

Assumptions and applications of physical therapy in autism

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ABSTRACT

Background: The theory of mind (ToM), defined as the ability to recognize differences between and identifying one's mental states, is currently believed to be a crucial condition concerning human body development. The lack of ToM capabilities indicates cognitive and developmental disturbances that may occur in autism, when primarily neurological and somatic impairments, along with social deficits, manifest themselves in a variety of deformities in posture and movement disorders. When taking into account the view of the Yale School of Medicine of autistic spectrum as related to Pervasive Developmental Disorder, not other specified (PDD-NOS), which symptoms refer in some cases to atypical autism, while in others, do not meet the autistic features, one can be aware of the challenges in the undertaken process of therapy with autistic patients, that complementarily includes physical rehabilitation.

Objective: To reveal successive proceedings of the short and long term goals prescribed to Kabat-Kaiser's PNF and Souchart's global posture re-education in case of autistic individuals.

Methods: Analysis of the world recognized scientists' works devoted to autism key facts considering the expected efficacy of treatment with autism spectrum disorder (ASD) patients that has been based upon the inclusion criteria for medical and social case study.

Results: The currently recognized methods of rehabilitation that have the roots in the classic conceptions of Frenkel and Lovet, meet the demands to implement the therapeutic tasks in autism.

Conclusion: The physical therapy in autism aimed at diminishing the multilevel postural and movement disabilities constitutes one of the pillars of the caregivers' team combatting the ASD severities.

Key words: theory of mind, autism spectrum disorders, PDD-NOS patients, atypical behaviours, rehabilitation methods

Introduction

Autism [1-2] has over a century-old history. Eugen Bleuler first used this term in reference to a symptom of schizophrenia in 1911 [3]. The interests into autism lead to the rise of several, still evolving, theories modelling autistic persons' thinking and social interactions. They help in understanding different mechanisms behind autism, as well as forming a more precise description of its course [4]. However, the currently distinguished processes of a pathogenic nature cannot be currently considered as the solely etiological causes of the disorder. Hence, autism still causes a huge, both social and medical, challenge for the professionals who serve autistic persons in the best way they can. In this sense, the autism specialists from the fields of medicine, social relationships, education, pedagogy, and relevant therapies, including physiotherapy look through the perspectives of their knowledge and practice at an individual under the care and confront the assumptions with the real expectations concerning an autistic child undergoing a treatment. On the one hand, they should effectively conduct the necessary treatment, while they must respect the will of autistic individuals who might not be prone to participate in the therapeutic sessions [5]. In order to delineate the characteristics of rehabilitation in autism the sections are devoted first to the description of autism and leading theories in the field, as well as the atypical behaviours accompanying the process of physical therapy. Ultimately, the nature of conducting movement treatment [6] in this work is presented in accordance with the inclusion criteria for medical and social case study aimed at autism spectrum disorder (ASD).

Facts concerning autism in light of the insights presented by the authorities

Autism can be defined as “a neurodevelopmental disorder characterized by deficits in social reciprocity and communication and by the presence of restricted and repetitive behaviours and/or interests” [7]. Catherin Lord [8] lists the following as autism key facts – it is diagnosed based on behaviour, lacks adequate tests or markers, affects boys four times as often as girls, develops syndromes before the age of two and influences a family's life. According to her those characteristics form contemporary approaches and challenges in autism spectrum disorders (ASD) that currently have been formalized in Diagnostic and Statistical Manual of Mental Disorders – 5th edition (DSM-5) dated on 2013 [9-10]. The preceding diagnostic concepts of autism [11] were in sequence: reports by Leo Kanner who emphasized “insistence of sameness” apparent difference from schizophrenia in 1940's, DSM-1 and DSM-2 in 1970's which still revealed autism as linked to childhood schizophrenia, DSM-3 and DSM-3-R in 1980's that included autism into a new class of childhood disorders, ICD-10 and DSM-4 in early 1990's of which main assumptions considered the aspects of syndrome change, but with an exclusion of cases referred to infants and very young children.

According to Leo Kanner [12] the definition of autism, originally introduced in psychiatry, did not account for the status of the patients examined by him at the Johns Hopkins Hospital in the 1940's, where he worked in the Children's Psychiatric Service. He described his patients in 1943 as “so concerned with the external world “that they watched “with tense alertness to make sure that their surroundings remain static, that the totality of an experience was reiterated with its constituent details, often in full photographic and phonic identity”. Kanner, who as a precursor of implementing the description regarded to the infantile autism entity in medicine, indicated in the quoted work the need for the decisive distinction between autism in children and schizophrenia contrary to the view (based on the atypical children behaviour and its intrinsic determinants' observations carried out by psychiatrists), which even until the 1960's seemed to be firmly maintained and commonly accepted in the medical surroundings. Persuading his rights, the author appeals briefly to the history of infantile autism divided into three consecutive phases. The first phase concerned the 1940's, when

the earliest theses addressing the issue were not published for several years, despite investigations conducted at the Johns Hopkins Hospital. Exceptions being two articles by Kanner on the problems of nosology and psychodynamics of early infantile autism, first in 1946 and next in 1949 [13-14], that had been printed. In the 1950's during the second phase, the number of the articles devoted to autism syndrome had increased to 52 and the first standpoints in Europe of D. Arn van Krevelen [15] (warning against the prevailing abuse of the diagnosis of autism) and E. Stern [16] arose in Holland and France. At that time, Clemens Benda [17], who analysed among others mental retardation, included in his book on developmental disorders of mentation and cerebral palsies a chapter on an autistic child and questioned the correctness of treating autism as a part of the schizophrenic syndrome complex, rather than a separate entity. The third phase running through 1960's characterized itself by identifying autism as a unique and complex entity. Kanner, had, based on his strict analysis of schizophrenia symptoms, ruled of the views regarding autism relation to schizophrenia, but pointed to the fact that "nosological allocation of infantile autism has continued to be a matter of puzzlement" [12, p. 414].

Gil Eyal et al. [18], the contemporary authors of the book devoted to 'the matrix of autism', notice autism to have become highly visible. Furthermore, the fact of the rising number of autism cases yields a question about their nature. Is autism an epidemic of the modern age or has it been around, but we realised its magnitude only now thanks to better diagnostic criteria and greater awareness of the problem. Answering this issue, they analyse the history of the disorder termed as autism going back to its origin from the beginning of the last century (Bleuer's definition). Then, through 1940's, when Leo Kanner in 1943 [19] and Hans Asperger in 1944 [20] chose independently the same term to describe the children they examined – 'autistic' upon observations they made of medical in case of former and educational (pedagogical) nature in the case of the latter. The recalled earlier in this text van Krevelen [15] who appreciates the inputs of Kanner and Asperger to the development of the nosology encompassing autistic children states that because Kanner's publications [21-24], in opposite to Asperger's works [25-27], were well known internationally this fact might be the reason of "the erroneous impression that Asperger's autistic psychopathology refers to analogous cases described by Kanner". He persuades that the clinical autistic pictures drawn by the two pioneers differ considerably. According to him, quoting for this argumentation his earlier insight dated yet to 1962, Kanner described psychotic process characterized by a course, while Asperger revealed autistic psychopathology in terms of static traits exposing the patient's abnormal personality with less sensitivity, but more rationality. Two standpoints of those authors have enabled the further development of the branch of professional knowledge dedicated to autism in both medical and educational fields. Consequently, these developments led to building a care model where autistic children are attended by therapeutic teams consisting of a physician, psychiatrist, nurse, speech therapist, pedagogue, physical therapist and physical educator when autistic mentees are under education at schools. In the following decades, ending the last century and beginning of the current one, the process of the deinstitutionalization of mental retardation took place [28-32]. As the result of this process, different categories of atypical children were identified leading to the creation of autistic spectrum disorder description and social awareness of the need for special education.

