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# INTENSIVE NEUROPHYSIOLOGICAL REHABILITATION SYSTEM FOR CHILDREN WITH AUTISM

MONOGRAPH

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This monograph describes the principal modern approaches and directions for the rehabilitation of children with autism, as well as the leading clinical neurological, psychopathological, and pathopsychological symptoms of this disease. We outline the stages, methods and technologies used in rehabilitating autistic children by means of the Intensive Neurophysiological Rehabilitation System (Professor V.I. Kozyavkin's Method). We provide data on the effectiveness of this system through an assessment of its impact on children's mental development. We demonstrate that Prof. Kozyavkin's Method is a highly effective modern rehabilitation system that can be used to treat children with autism and ASD.

The monograph is intended for a wide range of specialists, namely psychiatrists, psychotherapists, neurologists, psychologists, rehabilitation specialists, speech therapists, teachers, social workers, students and graduate students of higher educational institutions with such specialties.

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# ABBREVIATIONS

INRS – Intensive Neurophysiological Rehabilitation System
CP – cerebral palsy
MTP – myofascial trigger point
FB – functional blockage
CNS – central nervous system
ICR – International Clinic of Rehabilitation
RC – Rehabilitation Centre
ASD – Autism spectrum disorders
CARS – Childhood Autism Rating Scale
ATEC – Autism Treatment Evaluation Checklist
PEP-R – Psychoeducational Profile
MDI – Major Depression Inventory
GHQ-28 – General Health Questionnaire
FQoL – Family Quality of Life Questionnaire
IAT – Internet Addiction Test
ASQ – Autism Screening Questionnaire

**Key words:** Intensive Neurophysiological Rehabilitation System (INRS), Prof. Kozyavkin's Method, childhood autism, autism spectrum disorders, rehabilitation.

# INTRODUCTION

Today, one of the most urgent medical and psychological problems is the rehabilitation of a very large group of patients – persons with autism spectrum disorders (ASD). It should be underlined that over the past ten years in Ukraine, the incidence of these disorders has tripled, and there are now more of these patients than children with type 1 diabetes, oncological diseases and AIDS. Of particular importance is the creation of modern and highly effective methods of treatment and rehabilitation for this contingent of patients. These methods should encourage maximum medical, social and psychological adaptation of patients and their families. We can confirm that one of the most significant medical and social challenges of our time is the need to create a system of interdisciplinary medical and psychosocial care for children with autism spectrum disorders.

Rehabilitation of children with autism carries great social and economic burdens, including the fact that when they become adults, these patients remain ill and have corresponding needs. According to different data, lifetime care for one patient with autism costs $3.2 million US, so for the whole contingent of patients the figure will reach $137,000,000,000 US [1].

This book describes the test results of Professor Kozyavkin's Intensive Neurophysiological Rehabilitation System (INRS) on the rehabilitation of children with autism. The rehabilitation system is based on a multimodal approach using a variety of influencing methods that complement each other and are aimed at global mobilization of compensatory mechanisms using the morphometric features of both the nervous system and the body as a whole.

Assessment of the effectiveness of INRS rehabilitation demonstrated that a significant majority of children with autism showed positive dynamics of mental ontogenetic parameters and positive development of the motor sphere of varying severity. In the process of INRS rehabilitation, the patients demonstrated a positive transformation in indicator patterns reflecting their actual mental state and levels of their communicative, intellectual, speech and emotional development. Professor Kozyavkin's INRS is an innovative rehabilitation technology that can be used for effective rehabilitation of children with autism, during which the child's neuroonthogenesis is normalized. This rehabilitation system proposes qualitative and stable improvement of children's mental development and socialization and represents, in fact, a breakthrough in traditional medical and social rehabilitation technologies.

The introduction of INRS into specialized institutions and centres opens up new rehabilitation prospects for patients with such severe chronic pathology as autism spectrum disorders.

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# Part 1. Modern Approaches to the Rehabilitation of Children with Autism

Today, autism is one of the most urgent problems in modern medicine. On the one hand, this is due to the considerable prevalence of the disease and frequently untimely and incorrect diagnoses, and on the other hand, to poor and ineffective methods of treatment and rehabilitation available in the whole panoply of medical specialists. In this regard, these patients show a high level of disability and a low level of social adaptation. Despite the fact that children's nervous systems are very flexible and have good compensatory capabilities, a favourable medical and social prognosis for their future remains questionable without introducing a modern and adequate correction of their disorders. All the mental, motor, and speech disorders in such patients necessitate not only an early diagnosis of each category of disorders, but also the simultaneous implementation of complex treatment and rehabilitation measures aimed at correcting all of these disorders.

Such patients, who are under the supervision of specialists, often receive only one type of medical care, which is usually not very effective. This is due to the fact that the disease itself, firstly, requires comprehensive diversified treatment and rehabilitation approach from the standpoint of various medical specialties in order to correct communicative dysontogenesis, and secondly, the fact that there are practically no effective methods for treating clinical manifestations of autism.

Autism is a nonspecific developmental disorder with early (up to 30 months) appearance of uncooperative behaviour, disruption of speech development with echolalia, bizarre behaviour in the form of rejection of changes in immediate surroundings, or inadequate inclination towards inanimate objects in the absence of delusions and hallucinations [[2]]. This is a disease that features qualitative disorders of reciprocal social interaction and communication, and limited, repetitive, stereotypical behaviour, interests and activities. According to K.S. Lebedinska's figurative expression: "Children hide in autism, like snails in a shell; they feel much calmer and it's more pleasant and comforting there. However, while hiding behind the autistic barrier, they are deprived of the information required for their further development" [[3], p. 95]. Most children with autism are poor at coping with tasks that require abstract thinking, using symbols, and deducing logical

sequences. On the other hand, they are good at solving problems that require manipulation of objects and visual perception of space.

Rehabilitation of children with autism is of great medical and social importance and carries a great economic burden, including the fact that when they become adults, these patients remain ill and have corresponding needs. According to different data, lifetime care for one patient with autism costs $3.2 million US, so for the whole contingent of patients the figure will reach $137,000,000,000 US [1].

Based on a study conducted by the U.S. Center for Disease Control and Prevention (CDC), the prevalence of childhood autism is estimated at one case per 88 children [4]. Modern British statistics show that over the past five years, not only has the number of children with autism increased, but there is also a 15% increase in the number of children with behavioural, emotional and social problems. The results of numerous epidemiological studies performed in Europe, North America and Asia show an average prevalence of autism spectrum disorders (ASD) of about 1% [5]. A recent study of this problem in South Korea, where young pupils were surveyed, shows that 2.64% of all the children were affected by this disease [6]. Differences in statistical data in different regions of the world are due to differences in the quality of autism diagnosis. The prevalence rate of autism does not depend on racial, ethnic and socio-economic characteristics [7]. The existing differences in statistical data on autism and ASD incidence in different regions of the world can be explained to some extent by different methodological approaches to their diagnosis [8]. There is evidence of a significant increase in the number of diagnosed cases of autism in Ukraine in recent years [9].

We should emphasize that over the past ten years in Ukraine, the incidence of this disease has tripled. Today, there are more children with autism than children with type 1 diabetes, cancer and AIDS [10]. According to official statistics of the Ministry of Health of Ukraine, the incidence of autism spectrum disorders increased by 19.4% between 2009 and 2013, from 0.55 to 1.61 per 100,000 children. In these years, the primary incidence rate has been rising steadily since 2006: 28.2% in 2007, 32% in 2008, 27.2% in 2009, 35.7% in 2010, 21.2% in 2011, and 25.3% in 2012. The incidence of autism in children has increased 2.84 times, from 17 to 48.2 per 100,000 children. Despite such a significant increase, the absolute incidence of this disease in Ukraine remains significantly lower than in the U.S. and European countries. Newly diagnosed cases accounted for 53.1% of all the cases in Zaporizhzhya, Donetsk, Lviv, Kharkiv Regions and the city of Kyiv, whereas in Volyn, Zhytomyr, Luhansk, Zakarpattya, Ternopil, Rivne, Sumy, Cherkasy, and Chernihiv Regions and the city of Sevastopol they accounted for only 13.5% of all the cases. This indicates a rapid increase in the

incidence of autism in children against a background of improved diagnosis and the introduction of modern diagnostic procedures in clinical practice [11].

Autism manifests itself in many forms; the study of autism is complex due the interrelated nature of the child's social, cognitive, speech and emotional development. Disorders of any of these functions affect the functional areas of the child's psyche. We can identify the following characteristic manifestations of autism: disorders of mental functions, poor mental activity, inconsistency, partial intellectual development, motivation deficit and inattention, apathy, lack of interest in surroundings, poor perception of information (passively absorbing it in whole blocks), withdrawal from all surrounding influences, negative reaction or even no reaction in attempts to attract the child's attention to surrounding objects, difficulty in creating symbols and transferring skills from one situation to another, rapid exhaustion and oversaturation of any purposeful activity, and difficulty in forming social and communicative functions [12].

The exceptional diversity and severity of these disorders allow us to reasonably state that the education and upbringing of children with autism is the most difficult part of correctional pedagogy. Some researches on autism show that social interaction disorders, communication problems may be attributed to limited motor skills. The development of motor abilities is critically important as children with autism "hide" their inability to do simple physical exercises. If a child refuses to play with peers, it is often not a problem related to social skills, but his/her uncertainty about his/her physical ability to play such games. An increasing number of studies indicate that motor impairments varying in both nature and severity are common in autism [13,14,15,16].

According to Bauman's description of children with autism (1992), such patients suffer from different motor impairments, namely, delayed motor development, responsibility deficit, motor clumsiness, difficulties in performing bilateral movements, hyperactivity, and stereotypic hand and arm movements [17]. These disorders become more pronounced in neurotic or stress situations [18]. According to the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition and Movement Assessment Battery for Children, children with autism show poor arm and hand coordination when performing visual motor tasks and poor leg coordination when performing balance and speed tasks [19]. Half of the examined patients demonstrate motor impairments, and fine motor performance indicators are below the average statistical norms for corresponding age categories. According to Miyahara et al. (1997), 85% of all the children with autism spectrum disorders suffer from motor discoordination and dyspraxia [20]. Combined disorders of fine motor skills and motor functions are observed in the majority of cases. However, reduced hand and arm movements and lower

amplitude in grasping/catching objects resemble the kinematic pattern of bradykinesia in Parkinson's disease [21], while hand and arm dyspraxia and responsibility deficit disorders in this category of patients resemble the clinical picture of focal frontal lobe lesions [22].

According to Mari (2003), there is a difference in the quality of grasping/catching objects displayed by persons with autism who have different IQ levels (above and below 75). Children with an IQ <75 require more time to reach the object and grasp it compared to children with autism with an IQ> 75 [23]. Even if the brain building process is regular, children with autism lag behind in writing skills in comparison with normally developing children, but there is a pronounced correlation with large motor functions, and not with the IQ level. These studies indicate that motor disorders in children with autism are observed quite often and cannot be explained solely by cognitive development delay [24].

