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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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Содержание:

Tsitsino Abakelia, Ketevan Lashkhi, Sophio Kakhadze.
BRIDGING GAP BETWEEN PRE AND POSTOPERATIVE PROSTATE BIOPSIES: PI RADS CORRELATION WITH FINAL HISTOPATHOLOGICAL DATA……..……..……..……..…….....……6-12

Sopio Gvazava, Vladimer Margvelashvili, Nino Chikhladze, Diana Dulf, Corinne Peek-Asa.
A RETROSPECTIVE STUDY OF THE MAXILLOFACIAL INJURIES IN TWO EMERGENCY DEPARTMENTS IN TBILISI, GEORGIA…….....……13-19

Eraliyeva B.A, Paizova.M.K, Almakhanova A.N, Erkinbekova G.B, Nurgazieva G.Y, Tyndybay S.S.
EXPENDITURE ON MEDICINES IN A MULTIDISCIPLINARY HOSPITAL IN ALMATY BASED ON ABC /VEN ANALYSIS……..20-23

Tchernev G.
NITROSOGENESIS OF SKIN CANCER: THE NITROSAMINE CONTAMINATION IN THE CALCIUM CHANNEL BLOCKERS (AMLODIPINE), BETA BLOCKERS (BISOPROLOL), SARTANS (VALSARTAN/LOSARTAN), ACE INHIBITORS (PERINDOPRIL/ ENALAPRIL), TRICYCLIC ANTIDEPRESSANTS (MELITRACEN), SSRIS (PAROXETINE), SNRIS (VENLAFAXINE) AND METFORMIN: THE MOST PROBABLE EXPLANATION FOR THE RISING SKIN CANCER INCIDENCE…….....……24-32

Kachanov D.A, Karabanova A.V, Knyazeva M.B, Vedzizheva H.Kh, Makhtamerzaeva H.S, Ulikhanian E.G, Gukoyan A. A, Galdobina V.A, Dimakov D.A, Shakirianova A.V.
INFLUENCE OF PROFICIENCY OF SYNTHETIC FOLIC ACID ON THE NEUROLOGICAL SYMPTOMS OF RATS……..33-36

Zamzam AR. Aziz, Entedhar R. Sarhat, Zaidan J. Zaidan.
ESTIMATION OF SERUM FERROPORTIN AND LIVER ENZYMES IN BREAST CANCER PATIENTS…..…..37-41

Tereza Azatyan.
THE RHEOENCEPHALOGRAPHIC STUDY OF THE INTERHEMISPHERIC ASYMMETRY OF CEREBRAL BLOOD FLOW IN HEALTHY AND MENTALLY RETARDED CHILDREN…….....…….42-46

Ahmed T. Jihad, Entedhar R. Sarhat.
ALTERED LEVELS OF ANTI-MULLERIAN HORMONE AND HEPCIDIN AS POTENTIAL BIOMARKERS FOR POLYCYSTIC OVARY SYNDROME…….....…….47-51

L.V. Darbinyan, K.V. Simonyan, L.P. Manukyan, L.E. Hambardzumyan.
EFFECTS OF DIMETHYL SULFOXIDE ON HIPPOCAMPAL ACTIVITY IN A ROTENONE-INDUCED RAT MODEL OF PARKINSON'S DISEASE…….....……..52-56

Labeeb H. Al-Alsadoon, Ghada A. Taqa, Maha T. AL-Saffar.
EVALUATION OF PAIN-KILLING ACTION OF ACETYLSALICYLIC ACID NANOPARTICLES ON THERMAL NOCICEPTION IN MICE…….....…….57-61

Olesia Kornus, Anatolii Kornus, Olha Skyba, Iryna Mazhak, Svitlana Budnik.
FORECASTING THE POPULATION MORTALITY RATE FROM CARDIOVASCULAR DISEASES AS A CONDITION OF THE ECONOMIC SECURITY OF THE STATE…….....…….62-66