ASD being placed in the DSM-5 classified group of neurodevelopmental disorders has incorporated for that time three entities: Asperger disorder, Heller's syndrome and pervasive developmental disorder not otherwise specified (PDD-NOS). ASD diagnostic criteria – of which two are necessary to diagnose the spectrum - may be as follows: persistent deficits in multidimensional social communication and interaction, stereotyped behavioural patterns, interests or activities, the presence of spectrum symptoms in the early developmental period, clinically

significant impairment in basic areas of current functioning, inability of better explanation the disturbances by intellectual disability or developmental delay, which frequently co-occurred with ASD, and the presence of the comorbid catatonia. These diagnostic criteria are important factors in conducting autism therapy. Hence, it seems worthy to have briefly a closer look at Asperger's syndrome and PDD-NOS praxis. For instance, in the opinion of Lorna Wing [33], there is no known treatment that has any effect on the basic impairments underlying this syndrome, but handicaps can be diminished by appropriate management and education. In her view education enables to develop special interests and competences needed sufficiently to allow independence in adult life. Since, no one can indicate the type of school that is particularly suitable for those with Asperger syndrome, for some of them depending on the diagnosis stated, schools for normal children will perform well. While for others the best solution will be attending classes in schools for various kinds of handicaps. In both cases, educational progress depends on the severity of the concrete child's impairments as well as the understanding and skill of the teacher. Among many Asperger's syndrome features (such as speech and non-verbal communication, social interaction, repetitive activities, resistance to change skills and interests) clumsy and ill-coordinated motor coordination reveal itself in bad postures and gait patterns. As Wing highlights, there are also other items of the syndrome identified, that had not been recorded by Asperger, but currently are of big significance in therapies ordered to children [33]. Those atypical syndromes, being according to William Mandy et al. [34] currently characterized by a triad of behavioural features: (1) impairments in social interaction; (2) impairments in communication and (3) repetitive and stereo-typed behaviour (RSB), are just classified as pervasive developmental disorder—not otherwise specified (PDD-NOS). They will be more precisely described in the running sections of the article.

Theoretical explanations of the essence of autism

Defined as the ability of attributing mental states to oneself and others and understanding the differences of their various insights, the theory of mind (ToM) is currently believed to be the crucial condition concerning human body development [35]. The lack of ToM capabilities indicates the cognitive and developmental disturbances that may occur in case of autism, when primarily the neurological and somatic impairments, along the social deficits, manifest themselves in the variety of the posture's deformities and movement disorders. Norbert Wiley [36] as a sociologist reminds that although cognitive science has been investigating the theory of mind for several decades in his research field, which considers inward and outward conditions of human relations in society, the theory has been neglected. The theory - perceived as the way people can identify and understand their own and the others' mental states, and identified by Nicholas Humphrey [37] in his first papers on this topic from the early 1970s - had not yet expired its previous evolving stands such as "theory theory", "the simulation theory" and "the phenomenological approach". The sociologist proposes another - the "pragmatist stance" founding it on the reflexivity, role-taking, dialogue and interaction concepts. As he persuades, contemporary phenomenologists (A. Schutz, S. Gallagher) have admittedly shown the theory in distinct social interaction in terms of particular people's gestures, bodily movements, intonations, facial attitudes and speech, but the viewed approach underlying mind openness did not fully explain the depth and accuracy of mind reading. Thus, the proposed pragmatist stand enables a wider perception of the matter. Two of four pragmatic characteristics prescribed to the theory, such as reflexivity (the notion of introspection expressed by self-awareness or self-observation) and interaction (in the quoted view of Erving Goffman [38] connected with role-taking as a kind of reality, seem to play the significant role in solving the situations often met in autism, also those of the therapeutic character. According to Baris Korkmaz [39] ToM capabilities are attained at around 3rd–4th year of age in the children with normally progressing

development, although their first stages appear at approximately 18th month of life. He further refers to among others Robert Blair's [40] and Christoph Teufel [41] and his co-authors' works to show the theory's precursors views. For them the described theory constitutes a more complex cognitive ability to someone's empathy directed solely at the emotional-reaction categories appropriate to another person's mental state. In his opinion, human awareness treated as a feature that can enable one to distinguish his/her own mental state from those of other persons ("grasping the other person's perspective") has been presented in the recent studies as an interactive bidirectional relationship between the neural mechanisms supporting sensory processing of social information and the system of theory of mind.

Among the precursors who combined autistic behaviours with these theoretical assumptions, Simon Baron-Cohen notices in one of his works - concerning the issue - 'Theory of mind and autism: a review' [42] that "Flavell and colleagues [43-44] (...) found that children from about the age of 4 years old normally are able to distinguish between appearance and reality, (...) they can talk about objects which have misleading appearances", while "Children with autism (...) tend to commit errors of realism, (...) do not capture the object's dual identity in their spontaneous descriptions". The author sums up his reason: "Given that to do this requires being able to simultaneously keep track of what an object looks like, versus what it actually is – how you perceive or think about it subjectively, versus how it is objectively (...)". In his opinion, it additionally affirms the clue that in case of autism there is a deficit in the development of a theory of mind. However, taking into consideration the variety of the whole problem, the author also states, "that other alternative interpretations of the deficit described are possible, since this task relies on quite complex language skills" (p. 6). In the analysed perspective, the lack of ToM capabilities may indicate the cognitive and developmental disturbances occurring also in autism, when first the neurological and somatic impairments, along the social deficits, manifest themselves in the variety of the posture deformities and movement disorders. In case of the PDD-NOS, the complete language skills' deficits are very often noted or they are strictly connected with echolalia and Tourette's. Although communication is prior to speech, those symptoms make it in this case more complicated to conduct a therapy, since care-givers - in order to choose the correct action - are first expected to read and interpret properly the signals sent by their patients. Baron-Cohen proposes another theory strictly connected with ASD: the empathizing–systemizing (E-S) theory. In its light, the social and communication difficulties in autism and Asperger syndrome tend to be explained by taking into account delays and deficits in empathy, "while explaining the areas of strength by reference to intact or even superior skill in systemizing" [45, p. 71], which is the drive to analyse or construct systems. In other words, an individual uncovers the patterns of a system through iterating observations that are of his/her significant interest. As the author of the E-S theory persuades, it is giving rise to novel interventions, "in particular using the strong systemizing to teach empathy presenting emotions in an autism-friendly format" (p. 72).