At present, science has no clear understanding of complex etiopathogenetic mechanisms of autism. The origin of the disease is explained by adverse effects during the intrauterine period, birth trauma, vaccination, environmental degradation, and intolerance to casein, lactose, gluten (currently very popular in autism is the gluten-free diet – complete exclusion of cereals and bakery products). Siblings of children with autism often have speech development delay and mental retardation, so genetic factors play an important role. However, it is likely that preconditions for its evolution, and not autism itself, are inherited. Whether they are manifested or not depends on external circumstances, which are not the cause, but the conditions for the development of autism. That is why disorders during pregnancy and childbirth, birth trauma, asphyxia, as well as unfavourable factors in the perinatal period often precede the appearance of autism signs and symptoms.

Many areas of the brain of children with autism have been researched scientifically with diverse results. Neurological deficiency associated with autism shows a decrease in dendrite growth (Raymond, Bauman & Kemper, 1989), cerebellum disorders (Courchesne, 1989), temporal lobe lesions (Chiron, et al., 1993), reticular dysfunction (Bear, Connors, Paridiso, 2001), amygdala anomalies (Brothers, 1989, Fotheringham, 1991), limbic system dysfunction (Boucher & Warrington, 1976), enlarged brain ventricles (Bigler, 1989, Hauser, Delong & Rosman, 1975), right-sided / left-sided asymmetry (Prior & Bradshaw, 1979), lesions of the thalamus nuclei (Coleman, 1979), the hippocampus (Brazos & Goldstein, 1993) and cortical atrophy (Bigler, 1989). In addition, it is common knowledge that in autism, the prefrontal cortex, which participates in implementing responsibility functions (planning, cognitive flexibility in decision-making, activity directions, etc.), does not function normally. The integrative somatosensory

functions of the parietal cortex, responsible for somatognosis, that is, the general sense of one's own body, are disturbed. It is also common knowledge that in young children, such concepts are closely related to affective experiences and physical contact with their mothers. The lack of unified awareness (coordinated perception of multimodal sensory information) leads to the impossibility of forming integral representations in the imagination of autistic children. This evidently explains their heightened interest in details and individual properties of objects (finger fiddling in front of eyes in the light, shadow "games", love of small rectangular objects), as well as their inability to "read" signals made by surrounding people because this process requires integrative perception.

It is difficult to talk about the social niche that people with autism occupy because of the significant differences in their intellectual and speech development. There are cases when autists become successful professional scientists (T. Grandin, USA – biology professor), social activists (I. Johansson, Sweden), writers (D. Williams, Australia), etc. However, they often work in jobs that do not require constant direct communication with other people (gardeners, postal workers, music instrument technicians, airport X-ray employees, etc.). It has been recognized that autistic children, if they are well trained/educated, by virtue of their stereotypic inclination and in proportion to their intellectual abilities, will work the way they were taught, although this does not exclude a creative approach to the situation. If children with autism are properly educated and taught, they become more responsible for their work and are more easily integrated into society [25].

Early diagnosis of the disease is of utmost importance for the prognosis of cognitive development and social adaptation of children with autism. According to Lovaas [26], 47% of the children reach a more or less sufficient level of intellectual and educational functioning after two years of intensive care.

According to the results of a study by the Institute of Correctional Pedagogics of the Russian Academy of Education [27], if their work is carefully structured, 60% of autistic children can follow a normal school program, and 30% can follow a special school program; if their work is improperly structured, 75% do not adapt socially, 30% need constant tutoring, and only 2-3% achieve a satisfactory level of social adaptation.

Modern approaches to the treatment of persons with autism are extremely diverse, for example, the manual of the National Autistic Society of Great Britain – Approaches to Autism – describes more than 70 different treatments for this disease [28]. In general, there are two main spheres of treatment and rehabilitation for persons with autism: psychopharmacological and psychopedagogical, but above all things, psychocorrective [29].

Drug treatments for autism spectrum disorders, which are accompanied by pronounced cognitive impairment, include neuroleptics, antidepressants, anticonvulsants, and nootropics. However, with neuroleptics, there is a high risk of undesirable side effects, including extrapyramidal disorders and neuroleptic malignant syndrome. Nootropics, although characterized by good tolerability, can lead to increased motor disinhibition, irritability, emotional excitability, nervousness, and sleep dysfunction. The body often becomes resistant to therapy, especially in persons with severe forms of autism, which leads to higher dosage of daily medication intake. However, the anticipated effect cannot always be seen, and the side effects are often amplified. It is characteristic that such drugs have not been used for some time in other countries. In Western Europe, specialists insist that "social" influences, and not "chemical" ones, have more impact on children with autism. Therefore, medicines are recommended solely for the elimination of aggressive, autoaggressive, destructive, repetitive behaviour, high activity, inattention, comorbid depression, bipolar condition, anxiety, obsessive or compulsive disorders, and epilepsy.

Behavioural therapy for autistic children – Applied Behaviour Analysis (ABA) [30] – is one of the most relevant methods to correct children's autism. It is based on behavioural technologies and teaching methods that help specialists study the influence of environmental factors on the behaviour of children with autism, and change them, by manipulating these factors. The core of this method is imitation: in the early stages, it is mostly nonverbal, in later stages – nonverbal and verbal. The importance of imitation training lies in teaching the art of observation: children learn to observe how other children learn. ABA therapy comprises several hundred different programs, including treating autism with mental retardation, influencing general and fine motor skills, understanding language, learning names of objects and actions, and classifying objects (for example, placing cards with dog and a cat images in one pile, and cards with spoon and fork images in another). In addition, the correction of childhood autism includes programs like "Show how you ..." (child pretends to put on a hat / comb his/her hair / extinguish a fire / turn the steering wheel / meow, catch mice, etc.), learning pronouns (child correctly uses "I stand" – "you stand"), the answers to such questions as "Who?", "What?", "How?", "Where?", "When?", how to use "yes" and "no", etc. It is not important which program is more effective in treating autism because each child has his/her own individual characteristics, and should be approached individually. At the same time, there are more complicated ABA programs – "Tell me what will happen if ..." (child gives us the result of the action), "Do as… (any name of a peer), "Tell a story", "Call… (name of a peer) to play", etc. The ultimate goal of ABA therapy is to teach autistic children skills that will help them

grasp the surrounding world on their own. ABA methods are aimed at building correct behavioural responses and eliminating unwanted ones. According to the program, children should study 40 hours a week in a group consisting of several specialists and one of the parents, and a peer should sometimes be included. If behavioural therapy becomes less intense (less than 40 hours per week), there is a decline in the percentage of children who reach a good norm, both on the intellectual level and in school performance. In recent years, this method has been criticized because unnatural behavioural methods are used, some therapeutic elements cannot be transferred to the surrounding world, and adult-child cooperation is violated. The application of this method is most effective in developing controlled imitative actions at the basic level, but the program is less suitable for building the child's variative and independent behaviour.

FLOOR TIME [[31]] or DIRFloortime ("time spent on the floor"), created by Stanley Greenspan, uses a child's interests, even pathological (for example, rubbing glass for hours) to establish contact with him/her (the therapist or parent stands close by and also rubs the glass, or covers the glass, and the child has to react – start scraping the glass elsewhere, rubbing the therapist's hand, or rubbing the glass alternately with the therapist – all these reactions are beginning signs of contact). Greenspan identifies six stages of child development: interest in the world (reached in up to three months), attachment (up to five months), two-way communication (up to nine months), self-awareness (up to one and a half years), emotional ideas (up to two and a half years), and emotional thinking (up to four years).

Children with autism do not usually go through all the stages, but stop at one of them. "Play time" tasks help the child to go through all the stages. Two-way communication is achieved if the child responds to the therapist's actions. Whenever such a reaction occurs, one communication circle is closed. The therapist should ensure that the child closes as many circles as possible in the communication cycle. In this case, the therapist puts himself in the position of the child's assistant, the child leads, and the therapist follows. The child becomes more and more aware of his/her surroundings and affirms himself/herself as a separate self. The therapist does not offer new ideas in the game, but develops the ideas suggested by the child, asks questions, pretends not to understand and encourages the child to explain, that is, analyse different game situations. Thus, the child develops his/her emotional thinking. If the child stops closing the communication circle, that is, interrupts communication, only then can the therapist intervene and offer new ideas. Greenspan advises not to interrupt the child's activities, even if he/she introduces aggressive motives into the game. If children manifest themselves in this way, it helps them to dominate and manage their emotions. Greenspan believes that, in contrast to ABA, "game time" does

not require hours of training, and can be performed by parents. It is important for parents to follow a special training course. It is also recommended that a specialized supervisor advise the parents.

Relationship Development Intervention (RDI) [32] was developed in Texas, USA, by two psychologists – Steven Gutstein and Rachelle Shealy. It includes diagnostic criteria to determine the child's level and exercises designed for each level. The emphasis is on voluntary participation. Example: "My words are important." Objective: to enhance the child's attention to the conversation, teach him/her to appreciate words, teach him/her how to speak and be heard. Many children with autism do not know how to listen. They are easily distracted, and people who speak to them have to repeat themselves many times and check whether what they said was actually heard. The specialist helps the child understand that the communication process carries responsibilities for both the speaker and the listener.

Treatment and Education of Autistic and Related Communication Handicapped Children Disorders (TEACCH) applies cognitive psychology to create learning experiences [33]. The method includes training and research to help persons with autism spectrum disorders. According to supporters of the TEACCH program, efforts should be directed towards creating conditions for learning and development, and not adapting the child to the world. Significant efforts are directed towards developing non-verbal forms of communication. Speech training is considered appropriate only at IQ≥50 level and is not compulsory, nor is the teaching of educational and professional skills. At the heart of the whole program lies a clear structuring of space and time with reliance on visualization. TEACCH critics recognize that its application allows therapists to quickly achieve positive sustainable changes in their work even with very severe cases of autism. However, they note that this program does not ensure that the child reaches a sufficiently high level of adaptation to real life. Therefore, although the goal to achieve the possibility of living "independently and individually" is reached, it is carried out in limited or artificially created conditions.

Psychocorrection methods are used very often, but they have little effectiveness in scientific and evidence-based research studies. Therefore, given the insufficient effectiveness of existing rehabilitation methods, it is important to search for new therapeutic approaches to this disease. In this context, we would like to point to data presented in J. Alcantara's article on the effectiveness of a new rehabilitation method for children with autism – physical therapy [34]. Medical databases currently have up to ten scientific publications devoted to the analysis of this therapy for autism.

According to J. Alcantara, physical therapy can be considered effective in children's autism, but the sanogenetic mechanisms of this method remain practically undefined [35]. Therefore, the introduction into medical practice of new innovative highly effective technologies aimed at the rehabilitation of children with autism, including non-drug therapy, including physical therapy methods, is extremely relevant.

