to day 5), significant and statistically meaningful changes were detected ($\chi^2 = 140.494$; $p < 0.001$). The proportion of patients who reported complete pain relief increased substantially, confirming the high efficacy of the new method, which is attributable to the prolonged analgesic effect of the gel, facilitated by its multicomponent formulation and potent anti-inflammatory properties.

The analysis of pain dynamics according to the Visual Analog Scale (VAS), stratified by injury type–penetrating and non-penetrating–yielded the results presented in Table 1.

On the first day of observation, no statistically significant differences between the groups were found in relation to the type of injury ($p > 0.05$). However, by the third day of observation, a significant improvement in the condition of patients in the main group was noted for both penetrating and non-penetrating injuries, with statistically significant differences identified between the main and comparison groups ($p < 0.05$). By the fifth day, these differences became even more pronounced and statistically significant ($p < 0.05$) for both injury types. The main group exhibited a marked reduction in pain intensity to nearly minimal levels, indicating the high effectiveness and sustained impact of the proposed method.

Table 1 – Pain Dynamics According to the Visual Analog Scale (VAS) by Type of Injury

InjuryType	AssessmentStage	ComparisonGroup (m±SD)	MainGroup (m±SD)	p-value
Penetrating	Admission	4.21 ± 1.42	5.73 ± 1.01	p<0,05
	Day 1	3.50 ± 1.06	4.17 ± 1.09	p<0,05
	Day2	2.61 ± 1.03	1.23 ± 1.55	p<0,05
	Day3	1.97 ± 0.75	0.27 ± 0.58	p<0,05
Non-penetrating	Admission	4.08 ± 1.18	3.89 ± 0.99	p>0,05
	Day 1	3.03 ± 0.88	2.49 ± 1.09	p<0,05
	Day2	1.66 ± 0.84	1.04 ± 0.80	p<0,05
	Day3	1.09 ± 0.77	0.66 ± 0.51	p<0,05

Thus, the new method of providing first aid for soft tissue injuries demonstrates significant efficacy in pain reduction, particularly from the third day of observation, for both penetrating and non-penetrating wounds.

The dynamics of wound edema were then analyzed. At admission, the distribution of patients by the degree of local edema severity was comparable between the main and control groups. In the main group, 15.2% of patients showed no edema, mild edema was observed in 47.6%, and moderate edema in 37.2%. In the comparison group, the corresponding figures were 11.7%, 42.3%, and 46.0%, respectively. No severe edema was observed in either group. There were no statistically significant differences between the groups at this stage ($\chi^2 = 3.608$; df = 2; $p = 0.1646$; $p > 0.05$), indicating an initially comparable clinical status of the patients.

Already by the first day of observation, statistically significant differences between the groups were recorded ($\chi^2 = 25.093$; df = 3; $p = 0.000015$; $p < 0.001$). In the main group, 39.0% of patients had no edema, compared to only 19.9% in the comparison group. The proportion of patients with moderate and severe edema was significantly lower in the main group (11.6% and 7.9%, respectively) than in the comparison group (24.7% and 12.0%). On the third day, this trend persisted: 36.0% of patients in the main group had no edema, compared to 25.4% in the comparison group. Moderate and severe edema were observed in 20.7% and 4.9%, respectively, in the main group, and in 10.7% and 9.6% in the comparison group. The differences remained statistically significant ($\chi^2 = 19.879$; df = 3; $p = 0.0002$; $p < 0.001$).

By the fifth day, positive edema dynamics in the main group were sustained: complete absence of edema was recorded in 34.1% of patients versus 22.0% in the comparison group. The proportion of severe edema in the main group decreased to 2.4%, compared to 5.2% in the control group ($\chi^2 = 10.741$; df = 3; $p = 0.0132$; $p < 0.05$). By the seventh day of observation, the differences between the groups had leveled out. Both groups showed a significant reduction in edema severity: 81.7% of patients in the main group and 77.7% in the comparison group had no edema. The proportion of severe edema was less than 1% in the main group and 1.7% in the comparison group. At this stage, the differences were not statistically significant ($\chi^2 = 1.731$; df = 3; $p = 0.6301$; $p>0.05$).

In general, the analysis of wound edema dynamics revealed that on the first day after surgical intervention, edema persisted in 80.1% of patients in the comparison group and in only 61.0% of patients in the main group. Meanwhile, 39.0% of patients in the main group exhibited no edema, compared to 19.9% in the comparison group. These differences were statistically significant ($\chi^2 = 19.485$; df = 1; $p = 0.00001$; $p < 0.001$), indicating a strong positive effect of the proposed method in the early reduction of edema. By the third day, the proportion of patients without edema increased to 36.0% in the main group, compared to 25.4% in the comparison group ($\chi^2 = 5.639$; df = 1; $p < 0.05$). On the fifth day, edema was absent in 34.1% of patients in the main group and in only 22.0% in the comparison group ($\chi^2 = 7.978$; df = 1; $p = 0.0047$; $p < 0.01$). Thus, the gel's effect manifested early and persisted throughout the acute phase. By the seventh day, intergroup differences leveled out: 81.7% of patients in the main group and 77.7% in the comparison group showed no signs of edema, with no statistically significant differences observed at this stage ($\chi^2 = 1.038$; df = 1; $p = 0.3082$).

The next evaluated criterion was the degree of wound hyperemia. At admission, hyperemia status was comparable between groups: it was absent in 87 (53.0%) patients in the main group and 165 (56.7%) in the comparison group. Mild and moderate hyperemia were observed in 33.5% and 13.4% of the main group, versus 31.6% and 11.7% in the control group. No statistically significant differences were identified ($\chi^2 = 0.628$; df = 2; p = 0.7306; p > 0.05).

By postoperative day 1, the main group showed a marked reduction in hyperemia severity: 39 (23.8%) patients had no hyperemia, compared to only 23 (7.9%) in the control group. The number of patients with pronounced hyperemia was only 9 (5.5%) in the main group and 39 (13.4%) in the control group. The differences were statistically significant ($\chi^2 = 26.681$; df = 3; p < 0.001). On day 3, hyperemia was absent in 86 (52.4%) patients in the main group compared to 71 (24.4%) in the control group, again with significant differences ($\chi^2 = 37.208$; df = 3; p < 0.001). Moderate and severe hyperemia were less frequent in the main group (12.8% and 3.0%) than in the comparison group (24.4% and 5.2%).

On day 5, the positive trend persisted: hyperemia was absent in 114 (69.5%) patients in the main group, compared to 129 (44.3%) in the control group ($\chi^2 = 27.563$; df = 3; p < 0.001). The main group had fewer cases of mild, moderate, and severe hyperemia. By day 7, the differences between the groups diminished: hyperemia was absent in 138 (84.1%) patients in the main group and 215 (73.9%) in the control group ($\chi^2 = 7.212$; df = 3; p > 0.05). Severe hyperemia was rare–1 case (0.6%) in the main group and 4 cases (1.4%) in the comparison group.

When considering the overall criterion of hyperemia presence or absence, no differences were observed at admission: hyperemia was absent in 87 (53.0%) patients in the main group and 165 (56.7%) in the comparison group. By day 1, the main group demonstrated a statistically significant advantage: 39 (23.8%) patients showed no hyperemia compared to 23 (7.9%) in the comparison group ($\chi^2 = 22.464$; p < 0.001), indicating an earlier anti-inflammatory effect of the method. On day 3, this trend intensified–86 (52.4%) patients in the main group had no hyperemia compared to 71 (24.4%) in the control group ($\chi^2 = 36.492$; p < 0.001). By day 5, hyperemia persisted in only 50 (30.5%) patients in the main group compared to 162 (55.7%) in the control group ($\chi^2 = 26.73$; p < 0.001), while 114 (69.5%) patients in the main group and 129 (44.3%) in the control group exhibited no hyperemia. Even by day 7, the differences remained statistically significant: hyperemia was absent in 138 (84.1%) patients in the main group and 215 (73.9%) in the comparison group ($\chi^2 = 6.352$; p = 0.0117; p < 0.05).

The observed dynamics in pain severity, edema, and wound hyperemia clearly demonstrate the anti-inflammatory and antiseptic potential of the proposed first aid method. The accelerated resolution of the local inflammatory response in the early post-traumatic period creates favorable conditions for subsequent wound healing progression. A logical continuation of this analysis is the assessment of the frequency and structure of wound complications as a final clinical outcome indicator of the method's effectiveness.

Analysis of wound complication rates and structure revealed significant differences between the main and comparison groups, as visually represented in the charts. The overall complication rate in the main group was 19 cases (11.6%) versus 73 cases (25.1%) in the comparison group ($\chi^2 = 11.851$; p < 0.001), indicating nearly a twofold reduction in risk when the proposed first aid method was employed. This advantage is attributed to the multistage application of the combined antiseptic gel, which was used from the initial point of injury care.

The application of the gel on the wound surface and its pressurized introduction into deep wound tracts immediately after injury provided early antiseptic action and reduced bacterial contamination of tissues even before hospital admission. This created a local protective barrier that prevented wound infection during the critical early hours. Additionally, the gel was applied after surgical wound debridement–prior to closure of the subcutaneous tissue and skin–which contributed to the suppression of residual microflora and reduced the risk of secondary infection. The gel was also used during dressing changes in the early postoperative period, enhancing its antimicrobial effect and ensuring prolonged wound protection.

The most common complication observed in both groups was seroma: 29 cases (10.0%) in the comparison group versus only 7 cases (4.3%) in the main group. The incidence of suppuration was also lower with gel use–5 cases (3.0%) versus 20 cases (6.9%). Wound dehiscence occurred in 5 patients (3.0%) in the main group and in 16 patients (5.5%) in the comparison group. Hematomas were recorded in 2 patients (1.2%) in the main group and 8 patients (2.7%) in the comparison group ($\chi^2 = 11.971$; df = 4; p = 0.0176) (Table 2).

At the same time, the proportion of patients without complications in the main group was 145

(88.4%), significantly higher than 218 (74.9%) in the comparison group. This outcome confirms the high clinical efficacy of the proposed method, achieved through early antiseptic action of the gel, its application both before and after surgical wound debridement, and during dressing changes, thereby ensuring sustained suppression of inflammation and protection against microbial contamination.