Other authors [46] state that the theory of mind is perceived in light of someone's ability to understand what the others around feel. In this sense, it develops the thinking abilities following the adopted intrinsic norms. In turn, connected with this category empathy is described, as ascertaining of what an individual feels, based on the ability to imagine own feelings in a given situation. The cited earlier Shaun Gallagher [47] has just proposed his own concept relating this problem named as interaction theory, because of the lack in ToM, in his view, the complex approach to an individual with autism that should encompass not only the analysis on mind deficits and the probable etiologic factors, but include both inner and outer interactions with the persons from their closest surroundings, based on atypical behaviours of children with autism in each possible situation. As he writes (p. 205): "Primary intersubjectivity can be specified in more detail. Although these aspects of

infant behaviour are sometimes considered to be precursors of theory of mind (...), they support more immediate, less theoretical (nonmentalistic) mode of interaction.” He added: “If the mechanisms of primary intersubjectivity (...) are sufficient to enable the child to recognize dyadic relations between the other and the self, or between the other and the world, something more is added to this in secondary intersubjectivity” (p., 207). Thus, Gallagher’s [47] interaction theory of intersubjectivity includes two distinct elements: primary intersubjectivity (“embodied, sensory-motor (...) capabilities that enable us to perceive the intentions of others (...)” and secondary intersubjectivity (“embodied, perceptual, and action capabilities that enable us to understand others in the pragmatically contextualized situations of everyday life (...)” (p. 209). According to the author, the proposed concept allows to develop a more adequate explanation of autism compared to the remaining ones. He persuades it is evidenced that long before the problems in mentalizing (ability to comprehend mental states in oneself and others) in autistic subjects are, due to ToM’ assumptions, seen, the problems that affect the more basic intersubjective interaction characterized in primary and secondary intersubjectivity are noticed due to the interaction theory. The arguments stated for the rational attitude to autism in light of own proposed theory inclines Gallagher to treat autism as a neurophenomenological account based on its sensory-motor and central coherence problems.

The mentioned authors’ concepts on autism may have practical use in the process of physical rehabilitation dedicated to persons with autistic lesions. Those theories allow to better understand by therapists the motives of atypical activities initiated by the children during the treatment course. Baron-Cohen’s [45] idea may be very helpful for physiotherapy practitioners in those moments of their work with autistic persons when they must come into communication with them in order to successfully start and conduct the ordered treatment. That author’s main thoughts help them to find out the correct strategy before undertaking adequate curing actions. Gallagher’s theoretical point of view on autism gives physiotherapy practitioners useful tools when they are factually engaged in the treatment movement and face the critical moments which are required to be battled to complete the therapeutic one or more sessions. The theoretical approach of Gallagher enables physiotherapy practitioners to accurately read and interpret the erratic motor behavior of autistic persons considering both motor lesions they manifest, as well as social messages they simultaneously sent. Nevertheless, the atypical activities of autistic children ought to be also seen as answers addressed to their caregivers, in which they are trying to expose the disagreement of the forms of care they just met in the session.

Atypical behaviours’ examples regarding autistic persons

“An access to communication” decides about the cooperation and achievements of the prescribed therapies in case of providing ASD children with care. Connie Kasari [48] promotes peer interactions as one of the useful techniques solving the communication difficulties, mainly in school programmes dedicated to pupils. Her proposal may be also implemented in therapies with autistic children offered in clinical wards. Michael Powers [49-50] highlights the fact that persons with ASD present varying degrees of ability and functional impairment. The treatment procedures can be adjusted, among others, to the changing patients’ profiles and depend on developmental and behavioural level, cognitive and communication status, as well as on their family, educational and social environment needs. He exposed that individualized life-long therapy in autism requires therapists to assess precisely their mentees’ health, functional, somatic, motor and cognitive status for the appropriate course of curing. Mentioned in this text Korkmaz [39] informs about the authors analyzing ToM’s precursors and pointing at one of its development core stages during which it reveals itself in averted gaze. The opposite, encountered in normal cases, direct gaze is the basis for

referential gaze perception and communication. Children, according to this opinion, distinguish direct and averted gaze motion at a younger age, but cannot consciously judge direct gaze and certain effects before the age of three or four. Making an eye contact, which is performed from an early age during first year of human life, is the most powerful mode of establishing communicative abilities [51]. As they notice individuals with autism have difficulties with many forms of social communication, because of their gaze processing impaired at various levels: eye contact, or joint attention. Shared attention, presented for the first time by three months' infants, relates to intentional focus of two individuals on an object. In nine and eighteen months' babies, it becomes a mechanism of crucial importance for their further social development. Pointing, normally reached out at nine-fourteen months is an apt example of gesture preceding the communication abilities that enables the later appearance of conventional gesticulation. Furthermore, in the view of ToM development it is highly assessed and associated with human growth processes. ASD developmental delays inhibit establishing joint attention in children.

Grace Baranek et al. [52] accent understanding, assessing and treating sensory and motor issues in autism. They represent the view that sensory and motor systems of a human organism ought to be treated as a functional entity, but in analysing the issue each of those fields is taken by them separately into account. In the first case, the unusual sensory features (e.g. tactile signals, a highly-developed sense of smell) are not considered to be universal in autism. Nonetheless, those attributes appear to be highly prevalent, early emerging, and contributory to differential diagnosis and intervention planning. The authors inform that Greenspan and Wieder's research from 1997 reports hyperresponsiveness, hyporesponsiveness and mixed patterns recorded in clinical autism cases of pre-schoolers. In the second case, motor deficits may be met in autistic children in terms of specific praxis (skills' attainment in inventive ways) and movements' coordination difficulties. On the basis of the cited data, ASD children present strengths in repetitive gross motor skills (i.e. stair climbing), having at the same time difficulties in complex skills (in which imitation of movements is needed). Other motor abnormalities distinguished are stereotyped movements becoming more apparent during the preschool period. They are difficult to separate out in autism in first years of life, since normally developing children manifest movements' rhythmization in the early stages. The remaining motor lesions in autism cover a variety of involuntary idiopathic or medication-induced movements, rare in younger children, but present in the older. Those deficits may co-occur with functional movements, involve body parts, are difficult to differentiate from voluntary movements and classified as tics, catatonia, dyskinesia, akathisia, bradykinesia and gait/posture abnormalities. The latter, mostly visible in PDD-NOS patients, are the result of fixed changes in the tissues structure, such as muscle stiffness that requires the use of therapeutic stretching techniques. Maria Forycka [53] quotes Muriel Lezak et al. [54] views on neuropsychological assessment related to the importance of cognitive functions for managing human behaviours. According to Ian Robertson and Jaap Murre [55], the authors cited in her work, human brain plasticity that expresses itself by brain self-healing has favourable conditions in every running process of learning. Cognitive functions are a basis for human behaviours: undertaking the treatment movement by patients allows to keep or improve their motor functions and when initiating the mechanism of feedback (the afferent inputs from the environment dealing via the nervous tracks with the appropriate brain's cortex area cause the efferent demands sent by the brain to adapt to the changing outside conditions) [56] it succours the process referring to human neuroplasticity. Alvaro Pascual-Leone et al. [57] highlight both the positive role of brain cortical plasticity in human development, and its pathogenic function in ASD cases. Brain plasticity – perceived as an intrinsic human property present across the age-span - can be conceptualized as nature's invention to overcome limitations of the genome and adapt to a rapidly changing environment [58]. Its mechanisms may vary with age and its efficacy for each

individual declines throughout the age-span dependently on variable genetic, biological, and environmental factors. Mistimed plasticity may represent the proximal pathogenic cause of neurodevelopmental and neurodegenerative disorders, such as autism spectrum disorders or dementia. These authors claim that the opportunities to lessen the impairments over the period of development by the use of relevant treatment are key for the therapy.