# Part 2. The Intensive Neurophysiological Rehabilitation System (INRS)

It is widely known that Professor V.I. Kozyavkin has developed a modern and highly effective intensive neurophysiological rehabilitation system (INRS) [36]. This is an innovative highly effective technology for treating patients with chronic psychoneurological pathology. INRS can be applied in cerebral palsy, autism, osteochondrosis, trauma consequences, and organic lesions of the nervous system. This rehabilitation system is based on a multimodal approach using a variety of synergistic methods impacting positive effects on patients.

More than 65,000 patients from 67 countries have followed rehabilitation courses using Professor Kozyavkin's Method, including 4,500 patients from Germany, 3,800 from Russia, 321 from Kuwait, 250 from Austria, 250 from Azerbaijan, 200 from Switzerland, 200 from Poland, and 85 from the USA. For the most part, patients with cerebral palsy underwent treatment, but more than 450 patients with autism spectrum disorders were also treated by means of Professor Kozyavkin's Method. *(Fig. 1.)*

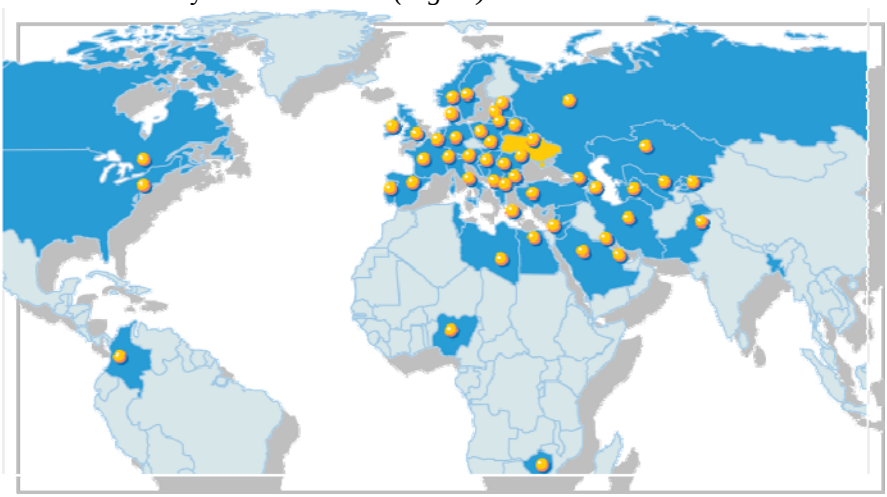

*Fig.1.* Geography of patients treated by INRS

INRS is a method to treat children with cerebral palsy (CP); it combines a variety of medical technologies and techniques that mutually complement and potentiate each other. INRS is based on a special technique of physical therapy, adapted to the needs of each child's body [37].

In the process of its creation and development, the Intensive Neurophysiological Rehabilitation System has gone through a number of evolutionary stages, moving along the path of continuous improvement.

The rehabilitation system, essentially based on biomechanical correction of the spinal column, was developed back in the eighties. The author of the system, Professor Kozyavkin, applied physical therapy methods while working with patients suffering from brain lesions and spinal pathologies. His many years of experience allowed him to discover that certain mobilization methods of the spine often made an impact on normalizing muscle tone and changing the patient's psychoemotional characteristics.

This practical experience prompted Professor Kozyavkin to apply biomechanical correction of the spine (physical therapy) to normalize muscle tone in children with different forms of cerebral palsy. However, the anatomical and physiological characteristics of a child's spinal column do not allow therapists to mechanically transfer classical manipulation methods to children. Therefore, an original technique was created and developed – the polysegmental biomechanical correction of the spine, which is more adapted to a child's body.

The first report on the effectiveness and performance of the new rehabilitation method was presented at the All-Union Scientific and Practical Conference on Child Neurology and Psychiatry in Vilnius in 1989.

The new rehabilitation technique aroused the interest of many doctors and scientists in the Soviet Union. That same year, a commission of the 18th Clinical Psychoneurological Hospital in Moscow (now the Scientific and Practical Centre for Child Psychoneurology), the leading institution of that time in the Soviet Union headed by Professor Kseniya Semenova, examined a group of patients and confirmed the effectiveness of the new rehabilitation method.

To make the INRS rehabilitation method available to a wider audience, a modern treatment and rehabilitation centre was established in 1990 in Lviv, Ukraine, where today qualified assistants provide highly skilled medical care to patients.

Information about the new rehabilitation method spread to neighbouring European countries, and the first group of patients from Germany arrived in 1991.

Positive and stable treatment results have boosted patient flow. Since 1993, groups of patients arrive regularly (twice a month) at the clinic from Germany, Austria and Switzerland via a special charter flight from Frankfurt to participate in INRS rehabilitation courses. *(Fig. 2.)*


*Fig. 2.* Arrival of the first group of patients from Germany by special charter flight

In 1993, the Cabinet of Ministers of Ukraine officially recognized the method in Ukraine, and recommended implementing it in medical and rehabilitation institutions. To expand scientific research studies and improve rehabilitation methods, the Institute of Medical Rehabilitation was founded in Truskavets, Lviv Region in 1996.

The Institute is dedicated to the study of problems related to remedial treatment of patients with organic lesions of the nervous system and spinal diseases. In their scientific and practical work, the staff cooperate closely with the Institute of Neurology, Psychiatry and Narcology of the Academy of Medical Sciences of Ukraine, the Danylo Halytsky National Medical University in Lviv, the P.L. Shupik Medical Academy of Postgraduate Education in Kyiv, the German Academy of Rehabilitation and Development, the Munich Children's Centre, the European Academy of Childhood Disability, the Karolinska Institute, and many other medical scientific and practical institutions.

The effectiveness and performance of the new rehabilitation technology contributed to the recognition of this method not only in Ukraine, but also far beyond its borders. Describing current conservative methods for treating patients with cerebral palsy in the encyclopaedia edition of Children's

Orthopaedics (1997), the famous German orthopaedist, Professor Fritz Nitard, rates the Kozyavkin Method among the top four most effective methods for treating cerebral palsy.

In 1999, a group of research authors, headed by Prof. Kozyavkin, was awarded the State Award of Ukraine in Science and Technology for outstanding achievements in research and science.

To promote advanced knowledge and studies, the Faculty of Physiotherapy, Rehabilitation and Wellness was established at the Institute for Medical Education in collaboration with the Kyiv Medical Academy of Postgraduate Education. Since 1999, about 500 Ukrainian doctors, specializing in different fields of medicine, have had the opportunity to familiarize themselves with the work and experience of Institute employees, and master diagnostic fundamentals of the Intensive Neurophysiological Rehabilitation System.

The growing flow of patients, continuous development and improvement of neurophysiological rehabilitation, as well as our foreign patients' requests for better accommodation encouraged us to create a new rehabilitation facility.

In the summer of 2003, the International Clinic of Rehabilitation was inaugurated in the resort town of Truskavets, an environmentally clean area of the Pre-Carpathian region, thus opening up great opportunities for future improvement and development of this rehabilitation method. (*Fig. 3.).*

*Fig. 3.* International Clinic of Rehabilitation

The clinic was built on the grounds of an ancient monastery, where everyone could find help, warmth and comfort. The Kozyavkin Method, officially recognized by the Government of Ukraine and in international circles, is applied in the clinic. Today, the clinic houses a branch of the Department of Medical Rehabilitation, Physiotherapy and Wellness of Kyiv's Shupik Medical Academy of Postgraduate Education, and advanced thematic programs – New Technologies in Medical Rehabilitation – are organized for doctors according to their different specialties. The Eastern European Academy of Childhood Disability has been functioning at the International Clinic of Rehabilitation since May 2010.

According to our observations, a very important component in reducing autistic symptoms is the emotional and personal sphere surrounding both patients and their parents. Therefore, the International Clinic of Rehabilitation is fully dedicated to creating a positive psychotherapeutic atmosphere. (*Fig. 4)*

*Fig. 4.* Interior of the International Clinic of Rehabilitation

We are convinced that parents and other family members can and should be invited to attend treatment courses with their children; partnership and trust must be established between families and professionals. Parents will better understand their child's condition, problems, goals and objectives, and they can learn how to better contribute to the child's development if they are included in therapeutic and educational processes. Exchanging experiences, listening to people with similar problems, and enjoying their moral support can help parents and relatives to drive away their feelings of loneliness, despair and insecurity.

Professor Kozyavkin's Method is used in the International Clinic of Rehabilitation (Truskavets), the Institute of Medical Rehabilitation (Truskavets), the Elita Rehabilitation Centre (Lviv), and the International Clinic of Medical Rehabilitation (Larnaca, Cyprus).

It is important to point out that INRS is not an alternative to existing rehabilitation methods, but it complements and significantly expands the effectiveness of existing remedial treatment methods. Created as a result of INRS, the patient's new functional state is set against a background of normalized muscle tone, restored joint mobility, improved trophism and blood circulation, and a balanced vegetative, psycho-emotional state, thus opening up entirely new opportunities for the child's development and improving the effectiveness of other rehabilitation techniques.

INRS is composed of two subsystems: intensive correction (a two-week cycle of treatment at the rehabilitation centre), and stabilization and potentiation (application of rehabilitation measures at the patient's home). The intensive correction subsystem is a complex of measures aimed at creating a new functional state in the child's body by activating internal plastic and compensatory possibilities, the ultimate goal of which is to improve the patient's lifestyle. The stabilization and potentiation subsystem includes individual tasks and rehabilitation measures that contribute to further improvement of the patient's psychomotor development.

The Intensive Rehabilitation System, developed by Prof. V.I. Kozyavkin, is based on an original technique of polysegmental biomechanical correction of the spine. It is aimed at eliminating functional blockage (FB) of vertebral motor segments and restoring normal movements of facet joints, which helps reduce nervous system dysfunction at different levels of the sensory and motor systems. Spinal correction is performed after a manual diagnosis has been carried out and all the sections of the spinal column – lumbar, thoracic, and cervical – have been successively prepared. *(Fig.5)*


*Fig. 5.* Biomechanical correction of the spine

All the blocked segments in the lumbar region are manipulated simultaneously; here, we apply our own technique – “backward rotation”. The blocked segments of the thoracic region are manipulated by applying special impulse techniques in sequence from top to bottom while the patient exhales. Correction is applied to the cervical region through complex movement patterns, which have an immediate impact on blocked segments. Impulse mobilization techniques are used if there is any blockage in the ilio-sacral joints. At the same time, the physical therapist asks the patient to perform special muscle relaxation exercises combined with a complex of other therapeutic measures: reflexology, remedial exercises, massage treatments, rhythmic gymnastics, mechanotherapy, and apitherapy.

By stimulating the compensatory capacity of the child’s body and activating brain plasticity, INRS creates a new functional state in the child’s body that opens up opportunities for faster mental and motor development.