Table 2 – Frequency and Structure of Wound Complications

Complication	ComparisonGroup		MainGroup		χ^2/p-value
	n	%	n	%	
Hematoma	8	2,7%	2	1,2%	χ^2=11,971; df=4; p=0,0176
Seroma	29	10,0%	7	4,3%	
Suppuration	20	6,9%	5	3,0%	
Wounddehiscence	16	5,5%	5	3,0%	
Nocomplications	218	74,9%	145	88,4%	χ^2=11,851; df=1; p=0,0006
Totalcomplications	73	25,1%	19	11,6%	

Table 3 – Frequency and Structure of Complications in Penetrating Injuries

Complication	ComparisonGroup		MainGroup		χ^2/p-value
	n	%	n	%	
Penetrating					
Hematoma	1	2,6%	1	3,3%	χ^2=3,756; df=4; p=0,44
Seroma	1	2,6%	0	0,0%	
Suppuration	6	15,8%	1	3,3%	
Wounddehiscence	2	5,3%	2	6,7%	
Nocomplications	28	73,7%	26	86,7%	χ^2=1,728; df=1; p=0,1886
Totalcomplications	10	26,3%	4	13,3%	
Non-Penetrating					
Hematoma	7	2,8%	1	0,7%	χ^2=10,487; df=4; p=0,033
Seroma	28	11,1%	7	5,2%	
Suppuration	14	5,5%	4	3,0%	
Wounddehiscence	14	5,5%	3	2,2%	
Nocomplications	190	75,1%	119	88,8%	χ^2=10,228; df=1; p=0,0014
Totalcomplications	63	24,9%	15	11,2%	

In cases of penetrating injuries, the overall complication rate in the comparison group was 26.3% (10 out of 38), compared to 13.3% (4 out of 30) in the main group; however, the difference was not statistically significant ($\chi^2 = 1.728$; df = 1; p = 0.1886). Within the complication structure, isolated cases of hematomas were registered in both groups (2.6% and 3.3% respectively), seromas occurred only in the comparison group (2.6%), suppuration rates were 15.8% versus 3.3%, and wound dehiscence was noted in 5.3% and 6.7% of cases respectively. Despite the visible reduction in complication rates with gel use, statistical significance was not achieved ($\chi^2 = 3.756$; p = 0.44), likely due to the limited sample size in these subgroups.

For non-penetrating injuries, differences were more pronounced: complications were observed in 63 of 253 patients in the comparison group (24.9%) and in 15 of 134 patients in the main group (11.2%), which was statistically significant ($\chi^2 = 10.228$; df = 1; p = 0.0014). The structure of complications included: seromas (11.1% vs. 5.2%), suppura-

tion (5.5% vs. 3.0%), wound dehiscence (5.5% vs. 2.2%), and hematomas (2.8% vs. 0.7%). The structural differences were also statistically significant ($\chi^2 = 10.487$; df = 4; p = 0.033), indicating the pronounced prophylactic effectiveness of the proposed method in cases of extensive soft tissue trauma (Table 3).

Significant differences were also identified between the groups regarding the need for repeat surgical interventions. In the second group (which used the proposed method), secondary suturing was required in only 8 out of 164 cases (4.9%), whereas in the comparison group such interventions were performed in 34 out of 291 patients (11.7%) ($\chi^2 = 5.798$; df = 1; p = 0.016).

Analysis of hospitalization duration (among hospitalized patients) demonstrated that the use of the proposed first aid method significantly reduced inpatient treatment times. Overall, the average length of hospital stay was 5.9 ± 2.3 days in the comparison group (227 patients) and 4.6 ± 1.9 days in the main group (122 patients) ($p < 0.001$), reflecting an overall acceleration of the wound healing process under the influence of the proposed method.

The most pronounced differences were noted in patients with penetrating wounds, where the average duration of hospitalization decreased from 9.0 ± 3.5 days in the comparison group (38 patients) to 6.8 ± 2.5 days in the main group (30 patients) ($p < 0.001$). This reduction of more than two days may be attributed to the prevention and early suppression of inflammation through deep antiseptic treatment of tissues and complication prevention due to the use of the gel starting from the pre-hospital phase.

In non-penetrating injuries, a significant reduction in hospitalization time was also observed: from 5.3 ± 1.9 days in the comparison group (189 patients) to 3.9 ± 1.3 days in the main group (92 patients) ($p < 0.001$). This effect is primarily associated with the reduction of edema and hyperemia, faster healing, and decreased need for repeat interventions due to the multi-phase antiseptic approach.

In all presented categories, the main group showed significantly better outcomes than the comparison group ($p < 0.001$ for all parameters). For instance, the number of return visits for dressing changes was significantly lower with the proposed method–2.5 ± 1.0 versus 3.5 ± 1.6–indicating a reduced need for additional wound management and more stable wound conditions. The time to initial healing was 7.3 ± 1.8 days in the main group compared to 8.6 ± 2.3 days in the comparison group, while the time to complete epithelialization was 11.6 ± 2.9 days versus 14.1 ± 3.0 days, respectively.

Effectiveness of the Primary Treatment Method for Non-Gunshot Soft Tissue Injuries in Military Personnel. The initial stage of analysis revealed no statistically significant difference in microbial growth frequency between the main and comparison groups at the time of injury. In the comparison group, microbial growth was detected in 17 out of 23 patients (73.9%), and in the main group, in 21 out of 26 patients (80.8%) ($\chi^2 = 0.33$; p = 0.5659). This can be attributed to the inherently high level of contamination in field-acquired injuries among military personnel in both groups.

However, the situation changed markedly at the hospital stage (during surgical intervention). At that point, the proportion of sterile cultures in the main group was 57.7% (15 out of 26 patients), whereas in the comparison group it was only 13.0% (3 out of 23) ($\chi^2 = 10.468$; p = 0.0012), indicating a statistically significant difference between the groups. Despite the initially comparable microbial status, by the time of surgery, those military personnel who had received treatment involving the antiseptic gel and algorithm-based assistance showed a 2.5 to 3-fold reduction in microbial load.

These findings underscore the effectiveness not only of the method itself (the use of an antiseptic gel), but also of the organizational component–the implementation of simulation-based training among junior military medical personnel. In field trauma settings, where the risk of environmental contamination is extremely high, the proposed approach not only compensates for these conditions but significantly improves the wound's microbiological profile by the time of surgery. This provides a foundation for reducing complications and improving outcomes in military personnel operating in combat or training environments. Analysis of the frequency and structure of postoperative complications in military personnel with non-penetrating soft tissue injuries showed that in the main group–where the proposed antiseptic treatment method and simulation training program were applied–complication rates were significantly lower compared to the comparison group.

In the comparison group, complications developed in 11 out of 23 military personnel (47.8%). Among these, seromas accounted for 17.4%, suppuration for 13.0%, wound dehiscence for 13.0%, and hematomas for 4.3%. In the main group, where an enhanced primary care system was implemented, complications were registered in only 4 out of 26 patients (15.4%). These included seromas in 7.7%, with

isolated cases of suppuration and wound dehiscence (3.8% each).

Although the overall difference in the structure of complications between the groups did not reach statistical significance ($\chi^2 = 6.448$; df = 4; p = 0.1681), the difference in the overall complication rate was statistically significant ($\chi^2 = 6.047$; df = 1; p = 0.0139). The proportion of patients without complications in the main group was 84.6% (22 out of 26), compared to only 52.2% (12 out of 23) in the comparison group.

These data indicate that the proposed approach–combining the use of an antiseptic gel with the training of junior personnel in the military medical service–not only reduces microbial contamination but also significantly decreases the risk of clinically relevant complications in military personnel under field care conditions.

Conclusions

According to data from the Visual Analog Scale (VAS), as early as the first day after care, pain intensity in the main group was significantly lower compared to the comparison group (2.79 ± 1.27 points vs. 3.09 ± 0.91 points; $p < 0.01$). This difference became more pronounced by day 3 (1.07 ± 0.98 vs. 1.79 ± 0.92; $p < 0.001$) and persisted through day 5 (0.59 ± 0.54 vs. 1.20 ± 0.82; $p < 0.001$). By day 7, values in both groups were comparable; however, the application of the gel provided a significant advantage in pain management during the critical initial 3–5 days.

The proposed method, involving multistage application of an antiseptic gel (at the point of first aid, post-surgical wound management, and during dressing changes), leads to a marked reduction in the risk of postoperative complications–especially in cases of non-penetrating soft tissue injuries. This confirms its effectiveness in preventing microbial contamination, controlling inflammation, and maintaining favorable healing conditions.

Comprehensive use of the gel at all treatment stages–from pre-medical first aid to postoperative care–ensures a substantial reduction in early complications by suppressing local inflammation, preventing infection, stabilizing wound edges, and significantly shortening treatment duration and accelerating healing. This is particularly crucial in environments with limited access to specialized medical assistance.

The obtained data affirm that the proposed approach–combining the antiseptic gel with the training of junior military medical personnel–effectively reduces microbial contamination and significantly lowers the risk of clinically significant complications in military personnel under field care conditions.

In military personnel with non-penetrating injuries included in the main group, the use of the proposed first aid method in combination with a simulation training program for junior military medical staff resulted in a significantly lower level of wound microbial contamination by the time of surgery (57.7% sterile cultures vs. 13.0% in the comparison group; $\chi^2 = 10.468$; $p = 0.0012$), as well as a lower incidence of postoperative complications (15.4% vs. 47.8%; $\chi^2 = 6.047$; $p = 0.0139$). These results confirm that the proposed approach ensures comprehensive effectiveness at both the microbiological control level and in clinical outcomes–especially critical in field medicine scenarios with limited time for intervention.

References

1. Babadzhanov A.Kh., Sadikov R.A., Usmonov U.D. Current state of the problem of gunshot and non-gunshot wounds and the development of wound infections. Biologiya va tibbiyot muammolari. 2024;(6):307–311.
2. Volkov P.V., Grin A.A. Surgical treatment tactics for patients with gunshot and stab-incised injuries of the spine and spinal cord. Neurosurgery (Neirokhirurgiya). 2010;(2):72–79.
3. Grzhibovsky A.M., Ivanov S.V., Gorbatova M.A. Comparison of quantitative data from two independent samples using Statistica and SPSS software: parametric and nonparametric tests. Science and Healthcare. 2016;(2):5–28.
4. Samokhvalov I.M., et al. Principles of medical triage in a military medical organization during mass admission of the wounded. Proceedings of the Anniversary Scientific and Practical Conference. 2018:122–126.
5. Tolmosov Yu.V., et al. Trends in organizing medical support for military units in extreme situations of peacetime and wartime based on the "golden hour" principles. Modern Problems of Science and Education. 2020;(4):153.
6. Shelepov A.M., et al. Determination of treatment and evacuation characteristics and assessment of their impact on the organization of medical care for wounded (ill) surgical patients in a military field medical organization. Bulletin of the Russian Military Medical Academy. 2015;(1):173–177.
7. Yadgarov M.Ya., Kuzovlev A.N., Berikashvili L.B., Baeva A.A., Likhvantsev V.V. The importance of assessing data distribution laws: theory and practical guidance. Anesthesiology and Resuscitation. 2021;(2):136–142.
8. Bulanov NM, Blyuss OB, Munblit DB, et al. Studies and research design in medicine. Sechenov Med J. 2021;12(1):4–17.

9. Fair KA, Gordon NT, Barbosa RR, et al. Traumatic diaphragmatic injury in the American College of Surgeons National Trauma Data Bank: a new examination of a rare diagnosis. Am J Surg. 2015;209(5):864–869.

10. Ghasemi A, Zahediasl S. Normality tests for statistical analysis: a guide for non-statisticians. Int J EndocrinolMetab. 2012;10(2):486–489.

11. Kholikov I. Ethical and legal basis for the standards of triage used in the Russian military medical service. In: Resource Scarcity in Austere Environments: An Ethical Examination of Triage and Medical Rules of Eligibility. Cham: Springer International Publishing; 2023:77–87.

12. Kirkwood B, Stern J. Essential Medical Statistics. 2nd ed. Blackwell Publishing; 2003. 512 p. ISBN: 978-0-865-42871-3.