Cases of PDD-NOS with its multilevel symptoms ranging from atypical autism in some cases to other erratic deficits suggest the scale of challenges while undertaking therapeutic treatment. In case of the adults diagnosed with the developmental disorders, an initiating step is focusing their attention and making contact combined with aware bilateral interactions [46]. Those mechanisms are shaped in the first periods of human life: healthy infant combines sensory and motor systems through an affect in the way that his/her sensations have both physical and affective features [59]. The capacity of creating connections between the physical and emotional sensations targeted at motor behaviours allows a growing baby to begin perceiving and ordering the concrete schemes, first single that subsequently are merged into the bigger ones [60]. Around the age of two the schemes conduct to building in a child the sense of awareness of himself. When the factors of different origin (i.e. biological) impact on the initially emerging connections between a child sensory system and an affect, then the presented action is not strongly linked to affective sensations, what finally results in demonstrating by involved infants the erratic behaviours. For those children, it is difficult to initiate a reciprocating communication scheme, or participate in it, unlike the correctly developing children who are able to master the next levels of the achieved earlier intellectual and emotional skills. The occurrence of aggressive behaviours including self-aggressive forms – caused by developmental disorders - particularly while entering puberty by autistic children may be combined with the risk of accidents relative to the children and persons from their nearest surroundings. Significantly important, appropriate communication with the autistic children preventing of unexpected and undesired, vigorous and harmful behaviours, like for instance jerks, pinches, scratches, kicks or biting, enables the therapists to start and continue the treatment procedures effectively. Using by therapists the manual techniques in order to stretch stiff tissues in joints in PDD-NOS patients with posture deformities requires continuous communication, before and during performing the procedures. While manipulating, clinicians must remember about keeping a safe physical distance from their patients to protect both sides against injuries being a result of the rapid emotional auto-aggressive and aggressive actions unexpectedly undertaken by a patient [9-10]. Another feasible kind of behaviours of the persons with atypical autism met, when conducting treatment, relates to unanticipated bowel movements or urinating. Even though they have been earlier judged as self-reliant in hygienic activities, they may rarely do or do not signal such problems at all. In this case, therapists ought to be duly prepared to react, e. g. by carrying with themselves the necessary hygienic aid package.

While realizing the therapeutic procedures during the session, therapists should attentively observe and anticipate the erratic behaviours of their mentees, listen to the verbal communicates when submitted, notice their mimicries and expressed by them gestures informing about the problem. Care-givers should not ignore the signals sent by patients, since disregarding them may prove too costly for both sides of this relationship. Solving the above situations in a pedagogical way, clinicians ought to patiently allow the child to attain the aims in his/her own pace, despite the procedures had been earlier adopted by them to their patients' abilities.

Recommendations for physical therapy in autism

Michelle O'Reilly et al. [61] undertake in their work the problem of utilising discourse (DA) and conversation analyses (CA) as useful methodologies that may effectively support therapies in autism. The authors are convinced that the growth of this research field founded on mostly practitioners' contributions indicates that those fastidious and socially oriented findings "can underpin novel approaches for assessment, intervention, identifying therapeutic progress, reflective practice, and training". According to them such work is potentially relevant to therapists taking care of individuals with ASD. The efficiency of rehabilitation had been approved in case of mild cognitive disorders [53].

Physiotherapists should bear in mind the issues from the paragraph above that are constantly present in physical therapy with PDD-NOS persons. The ways of the successive proceedings of the stated long and short term goals of physical rehabilitation in autism should suit the individual needs of the patient and give the clear perspective for achieving good treatment results. Andrew Guccione and co-authors [62] following T. Williams view state that the ultimate objective of any rehabilitation programme concerns returning the individual to as normal and full lifestyle as possible or, alternatively to maintain or to maximize remaining function. The quoted opinion clearly matches the rehabilitation strategies dedicated to the different stages of autism. For instance, both in Asperger syndrome and PDD-NOS, being placed in autism scale spectrum on the opposite points, the therapy procedures are firstly concentrated only on the distant goal revealed above. Thus, in the different autism pictures the concrete movement treatment steps corresponding in fact to the immediate rehabilitation goals may differ from each other depending on patients' somatic, motoric, cognitive and emotional deficits. In PDD-NOS patients' psychological assessment of their developmental age counted at around three-four deviates significantly from their mature biological age and physiological-somatic capabilities and very often the varying disorders' symptoms of neurological and somatic nature are at the same time associated with the presented by them current health status.

The professional therapists' experiences and solid knowledge are required in their work with autistic patients. Thus, the guidelines in the rehabilitation process encompass: (1) predicting possible patients' achievements respectively to the medical diagnosis and therapeutic assessment, in conjunction with the other specialists' evaluation; (2) defining clearly long and short term goals of the therapy; (3) preparing the programme of the movement treatment appropriately to the assessed deficits in patients; (4) realizing the therapy in practice due to the current capabilities of patients; (5) monitoring the effects obtained by patients in each stage of the conducted therapeutic process. Predicted achievements should include improving the patients' functional status (gait abilities, manipulating with objects) combined with diminishing the neuro-motor deficits in posture deformities that concern the different areas of a body such as cervical, thoracic and lumbar spine, scoliosis, pectus excavatum, pectus carinatum and others. The specification of long and short-term goals oriented at improving muscles function reflects the decision on which groups are primarily involved into the treatment: from a wide perspective well-functioning of a human body is the principal, while in a narrow sense, the handicapped tissue structures ought to be under the movement treatment. Individualized therapeutic assessment, programme and procedures for ASD persons should be adjusted to varying neuromotor, somatic, mental and functional degrees of disabilities. A choice of the appropriate treatment techniques depends on their usefulness in the therapy. The classic rehabilitation methods for autistic persons represent the usual solid knowledge foundations. However, variable motor abnormalities require a novel and more complex approach. For this reason, Heinrich Frenkel's [63] and Robert Lovett's [64] concepts, Herman Kabat's [65]

and his successors' PNF proposal [66] as well as the new idea of Phillippe Souchart's [67] of global postural re-education should be recommended in rehabilitation with ASD patients.