Different therapeutic effects, which mutually complement and reinforce each other, are aimed at achieving the main goal – improving the patient’s lifestyle. *(Fig 6.)*

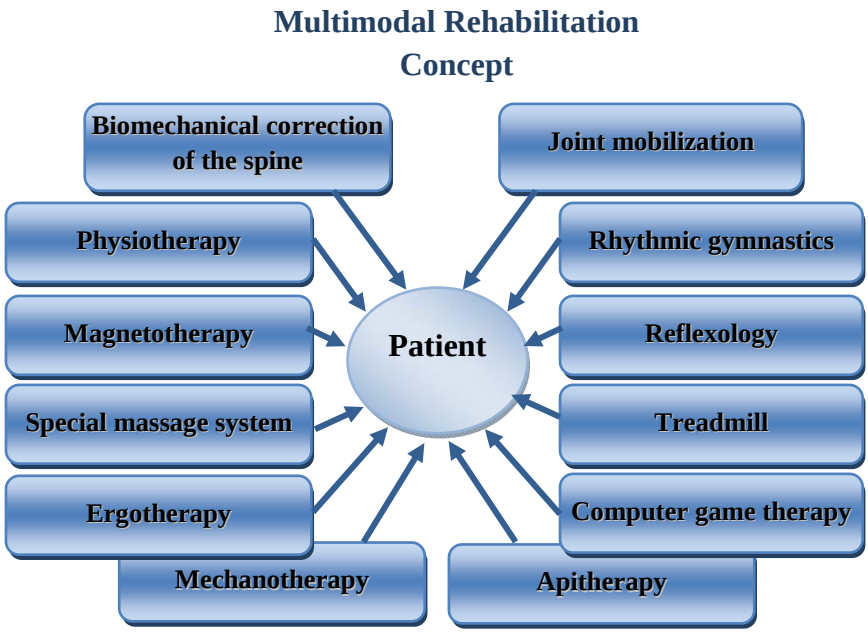


*Fig. 6.* INRS – a multimodal rehabilitation concept

Methods for mobilizing limb joints are used to restore limb mobility and correct muscular and articular imbalance, improve trophic processes, and create new conditions for forming new movements. Mobilization should begin in the large joints (hip, knee, and shoulder), and be applied further to the fine joints of the hands and feet. We use both traditional and our own mobilization techniques. Our methods are used to pull the joint smoothly beyond the physiological range of passive movements by applying pressure to the ligaments surrounding the joint. We frequently use the traction method, combined with vibrating movements, as well as impulse techniques called “tapotement” (rhythmic tapping) along the intra-articular gap, which are aimed at dewedging blocked joints and making articular surfaces return to their “central position”. Mobilization intensity is gradually increased during the treatment course. Mobilization is directed towards temporomandibular joints and combined with special massage techniques, which improves the child’s articulation. *(Fig.7)*

*Fig. 7.* Mobilization of peripheral joints

We use reflexology methods to potentiate achieved muscle relaxation, deactualize myofascial trigger points, and correct somatic and autonomic disorders. Traditional reflexology methods are applied together with our personally developed impact algorithms. Biologically active points can be influenced by using a portable electrostimulator – Pointer Excel II, which delivers low-frequency impulses of complex configuration. We also impact traditional meridian points, and specific biological points. Impacts on myofascial trigger points are performed simultaneously with isotonic or postisometric muscle tension. Procedures also include relaxing positions and postures. These procedures can be performed without damaging the skin so that the patient does not have any painful reactions. *(Fig. 8.)*

As part of the INRS rehabilitation program, we apply a special massage system in order to prepare the patient for biomechanical correction of the spine, relax spastic muscles and impact myofascial trigger points. This special system includes traditional techniques, segmental, and periosteal massage therapies, combined with elements of postisometric and anti-gravitational relaxation. By using different massage relaxation techniques, specialists can prepare the musculoskeletal system so that biomechanical correction can be effectively performed on the spinal column. (*Fig. 9.)*

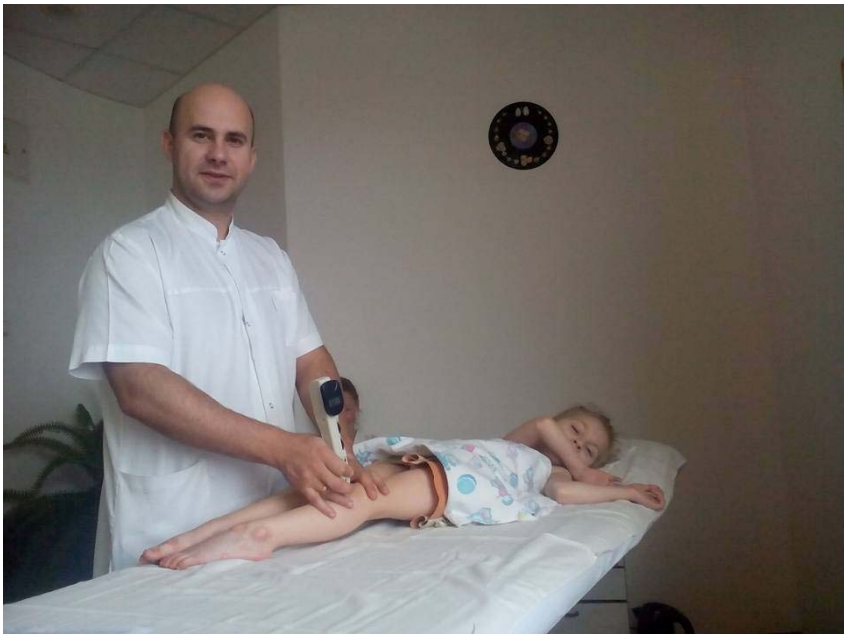

*Fig. 8.* INRS and reflexology

We use wax and paraffin applications and apitherapy – bee venom therapy – in order to stimulate the body's defences, improve local blood circulation, and activate tissue metabolism processes. Apitherapy consists in enveloping different muscle groups and joints in warm wax and paraffin wraps according to a defined pattern. In addition to having a thermal effect, these applications also have an impact on the musculo-articular system by diffusing biologically active substances through the patient's skin.

Remedial exercises are based on traditional kinesiotherapeutic principles. In children with autism, they are aimed at improving existing motor functions and forming new ones, and developing more advanced forms of movement and everyday motor skills. The main exercise is based on the principle of encouraging movements "from the midline to the periphery", starting from movements in limb and trunk joints, gradually mobilizing the distal joints, and enhancing fine motor skills. *(Fig. 10.)*

*Fig. 9.* Special massage system

The patient masters new motor skills by starting with simple movements and moving to complex ones. Thus, new mobility skills are created during this treatment course. Observing such a routine constitutes the key to success and effective rehabilitation. This is why parents are encourages to take part in such exercise sessions so that they can master the principles of individual courses with their child and then use them at home.

*Fig. 10.* INRS and therapeutic physical training

Particular attention is paid to socializing children with autism, namely integrating them into children's groups and encouraging them to cooperate with adults. We use elements of art therapy, group ergotherapy, and rhythmic gymnastics, organize children's Olympiads, theatre evenings, and drawing contests. *(Fig.11.)*

*Fig. 11.* Drawing contest

To form correct stereotypic movements, we have developed a biodynamic Spiral suit that helps correct movements. (*Fig. 12.)*

*Fig. 12.* Spiral suit

We have developed and tested several games and programs [38] for computer-based game therapy, which is an important component of Prof. Kozyavkin's Method. Patients with autism can engage in computer-based game rehabilitation both in the clinic and at home. The child's hand, trunk and foot movements coincide with the movements of the computer figure, or the patient's image is projected onto the screen, and the child becomes an active participant in the game. To balance the load that the patient must overcome during the game, the instructor chooses the appropriate level of speed and complexity. The general algorithm of these games is built in such a way as to constantly induce the patient to augment movement, increase movement speed and accuracy, and heighten concentration. During the game, the tasks become more and more complicated and require more and more refined movements. An interesting storyline motivates children with autism to perform the exercises correctly, enhances the speed and amplitude of their movements, and develops their reaction time and hand-eye coordination. Logical games are also used, whereby motor skills are combined with choosing the right object or image. Virtual reality elements are used to heighten emotional impact. An instructor is always present to monitor the computer training process.

The hand manipulator is the first in this series of devices: it is designed to improve wrist movements. Wrist movements can be trained depending on the position of the handgrip; children can train or flex/extend their hand, and also exercise their forearm in the supine/prone position. During the activity, the patient's forearm is fixed to a height-adjustable armrest. The resistance regulator is set at the required load. The first exercises should be performed with very little resistance, which increases slowly and gradually as the game progresses. *(Fig.13.)*

Two specialized games have been developed for the hand manipulator: "The Bee" and "The Cossacks". "The Bee" game focuses on exercising hand rotations to the left and right, that is pronation and supination. The actual game is based on the adventures of a bee that gathers honey from various flowers growing in a green meadow. The child uses his/her hand movements to move the bee around the field. When the bee lights on a flower, a drop of honey is added to a small bucket. As soon as the bucket is full, the bee moves on to the next game level. On all the levels, the bee encounters toadstools and bumblebees, tries to escape from them, and makes its way between falling raindrops. "The Cossacks" game focuses on exercising flexors and extensors in the hand joints. In order to guide the ship correctly, steer clear of rocky islands, and fight off enemy ships, the child should constantly extend and flex his/her hand. At the next level of the game, the child becomes a horse rider who must defeat his/her adversaries.

Each child has his/her own movement capabilities and limitations, so it is essential to define game parameters before the first training session so as to observe the entire range of the player's movements. Information on initial game parameters and result data of each game level are stored in the database, and can be used to analyze the results of all the training sessions.

Results have shown that the hand manipulator is a very effective tool in the overall complex of rehabilitation of children with autism; it contributes to improving the grasp function of the hand, augmenting active movements, and enhancing hand strength.