Saif K. Yahya, Haiman A. Tawfiq, Yasir Saber.
STIMULATION OF B3-RECEPTOR-INDUCED CENTRAL NEUROGENIC EDEMA AND VITIATED ELECTROLYTE HOMEOSTASIS IN EXPERIMENTAL RODENT MODEL…….....……..67-70

M.A. Babakhanyan, V.A. Chavushyan, K.V. Simonyan, L.M. Ghalachyan, L.V.Darbinyan, A.G. Ghukasyan, Sh.S. Zaqaryan, L.E. Hovhannisyan.
PRODUCTIVITY AND SELENIUM ENRICHMENT OF STEVIA IN HYDROPONIC AND SOIL CULTIVATION SYSTEMS IN THE ARARAT VALLEY…….....…….71-76

Ezzuldin Yaseen Aljumaily, Ali R. Al-Khatib.
HARDNESS AND ELASTIC MODULUS ASSESSMENT FOR TWO ALIGNER MATERIALS BEFORE AND AFTER THERMOCYCLING: A COMPARATIVE STUDY…….....……77-82

Tchernev G.
NITROSOGENESIS OF CUTANEOUS MELANOMA: SIMULTANEOUSLY DEVELOPMENT OF PRIMARY CUTANEOUS THICK MELANOMA OF THE BREAST, THIN MELANOMA/ DYSPLASTIC MOLE OF THE BACK DURING PARALLEL INTAKE OF BISOPROLOL, AMLODIPINE AND VALSARTAN/ HCT: NITROSAMINE POLYCONTAMINATION IN THE MULTIMEDICATION AS THE MOST POWERFUL SKIN CANCER TRIGGER…….....…….83-88

Manish Tyagi, Uzma Noor Shah, Geetika Patel M, Varun Toshniwal, Rakesh AshokraoBhongade, Pravesh Kumar Sharma.
THE IMPACT OF SLEEP ON PHYSICAL AND MENTAL HEALTH: IMPORTANCE OF HEALTHY SLEEP HABITS….……..89-94

Musayev S.A, Gurbanov E.F.
DYNAMICS OF THE MECHANICAL FUNCTION OF THE LEFT ATRIUM IN PATIENTS WITH ISCHEMIC MITRAL VALVE REGURGITATION…….....……95-98

Abrahamovych Orest, Abrahamovych Uliana, Chemes Viktoriia, Tsyhanyk Liliya, Mariia Ferko.
INDICATORS OF BONE METABOLISM IN PATIENTS WITH RHEUMATOID ARTHRITIS WITH IMPAIRED BONE MINERAL DENSITY: CHARACTERISTICS, THEIR FEATURES AND DIAGNOSTIC VALUE…….....…….…99-104

Jagdish Kumar Arun, Ashok Kumar Singh, Shashidhar ES, Geetika M. Patel, Yogita Verma, Samir Sapcota.
THE ROLE OF IMMUNOTHERAPY IN CANCER TREATMENT: CHECKPOINT INHIBITORS, CAR-T CELLS, AND VACCINES.....105-112

L.G. Buinov, L.A. Sorokina, S.N. Proshin, N.A. Fedorov, M.N. Magradze, A.B. Shangin, S.V. Alekseev, T.V. Kot, P.A. Torkunov.
A METHOD FOR IMPROVING THE PROFESSIONAL PERFORMANCE AND RELIABILITY OF PERSONS DRIVING HIGH-SPEED VEHICLES…….....……113-116

Bhupesh Goyal, Sandeep Bishnoi, Suphiya Parveen, Devanshu Patel J, Yasmeen, Anupama Nanasaheb Tarekar.
MANAGING ARTHRITIS PAIN: MEDICATIONS AND LIFESTYLE CHANGES…….....…….117-122

Sergienko Ruslan, Vovchenko Anna, Kravchuk Lyudmila, Zinchenko Vitaliy, Ivanovska Olha.
ANALYSIS THE RESULTS OF SURGICAL TREATMENT AND EARLY REHABILITATION OF PATIENTS WITH MASSIVE TEARS THE ROTATOR CUFF THE SHOULDER…….....…123-128