Frenkel's physical therapy system from 1902 consists of: (1) describing the practice of movements learnt on behalf of physiological mechanism; (2) accenting the role of knowledge on human muscles' coordination resulting from properly functioning of the central nervous system; (3) presenting the ways how to provide effectively the movement therapy, when the movement practice mechanism is generally known [68]. Frenkel stated this pioneering idea of using exercise while providing the curing process in the neurological disturbances, determined conditions and instructions linked with the movement treatment indicating simultaneously the need of the appropriate place and apparatus for exercise. He classified the treatment exercises and proposed practising them alone and in groups in different positions, also during walking (in the various tempo and forms: forward, sideways, backwards). The systematics, principles and ways of practised exercises had been based on the clinical premises and the author's work experiences. Moreover, he exposed the necessity of the treatment of the muscles of the eyeball, practising of breathing exercises, as well as instructing the patient to empty his bladder in regular intervals, a plan which invariably succeeds during the stages of disease. The use of Fernkel exercises is, in light of the current clinical studies, beneficial to gross motor skills [69] of autistic patients.

Lovett's concept concentrates on keeping a good posture, analyses the issues of scoliosis and puts a strong accent on evaluating muscles' strength [64]. A commonly used method of evaluating the efficacy of movement abilities in physiotherapy is Lovett's scale constructed in the second decade of the last century. In 1917, Lovett devoted his work to the treatment targeting at the time American population of children and youth with polio-myelitis [70]. The author highlighted the ways of the prophylaxis and curing in cases of deformities in a human organism joints such as ankles', knees', hips' or of upper extremities. His work was one of the first texts on compensating and correcting deformities in man's posture. Thus, Lovett's concept does not only concern the characteristics of polio-myelitis and the means of treating this disorder, but it also constitutes a complex therapeutic programme, mostly dedicated to orthopaedic rehabilitation. This movement treatment programme's vital point is linked with an appropriate diagnosis (the muscles' strength is revealed on the scale) considering certain muscles' groups that are engaged in human locomotion and are responsible for keeping a good posture. Testing muscle strength both while eliminating and against the gravity [71] is at the same time the way of how to reinforce them dependently on their current functional state. That is the core achievement of Lovett's idea addressed to physical rehabilitation [72], even if nowadays the differences between the original Lovett's proposal and its contemporary clinical version can be identified.

A few decades later the medical problem of epidemic polio had a strong impact on Kabat's first interest in "discovering" effective rehabilitation [65]. Moreover, he soon met in his practice Elizabeth Kenny who was developing methods of treating patients with poliomyelitis [70]. The infection with the virus polio damages internuncial neurons in the grey matter of the spinal cord, which results in the decrease of the inhibition of proprioceptive reflexes. The mechanism of muscle spasm in polio was studied by Kabat [73]. Hence, the deficits followed polio disorder varied significantly. That was the impulse for searching therapies centred at gait's impairment, posture deformities, strokes, or orthopaedic injuries, although the background of motor difficulties had primarily a neurophysiological character. The same observation was noted about MS patients, whom Kabat took medical and rehabilitative care of. Kabat and his successors' approach to the idea of proprioceptive neuromuscular facilitation (PNF) is based on Charles Scott Sherrington (Nobel Laureate in neurology) concept [74]. The techniques used in order to empower certain muscles are helpful at the same time for stretching their antagonists. Movements in joints are provided in their

full range of motion (if possible) in all anatomical planes and in the ergonomic positions due to patients' requirements. The mechanism of neuromotor reflexes has been adopted in this method. Improving functional patients' abilities is the core long term goal of the therapy. Many of the movement patterns in PNF act correctly on deformities that concern scapula and pelvis and connected with them extremities, thorax and spine. An example of an exercise correcting a position of pelvis is lower spine, hips and knees flexion in an aside lying position. However, while conducting this method, the therapists ought to help their patients to provide a proper movement and apply resistance during exercising. As it has been scientifically proved [75], proprioceptive neuromuscular facilitation is often applicable in physical therapies, including those targeted at autistic patients.

Souchard's approach, as one of the innovative methods of posture correction, is based on knowledge of human biomechanics, physiology and pathophysiology considering balance and motor coordination [67]. It is applied to postural re-education and neuromusculoskeletal rehabilitation through concentrating on muscles' groups that form muscles' chains, like for instance the main chains of the front and rear human body. The author stresses the necessity of keeping by therapists the balance between using the stimuli strengthening on certain muscles' groups and those stretching their antagonists. In his opinion, in most cases of tissues' stiffness of an affected joint stretching the contracted structures should be prior to strengthening weak muscles acting on a joint. To achieve the therapeutic objectives, Souchard proposes using starting positions for patients (recumbent, sitting and standing ones in which upper and lower extremities ought to be positioned – dependently on the treatment needs - in adduction/abduction, extension/flexion, and in required, due to the therapy, rotation in the appropriate joints) which enable therapists to properly manipulate contracted joints' structures. An additional role in the method plays gravity treated as a helpful factor correcting the patient's posture deformities. The clinical trial of this method's effectiveness has been conducted among others by Ana Claudia Violino Cuhna and her collaborators [76].

However, the above rules are characterized by many limitations in practise. Hence, they ought to always be taken into account by physiotherapists programming the movement treatment course for ASD patients.

Discussion and conclusions

The remarks proposed in the discussion reflect my academic interest in care quality of autistic people in respect to the inclusion criteria for medical and social case study. The criteria allow to describe the ASD cases' core aspects based upon the chosen worldwide research literature in the field. The discussed concerns are in conjunction with my many years' experience of clinical rehabilitation work with patients suffering from neurological disorders such as cerebral palsy, multiple sclerosis and autism spectrum including the PDD-NOS.

Many reasons for autistic patients' physical rehabilitation being oriented at choosing the relevant procedures to the identified treatment needs are of crucial importance. Hence, it is worth to accent the two issues in this discussion. The first one described by Sally Goddard Blythe [77] refers to an influence of the primitive reflexes on the human motor development and the resulting deficits in the situation when those reflexes do not disappear in a certain time. The second one, revealed by Ian Loram and co-workers [78] relates to the role of human intermittent motor control while under a continuous observation, which is based on the idea of deficiency in autistic children's joint attention. Both stands enable one to better understand mechanisms of movement disabilities and their functional consequences in autism.