*Fig. 13.* Hand manipulator

The dance mat, Xbox Kinect, and Nintendo Wii are widely available; they are inexpensive tools that provide for a greater variety of physical exercises and loads compared to conventional game controllers. (*Fig. 14.)*

*Fig. 14.* Sessions on a dance mat

Computer game therapy using NINTENDO is an important part of the complex treatment system in INRS rehabilitation, and a real hit with children of different ages. We use the Nintendo Wii Board and the Wii Remote control panel. The game has a great emotional impact on children: standing on the board, they forget about their disability. They become athletes, team members who have a real chance of winning the biggest prize ever – overcoming their illness and all the difficulties of daily life not only at that moment, while they are playing, but also in their future adult life. The main benefit of this game is that it helps develop and improve their functional positions, and strengthen their sense of balance and motor control. Computer game rehabilitation enhances the child's motivation to perform required movements and physical exercises. The instructor carefully selects games and tasks, starting positions and tempo for each patient. Personalizing the process means assessing the motor condition of each patient before each training session. *(Fig.15)*

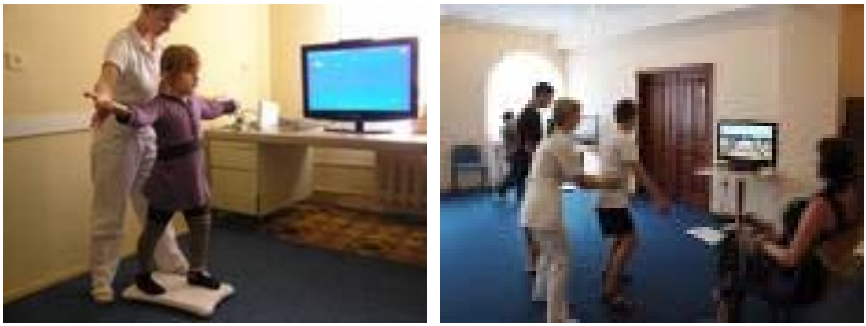

*Fig. 15.* NINTENDO computer game therapy

The dance mat is a platform with nine arrows pointing in different directions. Thanks to the Step Test, instructors can measure the child's reaction speed and concentration level. During the game, the challenge for the child is to step on the section that is displayed on the screen as quickly as possible. *(Fig.16)*


*Fig. 16.* Step Test on a dance floor mat

Stepping games are used not only to improve children's motor skills, but also to influence their cognitive abilities. In these logic games, children must choose the appropriate figure or object and click on the corresponding arrow. *(Fig.17)*


*Fig. 17.* Logic games on a dance mat

To train hand accuracy and speed, we have developed games that are controlled using the Kinect sensor. This is the latest game controller that monitors body and limb movements by analysing the video recording of a patient. It was developed by Microsoft for Xbox 360 video game consoles. The games that we have developed – “Lord of Balls”, “Animal World”, “Transport 1”, “Transport 2”, and “Apple Garden” – are operated by hand movements. Before the training session begins, instructors assess the individual calibration of each child’s hand movements and ensure that the game has been properly set. The Internet home-based play centre game is an important tool for repeated monitoring and regular training. *(Fig. 18.)*

The instructor draws up a home-based training program for the patient, which indicates recommended games, training positions, and frequency and duration of training sessions. At home, the patient or the parents adjust the computer for home use according to detailed instructions on the web page. The patient enters the training system with his/her password (http://game.reha.lviv.ua), chooses the games and starts the course. Information about the patient’s progress, as well as game duration and results are stored in the system and displayed on the page in the form of graphs. The instructor carries out remote monitoring of the patient’s training process, adjusts the home program, and gives recommendations to the patient. The home-based play centre for motor rehabilitation is a new tool for carrying out restorative treatment in home conditions.

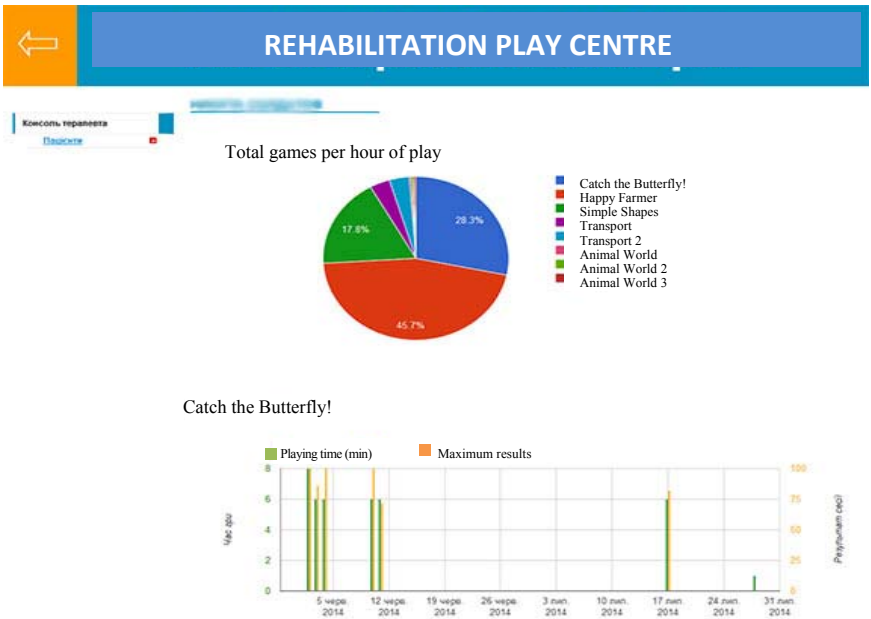


*Fig. 18.* Home-based rehabilitation play centre

It was only a matter of time before our team created a robot-assisted therapy, the study of the possibility and effectiveness using rehab-robotics for children with autism. A humanlike robot called “KineTron” made his first steps in 2013 [39]. *(Fig. 19)*

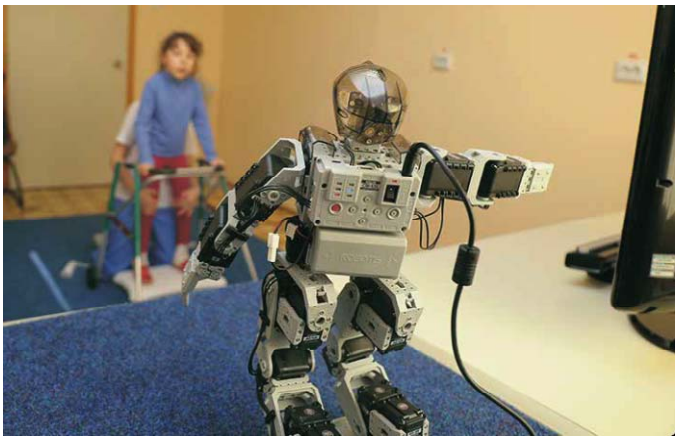

*Fig. 19.* Classes with the KineTron rehab-robot

In order to capture the interest of children with autism, we used a humanlike robot that acts as a coach, motivating and encouraging the child [40].

Parameters: height – 40 cm, weight – 1.7 kg. Types of movements: social robotics, motor rehabilitation, and motivation. The choice of movement depends on the child's inhibitory symptoms. The robot is driven by 18 servomotors (six in each leg and three in each hand), which are controlled by a microcontroller. RoboPlus software was used to organize complex movements [41].

We created nine scenarios for the robot's behaviour: three – to start the session, three – to encourage patients during the training session, and three – for the final part. For example, one of the scenarios goes like this: the music begins; the robot gets up, walks towards the patient, waves and says: "Hello, I'm KineTron, the rehab-robot. And what's your name?" As soon as the child answers, the robot says: "Nice to meet you!", and bows graciously. He offers to work with the child, adding that he will squat down and watch closely.

During the session, the instructor chooses a specific behaviour scenario for the robot by pressing the remote control button.

**Indications for INRS Rehabilitation**

1. Cerebral palsy (all forms, including spastic diplegia, double hemiplegia, hemiplegia, hemiparesis, paraparesis, atonic-astatic, mixed, hyperkinetic, etc.)
2. Autism spectrum disorders
3. Complications due to prior brain traumas, cerebral circulation disorders and neural infections during the period of residual phenomena
4. Headaches, migraines
5. Osteochondrosis, spondylosis with pronounced muscle tone syndromes, pain, motor, sensory and vascular disorders
6. Secondary vertebrogenic visceropathies (cardialgia, bronchial asthma, chronic bronchitis, dyskinesia of the gastrointestinal tract, etc.)
7. Non-inflammatory diseases of peripheral joints (arthropathy, arthrosis), but not during exacerbation of the disease
8. Scoliotic posture in children, I – II degree scoliosis
9. Diseases of the peripheral nervous system (plexitis, polyneuropathy, neuropathy of various etiologies), but not during exacerbation of the disease
10. Motor development delay in young children
11. Attention Deficit and Hyperactivity Disorder

**Contraindications**

1. Tumors of the nervous system or internal organs
2. Specific and nonspecific infectious diseases of the spine and joints (tuberculosis, brucellosis, tularemia, rheumatic diseases, osteomyelitis, severe osteoporosis)
3. Osteoporosis, spondylopathy of various etiologies (hormonal, metabolic)
4. Acute and subacute inflammatory diseases of the spinal cord and its membranes
5. Acute impairment of the spine, bones and joints
6. Condition after surgery on the spinal column (prescription up to one year)
7. Spondylolisthesis above the second degree
8. Intervertebral disc hernia with sequestration of the pulp nucleus, spinal cord compression
9. Hydrocephalus at the decompensation stage
10. Epilepsy with frequent, severe seizures and personality changes
11. Pronounced scoliotic deformities of the spine above the second degree
12. AIDS

# Part 3. Rehabilitation of Children with Autism Using Prof. Kozyavkin's Method and Assessment of its Effectiveness

### *3.1. Clinical and Anamnestic Features of Children with Autism*

More than 450 children with autism spectrum disorders have been treated with Prof. Kozyavkin's Method. 120 patients with childhood autism (F84.0) underwent complex clinical anamnestic, neurological, psychopathological and psychodiagnostic examinations *(Table 1.)* The majority of patients underwent three to four rehabilitation courses.

*Table 1.* Patient Characteristics

| Variable | Percentage (n=120) |
|---|---|
| **Country** | |
| Ukraine | 83% |
| Foreigners | 17% |
| **Assessment according to ATEC Scale** | |
| Average | 57.6 |
| Min-Max | 31-106 |
| | |
| **Age, years (starting from the first rehabilitation course)** | |
| Average (SD) | 6 years 2 months ±10 months |
| Min-Max | 3-18 |
| age<4 years | 35% |
| 4-8 years | 32% |
| 8-12 years | 19% |
| More than 12 years old | 14% |
| | |
| **Sex** | |
| Male | 76% |
| Female | 23% |

SD-standard deviation
Min-smallest variable value
Max- largest variable value

Patients with the following symptoms were diagnosed with childhood autism (F84.0): persistent and repeated difficulties in expressing themselves in society both verbally and nonverbally, namely, inadequate social communication, impairment in their ability to adapt to the listener's context or needs, difficulty in handling dialogue, difficulty in understanding phrases that require abstract interpretations, functional limitations in effective communication, social interaction, and social participation, manifestations of the disease in the early development period, and the fact that symptoms could not be attributed to another clinical diagnosis, for example, mental disorders, global developmental delay, etc.

According to detailed medical history, 19% of preterm infants had a positive result for autism compared with 5% of the general population; 9% were born earlier than 33 weeks of gestation and 3% earlier than 29 weeks of gestation. 21% of the infants born by caesarean section showed signs of autism compared with 13% of the general population. These data correlated with the low birth weight of newborns: if the infants weighed less than 2.5 kg, the risk of autism increased more than 2.5 times. Body weight of more than 4.5 kg was also a risk factor for this disease (it was double than in the general population).

17% of the pregnant mothers suffered from ARD / ARVI and hyperthermia of 37.7 degrees or more; this figure is significantly higher than the average statistical data for the general population. Two patients presented genetic studies indicating the presence of defects in the long arm of chromosomes 2 and 7. Autism spectrum disorders in siblings differed in 2% of children with autism.

The average age of marriage of parents of children with autism was 30.1 years for men and 27.2 years for women (average age of marriage for men was 25.4 years, for women 23.7 years). The average age of women who gave birth to a child with autism was 28. This means that the parents got married and gave birth to their child when they were older. Only 41% of the mothers of children with autism breastfed their infants, while this figure reached 70% for the general population.