Gulyaeva K.V, Fokin M.S, Kachanov D.A, Karabanova A.V, Dzhanbekova K.R, Zablotskaya P.Yu, Magomedov Sh. A, Gadzhiev M.B, Alilov A.A, Idiatullin R.M.
NEURODEGENERATION AND NMDA…….....……129-136

Dilshad Ahmad Usmani, Kavina Ganapathy, Devanshu Patel J, Anchal Saini, Jaya Gupta, Shalini Dixit.
THE ROLE OF EXERCISE IN PREVENTING CHRONIC DISEASES: CURRENT EVIDENCE AND RECOMMENDATIONS……...137-142

Tchernev G.
Controversies and paradoxes in melanoma surgery: consolidating two surgical sessions into one and sparing the sentinel lymph node- a possible guarantee of recurrence-free survival…….....……143-146

GEORGIAN MEDICAL NEWS
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THE RHEOENCEPHALOGRAPHIC STUDY OF THE INTERHEMISPHERIC ASYMMETRY OF CEREBRAL BLOOD FLOW IN HEALTHY AND MENTALLY RETARDED CHILDREN

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Abstract.

Aim: The features of functional organization of hemodynamic processes in brain basins of healthy children and children with mild mental retardation depending on the nature of asymmetry and gradient of cerebral blood filling are investigated.

Materials and methods: The study was executed in the scientific laboratory of the special and inclusive education department of the Armenian State Pedagogical University after Kh. Abovyan and Armenian State Institute of Physical Culture and Sport. The study involved children aged 8 to 11 years, a total of 131. The 73 of them were healthy school children and 58 children with a low degree of mental retardation. Each category of subjects was divided into 2 age groups: 8-9 years and 10-11 years.

Results: According to the results of the study, in the control group, 88% of the examined patients showed a hyperfrontal pattern in terms of RI (rheogramm amplitude). In seven children, the hypermastoidal pattern was observed, and in the two children of the control group, no significant differences between the RI values in the frontal and mastoidal basins were found.

Conclusion: The study involved 131 children aged 8 to 11 years old. 73 of them were healthy with normal physical and mental development as well as 58 children with a weak degree of mental retardation. The study was undertaken to determine which sport and physical activity allowed children with mental retardation.

Established that the parameter of TPWV in 8-9-year-old and 10-11-year-old schoolchildren of the control group was significantly higher than that of experimental children in the frontal, bimastoidal and hemispheric basins.

The hypermastoidal gradient pattern of IPVR was recorded in 55.2% of children in the control group, 13.8% of children have a hyperfrontal pattern, and 31% of schoolchildren lacked a reliable ($p > 0.05$) gradient of peripheral vascular resistance between the bifrontal and bimasthoidal basins, which indicates the same level of resistance of the vascular wall in the compared pools. Note that, in 8-year-old schoolchildren, only the hypermastoidal IPVR pattern was recorded. In children 9-11 years old, either the absence of a gradient was revealed, or the gradients of both signs were established. Thus, in children of 8–9 years of age, the magnitude of the gradient is positively related to the age of children ($r = 0.75$). Also with age, there is a decrease in resistance in the frontal and mastoidal basins, but to a greater extent in the frontal ones, which leads to a decrease in the gradient relative to 8-9 years old. A correlation between the brain IPVR in the frontal pool ($r = 0.54$) and age was observed in children 10–11 years old. It is possible that the fall in resistance of the vascular wall of the frontal pool in this age group ensures intensive maturation of the frontal lobes.

Key words. Hemodynamic processes in brain, method of rheoencephalography, brain interhemispheric asymmetry, mental retardation, cognitive impairment, chronic brain hypoxia.

Introduction.

To examine the functional interhemispheric asymmetry of brain blood flow in the examined groups of children, were used rheoencephalographic technique.

The paper presents the results of empirical studies of rheoencephalographic indicators of the brain of children in norm and mental retardation. The parameters of blood circulation of the brain of healthy children and children with mental retardation at the age of 8-11 years, reflecting the state of different parts of the vascular system of the brain.