13. Langford E. Quartiles in elementary statistics. J Stat Educ. 2017;14(3).

14. MohdRazali NM, Wah YB. Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. J Stat Model Anal. 2011;2:21–33.

15. Motulsky H. Intuitive Biostatistics. 4th ed. Oxford University Press; 2018. 568 p. ISBN-13: 978-0190643560.

16. Nguyen MP, Reich MS, O'Donnell JA, et al. Infection and complications after low-velocity intra-articular gunshot injuries. J Orthop Trauma. 2017;31(6):330–333.

17. Nuzzo RL. Histograms: a useful data analysis visualization. PMR. 2019;11(3):309–312.

18. Rothman K. Random error and the role of statistics. In: Epidemiology: An Introduction. 2nd ed. Oxford University Press; 2012:148–163.

19. Spriestersbach A, Röhrig B, Prel JB, et al. Descriptive statistics: the specification of statistical measures and their presentation in tables and graphs – part 7 of a series on evaluation of scientific publications. DtschArztebl. 2009;106(36):578–583.

Information about author:

U.D. Usmonov – PhD (Medicine), Associate Professor at the Department of Surgical Diseases, Andijan State Medical Institute, Doctoral Researcher at the Military Medical Academy of the Armed Forces of the Republic of Uzbekistan (Tashkent, Uzbekistan).

IRSTI 47.09.48 https://doi.org/10.26577/appmed2025624

G. Hasanova

Baku State University, Baku, Azerbaijan
e-mail: gunaiiita@gmail.com

STRUCTURAL AND THERMAL STABILITY OF AG NANOPARTICLES SYNTHESIZED FROM ARTEMISIA LERCHIANA: SEM, EDX, XRD AND TG-DTA ANALYSES

Abstract

The development of biologically mediated green synthesis of silver nanoparticles (AgNPs) has gained significant global attention due to its promising applications in medical science and disease treatment. Unlike conventional chemical and physical methods, green synthesis employs eco-friendly, non-toxic, and cost-effective approaches, utilizing biological resources such as plants, microorganisms, and natural extracts as reducing and stabilizing agents. In this context, the present study highlights the synthesis of silver nanomaterials using Artemisia lerchiana Web. extract as a novel and sustainable source. Compared to conventional antibiotics and chemically synthesized drugs, AgNPs obtained from green routes exhibit remarkable antibacterial, anticancer, antifungal, and anti-inflammatory activities, thereby offering potential solutions to pressing medical challenges such as antibiotic resistance, chronic infections, and tumor progression. The structural and morphological properties of the synthesized nanoparticles were systematically characterized using scanning and transmission electron microscopy (SEM and TEM), energy-dispersive X-ray analysis (EDX), X-ray diffraction (XRD), thermogravimetric-differential thermal analysis (TG-DTA), and zeta potential measurements. These results revealed that the biosynthesized AgNPs possess well-defined size, shape, crystallinity, and homogeneous distribution, which are strongly influenced by the phytochemical composition of the plant extract. Furthermore, this review provides an overview of recent advances in green synthesis strategies, emphasizing the role of biocompatibility in reducing nanoparticle toxicity, minimizing environmental risks, and lowering production costs. The findings confirm that biologically synthesized silver nanoparticles represent a promising alternative to conventional nanomaterials for biomedical and pharmaceutical applications, with enhanced safety profiles, stability, and therapeutic efficiency. This work contributes to the growing body of research focused on eco-friendly nanotechnology for sustainable and advanced healthcare solutions.

Keywords: AgNP, green synthesis, SEM-TEM, EDX, XRD, TG-DTA, Zeta potential.

Introduction

Nanobiotechnology is a promising field that studies the structure and practice of nanoparticles (NPs) in many fields (Sunderam et., 2019). The unique properties of nanoparticles are based on their monodisperse size and surface morphology; different shapes and sizes can be obtained by changing the synthesis stage of nanomaterials (Clarance, 2020; Hosny, 2021). Nanoparticles are widely produced in industry by physical and chemical methods (Bandeira et ., 2020). Nowadays, instead of traditional methods, it is more preferred to produce nanoparticles by fast and cheap green synthesis procedures that do not pollute the environment and do not use toxic solvents (Badeggi et., 2020). In this context, scientific research has focused on synthesizing these nanomaterials from biological sources such as plants, algae, seaweed, viruses, bacteria, and fungi (Chellamuthu, 2019; Aktepe, 2021).

In nanoparticle research, zinc (Thema et., 2015) gold (Soliman et., 2020), silver (Salem et., 2020), nickel (Pandian et., 2015), iron (Devatha et., 2016), platinum (Thirumurugan et., 2016), and selenium (Cittrarasu et., 2021) salts have been extensively investigated in nanoparticle synthesis.

Due to their unique physical and chemical properties, silver nanoparticles (AgNPs) are increasingly used in various fields, including medicine, food, healthcare, consumer, and industrial applications. These include optical, electrical and thermal, high electrical conductivity and biological properties (Gurunathan, 2015; Li, 2010; Mukherjee, 2001). Due to their unique properties, they are suitable for several applications, including as antibacterial agents in industrial, household and health-related fields, con-

sumer products, medical device coatings, optical sensors and cosmetics, pharmaceutical industry, food industry, diagnostics, orthopedics, drug delivery, anticancer are used as agents (Chernousova&Epple, 2013). Nanoscale metal particles are unique and can significantly change their physical, chemical, and biological properties due to their surface-to-volume ratio; therefore, these nanoparticles have been used for various purposes (Li, 2001; Sharma, 2008). Various methods have been adopted for the synthesis of AgNPs. In general, traditional physical and chemical methods seem to be very expensive and dangerous (Gurunathan, 2015; Kalishwaralal, 2015). Interestingly, biologically prepared AgNPs exhibit high yield, solubility, and high stability (Gurunathan et., 2015). Among several synthetic methods for AgNPs, biological methods are more widely used as simple, rapid, non-toxic, reliable and green approaches.

As an alternative for sustainable development in green nanobiotechnology, environmentally friendly and economically efficient technology is used to reduce toxic waste generated by industrial and chemical processes (Rai, 2013). Nanoparticles (NPs) can be synthesized by physical, chemical and biological methods (Reverberi et., 2019). Physical and chemical synthesis is energy-intensive and in many cases involves toxic substances, while biological methods are more cost-effective, clean, non-toxic and environmentally friendly. Biological synthesis using plant extracts has been proposed as an environmentally friendly alternative compared to other methods (Saravanakumar et., 2017). Plants are widespread, readily available, safe to handle, low production cost, and a source of various metabolites (bioactive phytochemical elements) (Elumalai et., 2010)

Therefore the aim of our study was to investigate the characteristics of silver nanoparticles obtained using the extract of Artemisia lerchiana Web, since the search for the most effective and environmentally safe ways of obtaining NPs still remains a pressing issue.

Materials and methods

Preparation of wormwood extract and silver nitrate (AgNO3) solution

In order to get the plant extract have been used the vegetative organs of Artemisia lerchiana Web. plant samples were collected from Lokbatan settlement of Absheron region of Azerbaijan in the summer season. The samples were washed several times first with tap water and then with distilled water. The leaves of plant samples were dried in room conditions for 48 hours. 50 g of dried plant leaves were placed in a 500 ml beaker, then 250 ml of distilled water was added, and the mixture was boiled. The mixture is boiled for 5 minutes to get the desired result. Then the extract was cooled to room temperature. Filtering of the plant extract was done with No. 1 Whatman filter paper. The obtained extract was stored at +4 °C until experiments. In order to obtain silver NPs, a solution of silver nitrate was prepared in the following proportion: 25 grams of salt were dissolved in 300 ml of distilled water.

Biosynthesis

50 ml extract of wormwood leaves and 250 ml AgNO3 solution were placed in a 1000 ml flask and reacted at 45 °C after just shaking by hand. The reaction mixture was found to change color with time. The extract obtained as a result of the reaction was centrifuged at 6000 rpm for 15 minutes with an OHAUS FC 5706 device. After several washings, the precipitated solid was dried in an oven at 75°C for 24 h. The obtained particles were then prepared for characterization. Phytochemicals in plant extracts reduced Ag+1 to Ag0, thus forming AgNPs (Mani et., 2021).

Scanning Electron Microscopy (SEM)

The surface morphology of the synthesized Ag nanoparticles was examined using a Field Emission Scanning Electron Microscope (FESEM, EVO 40 LEQ). Dried nanoparticle powder was mounted on conductive carbon tape and analyzed under high vacuum. Images were collected at 5–15 kV accelerating voltage, depending on resolution requirements. The SEM micrographs were used to assess particle shape, agglomeration behavior, and qualitative size distribution.

Transmission Electron Microscopy (TEM)

Nanoscale morphology and internal structural features were investigated using Transmission Electron Microscopy (TEM, JEOL JEM-1010) operating at 200 kV. A dilute suspension of Ag nanoparticles in ethanol was prepared and ultrasonicated for 10 min to minimize agglomeration. High-resolution TEM (HRTEM) imaging was performed to determine lattice fringes and interplanar spacings. Particle size analysis was conducted using ImageJ software based on measurements of >100 particles.

Energy-Dispersive X-ray Spectroscopy (EDX)

Energy Dispersive X-ray Analysis (EDX) reveals the presence of silver and oxygen elements

in the nanoparticles, which indicates the purity and complete chemical composition of the AgNPs. EDX analysis shows the relative composition of elements such as Oxygen (O), Aluminum (Al), Carbon (C) and Silver (Ag). Other elements are organic substances bound to the surface of the silver nanoparticles (Dada et al., 2017). The percentage of Ag metal found is significant compared to other chemical elements. Red, green and blue spots indicate the presence of silver, oxygen and carbon elements, respectively, in the green synthesized silver nanoparticles. The elemental composition was confirmed using EDX spectroscopy integrated with a FESEM system (Rad B-DMAX II, Japan). The spectra were obtained under high vacuum under optimized beam conditions. The characteristic emission lines of silver (Ag Lα ≈ 3.0 keV) were used to verify the identity of the elements and assess the purity.

X-ray Diffraction (XRD)

XRD is a technique used to determine both qualitative and quantitative analyzes of nanoparticles. This analyzes are used to confirm the formation of nanoparticles and determine their crystal structure. In addition, this technique was used to calculate the crystalline nanoparticle size and measure the degree of crystallinity. Crystalline structure and phase purity of the Ag nanoparticles were analyzed using X-ray diffraction ((Rad B-DMAX II, Japan) equipped with Cu Kα radiation (λ = 1.5406 Å) operating at 40 kV and 15 mA. Diffraction patterns were collected in the 2θ range of 20°–80° with a scan rate of 0.02°/s. Average crystallite size was calculated using the Debye–Scherrer equation, based on the FWHM of the and reflections.

Thermogravimetric–Differential Thermal Analysis (TG–DTA)

Thermal stability was examined using TG–DTA analysis (Shimadzu, Japan). Approximately 8–10 mg of dried nanoparticles was placed in an alumina crucible and heated from 25°C to 800°C at a constant rate of 10°C/min under a nitrogen atmosphere (flow rate: 50 mL/min). The TG curve provided information on mass-loss events, while the DTA signal was used to identify associated endothermic and exothermic transitions.

Zeta Potential Analysis

Colloidal stability and surface charge of the nanoparticle suspension were evaluated using a Zetasizer Nano ZS (Malvern Panalytical, UK) based on electrophoretic light scattering. Nanoparticles were dispersed in deionized water and sonicated for 5 min prior to analysis. Measurements were performed at 25°C, and the reported zeta potential represents the mean of three replicate readings. The magnitude of zeta potential was interpreted as an indicator of colloidal stability.