Regurgitation is the most common type of functional disorder among newborns and children in the first year of life, and can be observed in 20-50% of the newborns. This type of pathology was recorded in 71% of the children with autism and persisted in 19% during the first year of life.

Patients with autism often manifested different neurological pathologies, in particular, pyramidal deficiency was diagnosed in 28% of the children, perinatal CNS lesions in 22%, and cerebral palsy in 8%. Electroencephalogram tests showed that 19% of the children had seizure activity, of which 9% had clinical manifestations of convulsive seizures.

The average age when children with autism learned to sit was eight months and four days compared to an average rate of six to seven months, to stand – twelve months six days compared to an average rate of ten months, to walk – 16 months compared to an average rate of twelve months. The children started walking backward at 18 months compared to an average rate of 15 months, running at 18 months (average rate of 16 months), walking up and down stairs at (average rate of 17 months), and jumping up and down on both legs at 28 months compared to an average rate of 24 months.

### *3.2. Applying Prof. Kozyavkin's Intensive Neurophysiological Rehabilitation System in Children with Autism*

18% of the patients with autism were treated once with INRS; 9% completed the treatment course twice, 11.5% – three times, 61.5% – more than three times, of which 3% more than ten times.

The INRS rehabilitation course for children with autism lasted two weeks. The average daily duration of procedures was 176 minutes per day for primary patients and 197 minutes for patients who had been assigned two or more INRS rehabilitation sessions. The total duration of these procedures depended on the inclusion of additional techniques in the second treatment course / rehabilitation course.

All the children with autism without exception were assigned a basic complex of rehabilitation technologies: biomechanical correction of the spine according to Prof. Kozyavkin's Method, remedial exercises, wax and paraffin applications, special massage systems, and reflexology. (*Table 2.*)

*Table 2.* Duration of basic procedures

| | |
|---|---|
| Biomechanical correction of the spine | 5 minutes |
| Special massage system | 60 minutes |
| Reflexology | 10-15 minutes |
| Wax and paraffin applications | 20 minutes |
| Remedial exercises | 30 minutes |

If specific indications were observed, we used light therapy (94% of the children), mechanotherapy (86%), treadmill activities (84%), joint mobilization techniques (70%), computer game therapy with virtual reality elements (82%), ergotherapy and art therapy (30%), rhythmic group

gymnastics (26%), exercises using the Spiral suit (6%), magnetotherapy (4%), and amplipulse therapy (4%).

A mandatory social integration activity was included in the system during each rehabilitation course, such as group Olympiads, theatre evenings, drawing competitions, and other group events in order to improve the child's social integration and communication. The best option is to integrate autistic children with ordinary children since it is of fundamental importance for them to communicate and interact with others.

### *3.3 Methods for Assessing the Effectiveness of INRS Rehabilitation in Children with Autism*

To assess the effectiveness of INRS rehabilitation, we used computer data analysis and ELEKS Avalon software for medical institutions, developed specially for the International Clinic for Rehabilitation, the Institute of Medical Rehabilitation, and the Elita Rehabilitation Centre.

In order to assess the effectiveness of INRS rehabilitation in patients with autism, we used clinical and psychological methods and the childhood autism rating scale (CARS), autism scoring scale (ATEC), neurological status (with muscle tone scores measured by the Ashworth Scale and goniometry), the child's psychodiagnostic profile (Raven's Progressive Matrices, the child's psycho-educational profile (PEP-R)), and mathematical statistical methods. Motor functions were monitored by video before and after each course of treatment. To assess the fine motor skills of the hands, we used the Nine Peg Test, the Block and Box Test, and dynamometry. We also used the Neuroflexor device to quantify muscle tone level.

We conducted a set of six tests to evaluate the parents' psychoemotional state: MDI (special depression description, GHQ-28 (General Health Questionnaire), Family Relationship Analysis, FQoL (Family Quality of Life Survey), IAT (Internet Addiction Test), and ASQ (Autism Spectrum Quotient).

To analyze the data, we used ELEKS Avalon Administrator 1.0.0.122 software for medical institutions, developed specially for the International Clinic of Rehabilitation (Truskavets), the Institute of Medical Rehabilitation (Truskavets), and the Elita Rehabilitation Centre (Lviv).

We used IBM SPSS Statistics 22.0, Microsoft Excel 2010, and StatBase version 2.5.4 for statistical processing, and non-parametric evaluation criteria, namely Mana-Whitney for statistical processing of quantitative indicators. Descriptive statistics included a median and a quadratic variation. Statistically significant differences between the indicators were calculated with the probability of null hypothesis being less than 5% (<0.05).

Studies were carried out in accordance with CONSORT 2010 and STARD international requirements (Standards for Reporting of Diagnostic Accuracy Studies, version January 2003, updated in 2015).

The parents / guardians of each patient with autism were asked to submit a handwritten consent for INRS rehabilitation and other relevant studies.

The CARS Scale (Childhood Autism Rating Scale) helps define childhood autism, determines autism severity by scores, and compares them during a specific period. [42] Assessment was carried out in 15 subscales: relations with other persons, imitation ability, emotional and perceptual processes, motor agility, ability to use objects appropriately, adaptation ability, impaired visual perception, taste, olfactory, and tactile perception, anxious reactions and fears, verbal and non-verbal communication, overall activity level, cognitive activity development and consistency, and the clinician's general impressions.

Bernard Rimland's Autism Treatment Evaluation Score (ATEC) is designed to assess the effectiveness of all autism treatment methods using scale measurements in four areas: speech/communication, sociability, sensory/cognition awareness, health/ physical development/ behaviour [43].

Raven's Progressive Matrices is a non-verbal test designed to determine the intellectual development of children from 4.5 years to 11 years [44].

The Psychoeducational Profile-Revised (PEP-R) Test for children from six months to seven years is one of the most important international methods for assessing a child's psychomotor abilities and behavioural disorders [45]. In addition, the test is flexible and does not require sequential tasks for diagnostic purposes, which corresponds to the mental characteristics of childhood autism. The test has two scales: development that covers seven spheres (imitation, perception, fine motor skills, general motor skills, visual and motor coordination, cognitive functions, communication, active speech) and behaviour that covers four spheres (contact and emotional reactions, playing games and expressing interest in objects, incentive reaction, and language/speech). The test finishes with the creation of a profile, which enables practitioners to determine the child's particular mental function.

Dynamometry of each upper limb was performed with a Sammon Jamar Hydraulic Hand Dynamometer used twice in each hand with an interval of 30 seconds.

The Block and Box Test is a simple, reliable and valid test for measuring manual dexterity, and is widely used by physical rehabilitation therapists and ergotherapists [46]. It allows practitioners to see how many wooden blocks the patient can move with his right and left hand from one section of the box to another in one minute. One section of the box contains 150 wooden blocks measuring one inch (2.5 cm). The instructor gives the order, and the child starts transferring the blocks from one section of the box to another as

quickly as possible. First, the dominant hand is observed, and then the second hand is measured in the same way. The instructor records the number of blocks that the child has transferred with each hand.

The Nine Peg Test [47] is designed to determine manipulative hand dexterity. It consists of nine pegs and a platform with nine holes where the child has to insert these pegs. The test allows the practitioner to see how much time the patient requires to place all the pegs in the appropriate holes.

Distal muscle tone deficiencies of the hands were explored with a Neuroflexor device [48], which was developed jointly by the Karolinska Institute and the University of Uppsala (Sweden). Non-neural components, which are due to inertia, elasticity and wrist flexion also appear in passive movement structures together with the neural component [49]. Spasticity is usually measured by passive joint flexion and extension, simultaneous assessment of resistance to movement in accordance with either the Tardieu or Ashworth Scale, although recently the reliability and credibility of these methods have been questioned in many studies. Another problem is that the Ashworth Scale assesses only total resistance to movement and does not allow for separation of neural and non-neural tonicity components. The Neuroflexor device allows us to evaluate and differentiate the neural component of spasticity (real spasticity) from the components of viscosity (friction of muscle fibers at movement start) and elasticity (ability of muscles to stretch to maximum length) [50].

From the family's point of view, dysfunction or illness of a family member affects the other members since the family itself functions as a single whole [51]. To determine the characteristics of the parents' psychoemotional state, the following tests were used:

The Major Depression Inventory (MDI) determines a person's mood, in this case the parents of a child with autism, using a set of special tests [52]. This description was created by the WHO Mental Health Centre. An important criterion in MDI is measuring parental depression severity in general and for a short period of time (two weeks), which allows specialists to assess both the general level of depression and the level of parental satisfaction with the child's actions, his/her awareness, sleep, etc., which ultimately affects parental feelings and emotions. The assessment scale attributes 0 to 50 points: the higher the score, the lower the mood, and the more severe the depression component.

The General Health Questionnaire (GHQ-28) [53] was developed by David Goldberg in 1972. It is designed to diagnose a person's psychological well-being and emotional stability. We used it to test the current psychological state of parents of children with autism. GHQ-28 includes four subscales: A – somatic symptoms, B – anxiety and insomnia, C – social dysfunction, and D – depression. Responses are assessed according to a four-

point system: 0 – <not at all>, 1 – <no more than usual>, 2 – <rather more than usual>, and 3 – <much more than usual>. High scores (characterizes the pole of mental discomfort) correspond to affirmative responses that reveal a state of psychological ill-being, emotional instability, while negative responses show positive emotions and psychological stability (reverse order assessment). The questionnaire allows specialists to assess the level of overall health, as well as the severity of somatic symptoms, anxiety, social dysfunction and depression. It takes about five minutes to fill out the questionnaire. Higher scores indicate higher levels of psychological distress.

The Family Relationship Analysis developed by E.G. Eidemiller and V.V. Yustitskis [54] enables specialists to identify the dominant type of parenting that parents use in rearing their child. Information is collected on eleven scales that reflect disruption in the upbringing process: hyperprotection, hypoprotection, deprivation, ignoring the child's needs, excessive demands/obligations imposed by the parents, insufficient demands/obligations imposed by the parents, repeated prohibitions, inadequate demands/prohibitions imposed by the parents, strict sanctions (punishments) for disobedience, minimal sanctions, and unstable parenting style.

The Family QoL Survey (FQOLS-2006) [55] assesses the quality of life of families living with children affected by developmental disability and dysfunction. The survey has a five-point scale in nine main domains (health, finances, family relations, support (others), support (subservience), values, career, leisure and relaxation, and friendship.

### *3.4 Effectiveness of Rehabilitation of Childhood Autism Using INRS*

The results of comprehensive studies conducted before and after INRS rehabilitation showed that 68% of the children improved significantly, 21% moderately/slightly, and 11% demonstrated no positive or negative dynamics.

After an INRS treatment course, 98 ± 10% of the patients with autism showed lower muscle tone in the distal lower limbs, and 94 ± 9% were able to augment their active and passive movements. 41 ± 6% of the patients improved their fine motor motility, which contributed to better self-care skills in 24 ± 5% of the children.