We also analyzed and compared age-specific changes in the functional organization of hemodynamic processes in healthy children aged 8-11 years and children diagnosed with mental retardation and mild intellectual development.

On our opinion, in children with mental retardation, violation of the vascular tone of the brain microcirculation is a factor contributing to cognitive failure. At the same time, chronic brain hypoxia observed in mental retardation is likely to destabilize regulatory functions, leading to the disintegration of systemic brain activity.

Blood supply to the brain depends on two vascular systems, the blood flow in which is able to complement each other. At the same time, the internal carotid arteries normally provide the largest blood flow to the brain and have a direct effect on the state of cerebral circulation [1-3].

The image of cerebral circulation seems to be a dynamic mosaic with a continuously changing local blood flow in various areas, due to the redistribution of blood flow from areas less active in functional terms in areas with intense activity, with a relative constancy of the total blood flow to the brain [3-5].

Self-regulation is crucial for adequate blood supply to the brain and is characterized by the ability of the cerebral vessels to maintain a relatively unchanged volume velocity of the cerebral blood flow when perfusion pressure changes.

Between the system of carotid and vertebral arteries there is a connection aimed at maintaining adequate cerebral blood flow with decreasing in the diameter of some arteries and increasing the diameter of others, which indicates the compensatory-adaptive interdependence of these two-blood supply main routes of the brain [6-8].

Morphological asymmetry of cortical branches of paired vessels in the right and left hemispheres has been studied in a number of studies [9-11]. There are studies concerning asymmetry of morphological parameters of extracranial parts of main arteries: common carotid arteries [12,13], vertebral arteries [7,13,14]. At the same time, there is a small number of studies in which the parameters of paired vessels were compared

taking into consideration sex [7,12,13], in the dynamics of their changes in different age periods [13,15].

Currently, the literature lacks a clear understanding of the interhemispheric features of cerebral blood flow in children of primary and secondary school age with mental retardation, which indicates the relevance of further study of this issue.

The objectives of the study were to establish the features of the functional organization of hemodynamic processes depending on the nature of asymmetry and gradient of cerebral blood filling in the brain basins of healthy children and children with mild mental retardation to determine the degree of physical activity of these children [16,17].

Materials and methods.

The study was executed in the scientific laboratory of the special and inclusive education department of the Armenian State Pedagogical University after Kh.Abovyan. The study involved children aged 8 to 11 years, a total of 131. 73 of them are healthy schoolchildren and 58 children with a low degree of mental retardation. Each category of subjects was divided into 2 age groups: 8-9 years and 10-11 years.

The control group of healthy schoolchildren:

- 8-9 years old - 38 children, including 20 girls and 18 boys.
- 10-11 years old 35 children of them 17 girls and 18 boys.

Experimental group of children with mental retardation:

- 8-9 years old - 28 children, 11 of them girls and 17 boys.
- 10-11 years old 25 children, including 12 girls and 13 boys.

The selection of children in the experimental group was made on the basis of accompanying documents with an approved diagnosis of "mental retardation of a mild degree". After reviewing the results of clinical, laboratory, pedagogical and psychological examinations, family members and guardians signed a voluntary agreement for the child to participate in scientific research.

To study the functional interhemispheric asymmetry of the cerebral blood flow of the examined groups of children, the rheoencephalographic technique was used.

In recent years, rheoencephalography (REG) as a method of research of cerebral blood circulation has not lost its relevance. Comparison of the data of REG and ultrasound dopplerography (USDG) showed that REG provides more information about the functional state of the microcirculatory channel.

The physiological technique of rheoencephalography, based on the rheographic registration of cerebral blood flow in the basins of basal (basilar), internal carotid arteries, as well as transverse bi-temporal, bi-frontal and bi-occipital rheovasography, allows to assess the asymmetry of blood flow in the same areas of the brain. This method is used to a greater extent for the integral assessment of cerebral blood supply in individual vascular basins, rather than in specific brain structures.