Results and discussion

Scanning Electron Microscope (SEM)

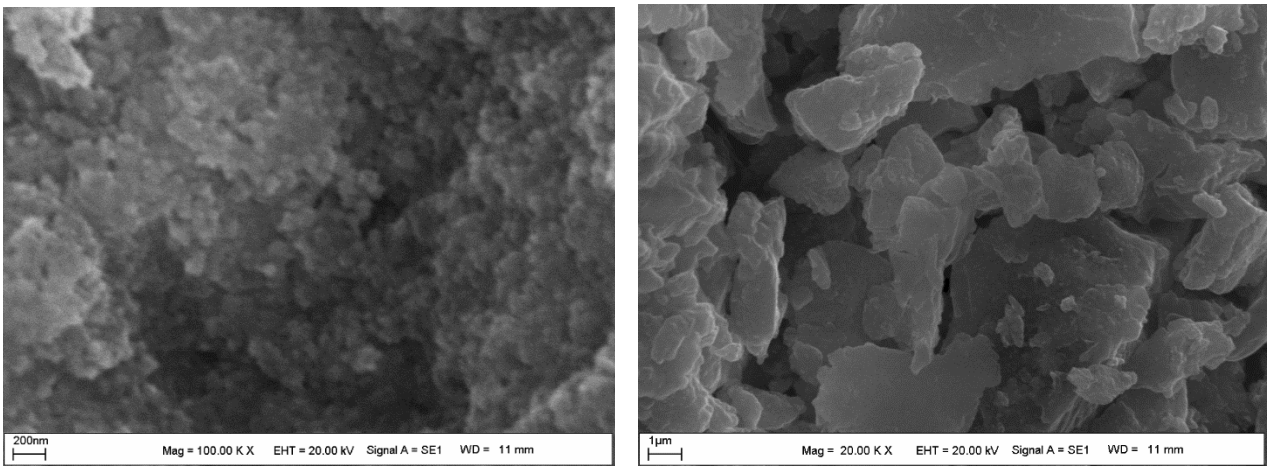
Due to aberration and the limitation of the wavelength of light, it is not possible to achieve additional magnification with optical microscopes. This creates a highly magnified image of the surface or sample.

Silver nanoparticles are very good electrical conductors, making them easy to scan using SEM. Although SEM cannot observe the internal structure of samples, it can provide useful information on particle purity and aggregation (Lavoie, 1995). AgNPs are usually spherical, cubic, triangular, oval, round in shape and appear as single or aggregated particles (Abdellativ et., 2022). Changes in shape can be causedby changes in synthesis parameters such as pH, temperature and plant concentration.

FE-SEM methods were used to evaluate the size and shape of the silver nanoparticles obtained from the Artemisia lerchianaWeb. plant extract. As a result of the conducted studies, it was determined that the sizes of AgNPs ranged from 25 to 50 nm and were generally spherical (Fig 1).

In most cases, the obtained particle sizes range from 20 to 30 nm. Thus, Khan et al. (2022) investigated AgNPs synthesized from *Acer pentapomicum* using SEM. Their study found that the average size of AgNPs ranged from 19 to 25 nm and their shape was spherical. Ghabban et al. (2022), using SEM, found that AgNPs produced from *Astragalus spinosus* were spherical in shape and 30–40 nm in size. Another study on green-synthesized AgNPs from *Areca catechu* using SEM also revealed that the nanoparticles were spherical in shape (Choi et al., 2021). However, AgNPs synthesized from *Allium cepa* L. plant were in cubic shape (Abdellatif, 2022).

In the shape morphology of silver nanoparticles, icosahedron (polyhedron) and leaf-shaped particles were found (Choi et al., 2021). SEM images also revealed that the silver nanoparticles were highly aggregated at some points, which may be due to the magnetic behavior of the silver nanoparticles, and their larger surface area to volume ratio tends to concentrate them to reduce the surface energy (Khan et al., 2022). To eliminate agglomeration, these particles can be coated with a biocompatible polymer (Ghabban et al., 2022).



(a) (b)

Figure 1 – SEM results of AgNPsobtainedbyArtemisia lerchianaWeb. plant extract in various scales

TEM Analysis

TEM makes the atomic scale visible since it is more powerful than optical microscopes that rely on visible light to achieve a magnification of 50 million nanometer objects. The topography and dimension of green-synthesized *Artemisia lerchiana* are discussed. The TEM analysis was done to characterize AgNPs.

EM images of low and high resolution showed that nanoparticles were highly stable in nature, of small size, monodisperse and spherical in shape, and had smooth surfaces with no agglomeration. The TEM images were obtained at a scale bar of 50 nm to give the size reference of AgNPs and average particle size of 4–19 nm (Figure 2).

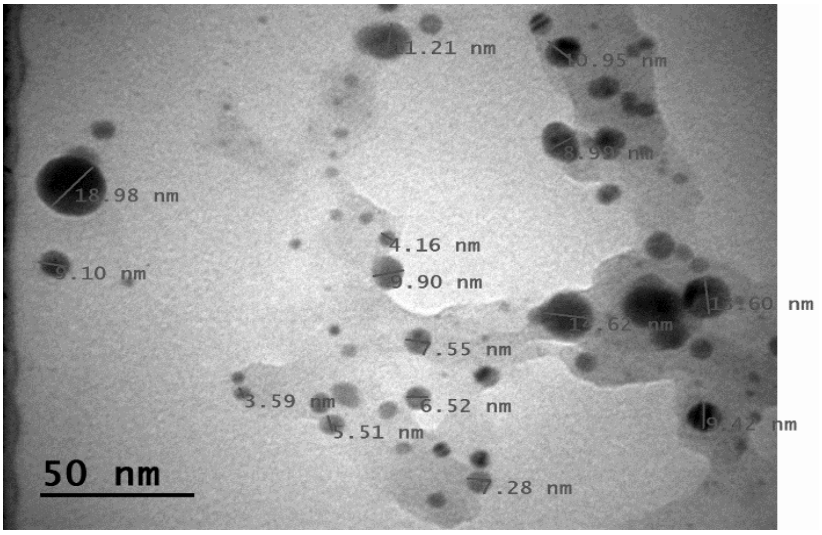
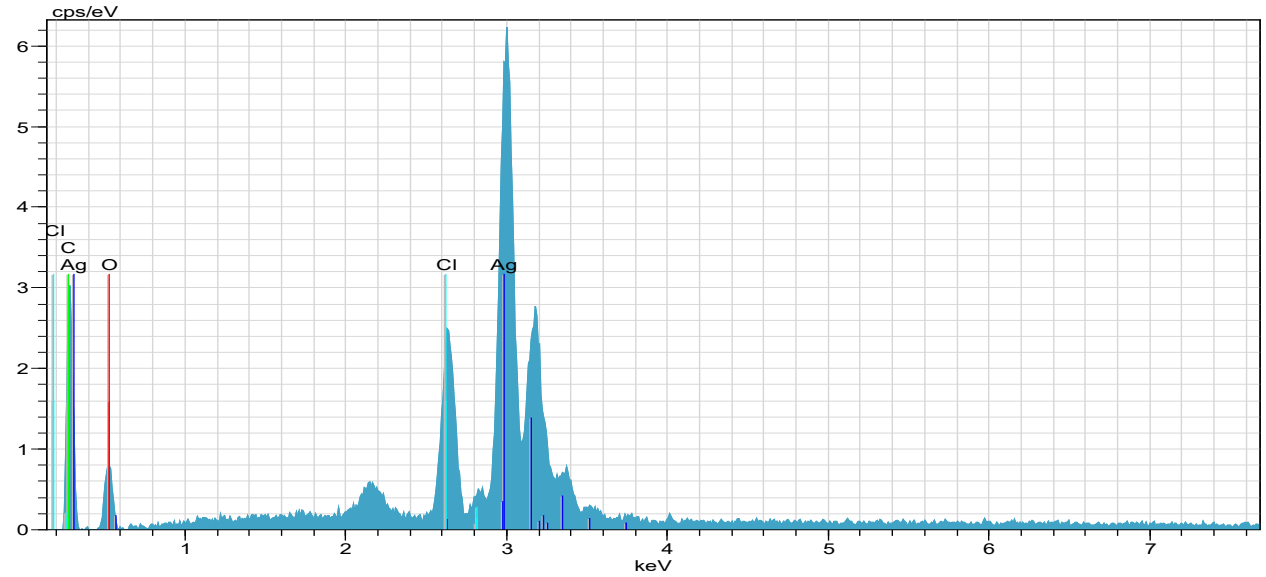


Figure 2 – TEMimage of AgNPsobtainedfrom *Artemisia Lerchiana* plantextractat 50 nm

Energy Dispersive X-ray Analysis (EDX)

The EDX spectrum revealed strong signals indicating the presence of Ag atoms in the biosynthesized *Artemisia lerchiana* Web. plant extract nanomaterial. The presence of elements carbon, chlorine, and oxygen, which are sources of weak signals in the spectrum, was due to the plant extract. As reported in many studies with various plants, AgNPs showed a characteristic optical absorption peak at about 3 KeV depending on the SPR (Figure 3).



Element (El)	AN	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error [%]
Ag	47	L-series	53.69	64.35	18.85	2.5
C	6	K-series	14.38	17.24	45.37	2.7
Cl	17	K-series	0.46	0.55	0.49	0.1
O	8	K-series	14.90	17.86	35.29	3.1
Total	–	–	**83.44**	**100.00**	**100.00**	–

Figure 3 – EDX analysis of AgNPsobtainedbyArtemisia lerchianaWeb. plant extract

EDX analysis is one of the widely used methods by other authors. Thus, aqueous *Abutilon indicum* leaf extract was used for the biosynthesis of AgNPs, and EDX analysis presented a strong signal of Ag at 2.7 KeV (Ullah et al., 2021). Mani et al. (M. Mani et al., 2021) used *Cleome gynandra* leaf extract for the green synthesis of silver oxide nanoparticles and reported a similar type of spectrum. Vinay et al. (S.P. Vinay et al., 2019) used cow urine for the green synthesis of silver oxide nanoparticles and reported the same type of spectrum.

X-ray Diffraction (XRD) Analysis

An intense peak at 2θ 38.04° was chosen to calculate the crystal size, where K is the Scherrer constant, λ is the wavelength of the light used for diffraction, β is the FWHM value of the peak, and θ is the Bragg angle. The Scherrer constant (K) in the formula above takes into account the shape of the particle and is generally taken to have a value of 0.9. As a result of calculations, it was determined that the average crystal size of silver nanoparticles is 24.83 nm (Figure 4).

According to the XRD spectrum data of *Artemisia Lerchiana*-AgNPs, the diffraction peaks are at 27.77°, 32.14°, 38.04°, 44.29°, 46.18°, 54.79°, 57.4°, 64.40°, and 77.36°, which indicates that silver is cubic and represents the crystal structure in the 2θ plane (index).

Peaks representing the crystal structure of silver have been reported in many herbal silver nanoparticle synthesis studies such as *Cinnamomum camphora* (Aref & Salem, 2020), *Crossopteryx febrifuga*, *Brillantaisia patula*, *Senna siamea* (Kambale et al., 2020), *Cicer arietinum* (Baran et al., 2022), and *Prunus dulcis* (Aktepe et al., 2021).