Before the start of treatment, 43% of the children with autism suffered from spasticity in the distal upper limbs, namely, wrist and forearm extensors – level 1 on the Ashworth Scale. It is important to note that muscle spasticity in this category of patients is not dominant in their clinical picture, but underlies different sensory and motor disorders. The latter can be divided

into primary (stereotype motor model, synkinesia, impaired movement coordination, pathological sensory afferentation, loss of functional independence, increased energy expenditure for muscle function), and secondary (joint contractures that lead to poor self-care and personal hygiene). Myotendinoses, myofibrosis with development of secondary muscle pain, and functional joint blockage gradually appear as a result of tonicity disorders, and the limbs stop growing, which leads to vegetative and trophic dysfunction [56]. We used the Neuroflexor device to quantify the level of hypertension in hand extensors of patients with autism, who had higher muscle tone in the distal upper limbs, which allowed us to perform careful qualitative and quantitative processing of the results. The neural spasticity component was 6.3 ± 2.5 points against a norm of 0-3 points, the elastic component – 3.1 ± 1.0 points against a norm of 0-3 points, and the tensile component – 0.9 ± 0.2 against a norm of up to one point. After the rehabilitation course, the neural component of spasticity decreased to 3.3 ± 1.9 points, that is, hypertension in the hand extensors was reduced.

During INRS rehabilitation treatment, the children's motor potential increased significantly. New major motor functions were formed in 34% of the patients: 6% of the children started jumping up and down on one leg, 4% were able to stand/rise without assistance from a lying position, 4% of children started jumping on both legs, 4% of the children could walk without assistance, and 2% could sit without assistance *(Fig.20).*

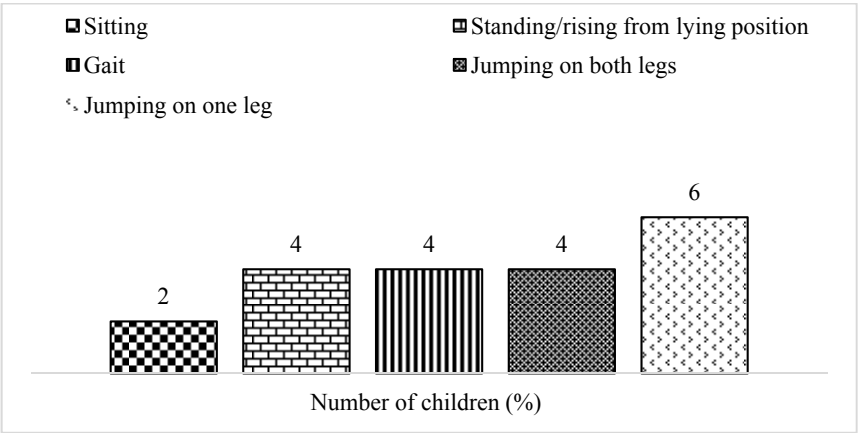


*Fig. 20.* Formation of new motor functions in patients with autism using INRS rehabilitation (%)

We measured all the children's hand strength with a carpal dynamometer. The study showed that their upper limbs were weaker: the average score was 20 ± 13 kg for the right hand and 19 ± 12 kg for the left hand against an average norm of 30.2 ± 4.7 kg and 28.5 ± 4.8 kg for corresponding age categories. After INRS rehabilitation, the carpal dynamometry index showed 25 ± 15 kg for the right hand and 22 ± 15 kg for the left hand, that is, strength increased in both hands: by 25 ± 5% in the right hand and 16 ± 4% in the left hand.

According to the results of the Block and Box Test, the indicator was 27.7 ± 5.2 blocks for the right hand and 26.3 ± 5.1 for the left hand against an average norm of 34 ± 6 and 31 ± 5 for this age category. The speed of transfer of the blocks from one section of the box to the other decreased. After INRS rehabilitation, the following improvements were observed: 32.4 ± 5.7 blocks or by 17 ± 4% for the right hand, and to 32.2 ± 5.6 blocks or 20 ± 4% for the left hand.

Before the Nine Peg Test, the average time spent on arranging the pegs with the right hand was 31 ± 7 seconds and with the left hand 33 ± 7 seconds at a rate of 25 ± 5 and 26 ± 5 seconds, respectively, which points to fine motor disorders and dyspraxia in childhood autism. After the rehabilitation course, children with autism needed 24 ± 5 seconds to arrange the pegs with their right hand (able to place the pegs faster by 29 ± 5%). Similar changes were observed in the left hand – 27 ± 5 seconds (improved by 22 ± 4%). *(Table 3.)*

*Table 3.* Changes after tests – Block and Box Test and Nine Peg Test – involving fine motor skills using dynamometry

| Test | Before treatment – on the right | After treatment – on the right | Change (%) | Before treatment – on the left | After treatment – on the left | Change (%) |
|---|---|---|---|---|---|---|
| Dynamometry | 20±13 | 25±15 | 25±5* | 19±12 | 22±15 | 16±4 |
| Block and Box Test | 27.7±5.2 | 32.4±5.7 | 17±4 | 26.3±5.1 | 32.2±5.6 | 20±4 |
| Nine Peg Test | 31±7 | 24±5 | 29±5* | 33±7 | 27±5 | 22±4* |

Note: * – difference in figures < 0.05

Before INRS treatment, psycho-speech development delay was observed in 89 ± 9% of the children. 18 ± 5% of the children showed fewer signs of psycho-speech development delay after the first treatment session, and 63 ± 8% of the children after repeated treatment (<0.05).

This group of patients has various complex communication disorders, so, behaviour disorders were observed in 97 ± 10% of the children before actual rehabilitation. After the completion of repeated courses of treatment, such sociability disorders disappeared in 46 ± 7% of the children, while in 54 ± 7% of the children the signs were preserved, but their manifestations were less intense (<0.01).

Attention deficit was observed in 96 ± 10% of the patients with autism before rehabilitation. We noted a significant improvement in active attention in 23 ± 5% of the children after one INRS session, and in 44 ± 7% after repeat INRS sessions (<0.05).

There was positive dynamics in speech functions: 14 ± 4% of the patients began pronouncing new sounds, syllables – 12 ± 4%, words – 10 ± 4%, 9 ± 3% started using phrases, and 6 ± 2% started making suggestions. *(Fig 22.)* Reverse speech was better understood in 39 ± 6% of the children; speech tempo improved in 30 ± 6% of the children; dyslalia became less pronounced in 25 ± 5% of the children.

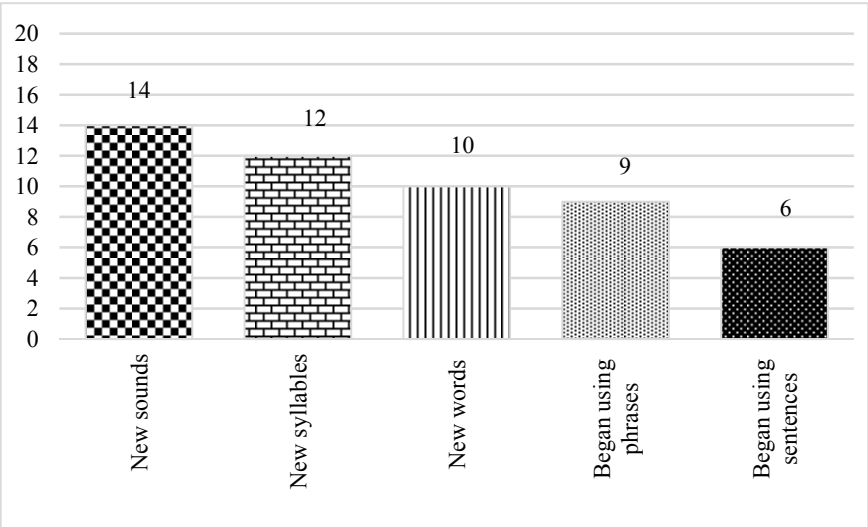


*Fig. 22.* Formation of new speech functions in patients with autism after INRS rehabilitation (%)

After repeated INRS rehabilitation, we noted that 55 ± 7% of the patients used new speech functions and their language was more developed. Distinct phrasal language appeared in 14.2 ± 3.9% of the children who had communicated previously in single words and in 6.2 ± 2.4% of the patients who had pronounced only sounds / syllables. *(Table 4.)*

*Table 4.* Indicator dynamics of speech functions in patients with autism.

| Effectiveness of rehabilitation measures | After first rehabilitation course | After final rehabilitation course |
|---|---|---|
| No improvement / deterioration | - | - |
| Improvement (expressiveness, speech tempo, more diverse voice and sound reactions) | 64% | 32% |
| Significant improvement (new language functions, following stage of speech development) | 34% | 52% |
| Stable improvement / recovery | 2% | 16% |

Before INRS rehabilitation, the average score on the ATEC Scale was 66.83 points, which indicates that the children suffered from pronounced disorders of communication, speech functions, sociability, and behavioural response. After the rehabilitation course, this indicator decreased to 57.6 points, that is, there was positive indicator dynamics. According to the scale as a whole, 89% of the children showed improvement in their psychoemotional state. The greatest changes were noted in language (17.0 points before rehabilitation and 14.6 points after), sociability (15.9 points and 12.2 points, respectively), and behaviour (22.2 and 18.1 points, respectively). *(Fig.23.)*

In assessing childhood autism according to the CARS Scale (during INRS rehabilitation), we noted that 61.3% of children showed marked or significant improvement, 29% – slight improvement or mild / moderate manifestations, and in 9.7% % of the children, their mental state remained without significant changes and manifestations of autism remained. CARS dynamics did not indicate deterioration in one child's condition. The final assessment of overall CARS dynamics demonstrated significant positive changes in the reduction of autistic symptomatology in 90.3% of the children

who had undergone regular INRS treatment. In the comparison group, positive changes were observed in 48.9% of the children; one child also showed no signs of deterioration.

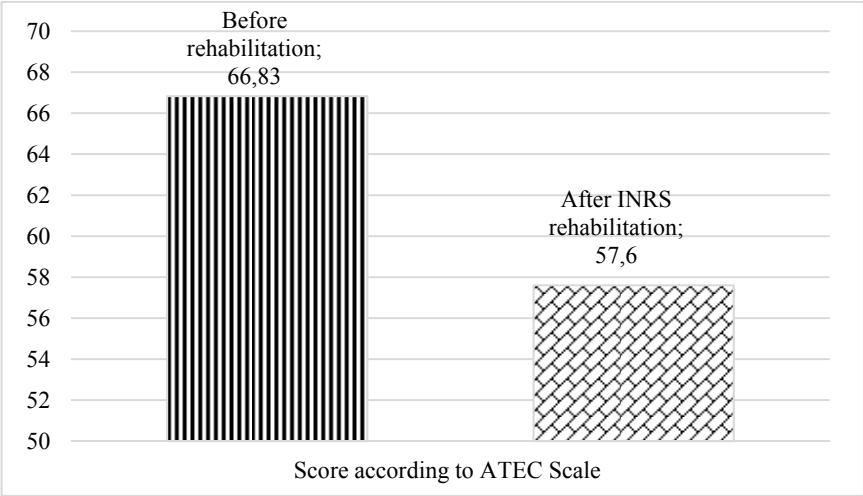


*Fig. 23.* Change dynamics in scores on ATEC Test before and after INRS rehabilitation

Before INRS rehabilitation, it took children with autism 54.4 months to assimilate stereotypic patterns of behaviour according to PEP-R assessment. After INRS rehabilitation, this duration decreased by 10.1 (36.9%) months (<0.05). The greatest variations were observed in general and minor motor skills, cognitive functions, games and interest in objects, and language.