The survey was carried out on a computerized complex "Diamant-RCSM (rheo-cardio-spiro monitor)" in a specially equipped soundproof electrophysiological laboratory. The subject had the opportunity to adapt to the conditions of the study for 5-10 minutes.

The dynamics of the REG tracked in 4 leads: frontal-mastoidal left and right hemispheres (FM L, FM R), which allows to judge the state of blood flow in the basin of the internal carotid arteries; bifrontal (FF) indicating the blood flow to the frontal regions of the cerebral hemispheres; bimastoidal (MM), reflecting the characteristics of blood flow in the vertebral-basilar basin.

The analysis of rheographic waves is carried out in 2 directions:

- evaluation of quality characteristics - interpretation of the wave shape;
- evaluation of quantitative characteristics-digital processing.

Digital analysis of the REG wave includes a quantitative assessment of a number of indicators that characterize mainly the tone and elasticity of blood vessels.

According to the literature, adults are characterized by the presence of a hyperfrontal gradient of blood flow, i.e., greater values of the amplitude of the rheographic curve and cerebral blood flow volume in the vessels of the anterior cerebral artery basin compared to the basin of the vertebrobasilar system.

The absence of hyperfrontal pattern according to volume blood flow data in children 8-9 years old and its presence only in a part of adolescents, 12-13 years old is associated with functional immaturity of frontal regions of children of 8-9 years old.

In the literature for REG-indicators the presence of gradient values is described only for rheographic index and venous outflow index, but the peculiarities of blood supply of the basin depend on other indices of the vascular channel state.

Thus, to date, the formation of blood flow gradient between frontal and mastoidal brain basins in 8–11-year-old children in norm and at UW has been insufficiently studied.

The question of the existence of blood flow gradients in smaller parts of the cerebral vascular system also remains open.

Digital analysis of cerebral blood flow in children were calculated the average values of the following parameters of rheoencephalography:

- **rheographic index (RI)**, characterizing the degree of pulse blood filling of large arteries. The rheographic index is the ratio of the amplitude of the REG wave to the value of the standard calibration signal. We used a 0.1-Ohm calibration signal. The rheographic index is estimated in relative units or fractions of Ohms.
- **indicator of peripheral vascular resistance (IPVR)**, reflecting the total lumen of small vessels.
- **venous outflow index (VOI)**, indicating the tone of medium and large veins.
- **diastolic index (DSI)**, characterizing the state of small veins.
- **time of pulse wave velocity (TPWV)**.
- **dicrotic index (DCI)**, indicating the state of the small arteries.
- **modulus of elasticity (ME)**, reflecting the elasticity of the artery wall.

The presence of cerebral blood flow asymmetry was determined by rheographic index for each child individually.

At the preliminary stage of data processing, all rheoencephalogram indices were calculated and analyzed separately for boys and girls. Correlation analysis of differences in different-sex children in the control group and the group of children with EI aged 8 to 11 years did not reveal significant differences in cerebral blood flow parameters, so in the future REG parameters of intracranial macrohemodynamics of different-sex children were analyzed together.

To assess the asymmetry of blood supply to the brain basins, we calculated the asymmetry coefficient (AC) of blood flow (by RI) of the hemispheric basins (FM-L, FM-R) for each child individually, and also individually calculated the reliability of differences between the RI of the right and left hemispheres using the formula:

CA = (RI FM-R - РИ FM-L) / (RI FM-R +RI FM-L) x 100%

According to the literature, adults are characterized by the presence of a hyperfrontal gradient of blood flow, i.e., greater values of the amplitude of the rheographic curve and cerebral blood flow volume in the vessels of the anterior cerebral artery basin compared to the basin of the vertebrobasilar system.

The absence of hyperfrontal pattern according to volume blood flow data in children 8-9 years old and its presence only in a part of adolescents, 12-13 years old is associated with functional immaturity of frontal regions of children of 8-9 years old.

In the literature for REG-indicators the presence of gradient values is described only for rheographic index and venous outflow index, but the peculiarities of blood supply of the basin depend on other indices of the vascular channel state.