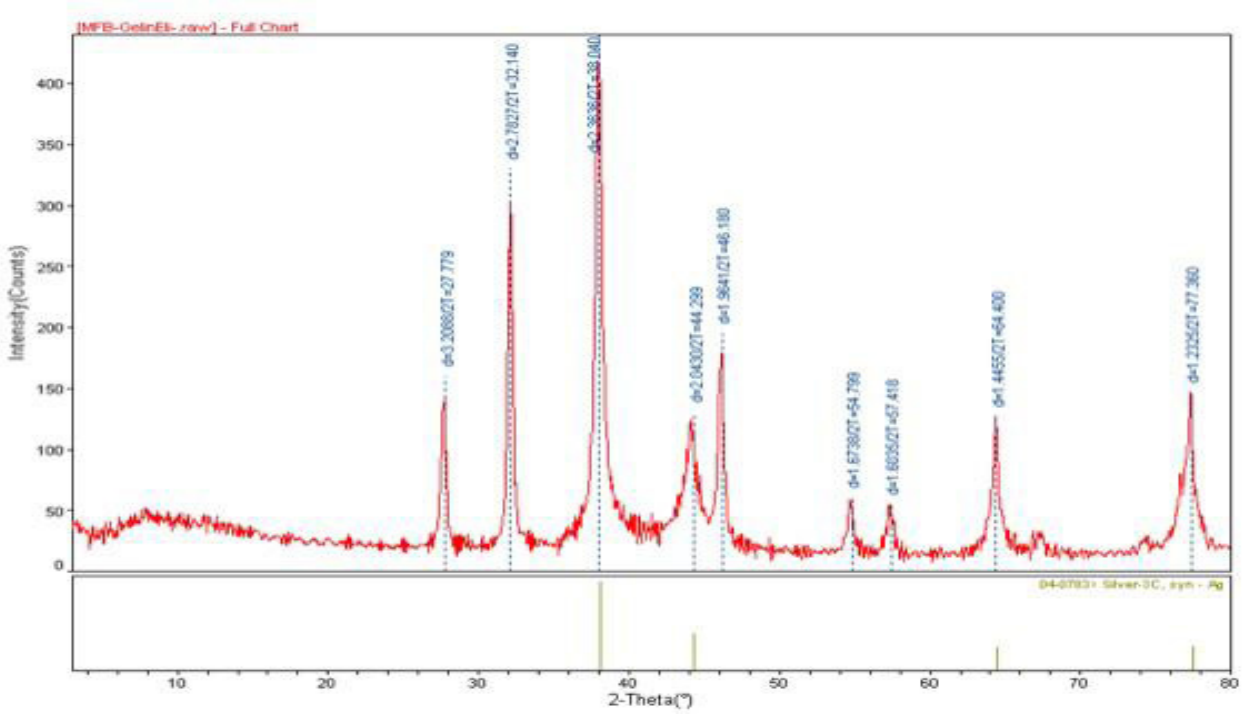


Figure 4 – XRD analysis of AgNPsobtainedby*Artemisia lerchiana* Web. plant extract

TG and DTA Analysis

According to the research, 18.7% mass loss occurred in the sample at a temperature ranging from 200°C to 390°C, and 20.6% at a temperature ranging from 390°C to 731°C. Mass loss occurred mostly at temperatures ranging from 390°C to 731°C (Figure 5). These mass losses simply indicate a slow degradation of the nanomaterial, suggesting that the resulting AgNPs are stable even at high temperatures.

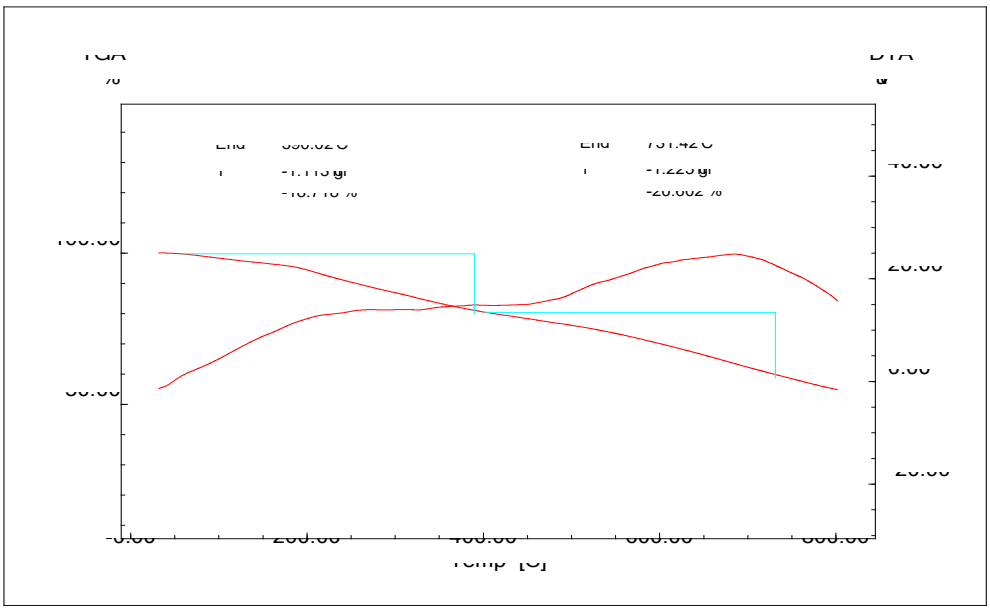
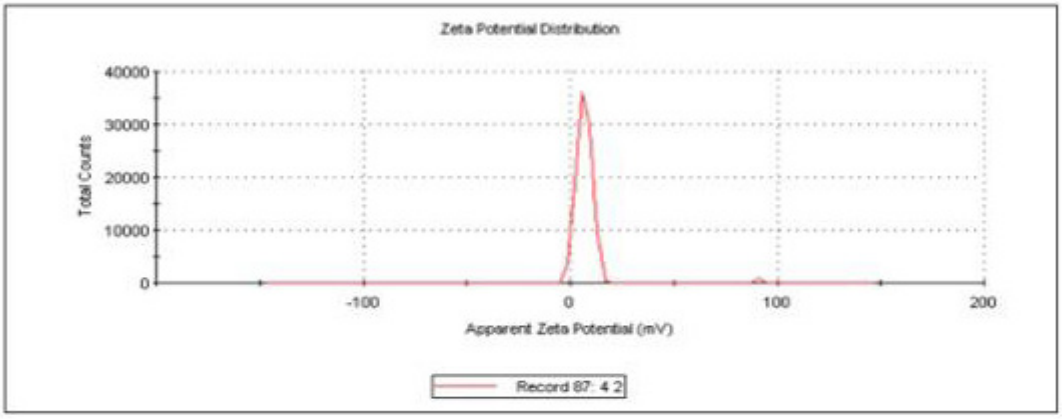
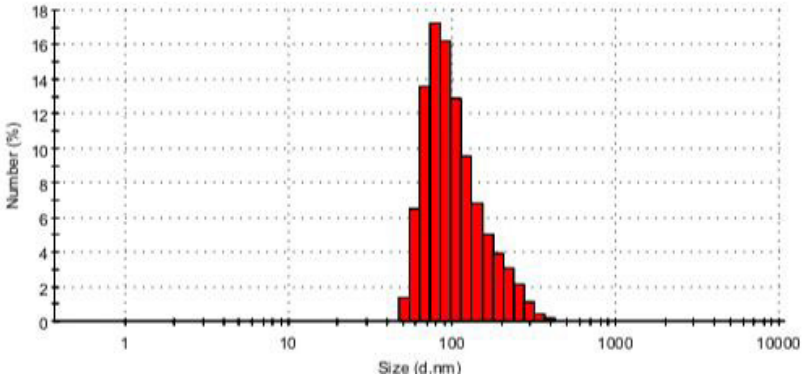


Figure 5 – TG-DTA results of AgNPssynthesizedviawormwoodextract

nalysis of the zeta size and zeta potential was done to ascertain the surface charges and size distributions of the biosynthesized AgNPs, and it was determined that AgNPs featured a surface charge of −20 mV (Fig. 6)A negative zeta potential is often attributed to the presence of capping phytochemicals on the nanoparticle surface, which prevents aggregation and supports long-term colloidal stability.The synthesis of nanoparticles cannot be done in a standard size, and nanoparticles with different sizes can be produced. The mean sizes of nanoparticles have been found to be 27–32, 59.74, and 510 nm in numerous investigations (Al Ogaidi et al., 2017).It could be because the negative zeta potential of AgNPs indicates that they are a stable substance with non-sticking particles.



(a)



(b)

Figure 6 – Physicochemicalcharacterisation of biosynthesizedAgNPs:
(a) Zetapotentialanalysisindicating a surfacecharge of- 20 mV, suggestingcolloidalstability.
(b) Dynamiclightscattering (DLS)- basedparticlesizeanalysisshowing an averagesizedistribution of 165 nm

AgNPs synthesized under a greener approach have a superior negative charge distribution compared to other conventional (chemical and physical) synthesis methods. According to studies, several plants–Andrographis paniculata (Prabhu & Poulose, 2012), Convolvulus arvensis, and Matricaria chamomilla (Rasheed et al., 2018)–exhibit surface charge and zeta potential distributions of 136 nm, −26 mV; 68.06 nm, −21.4 mV; and 90.9 nm, respectively.

Conclusion

The present study successfully demonstrated the green synthesis of silver nanoparticles (AgNPs) using Artemisia lerchiana Web. plant extract as an eco-friendly reducing and stabilizing agent. The biosynthesis approach proved efficient, rapid, and sustainable, producing nanoparticles without the need for toxic chemicals or high-energy procedures. Vi-

sual color change during the reaction indicated the reduction of Ag^{+} to Ag^{0}, and subsequent characterization confirmed the successful formation of Ag-NPs. SEM analyses revealed predominantly spherical nanoparticles with sizes ranging from 25–50 nm, while TEM images showed more detailed nanoscale morphology with smooth, monodisperse particles in the size range of 4–19 nm. These differences in observed particle size likely result from agglomeration in the dried SEM samples versus individual dispersion under TEM analysis.

EDX spectroscopy verified silver as the major element, accompanied by carbon, oxygen, and chlorine originating from plant phytochemicals, thus confirming the purity and biosynthetic origin of the nanoparticles. XRD analysis showed distinct diffraction peaks corresponding to the face-centered cubic (fcc) crystalline structure of silver, and the calculated crystallite size (24.83 nm) further supported the formation of nanoscale material. Thermal (TG–DTA) evaluation demonstrated good thermal stability, suggesting that the nanoparticles maintain structural integrity even at elevated temperatures. Zeta potential measurements indicated a negative surface charge (−20 mV), attributed to phytochemical capping, which is consistent with long-term colloidal stability and reduced aggregation.

Overall, the results confirm that Artemisia lerchiana extract is a highly effective bio-reducing agent for producing stable, crystalline AgNPs. The synthesized nanoparticles exhibit desirable physicochemical properties, indicating their potential applicability in antimicrobial, catalytic, biomedical, and environmental systems. This green synthesis method offers a promising pathway toward sustainable nanomaterial production.