According to Raven's Test, 39 ± 6% of the patients with autism appeared intellectually defective (V zone), 35.5 ± 6.0% were extremely defective (IV zone), and 22 ± 5% had average intellectual development (III zone). Only 3.5 ± 2.0% of the examined children showed good intellectual functioning (II zone); there were no cases of high-level intellectual development in these children. Our results on children's intellectual capabilities were basically consistent with clinical and psychopathological data of these children and confirmed most of them. They convincingly showed that cognitive impairment in childhood autism is one of the most important and frequent syndromes in the clinical picture of this disease.

When analyzing the results of dynamic studies on children's intellectual development by means of Raven's Test, after the first rehabilitation course we noted that there were positive changes in the level of the children's

intellectual productivity. Dynamics of intellectual indicators in various clinical groups of children with autism was unidirectional. The most pronounced positive changes in intellectual development occurred in patients with low parameters (after rehabilitation treatment 30.5 ± 5.5% of the children remained in the intellectually defective zone compared with 39 ± 6% before the start of treatment, in the borderline zone state – 25.5 ± 5.0% compared with 35.5 ± 6.0% before treatment). After repeated courses of treatment, the number of children with normal development of intelligence reached 73 ± 8% (before treatment – 25.5 ± 5.0%, <0.01), 4 ± 2% of children with high intelligence development (I zone). After repeated rehabilitation courses, the number of patients with mental defect (V zone) decreased from 39 ± 6% to 14 ± 4% (<0.05). *(Table 5.)*

*Table 5.* Breakdown of patients with autism according to intellectual development zones (Raven's Test)

| Intellectual development zone | Number of affected children (in %) | | |
|---|---|---|---|
| | Before treatment | After first treatment | Final treatment |
| I zone (high-level) | - | - | 4±2 |
| II zone (satisfactory level):<br>II +<br>II –<br>Total: | <br>3.5±2.0<br>-<br>3.5±2.0 | <br>2.5±2<br>12±3<br>14.5±4.0* | <br>23±5<br>11±3<br>34±6** |
| III zone (average level):<br>II +<br>III –<br>Total: | <br>9±3<br>13±4<br>22±5 | <br>16±4<br>11.5±3.0<br>27.5±5.0 | <br>18±4<br>17±4<br>35±6 |
| IV zone (borderline level):<br>IV +<br>IV-<br>Total: | <br>16.5±4.0<br>19±4<br>35.5±6.0 | <br>12±3<br>13.5±4.0<br>25.5±5* | <br>8±3<br>5±2<br>13±4** |
| V zone (mental defect) | 39±6 | 30.5±5.5 | 14±4** |

Note: * – difference in figures before and after the rehabilitation course (<0.05) ** – Difference in figures between the first and final course (<0.05)

We should also talk about sleep disorders separately; according to detailed medical histories, they occur in 91% of patients with autism. Sleep disorders include reduction of sleep duration, reduction of sleep depth, disturbed sleep, difficulty falling asleep, general anxiety, and crying during sleep. According to parental surveys, sleep duration averaged nine hours and thirty minutes. After a two-week INRS rehabilitation course, average sleep duration rose to ten hours and thirty minutes; there was also lower incidence of crying during sleep.

In conclusion, we observed positive dynamics in motor development indicators after INRS rehabilitation of children with autism, namely, improvement of fine motor motility, and formation of new motor functions. During the rehabilitation course, we noted better communication skills, improved sociability, longer sleep duration, fewer autistic symptoms, and enhanced cognitive performance. Rehabilitation also resulted in positive dynamics of speech functions: better understanding, faster speech tempo, fewer manifestations of dyslalia, and especially significant – higher levels of speech development.

### *3.5. Emotional Features and Quality of Life among Parents of Children with Autism*

Prolonged emotional stress experienced by parents of children with autism leads to particular personality features, such as heightened sensitivity and anxiety, self-doubt, and internal self-contradictions. Such an emotional state in combination with anxiety and self-doubt adversely affects the child's emotional and personal development.

Social surveys among parents of autistic children on the quality and timely examination, diagnosis, systemic medical, psychological and pedagogical assistance do not always correspond to the realities of life. Faced with this disease, the family may be isolated due to misunderstanding or rejection by society. An important component for helping such parents is interaction between them and correctional educators, psychologists, and speech therapists that can provide the family with appropriate assistance.

The International Clinic of Rehabilitation was founded on the grounds of an ancient monastery, where everyone could find help, warmth and comfort. According to our observations, the emotional and personal sphere of both patients and their parents plays a very important role in reducing autistic signs and symptoms. Therefore, our goal is to create a positive psychotherapeutic atmosphere during the rehabilitation sessions at the clinic.

We are convinced that parents and other family members can and should be invited to attend rehabilitation courses with their children; partnership and trust must be established between families and professionals, and a permanent therapeutic alliance should be formed.

According to our observations, the emotional and personal sphere of both patients and their parents plays a very important role in reducing autistic signs and symptoms. Therefore, our goal is to create a positive psychotherapeutic atmosphere during the rehabilitation sessions at the International Clinic of Rehabilitation. *(Fig.24)*

*Fig. 24.* Meeting with patients and their parents

Parents will better understand their child's condition, problems, goals and objectives, and they can learn how to better contribute to the child's development if they are included in therapeutic and educational processes. Exchanging experiences, listening to people with similar problems, and enjoying their moral support can help parents and relatives to drive away their feelings of loneliness, despair and insecurity.

During our work with childhood autism, it is important for our teams to support and encourage interaction between parents and their child. First, it is essential to understand how to work with parents, their attitude to the child's rehabilitation, and what methods they use to enhance motivation and create a positive rehabilitation environment.

We analyzed data collected after conducting surveys of parents and the Major Depression Inventory (MDI), according to which the average level of depression was recorded at 24, which reflects the presence of different

depressive emotions. After the child had completed rehabilitation at the clinic, the average score was 21, which indicates an improvement in parental feelings and a better mood after a stay at the International Clinic of Rehabilitation (> 0.05). The highest positive dynamics was observed in the following sectors: “Better Sleep”, “Guilt and Remorse”, and “Strength and Energy”. *(Fig. 25.)*

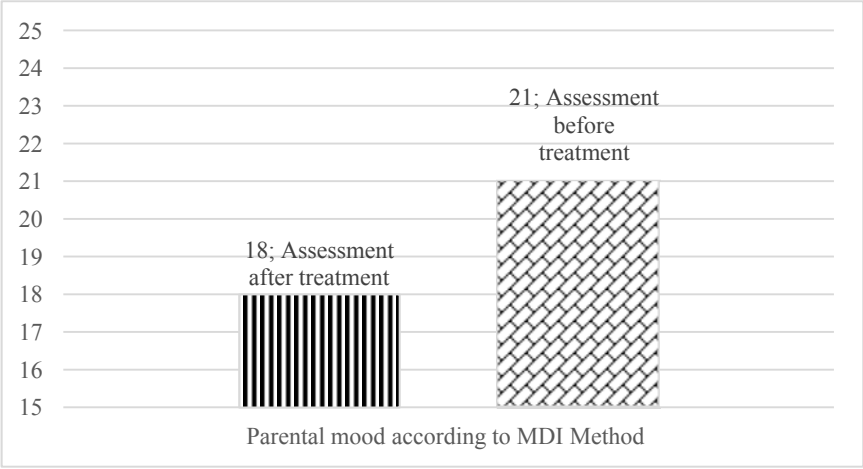


*Fig. 25.* Assessment of parental mood using the MDI Method (points)

According to the General Health Questionnaire (GHQ-28), the average parental score was ten points (against a norm of up to four), which indicates that parents experience deep anxiety, depression, and social dysfunction. After a stay at the ICR, this indicator dropped to eight points, which indicates an improvement in the psychological state of parents of children with autism (> 0.05).

Based on data analysis from the Family Relationship Analysis, five main personal problems were identified among the parents: expansion of the sphere of parental feelings, parental educational insecurity, underdeveloped parental feelings, projection of their own undesirable qualities on the child, and conflict between spouses regarding education.

According to the Family Quality Questionnaire (FQOLS-2006), the average score was 3.4 points (highest possible score: five points), which indicates lower quality of life among parents of children with autism. After the rehabilitation course, the index improved slightly, namely to 3.7 points

(>0.05). More often than not, positive changes, if any, were observed in "Support" and "Leisure and Relaxation". These results point to persistent parental dissatisfaction with their health, financial status, family relations, and holidays.

In conclusion, parents of children with autism managed to improve the level of social adaptation, self-confidence, and reduce depression and feelings of anxiety.

# CONCLUSION

The monograph is dedicated to the assessment of effective application and use of Prof. Kozyavkin's Intensive Neurophysiological Rehabilitation System (INRS) in order to improve rehabilitation of children with autism. This rehabilitation system is based on a multimodal approach using a variety of influencing methods that complement each other and are aimed at global mobilization of compensatory mechanisms using the morphometric features of both the nervous system and the body as a whole.

The results of our studies definitely point to positive dynamics of motor development indices after INRS rehabilitation of children with autism, namely: reduced muscle tone in the distal lower limbs, amplified active and passive movements, better hand motility, and new motor functions. During rehabilitation, we observed general improvement in the children's communicative skills and their sociability, fewer autistic symptoms, better cognitive performance, while the number of children with standard levels of intellectual development increased significantly. Rehabilitation also resulted in positive dynamics of speech functions: better understanding, faster speech tempo, fewer manifestations of dyslalia, and especially significant – higher levels of speech development. In general, 68% of the children showed significant improvement during INRS rehabilitation, 21% – moderate / slight improvement, and 11% demonstrated no positive or negative dynamics.

Given the above data, it can be concluded that INRS is a modern rehabilitation technology that can be used for effective rehabilitation of childhood autism because during the treatment course, children's motor, communicative, intellectual and speech functions are normalized. INRS influences brain neuroplasticity and, launching a cascade of complex sanogenetic processes, contributes to restoring the child's normal neuronontogenetic processes. The introduction of such a rehabilitation system will contribute to social and psychological adaptation and integration of children with autism.

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# INTENSIVE NEUROPHYSIOLOGICAL REHABILITATION SYSTEM FOR CHILDREN WITH AUTISM

MONOGRAPH

*(Англійською мовою)*

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