Thus, to date, the formation of blood flow gradient between frontal and mastoidal brain basins in 8–11-year-old children in norm and at mental retardation has been insufficiently studied.

The problem of the existence of blood flow gradients in smaller parts of the cerebral vascular system also remains open.

Correlation analysis showed the absence of correlation between cerebral blood flow parameters of children with EI and their age, which is apparently associated with delayed maturation of brain structures in this group of children.

Results.

According to the results of the study, in the control group, 88% of the examined patients showed a hyperfrontal pattern in terms of RI (rheogramm amplitude). In seven children, the hypermastoidal pattern was observed, and in the two children of the control group, no significant differences between the RI values in the frontal and mastoidal basins were found.

Consequently, the hyperfrontal gradient of RI is already formed by the age of 8, and in the group of 10–11-year-old children the difference in blood supply to the anterior and posterior regions of the brain only increases.

The distribution of the modulus of elasticity (ME) pattern in healthy children was as follows: 56% had a hyperfrontal pattern, 31% of children had a hypermastoidal pattern, and 13% of children in the control group did not have a predominance of values of this indicator. The average value of the elastic modulus decreases with age in both basins. However, in the frontal basin this decrease is insignificant, while for the mastoidal there is a significant decrease in the ME value in the group of 10-11 years, which leads to the appearance of a reliable hyperfrontal pattern in this group ($g = 0.48$; $p < 0.05$).

In 68% of cases in healthy children, the DCI gradient had a hypermastoidal pattern, which suggests that the tone of the arteries of the small caliber of the mastoidal basin is higher than the frontal, in 11% of children it is hyperfrontal, and 21% of the children did not have significant differences in the tone of the arteries of the small caliber. Comparison of DCI values shows that in the group of 10-11-year-old children there is an unreliable increase in the index compared with the group of 8-9 years. Correlation analysis revealed the dependence of the DCI gradient on age ($r = 0.7$) in children 8–9 years old, which indicates a deepening of the gradient in this age group.

The hypermastoidal gradient pattern of IPVR was recorded in 55.2% of children in the control group, 13.8% of children have a hyperfrontal pattern, and 31% of schoolchildren lacked a reliable ($p > 0.05$) gradient of peripheral vascular resistance between the bifrontal and bimasthoidal basins, which indicates the same level of resistance of the vascular wall in the compared pools. Note that, in 8-year-old schoolchildren, only the hypermastoidal IPVR pattern was recorded. In children 9-11 years old, either the absence of a gradient was revealed, or the gradients of both signs were established. Thus, in children of 8–9 years of age, the magnitude of the gradient is positively related to the age of children ($r = 0.75$). Also with age, there is a decrease in resistance in the frontal and mastoidal basins, but to a greater extent in the frontal ones, which leads to a decrease in the gradient relative to 8-9 years old. A correlation between the brain IPVR in the frontal pool ($r = 0.54$) and age was observed in children 10–11 years old. It is possible that the fall in resistance of the vascular wall of the frontal pool in this age group ensures intensive maturation of the frontal lobes.

The DSI gradient had a hypermastoidal pattern in 79.3% of the subjects. Consequently, in most healthy children, small veins in the basal arteries basins are more toning than in the basins of the anterior arteries. 17.2% of schoolchildren of control group are characterized by a hyper-frontal pattern of DSI and 3.5% do not have a difference in the tone of the small-caliber veins of the bifrontal and bimastoidal basins. The magnitude of the DSI gradient correlates with venous outflow rates in children 8–9 years old ($r = 0.7$), and in children of the older subgroup there is no such correlation relationship ($r < 0.4$), therefore, the gradient of small veins is formed by 11 years. In 89.7% of the examined schoolchildren in the control group, the venous outflow index was higher in the mastoidal basin. At the same time, with a higher tone of the venous vessels in the frontal area, a greater tone of its arterial bed and a higher amplitude of the program were detected.