References

1. Thirumurugan A., Aswitha P., Kiruthika C., Nagarajan S., Christy A.N. (2016) Green synthesis of platinum nanoparticles using Azadirachta indica an eco-friendly approach. Mater. Lett., vol. 170, pp. 175–178.
2. Abdellatif et al. (2022) Bioactivities of the green synthesized silver nanoparticles reduced using Allium cepa L aqueous extracts induced apoptosis in colorectal cancer cell lines.
3. Aktepe N., Baran A., Atalar M.N., Baran M.F., Keskin C., Düz M.Z., Yavuz Ö., İrtegünKandemir S., Kavak D.E. (2021) Biosynthesis of black mulberry leaf extract and silver nanoparticles: characterization, antimicrobial and cytotoxic activity. MAS J. Appl. Sci., vol. 6, pp. 685–700.
4. Aref M.S., Salem S.S. (2020) Bio-callus synthesis of silver nanoparticles, characterization, and antibacterial activities via Cinnamomum camphora callus culture. Biocatal. Agric. Biotechnol., vol. 27, 101689.
5. Al Ogaidi I., Salman M.I., Mohammad F.I., et al. (2017) Antibacterial and cytotoxicity of silver nanoparticles synthesized in green and black tea. World J. Exp. Biosci., vol. 12, no. 1, pp. 39–45.
6. Baran A., Fırat Baran M., Keskin C., Hatipoğlu A., Yavuz Ö., İrtegünKandemir S., Adican M.T., Khalilov R., Mammadova A., Ahmadian E., et al. (2022) Investigation of antimicrobial and cytotoxic properties of silver nanoparticles derived from Cicer arietinum L. Front. Bioeng. Biotechnol., vol. 10, 855136.
7. Chellamuthu C., Balakrishnan R., Patel P., Shanmuganathan R., Pugazhendhi A., Ponnuchamy K. (2019) Gold nanoparticles using red seaweed Gracilariaverrucosa: green synthesis, characterization and biocompatibility studies. Process Biochem., vol. 80, pp. 58–63.
8. Pandian C.J., Palanivel R., Dhananasekaran S. (2015) Green synthesis of nickel nanoparticles using Ocimum sanctum and their application in dye adsorption. Chin. J. Chem. Eng., vol. 23, no. 8, pp. 1307–1315.
9. Devatha C.P., Thalla A.K., Katte S.Y. (2016) Green synthesis of iron nanoparticles using different leaf extracts for treatment of domestic wastewater. J. Clean Prod., vol. 139, pp. 1425–1435.
10. Chernousova S., Epple M. (2013) Silver as antibacterial agent: ion, nanoparticle, and metal. Angew. Chem. Int. Ed., vol. 52, pp. 1636–1653. https://doi.org/10.1002/anie.201205923.
11. Choi H.C., Jung Y.J., Baek et al. (2021) Antibacterial activity of green-synthesized silver nanoparticles using Areca catechu extract.
12. Dada A.O., Adekola F.A., Odebunmi E.O. (2017) Zerovalent manganese for copper removal: synthesis, characterization and adsorption studies. Appl. Water Sci., vol. 7, no. 3, pp. 1409–1427.
13. Elumalai E.K., Prasad T.N.V.K.V., Hemachandran J., Therasa S.V., Thirumalai T., David E. (2010) Extracellular synthesis of silver nanoparticles using Euphorbia hirta leaves and their antibacterial activities.
14. Thema F.T., Manikandan E., Dhlamini M.S., Maaza M. (2015) Green synthesis of ZnO nanoparticles via Agathosmabetulina extract. Mater. Lett., vol. 161, pp. 124–127.
15. Ghabban S.F., Alnomasy H., Almohammed et al. (2022) Antibacterial, cytotoxic and cellular mechanisms of green synthesized silver nanoparticles.
16. Kalishwaralal K., Vaidyanathan R., Venkataraman D., Pandian S.R., Muniyandi J., Hariharan N., Eom S.H. (2009) Biosynthesis, purification and characterization of silver nanoparticles using Escherichia coli. Colloids Surf. B Biointerfaces, vol. 74, pp. 328–335. https://doi.org/10.1016/j.colsurfb.2009.07.048.

17. Gurunathan S., Park J.H., Han J.W., Kim J.H. (2015) Apoptotic potential of silver nanoparticles synthesized by Bacillus tequilensis and Calocybe indica. Int. J. Nanomed., vol. 10, pp. 4203–4222.

18. Kambale E.K., Nkanga C.I., Mutonkole B.-P.I., et al. (2020) Green synthesis of antimicrobial silver nanoparticles using Congolese plant species. Heliyon, vol. 6, e04493.

19. Khan Z.M., Almarhoon J., Bakht et al. (2022) Acer pentapomicum-mediated green synthesis of silver nanoparticles and evaluation of antimicrobial and antioxidant activities.

20. Lavoie et al. (1995) Environmental scanning electron microscopy of marine aggregates. J. Microsc., vol. 178, no. 2, pp. 101–106.

21. Li L., Hu J., Yang W., Alivisatos A.P. (2001) Band gap variation in size- and shape-controlled CdSe quantum rods. Nano Lett., vol. 1, pp. 349–351.

22. Li W.R., Xie X.B., Shi Q.S., et al. (2010) Antibacterial activity and mechanism of silver nanoparticles on E. coli. Appl. Microbiol. Biotechnol., vol. 85, pp. 1115–1122.

23. Bandeira M., Giovanela M., Roesch-Ely M., Devine D.M., da Silva C.J. (2020) Green synthesis of ZnO nanoparticles: methodology and mechanism. Sustain. Chem. Pharm., vol. 15, 100223.

24. Hosny M., Fawzy M., Abdulfetah A.M., Fawzy E.E., Eltaweil A.S. (2021) Green synthesis of gold nanoparticles using halophytic species: anticancer and catalytic efficiencies. Adv. Powder Technol., vol. 32, no. 9, pp. 3220–3233.

25. Soliman M., Qari S.H., Abu-Elsaoud A., et al. (2020) Rapid green synthesis of silver nanoparticles enhances plant growth via antioxidant modulation. Acta Physiol. Plant., vol. 42, no. 9, pp. 1–16.

26. Mani M., Harikrishnan R., Purushothaman P., Pavithra S., Rajkumar P., Kumaresan S., et al. (2021) Systematic green synthesis of silver oxide nanoparticles for antimicrobial activity. Environ. Res., vol. 202, 111627.

27. Mukherjee P., Ahmad A., Mandal D., et al. (2001) Fungus-mediated synthesis of silver nanoparticles. Nano Lett., vol. 1, pp. 515–519.

28. Aktepe N., Baran A. (2021) Fast and low-cost biosynthesis of AgNPs with almond leaves. Prog. Nutr., vol. 23, no. 3, e2021271.

29. Clarance P., Luvankar B., Sales J., et al. (2020) Green synthesis of gold nanoparticles using Fusarium solani and biomedical applications. Saudi J. Biol. Sci., vol. 27, no. 2, pp. 706–712.

30. Patra J.K., Gitishree D., Baek K.H. (2016) Phyto-mediated biosynthesis of AgNPs using watermelon rind extract: antibacterial and antioxidant efficacy. J. Photochem. Photobiol. B., vol. 161, pp. 200–210.

31. Prabhu S., Poulose E.K. (2012) Silver nanoparticles: antimicrobial mechanism and toxicity. Int. Nano Lett., vol. 2, pp. 1–10.

32. Rai (2013) Green nanobiotechnology: biosynthesis of metallic nanoparticles and antimicrobial applications. Ciência e Cultura, vol. 65, no. 3, pp. 44–48.

33. Rasheed T., Bilal M., Li C., et al. (2018) Catalytic degradation of pollutants using biosynthesized silver nanoparticles. J. Photochem. Photobiol. B., vol. 181, pp. 44–52.

34. Reverberi M., Vocciante M., Salerno M., Ferretti B., Fabiano B. (2019) Green synthesis of silver nanoparticles by low-energy bead milling.

35. Salem S.S., El-Belely E.F., Niedbała G., et al. (2020) Bactericidal and cytotoxic efficacy of silver nanoparticles fabricated by endophytic actinomycetes. Nanomaterials, vol. 10, p. 2082.

36. Vinay S.P., Nagaraju G., Chandrappa C.P., Chandrasekhar N. (2019) Cow-urine mediated synthesis of silver oxide nanoparticles. J. Sci. Adv. Mater. Dev., vol. 4, pp. 392–399.

37. Saravanakumar M.M., Peng M., Ganesh M., Jayaprakash J., Mohankumar M., Jang H.T. (2017) Green synthesis of AgNPs using Prunus japonica and evaluation of antibacterial and antioxidant properties.

38. Sharma V.K., Yngard R.A., Lin Y. (2008) Silver nanoparticles: green synthesis and antimicrobial activities. Adv. Colloid Interface Sci., vol. 145, pp. 83–96.

39. Badeggi U.M., Ismail E., Adeloye A.O., et al. (2020) Green synthesis of gold nanoparticles capped with procyanidins: antidiabetic potential. Biomolecules, vol. 10, p. 452.

40. Ullah S., Noman M., Ali K.S., et al. (2021) Biosynthesis of AgNPs using Abutilon indicum leaf extract. IOSR J. Environ. Sci. Toxicol. Food Technol., vol. 15, no. 1, pp. 4–14. https://doi.org/10.9790/2402-1501010414.

41. Cittrarasu V., Kaliannan D., Dharman K., et al. (2021) Green synthesis of selenium nanoparticles from Ceropegia bulbosa: antimicrobial and photocatalytic activities. Sci. Rep., vol. 11, p. 1032.

42. Sunderam V., Thiyagarajan D., Lawrence A.V., Mohammed S.S., Selvaraj A. (2019) Antimicrobial and anticancer properties of gold nanoparticles synthesized using Anacardium occidentale leaf extract. Saudi J. Biol. Sci., vol. 26, no. 3, pp. 455–459.

Information about author:

Gunay Hasanova – Baku State University, Z. Khalilov 23, Baku AZ1148, Azerbaijan.

IRSTI 76.29.07 https://doi.org/10.26577/appmed2025625

M.A. Temirbaev*, R.I. Yui

Al-Farabi Kazakh National University, Almaty, Kazakhstan
*e-mail: maksut.temirbayev@kaznu.edu.kz

COMPARATIVE ANALYSIS OF THE OCCURRENCE OF BO LINES AFTER SPORTS INJURIES AND COVID-19

Abstract

Introduction: Beau's lines (Beau's grooves, Beau's lines) are one of the most common types of onychodystrophy. Beau's lines occur for many reasons, both external and internal.

Internal factors include: side effects of chemotherapy, serious illnesses (myocardial infarction, pulmonary embolism, shock, high fever), metabolic disorders, eczema, psoriasis, especially if the rash is located on the back of the hands, uncontrolled use of potent drugs, infectious diseases that disrupt the function and nutrition of the nail matrix, general intoxication of the body, stress and past neuropsychiatric diseases, a symptom of latent skin pathologies, rheumatism, pemphigus, diabetes mellitus, malaria, Raynaud's disease.

Materials and methods: The article presents a clinical case of a patient who developed Beau's lines as a result of a sports injury to the distal phalanx of the fingers and subsequently contracted COVID-19.