Goddard Blythe's INPP (Institute for Neuro-Physiological Psychology, founded in 1975) [79] explores the effects of immaturity in the functioning of the central nervous system on learning

outcomes, emotional functioning and behaviour through underlying non-invasive methods as applicable in children and adults diagnosed with neuromotor immaturity (NMI). In the Institute's view on the issue the disturbances in humans' posture and balance can manifest themselves because of a presence of the primitive reflexes like Moro reflex, symmetric and asymmetric tonic neck or tonic labyrinthine reflex and others, which are not suppressed on time respectively to the developmental natural mechanisms. Loram et al. [78] explain that entirely natural and highly effective human intermittent control lasts as a continuous observation, but acts intermittently. Human intermittent control of this inverted pendulum is described as entirely natural, highly effective and robust. As the authors persuade homeostasis, the physiological control of body position, is founded on negative feedback mechanisms. Based on extensive knowledge concerning peripheral reflexes, it is highly probable according to them that feedback mechanisms controlling body position act continuously. Thus, as they point out, serial ballistic control of a human body, limited to an optimum rate, provides a new physiological paradigm for interpreting sustained control of posture and movement, which in PDD-NOS patients reveal themselves with multilevel orthopaedic and motor deformities.

Physiotherapy that serves patients, including those with autism, throughout diminishing neuromuscular severities [80-81] may play a very beneficial role in each of the above cases. Thus, to minimize or correct one's posture and motor deficits [82], the adequate therapeutic methods of rehabilitation as exposed in the last section of this article seem to be significant. The authors, Osnat Teitelbaum and co-workers [82], have evidenced that in the group of persons later diagnosed with Asperger syndrome, Moebius-shaped mouth can be an early sign of neurological damage when it is accompanied by the movement disturbances in motor development of infants. The dysfunctions noted by them in the research were persistent asymmetry of the posture or movement at the third month of life, the disintegration of segmental righting/rolling from supine to prone at fourth month (controlled by uninhibited asymmetric tonic neck: ATNR), inability to sit upright without support at around six months, asymmetrical crawling (one side stepping, one side crawling), and a toddler's falling head-on onto the ground (without the use of protective reflexes of arms) while walking being under control of partially inhibited ATNR. Therefore, to combat the patients' (also with PDD-NOS) detected persistent delays in motor development as they age, the rehabilitation methods discussed in this work seem to be the relevant therapeutic means [83-86]. Frenkel exercises, which encompass among other various forms of locomotion, may be useful while maintaining gait patterns and balance in the PDD-NOS. PNF based upon the mechanism of neuromotor reflexes offers the therapeutic means to strengthen movements of the impaired body segments in the PDD-NOS, for instance when inhibiting pathologic motor effects of the primitive reflexes (e.g. tics) or correcting a body posture. Souhard's GPR targeted at eliminating or diminishing the compensative contractures of muscles' chains may help PDD-NOS patients in releasing their muscles stiffness, e.g. of the neck and shoulder girdle, by stretching connective tissue and muscles of a patient whose body remains in the relaxed position during manipulation. Lovett testing allows the muscles to work optimally. Due to this concept, both the against-gravity exercises with additional resistance and those performed in antigravity positions are designated to reinforce weak muscles of patients.

However, one should treat that section of the work as a wide reference as there are might be more appropriate methods in concrete cases. To the certain extend contemporary rehabilitation tends to be more personalized. In autism, as it has been earlier noted in this work, to perform a physical therapy communication with patients often poses an additional difficulty which should not be undermine and properly addressed.

The stated insights reveal the following conclusions:

1. Although autism revealing itself by the variety of deficits in patients becomes a challenge for therapists involved in the process of treatment, the physical therapy's basic role is in this case strictly connected with application of the physiotherapeutic procedures aimed at factual diminishing the postural and movement disabilities.
2. When combatting the ASD severities, which manifest themselves both in communicative and neuromuscular deficiencies, physiotherapists should not only use the recommended therapeutic methods, but fully cooperate during the treatment process with other specialists from the caregivers' team.
3. Both theoretical foundations of autism and knowledge of the recommended techniques based on the classic and novel professional paradigms combined with an experience obtained in previous work allow the rehabilitation specialists to conduct effectively movement treatment with autistic persons.

References:

- [1] Feinstein, A. A history of autism. Conversations with the pioneers, 1st ed.; Willey Blackwell: Malden, Oxford, Chichester, 2010.
- [2] Donvan, J.; Zucker, C. In a different key: a story of autism, 1st ed.; Crown Publishers: New York, 2016.
- [3] Bleuler, E. Dementia praecox oder gruppe der schizophrenien, 1st ed.; Deuticke: Leipzig, 1911.
- [4] Trevarthen, C.; Aitken, K.; Papoudi, D.; Robarts, J. Children with autism, 2nd ed.; Jessica Kingsley Publishers: London, New York, 1998.
- [5] Kroupa; S. The TEACCH approach to working with individuals on the autism spectrum: understanding, educating, empowering. In: *Neurobiology, diagnosis and treatment in autism. An update*; Riva, D.; Bulgheroni, S.; Zapella, M., Eds: John Libbey Eurotext: Montrouge, France, 2013, pp. 107-119.
- [6] O'Sullivan, S.; Schmitz, T., Eds. Physical rehabilitation: assessment and treatment, F.A. Davies Company, Philadelphia 1988.
- [7] Bishop, S.; Luyster, R.; Richler, J.; Lord, C. Diagnostic assessment. In: *Autism Spectrum Disorders in Infants and Toddlers. Diagnosis, assessment and treatment*; Chawarska, K.; Klin, A.; Volkmar, F., Eds: The Guilford Press: New York, London, 2008, USA, UK, pp. 23-49.
- [8] Lord, C. New directions in diagnosis and assessment, the lecture at: the "Conference Autism - from science to practice", Jagiellonian University in Krakow, September 25-27, 2015.
- [9] DSM-5 diagnostic criteria. <https://www.autismspeaks.org/what-autism/diagnosis/dsm-5-diagnostic-criteria> (Accessed February 1, 2016).
- [10] DSM-5 overview: the future manual. <http://www.dsm5.org/about/Pages/DSMVOverview.aspx> (Accessed February 1, 2016).
- [11] Volkmar, F.; Chawarska, K.; Klin A, 2008, Autism spectrum disorders in infants and toddlers. Introduction. In: *Autism Spectrum Disorders in Infants and Toddlers. Diagnosis, assessment and treatment*; Chawarska, K.; Klin, A.; Volkmar, F., Eds: The Guilford Press: New York, London, 2008, USA, UK, pp. 1-22.