With age, a tendency to decrease in the VOI was revealed. In subjects aged 8–9 years, the magnitude of the VOI gradient positively correlates with age ($r = 0.61$). Thus, at 8–9 years of age, a high hypermastoidal gradient is characteristic of the VOI, that is, the large veins of the posterior cerebral arteries pool have a greater tone, and by the age of 10–11 this pattern is likely to be already formed. It should also be noted that the majority of children in the control group (96.6%) are characterized by a hyperfrontal gradient of TPWV, i.e., after systole TPWV to the pool of the posterior cerebral arteries less than to the frontal zones. According to the results of the research, it turned out that the pattern of ratios of indicators has age dynamics. Thus, for a group of healthy children, the gradient of parameters of rheoencephalograms characterizing the state of large arteries (RI) and veins of different caliber (VOI, DSI) is already established by the age of eight, as evidenced by the absence of further age-related changes and the prevalence of blood filling

and the degree of venous outflow in the frontal pool. The DKI gradient, which characterizes the regional differences in the tone of the small arteries, is formed in an adult type by the age of 10, which reflects the predominance of the tone of these vessels in the basins of the posterior cerebral arteries.

The ratio of the total lumen of all small vessels (IPVR gradient) at 8-11 years of age continues to form. At the same time, dynamic age-related changes are aimed at reducing resistance in the basins of the anterior cerebral arteries. The gradient of the tone of large arterial vessels (ME) is actively formed, the change of which goes in the direction of the prevalence of tone in the frontal areas. Thus, the pattern of ratios of the values of the REG indicators, that is, the ratio of the tone of the veins and arteries of different caliber, begins to take shape in childhood, providing functional maturation of the frontal brain. This process is characterized by unevenness and heterochronicity. The emerging gradients of the values of the indicators reflect changes in the regulation of the vascular bed, which are associated with an increase in the functional activity of the frontal areas and lead to an improvement in their blood supply conditions.

An analysis of the REG parameter values in children with mental retardation with different gradients of blood supply to the brain basins showed that a hyperfrontal gradient along RI was detected in 70.6% of children in the experimental group, i.e., in the experimental group, the predominance of the amplitude of the rheoencephalogramm in the frontal area is found to be 17.4% less than in the control group. The distribution of variants of the gradient ME, reflecting the tone of the arteries of large and medium caliber in the experimental group, in general, corresponds to the control group. In 47% of children in the experimental group, the tone of the small arteries in terms of the DKI index has a hypermastoidal pattern, in 32.4% it is hyperfrontal, in 20.6% of children with mental retardation, there are no significant differences in DKI between the bifrontal and bimastoidal zones.

The age dynamics of the formation of a DKI gradient between regions is not established. The prevalence of peripheral vascular resistance in the frontal or occipital areas is the same in children of the experimental group (38.25% each). At the same time, 23.5% of children made up a group without an IPVR gradient. We registered no significant age-related changes in the IPVR gradient in children of the experimental group. The predominance of the small vein tone (DSI) in the pool of the posterior cerebral arteries relative to the anterior (hypermastoidal gradient) is characterized by 44% of schoolchildren with EI, i.e., 35.3% less than the representation of this pattern in the control group, and in the frontal pool - 38 3% is also higher than in the control group by 21.1%. The absence of a gradient, DSI was recorded in 17.7% of children of the experimental group (5 times more than in children without a gradient in the control group).

In the experimental group, 50% of schoolchildren (29 people) had a hyperfrontal VOI gradient, and in the control group, only 3.1% (2 people), which is 14.5 times higher than that of healthy children. Children with hypermastoidal distribution of large veins in the experimental group 32.4%, and in the control group - 89.7%, i.e., the hypermastoidal VOI pattern in children with mental retardation occurs 2.77 times less frequently than the examined healthy schoolchildren.

The distribution of IPVR patterns among schoolchildren in the experimental group is as follows: 20.6% is a hyperfrontal gradient, 50% is hypermastoidal, 29.4% of children do not have a significant predominance of IPVR in the compared basins ($p > 0.05$).