Results: Patient T suffered a sports injury to the distal phalanx in 1987. Five to six weeks after the injury, a specific deformation of the nail plates, similar to a washboard, was observed during examination. Transverse arcuate grooves were observed across the entire surface, crossing the nail plate from one edge of the nail fold to the other, which were identified as Beau's lines. In 2021, patient T suffered from a severe form of COVID-19 with extensive lung damage and was in intensive care for 2 weeks.

Conclusion: Damage to the nail plate in the form of Beau's lines is possible both in cases of trauma and in severe conditions of the body. When Beau's lines appear and trauma to the nail bed is ruled out, an in-depth examination is necessary to rule out severe pathology. The time of appearance of Beau's lines in trauma differs from the time of their appearance in severe COVID-19 and averages 5-6 weeks.

Keywords: nail damage, Beau's lines, COVID-19, nail plate injury, post-infectious nail changes, traumatic nail injury, clinical case report.

Introduction

Bo-Reylev's arched stripes, which appear as transverse linear depressions in the nail plates on the upper and lower extremities, were first described by French military surgeon Joseph Honoré Simon Bo in the mid-19th century, who noticed this symptom in many wounded soldiers. He attributed this nail pathology to a temporary halt in nail growth as a result of trauma and stress.

Normally, the nail matrix, which is capable of growth due to the keratinocytes of the epidermis of the thickened proximal part of the nail bed, is located under the root of the nail. It lies on the underlying dermis, which contains numerous vessels, as well as collagen and elastic fibres that firmly attach it to the periosteum of the distal phalanx of the finger. Newly formed matrix cells are quickly incorporated into the root of the nail (without the formation of keratogialin) and are transformed into horny scales, ensuring the continuous slow movement of the nail plate along the nail bed at an average speed of 0.1 mm/day (on the hands). Active division of matrix cells not only ensures the growth of the nail plate, but also guarantees the constancy of the chemical composition of the hard keratin of the horny scales of the nail. The white crescent of the nail (or nail lunula) marks the boundary of its growing part [1,2].

The appearance of Bo's lines indicates a violation of the trophism of the nail plate due to a number of reasons, both external and internal.External causes include: previous inflammation or trauma to the posterior nail fold, damage to the nail skin (cuticle, epinohia), inflammation in the upper part of the fingers and nail area, fungal nail infection, heavy physical exertion, prolonged exposure to low temperatures.

Internal causes include: side effects of chemotherapy, serious illnesses (myocardial infarction, pulmonary embolism, shock, high fever), metabolic disorders, eczema, psoriasis, especially if the rash is located on the back of the hands, uncontrolled use of potent drugs, infectious diseases that disrupt the

function and nutrition of the nail matrix, general intoxication of the body, stress and past neuropsychiatric diseases, a symptom of latent skin pathologies, rheumatism, pemphigus, diabetes mellitus, malaria, Raynaud's disease. The appearance of Beau's lines has been described in children who have had measles, scarlet fever and other childhood infections.

In recent years, the appearance of Beau's lines has been noted in patients who have had SARS-Cov2 infection, especially in severe cases of the disease, with lung damage and immune system reactions.

Dermatologists differentiate Beau's lines from onychomycosis, psoriasis of the nails, and lichen planus in order to identify and correct the underlying pathology. If necessary, dermatoscopy is also performed to rule out fungal nail infection.

Mechanical damage to the nail in the nail matrix area after a sports injury leads to a blockage of its natural nutrient channels, which impairs the trophism of the onychoblasts and inhibits their division rate.This leads to a disruption in the chemical composition of the hard keratin of the nail, dystrophy and its deformation. In other words, Bo lines appear as a result of the spontaneous cessation of normal hard keratin synthesis. As a result, mechanical Bo lines appear [4,5]. The severity of nail deformation reflects the nature of the pathology.

Thus, the mechanism of Bo lines in sports injuries is caused by the rupture and subsequent regeneration of the tendon using a special device that ensures the distal phalanx of the finger (Malletfinger) is placed in a normal position. These processes, as stress factors, lead to a disruption in the trophism of the nail matrix, suppression of the division activity and synthetic activity of onychoblasts.

Figure 1 – Photo of Beau's lines on the nail plates 35 days after COVID-19

Beau's lines may appear 1-2 weeks after an infectious or other disease that leads to a disruption in the supply of nutrients to the growth zone of the nail plate (Figure 1). Scientists believe that the appearance of Beau's lines against the background of COVID-19 can be explained by a temporary cessation of nail matrix growth.In April 2021, a group of scientists from Italy and Mexico published a review article in which they attempted to compile known cases of nail changes associated with COVID-19. The average age of the patients they examined was 53.5 years (ranging from 37 to 89 years). Four of the patients were women. On average, nail lesions developed 56 days after the diagnosis of COVID-19 (ranging from 2 to 112 days) [5,6,7,8,9].

In addition, the following nail changes were identified in patients with COVID-19:

•Red half-moon sign.

A convex red crescent-shaped band bordering the distal edge of the nail bed (i.e., closer to the outer edge of the nail plate). These red crescents persisted in patients for a month or more, expanding slightly during that time. No other skin manifestations may be observed.

Tammaro et al., who published a description of the "red crescent sign" in June 2020, emphasise that polydactyl erythronychia (red streaks on all fingers) is not surprising in itself, as it occurs in Kawasaki disease, lupus erythematosus, Darier's disease, primary amyloidosis, and transplant rejection. However, in all these cases, the red streaks are longitudinal lines (in Kawasaki disease, they are transverse), while in COVID-19, erythronychia takes the form of a crescent along the edge of the

lunula. There are no other diseases that cause similar lesions.

Scientists suggest that this unusual lesion develops due to damage to microvessels or is associated with a procoagulant state (on the verge of thrombus formation) triggered by the immune system's response to viral invasion.

•Misa lines.

This is the name given to horizontal whitish lines that cross the entire nail plate. The main cause is abnormal protein production in the nail bed due to a systemic disease.

•Onychomadesis.

This is a rare pathology in which the nail plate separates from its bed, but it starts from the proximal edge of the nail (the one closer to the body). Among the causes of onychomadesis are systemic diseases that disrupt the blood supply to the nail, as well as infections such as syphilis, scarlet fever, and enterovirus infections. In this case, scientists believe that the cause of onychomadesis in COVID-19 is a disruption in the nutrition of the nail, inhibiting its growth.

•Orange nails

This is a rare condition, but it has been reported in an elderly patient with COVID-19. Sixteen weeks after her recovery, orange spots appeared on the tips of her fingernails. Gradually, as the nails grew, the orange stripe shifted towards the distal edge of the nail, repeating the shape of the lunula, which indicates the systemic nature of the pathology.

It should be noted that all of the above nail lesions, except for the red crescent, occur in patients with Kawasaki disease, which is also vascular in nature.

The appearance of Beau's lines in the case of trauma to the distal phalanges of the fingers allowed us to compare the history of the appearance of Beau's lines in the same patient T., who subsequently suffered from a severe form of COVID-19 in 2020.

While playing volleyball in 1987, the patient injured his left hand, striking the nail plates of the distal phalanges of both hands. The blow was so severe that it led to a rupture of the extensor tendons of the middle finger of the left hand. The distal phalanx hung down in the shape of a hammer, known as mallet finger. The damaged joint was treated conservatively using a plastic splint made of fast-setting Protacryl plastic of our own design for 5 weeks.

Five to six weeks after the injury, examination revealed a specific deformation of the nail plates, similar to a washboard. Transverse arcuate grooves were observed across the entire surface, crossing the nail plate from one edge of the nail fold to the other. At the same time, they did not differ in colour from healthy nails. The grooves always appeared in the lunula area of the nail, at the edge of the posterior nail fold, and as the nail grew, they moved forward towards its free edge, where they disappeared without a trace. These arcuate grooves were identified as Beau's lines.

In 2021, the same patient, suffering from COVID-19, was hospitalised in the intensive care unit of the Almaty City Infectious Diseases Hospital with 80% lung damage. Due to the severity of his condition, the patient remained in the intensive care unit for 24 days. Rehabilitation was carried out under the supervision of doctors using appropriate medical care and simultaneous oxygen support. After inpatient treatment, the patient regained his physical fitness by taking daily morning walks, starting with 50-60 steps and increasing to 10,000. He regained the 12 kg he had lost in weight within 3 months. After 5-6 weeks, the nail plates on his hands and feet began to grow with characteristic transverse wavy lines, resembling a washboard. It should be noted that the changes in the nail plate described in patient T. with Covid-19 were similar to those seen in sports injuries.

Conclusion

Let us try to summarise the above and bring together the possible causes of nail damage in coronavirus infection. As mentioned above, onychodystrophy detected in coronavirus infection is associated with a violation of the trophism of the nail bed matrix due to damage to the endothelium of the capillaries and their microthrombosis [10,11, 12].As a result, there is a delay or temporary cessation of nail plate growth due to a decrease in the division and synthetic activity of onychoblasts.

In Covid-19 patients, this is generally due to a disruption in the synthesis of connective tissue components in the body, as evidenced by respiratory arrest and sudden death as a result of insufficient lung function, which are air-filled connective tissue sacs. It is also known that the severity of COVID-19 correlates with ferropenia (a decrease in serum iron) in the blood, which can cause nail damage.

Thus, a comparative analysis of onychodystrophy in the same patient with a sports injury and COVID-19 indicates different aetiologies and similarities in the pathogenesis of its occurrence. It should be noted that in the absence of external influences on the nail plates, the appearance of Beau's lines may indicate a serious process that requires in-depth diagnostic investigation and differential diagnosis.

Conclusions

1. Nail lesions in the form of Beau's lines in COVID-19 are rare. However, a number of authors point to nail changes in COVID-19.

2. A unique case of nail damage in a patient with a distal phalanx tendon rupture and then COVID-19 allowed us to conclude that the pathogenesis of Beau's lines is similar.

3. Most often, skin and nail damage develops some time after infection or even after COVID-19 has already been contracted. This is because nails grow slowly, at a rate of 2-5 mm per month, so the affected area only becomes noticeable after some time.

4. No special treatment is required for onychodystrophy in COVID-19. However, in the case of trauma, in particular, a rupture of the extensor tendons of the fingers, an original treatment method has been developed – the use of a splint of our own design, based on the use of recently invented plastics. This method allows for effective restoration of the anatomy and function of the damaged fingers without surgical intervention. All of the listed signs of onychodystrophy disappear as the affected area grows and is trimmed.

References

1. de Berker, David. "Nail anatomy." *Clinics in dermatology* vol. 31,5 (2013): 509-15. doi:10.1016/j.clindermatol.2013.06.006

2. Higashi T, Aso S, Horisaki H, Ito T, Tanaka S, Nishimoto-Kusunose S, ***et al***. Evaluation of thumbnail clipping as a specimen for retrospectively assessing average production of testosterone. ***ClinChimActa***. 2023 Jan1;538:157-163. doi:10.1016/j.cca.2022.11.019.