- [12] Kanner, L. Infantile autism and the schizophrenias. *Behav Sci*, 1965, 10, 4, 412-420.
- [13] Kanner, L. Irrelevant and metaphorical language in early infantile autism. *Am J Psychiatry*, 1946, 103, 2 pp.242-246.
- [14] Kanner, L. Problems of nosology and psychodynamics of early infantile autism. *Am J Orthopsychiatry*, 1949, 19, 3, 416-426.
- [15] van Krevelen, D. A. Early infantile autism and autistic psychopathy, *J. autism & Childhood Schizophrenia*, 1971, 1, 1, 82-86.
- [16] Rimland, B. Infantile autism. The syndrome and its implications for a neural theory of behaviour, 50th anniversary updated ed.; Jessica Kingsley Publishers: London, Philadelphia, 2015.
- [17] Benda, C. Developmental disorders of mentation and cerebral palsies, 1st ed.; Grune&Stratton: New York, 1952.
- [18] Eyal, G.; Hart, B.; Onculer, E.; Oren, N.; Rossi, N. The autism matrix. The social origin of the autism epidemic, 1st ed.; Polity Press: Cambridge, 2010.
- [19] Kanner, L. Autistic disturbances of affective contact. *Nerv Child*, 1943, 2, 1, 217-250.
- [20] Asperger, H. Die "Autistischen Psychopathen" im Kindesalter. *Archiv für Psychiatrie und Nervenkrankheiten*, 1944, 117, 1, 76–136.
- [21] Kanner, L. The adrenalin blood pressure curves in dementia præcox and the emotional psychoses. *Am J Psychiatry*, 1928, 85,1, 75–96.
- [22] Kanner, L. Child psychiatry, 1st ed.; Springfield, Ill.: Charles C Thomas, 1935.
- [23] Kanner, L. Habeas corpus releases of feeble-minded persons and their consequences. *Am J Psychiatry*, 1938, 94, 5, 1013-1033.
- [24] Kanner, L. Exoneration of the feeble-minded. *Am J Psychiatry*, 1942, 99, 1, 17–22.
- [25] Asperger, H. Jugendpsychiatrie und Heilpädagogik. *Münch. Med. Wschr.*, 1942, 89, 352-356.
- [26] Asperger, H. Der Heilpädagogische Hort. *Wien. Klin. Wschr.*, 1944, 57, 31/32, 392-393.
- [27] Asperger, H. Die „Autistischen Psychopathen" im Kindesalter. *Archiv f. Psychiatrie*, 1944, 117, 1, 76-136.
- [28] van Krevelen, D. A. Problems of differential diagnosis between mental retardation and autismus infantum. *Acta Paedopsychiatr.*, 1973, 39, 8, 199-203.
- [29] Landesman, Sh., Butterfield, E. C. Normalization and deinstitutionalization of mentally retarded individuals: Controversy and facts. *Am Psychol.*, 1987, 42, 8, 809-816.
- [30] Tantam, D. Asperger's syndrome, *J. Child. Psychol. Psychiatry*, 1988, 29, 3, 245-255.
- [31] Lemay, R. A. Deinstitutionalization of people with developmental disabilities: A Review of the Literature. *Can J Commun Ment Health*, 2009, 28, 1, 181-194.
- [32] Wolff, S., Barlow, A. Schizoid personality in childhood: a comparative study of schizoid, autistic and normal children, *J. Child. Psychol. Psychiatry*, 1979, 20, 1, 29-46.
- [33] Wing, L. Asperger syndrome: a clinical account. *Psychological Medicine*, 1981, 11, 1, 115-129.
- [34] Mandy, W.; Charman T.; Gilmour J.; Skuse D. Toward specifying pervasive developmental disorder—not otherwise specified. *Autism Res* 2011, 4, 2, 121-131.

- [35] Premack, D., Woodruff, G. Does the chimpanzee have a theory of mind? *Behav. Brain. Sci.*, 1978, 1, 4, 515-526.
- [36] Wiley, N. Theory of mind: a pragmatist approach. docs.com/pdf_norbert_wiley.html (Accessed February 1, 2016).
- [37] Humphrey, N. The social function of intellect. In: *Growing Points in Ethology*; Bateson, P. P. G.; Hinde, R. A., Eds: Cambridge University Press: Cambridge, 1976, pp. 303- 317.
- [38] Goffman, E. Asylums: essays on the social situation of mental patients and other inmates. 1st ed.; New York: Anchor, 1961.
- [39] Korkmaz, B. Theory of mind and neurodevelopmental disorders of childhood. *Pediatric Research*, 2011, 69, 5, 101R–108R.
- [40] Blair, R. J. Fine cuts of empathy and the amygdala: dissociable deficits in psychopathy and autism. *Q J Exp Psychol (Hove)*, 2008, 61, 1, 157-70.
- [41] Teufel, C., Fletcher, P. C., Davis, G. Seeing other minds: attributed mental states influence perception. *Trends Cogn Sci*, 2010, 14, 8, 376–382.
- [42] Baron-Cohen, S. Theory of mind and autism: a review. *Special Issue of the International Review of Mental Retardation*, 2001, 23, 169-204.
- [43] Flavell, J., Botkin, P., Fry, C., Wright, J., Jarvis, P. The development of role-taking and communication skills in children. 1st ed.; New York: Wiley, 1968.
- [44] Flavell, J. H. Cognitive development. 2nd ed.; Englewood Cliffs, N.J.: Prentice-Hall, 1985.
- [45] Baron-Cohen, S. Autism: the empathizing–systemizing (E-S) theory. *The Year in Cognitive Neuroscience*, 2009, 1156, 68-80.
- [46] Greenspan, S.; Wieder, S. Engaging autism. Using the floortime approach to help children relate, communicate, and think, 1st ed.; Da Capo Lifelong Books: Philadelphia, PA, 2009.
- [47] Gallagher, S. Understanding Interpersonal Problems in Autism: Interaction Theory as an Alternative to Theory of Mind. *Philosophy, Psychiatry, & Psychology*, 2004, 11, 3, 199-211.
- [48] Kasari, C. Promoting peer interactions in school programs for children with ASD, the lecture at: the “Conference Autism - from science to practice”, Jagiellonian University in Krakow, September 25-27, 2015.
- [49] Powers, M. Evidence-based treatment for individuals with ASD: a functional-developmental approach, the lecture at: the “Conference Autism - from science to practice”, Jagiellonian University in Krakow, September 25-27, 2015.
- [50] Powers, M. Functional assessment and treatment of behaviour problems in individuals with ASD, the lecture at: the “Conference Autism - from science to practice”, Jagiellonian University in Krakow, September 25-27, 2015.
- [51] Farroni, T.; Csibra, G.; Simion, F.; Johnson, M. Eye contact detection in humans from birth. *PNAS*, 2002, 99, 14, 9602-9605.
- [52] Baranek, G.; Wakeford, L.; David F. Understanding, assessing and treating sensory motor issues. In: *Autism Spectrum Disorders in Infants and Toddlers. Diagnosis, assessment and treatment*; Chawarska, K.; Klin, A.; Volkmar, F., Eds: The Guilford Press: New York, London, USA, UK, 2008, pp. 104-140.