The interdependence of different, considered by us, characteristics of cerebral blood flow in different parts of the vascular bed of the brain is confirmed by the data of correlation analysis. The mean values of such parameters of rehoencephalograms as: RI, IPVR, TPWV, VOI, DSI, DKI, ME of one basin are interconnected with the average values of this parameter of the opposite basin (bifrontal with bimastoidal basins of the cerebral hemispheres of the brain) in children of the control and experimental groups, forming the average and high positive correlation relationships ($0.55 > r < 0.96$).

A comparative analysis of the indicators of REG by age subgroups (8-9 years and 10-11 years) of the control and experimental groups showed that at 8 years of age, the RI value of the bimostoidal area was significantly lower in the control group relative to children with mental retardation ($p < 0, 05$). In children of the control group of 10–11 years, the RI value in the bifrontal region is significantly higher than in children of the experimental group due to its lowering in the children of the experimental group by 10–11 years. It was also shown that in children of the experimental group the hemispheric indices of the venous outflow were significantly higher than IVO of the left and right hemispheres relative to the children of the control group ($p < 0.05$), as well as in the frontal pool ($p < 0.05$). The value of IVO in the basin of the posterior cerebral arteries is not significantly different in children of 8-11 years of age in both groups. In addition, it was established that the parameter of TPWV in 8-9-year-old and 10-11-year-old schoolchildren of the control group was significantly higher than that of experimental children in the frontal, bimastoidal and hemispheric basins.

Conclusion.

The age range from 8 to 11 years is the time to improve the systemic activity of the brain. At this time, the active maturation of the cortex and the commissures of the brain, the specialization of the cerebral hemispheres, as well as the formation of the mechanisms of regulation of the cerebral blood flow occurs. In our work, we studied the characteristics of rheoencephalographic indices of the brain of children in normal and mental retardation. The parameters of blood circulation in the brain of healthy children and children with mental retardation at the age of 8-11 years, reflecting the state of various parts of the vascular system of the brain, were analyzed. We also analyzed and compared the age peculiarities of changes in the functional organization of hemodynamic processes of conditionally healthy children 8–11 years old and children diagnosed with mental retardation and delayed intellectual development of a mild degree in conditions of calm wakefulness.

In healthy children aged 8-9 years, there is an increase in the difference in the tone of the arteries of large, medium (ME) and small caliber. (DKI), large vein tone (VOI) and small caliber (DSI), as well as the level of peripheral vascular

resistance between the bifrontal region and the vertebra-basilar basin of the cerebral blood flow. In 10-11 years, there is a drop in vascular resistance in the frontal area. The amplitude of rheoencephalogramm does not correlate with the age of the children examined, which indicates an earlier formation of this parameter. According to the results obtained in our study the average values of the parameters of the REG by sex groups differed, but the statistical analysis using the methods of correlation by the Student's t-criterion of reliable sex differences in the parameters of cerebral blood flow in children in the control group and the group of children with delayed mental development did not reveal. On our opinion, in children with mental retardation, dysregulation of the vascular tone of the system of macrohemocirculation of the brain is a factor contributing to cognitive insufficiency. At the same time, in chronic brain hypoxia observed in mental retardation, destabilization of regulatory functions is likely to occur, leading to disintegration of the systemic activity of the brain.

The absence of asymmetry of mean linear blood flow velocity, sex differences and asymmetry of shear stress indicates that the right and left UVB, regardless of sex, retain such hemodynamic parameters of blood flow (diameter, resistance, volumetric flow velocity), which are necessary for normal blood supply of both hemispheres of the brain.

Thus, the conducted research shows that children of 8-9 years old with mild and moderate mental retardation of various etiologies, especially boys, differ from their peers by lagging behind in the development of functional brain asymmetry, which leads to less pronounced lateralization of the brain, global undifferentiation of non-verbal activity of the left hemisphere, low level of development of spatial perception, especially spatial orientation in such differentiated relations as right - left.

According to the results of our research, children with a low degree of mental retardation can be involved in sports without restrictions if they do not have physical disabilities.

In further publications we will present the results of our physiological and psychological studies of interhemispheric asymmetry and interhemispheric interaction in normal and mentally retarded children.

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