3. Liu, Tsung-Hsien, Meng-Chien Hsieh, Ping-Ruey Chou, and Shu-Hung Huang. 2020. "Reconstruction for Defects of Total Nail Bed and Germinal Matrix Loss with Acellular Dermal Matrix Coverage and Subsequently Skin Graft" *Medicina* 56, no. 1: 17. https://doi.org/10.3390/medicina56010017

4. Galván Casas CбClassification of the cutaneous manifestations of COVID-19: a rapid prospective nationwide consensus study in Spain with 375 cases. /, et al. // Br J Dermatol. – 2020 Jul – 183(1):71-77.DOI: 10.1111/bjd.19163

5. Onychomadesis following COVID-19 infection: Is there a relationship? / Senturk N, Ozdemir H. // Dermatol Ther. – 2020 Nov – 33(6)DOI: 10.1111/dth.14309

6. Transverse orange nail lesions following SARS-CoV-2 infection. / Tammaro A, Adebanjo GAR, Erasmus HP, et al. // Dermatol Ther. – 2021 – 34(1)

7. Nail changes as manifestation of systemic disease in COVID-19 infection [published online ahead of print, 8 April 2021]. / Ocampo-Garza SS, Ocampo-Candiani J, Camela E, et al. // J Eur Acad Dermatol Venereol. – 2021

8. The red half-moon nail sign: a novel manifestation of coronavirus infection. / Neri I, et al. // J Eur Acad Dermatol Venereol. – 2020 – 34(11)

9. 10.Buryachkovskaya LI, Melkumyants AM, Lomakin NV, et al. Damage to the vascular endothelium and erythrocytes in patients with COVID-19 // ConsiliumMedicum. – 2021. – Vol. 23. – No. 6. – pp. 469–476.

10. 11. V.I. Starodubov, V.V. Beregovykh, V.G. Akimkin. T.A. Semenko, S.V. Ugleva et al. Annals of the Russian Academy of Medical Sciences. 2022;77(4):291–306. Bulletin of the Russian Academy of Medical Sciences. – 2022. – Vol. 77. – No. 4. – P. 291–306. REVIEW.

11. 12. Richardson S, Hirsch JS, Narasimhan M, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalised with COVID-19 in the New York City Area. JAMA. 2020;323(20):2052–2059. doi: https://doi.org/10.1001/jama.2020.6775

Information about authors:

M. Temirbaev – Head of Department (Higher School of Medicine) Employment, Al-Farabi Kazakh National University (Almaty, Kazakhstan).

R.I. Yui – Professor, Fundamental Medicine, Al-Farabi Kazakh National University (Almaty, Kazakhstan).

INFORMATION FOR AUTHORS

Submissions to the journal Interdisciplinary Approaches to Medicine are made using Open Journal System, the online submission and peer review system. Registration and access is available at Submission

The author for correspondence is obliged to provide a cover letter for publication in the journal.

MANUSCRIPT REQUIREMENTS

Please prepare your manuscript before submission, using the following guidelines (You can use the TEMPLATE for preparing your manuscript):

- The editorial board accepts previously unpublished articles in the scientific areas of the journal. The article is submitted in electronic format (in the formats .doc, .docx, .rtf) ONLY by downloading it through the functionality of the journal website (Open Journal System).
- Font size – 12 (abstract, keywords, literature – 10, table text – 9-11), font – Times New Roman, alignment – width of the text, spacing – single, paragraph indent – 0.8 cm, margins: top and lower – 2 cm, left and right – 2 cm.
- Figures, tables, graphs, charts, etc. are presented directly in the text on the left edge with the numbering and title (for example, Fig. 1 – Name of the picture). The number of figures, tables, graphs and charts should not exceed 20% of the total article (in some cases, up to 30%).

The journal accepts the following manuscripts:

1. Original articles – articles that include the results of their own scientific research. The volume of the article is up to 3000 words (including literature sources, figure captions and tables), at least 10 literature sources. The original article should have sections: introduction, purpose, material and methods, results, discussion, conclusion, bibliography. The abstract should not exceed 300 words.
2. Review article – an overview of research results, analysis and discussion of published information on a specific topic in a concise manner. The volume of the text is up to 7,000 words (including literature sources, figure captions and tables), up to 50 literature sources, an unstructured resume not exceeding 150 words.
3. Clinical case – a message representing a scientific description of a clinical case from practice, representing a complex diagnostic or therapeutic problem or a rare clinical case. The volume of the manuscript is up to 600 words (including literature sources, figure captions and tables), up to 5 literature sources, without a resume.
4. An editorial – a text volume of up to 7,000 words (including sources of literature, figure captions and tables), up to 15 sources of literature, with a short (150 words) unstructured resume.

- Authors MANDATORY must indicate in a cover letter in the Open Journal System or Editorial Manager that the article / manuscript has not been published anywhere before, and that the article does not contain borrowed text fragments from other works without reference to them.
- The submitted manuscript without fail passes through the KazNU Antiplag system, as a result of which the originality of the submitted manuscript should be at least 75%.
- After checking for originality, the manuscript is sent for review. In KazNU named after al-Farabi the type of reviewing is four-level: by the chief editor; open one-sided blind (anonymous) peer review by a foreign scientist who is not affiliated with the author (s) of an article with a full report in English; unilateral blind (anonymous) peer-reviewing from among scientists not affiliated with Al-Farabi Kazakh National University and the author (s) of the article with a full report in English.
- The payment procedure and cost for publishing the article is established by the publishing house "Kazakh University" and is made by the author after approval by external reviewers and a scientific editor.

Article structure:

First page:

- The first line is the **IRSTI** number (in exceptional cases, UDC) and the **DOI** identifier (**assigned by the DSPA**), alignment is left-aligned for IRSTI, right-aligned is for DOI, the font is bold.

- Article author (s) – Initials and surname, place of work (affiliation), city, country, email, **ORCID ID**. Information about the authors is represented in regular letters in lower case, alignment – in the center.
- The title of the article (Title) should reflect the essence and content of the article and attract the attention of the reader. The name should be short, informative and not contain jargon or abbreviations. The optimal length of the title is 5-7 words (in some cases 10-12 words). The title of the article is represented in bold in capital letters in the language in which the article is written, in lower case translations, alignment – in the center.
- An annotation of at least 150 words and no more than 300 words in English.
- The structure of the annotation includes the following MANDATORY clauses:
- Opening remarks on the research topic.
- Purpose, main directions and ideas of scientific research.
- A brief description of the scientific and practical significance of the work.
- A brief description of the research methodology.
- Main results and analysis, conclusions of research work.
- The value of the study (the contribution of this work to the relevant field of knowledge).
- The practical significance of the outcome of the work.
- Keywords / phrases – number of words 3-7.

Next page (new):

The name of all sections is shown in bold lowercase letters on the left. Original articles.

- **Introduction** consists of the following main elements:

▪ Justification of the choice of topic; relevance of the topic or problem. In substantiating the choice of a topic based on a description of the predecessors experience, a problematic situation is reported (the absence of any research, the appearance of a new object, etc.). The relevance of the topic is determined by the general interest in the knowledge of this object, but the lack of comprehensive answers to existing questions, it is proved by the theoretical or practical significance of the topic.

▪ Definition of the object, subject, goals, objectives, methods, approaches, hypotheses and the significance of your work. The purpose of the study is related to the proof of the thesis, that is, the presentation of the subject of research in the aspect chosen by the author.

- **Material and Methods** – should consist of a description of the materials and the progress of work, as well as a full description of the methods used.

▪ Characterization or description of the research material includes its presentation in qualitative and quantitative terms. The characteristic of the material is one of the factors determining the reliability of conclusions and research methods.

▪ This section describes how the problem was studied: detailed information without repeating previously published established procedures; identification of equipment (software) and a description of materials are used, with the obligatory introduction of novelty when using materials and methods.

The scientific methodology should include:

- research question (s);
- put forward hypothesis (thesis);
- stages of the study;
- research methods;
- research results.

- The **Results and Discussion** section provides an analysis and discussion of the research results you received. A conclusion is drawn on the results obtained during the study, the main essence is revealed. And this is one of the most important sections of the article. It is necessary to analyze the results of its work and discuss the relevant results in comparison with previous works, analyzes and conclusions.
- **Conclusions, findings** – summarizing and integrating the work at this stage; confirmation of the truth of the statement made by the author, and the author's conclusion on the change in scientific knowledge, taking into account the results. The conclusions should not be abstract, they should be used to summarize the results of the study in a particular scientific field, with a description of the proposals or possibilities for further work.

- The structure of the conclusion should contain the following questions: What are the goals and methods of the study? What are the results? What are the findings? What are the prospects and opportunities for implementation, application development?

- In the literature review section, fundamental and new works on the studied topics of foreign authors in English should be covered (at least 15 works), an analysis of these works in terms of their scientific contribution, as well as research gaps that you supplement in your article.

▪ IT IS UNACCEPTABLE to have many links that are not related to work, or inappropriate judgments about your own achievements, links to your previous works.

The list of used literature, or the Bibliographic list consists of at least 5 titles of literature for a clinical case 15 titles for other options for articles, and of the total number of foreign authors should be at least 50%. If there are works presented in the Cyrillic alphabet in the list of literature, it is necessary to present the list of literature in two versions: the first in the original, the second in the Romanized alphabet (transliteration).

▪ **The romanized list of literature** should look like this: author (s) (transliteration – translit.ru) → (year in parentheses) → title of the article in transliterated version [translation of the title of the article in English in square brackets], name of the Russian-language source (transliteration, or English name – if any), output with designations in English.

For example: Gokhberg L., Kuznetsova T. (2011) Strategiya-2020: novye kontury rossiiskoi innovatsionnoi politiki [Strategy 2020: New Outlines of Innovation Policy]. Foresight-Russia, vol. 5, no 4, pp. 8-30. The list of references is presented in alphabetical order, and ONLY those works that are cited in the text.

▪ The design style of the Romanized list of literature, as well as sources in English (another foreign) language for socio-humanitarian areas – the American Psychological Association (http://www.apastyle.org/), for science and technology – Chicago Style (www.chicagomanualofstyle. org).

▪ In the bibliographic list

▪ References to cited works in the text of the socio-humanitarian direction are given in brackets, indicating the first author of the work, year of publication: page number (s). For example, (Zalessky 1991: 25). If there are several works of the same author in the list of literature published in one year, then in addition to the year of publication, the letter “a”, “b”, etc. For example, (Saduova, 2001a: 15), (Saduova, 2001b, 22). For natural science articles, links are made out in square brackets with numbering as the cited works appear in the text.

- **All abbreviations and acronyms** must be deciphered at first use in the text, with the exception of well-known abbreviations and acronyms.

For bibliographic references, you can also use the Mendeley Reference Manager.

CONTENTS

L.B. Kuanova, G.O. Zhienkulova, J.A. Nugmanova
Bridging the Gap: A Conceptual Model for Transitioning Nf1 Patients from Pediatric to Adult Care in Resource-Limited Settings . 3

Y.P. Ziyayev, M.N. Tillyashaykhov, S.M. Dzhanklich
The Impact of Pesticides on Cancer Incidence Among Children in Uzbekistan: a Survey Study..... 8

U.D. Usmonov
Effectiveness of a New Method of Providing First Aid For Non-Gunshot Wounds to Soft Tissue 12

G. Hasanova
Structural and Thermal Stability of Ag Nanoparticles Synthesized from Artemisia Lerchiana: Sem, Edx, Xrd
And Tg-Dta Analyses 21

M.A. Temirbaev, R.I. Yui
Comparative Analysis of the Occurrence of Bo Lines after Sports Injuries and COVID 19 30

Information For Authors 34