- [53] Forycka, M. Psychologiczne uwarunkowania zaburzeń funkcji poznawczych. In: *Rehabilitacja osób z zaburzeniami funkcji*; Borowicz, A.; Forycka, M.; Wieczorowska-Tobis, K., Eds: PZWL: Warszawa, Poland, 2015, pp. 19-29.
- [54] Lezak, M. D., Howieson, D., Bigler, E., Tranel, D. Neuropsychological assessment. 5th ed.; New York: Oxford University Press; 2012.
- [55] Robertson, I. H., Murre, J. M. Rehabilitation of brain damage: brain plasticity and principles of guided recovery. *Psychol Bull*, 1999, 125, 5, 544-75.
- [56] Krebs, D. Biofeedback. In: *Physical rehabilitation: assessment and treatment*; O'Sullivan, S.; Schmitz, T., Eds: F. A. Davies Company: Philadelphia, USA, 1988, pp. 629-646.
- [57] Pascual-Leone, A.; Freitas, C.; Oberman, L.; Horvath, J. C.; Halko, M.; Eldaief, M.; Bashir, S.; Vernet, M.; Shafi, M.; Westover, B.; Vahabzadeh-Hagh, A. M.; Rotenberg, A. Characterizing brain cortical plasticity and network dynamics across the age-span in health and disease with TMS-EEG and TMS-fMRI, *Brain Topogr*, 2011, 24, 3-4, 302-315.
- [58] Papegaaij, S., Taube, W., Baudry, S., Otten, E., Hortobágyi, T. Aging causes a reorganization of cortical and spinal control of posture. *Front Aging Neurosci*, 2014, 6, 3, 1-15.
- [59] Cairney, J. Veldhuizen, S., Szatmari, P. Motor coordination and emotional-behavioral problems in children. *Curr Opin Psychiatry*, 2010, 23, 4, 324-329.
- [60] Understanding the brain: the birth of a learning science. 1st ed.; Centre for Educational Research and Innovation: Organisation for Economic Co-Operation and Development, 2007.
- [61] O'Reilly, M.; Lester, J.; Muskett, T., Discourse/Conversation analysis and Autism Spectrum Disorder, *J Autism Dev Disord*, 2016, 46, 2, 355-359.
- [62] Guccione, A.; Cullen, K.; O'Sullivan, S. Functional assessment. In: *Physical rehabilitation: assessment and treatment*; O'Sullivan, S.; Schmitz, T., Eds: F. A. Davies Company: Philadelphia, USA, 1988, pp. 219-326.
- [63] Frenkel, H. S. The treatment of tabetic ataxia by means of systematic exercise. An exposition of the principles and practice of compensatory movement treatment, 1st ed.; P. Blakiston's Son & Co: Philadelphia, PA, 1902.
- [64] Lovett, R. W. The treatment of infantile paralysis, 2nd ed.; PA: Blakiston's son and Co: Philadelphia 1917.
- [65] Sandel, E. Dr. Herman Kabat: Neuroscience in translation. From bench to bedside, *PM&R*, 2013, 5, 6, 453-461.
- [66] Adler, S.; Beckers, D.; Buck, M. PNF in practice, 3rd ed.; Springer Medizin Verlag: Heidelberg, 2008.
- [67] Souchard, Ph. Reeduction posturale globale RPG, 1st ed. (Polish edition: Zak, M. Ed.); Elsevier Urban&Partner: Wroclaw, 2014.
- [68] Makula, W. The role and use of Frenkel's exercises in rehabilitation. *Antropomotoryka*, 2013, 23, 61, 29-36.
- [69] Nardone, A.; Godi, M.; Artuso, A.; Schieppati, M.; Balance rehabilitation by moving platform and exercises in patients with neuropathy or vestibular deficit, *Arch Med Rehab*, 2010, 91, 12, 1869-1877.

- [70] Rogers, N. Polio wars: sister Kenny and the golden age of American medicine. 1st ed.; New York: Oxford University Press, 2014.
- [71] Wilk-Frańczuk, M.; Tomaszewski, W.; Zemła, J.; Noga, H.; Czamara, A. Analysis of rehabilitation procedure following arthroplasty of the knee with the use of complete endoprosthesis, *Med Sci Monit*, 2011, 17, 3, CR165-168.
- [72] Deeben-Irimia, O. Introduction to physical therapy for physical assistants; 2nd ed.; Jones&Bartlett Learning: Sudbury, 2011.
- [73] Kabat, H., Knapp, M. E. The mechanism of muscle spasm in poliomyelitis. *J Pediatr*, 1944, 24, 2, 123–137.
- [74] Sherrington, C. S. The integrative action of the nervous system. 1st ed.; New Haven: Yale University Press, 1906.
- [75] Chen, D. Essential elements in early intervention. Visual impairment and multiple disabilities, 1st ed.; AFB Press: New York, 1999.
- [76] Cunha, A.C.V.; Burke, T.N.; França, F.J.R.; Marques A.P. Effect of global posture reeducation and of static stretching onto pain, range of motion, and quality of life in women with chronic neck pain: a random clinical trial, *Clinics*, 2008, 63, 6, 763-770.
- [77] Goddard Blythe, S. Neuromotor immaturity in children and adults, 1st ed.; Willey Blackwell: Malden, Oxford, Chichester, 2014.
- [78] Loram, I. D.; Gollee, H.; Lakie, M.; Gawthrop, P. J. Human control of an inverted pendulum: Is continuous control necessary? Is intermittent control effective? Is intermittent control physiological? *J Physiol*, 2015, 589, 2, 307-324.
- [79] Goddard, S. Reflexes, learning and behavior: a window into the child's mind 1st ed.; Oregon: Fern Ridge Press, 2002.
- [80] Schmitz, Th. Coordination assessment. In: *Physical rehabilitation: assessment and treatment*; O'Sullivan, S.; Schmitz, T., Eds: F. A. Davies Company: Philadelphia, USA, 1988, pp. 121-134.
- [81] Norkin, C. Gait analysis. In: *Physical rehabilitation: assessment and treatment*; O'Sullivan, S.; Schmitz, T., Eds: F. A. Davies Company: Philadelphia, USA, 1988, pp. 195-218.
- [82] Teitelbaum, O.; Benton, T.; Shah, P. K.; Prince, A.; Kelly, J. L.; Teitelbaum, Ph. Eshkol–Wachman movement notation in diagnosis: The early detection of Asperger's syndrome, *PNAS*, 2004, 101, 32, 11909–11914.
- [83] Skinner, J.; Pekka, O. Laboratory and field tests for assessing health-related fitness. In: *Physical activity, fitness, and health. International proceedings and consensus statement*; Bouchard, C.; Shephard, R.; Stephens, Th., Eds: Human Kinetics Publishers: Champaign, 1994, pp. 160-179.
- [84] Laughlin, H.; McAllister, R.; Delp, M. Physical activity and the microcirculation in cardiac and skeletal muscle. In: *Physical activity, fitness, and health. International proceedings and consensus statement*; Bouchard, C.; Shephard, R.; Stephens, Th., Eds: Human Kinetics Publishers: Champaign, 1994, pp. 302-319.

[85] Faulkner, J.; Green, H.; While, T. Response and adaptation of skeletal muscle to changes in physical activity. In: *Physical activity, fitness, and health. International proceedings and consensus statement*; Bouchard, C.; Shephard, R.; Stephens, Th., Eds: Human Kinetics Publishers: Champaign, 1994, pp. 342-357.

[86] Vailas, A.; Vailas, J. Physical activity and connective tissue. In: *Physical activity, fitness, and health. International proceedings and consensus statement*; Bouchard, C.; Shephard, R.; Stephens, Th., Eds: Human Kinetics Publishers: Champaign, 1994, pp. 369-382.

