Spasticity syndrome in cerebral pathology: evaluation and clinical models

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Knowing the frequency of spasticity patterns in different muscles allows correcting the botulinum neurotoxin (BoNT) administration schemes and creating spasticity models that could predict the drug consumption and treatment cost.

Objective: *to develop clinical spasticity models based on the frequencies of the spastic syndrome in the muscles of the extremities in post-stroke patients to optimize BoNT administration.*

Patients and methods. *We examined 129 patients of both sexes aged 61.2±8.0 years with post-stroke spasticity (mean time after the stroke – 4.6±2.2). Twenty-seven muscles were tested for spasticity: shoulder girdle (n=3), upper (n=9) and lower (n=15) extremities. We used the original manual testing methods (MTM) of spasticity and the Tardieu scale (TS).*

Results and discussion. *We observed the following frequencies of spasticity in the arm muscles: pectoralis major, brachioradialis, pronator teres, fl. carpi radialis, fl. digitorum profundus et superfacialis, fl. pollicis long. – over 70%, subscapularis – 61%, brachialis – 56.6%, biceps brachii – 35.8%. Frequencies of spasticity in the leg muscles were: semitendinosus, semimembranosus, fl. digitorum long. – 37.5%, gracilis – 21.4%, cap. med. gastrocnemius – 48%, tibialis post. – 39.2%, soleus – 19.6%, fl. halluces long. – 23%. There was no spasticity in the hip adductors; low spasticity incidence was seen in fl. digitorum brev. et fl. halluces brev. (<10%), tibialis ant., rectus femoris (<5%); biceps femoris, teres major, fl. carpi ulnaris, and cap. lat. gastrocnemius (<2%). Based on the frequency of identified spastic patterns, we created four models of patients with arm spasticity and five models – with leg spasticity with the calculation of the necessary doses of BoNT.*

Conclusion. *We propose several spasticity models, which allow calculating the treatment costs, considering the frequency of involvement of specific muscles in spasticity evaluation, and tracking the rehabilitation follow-up of the patient's transition from one clinical model to another.*

Keywords: *spasticity testing; spasticity frequency; botulinum neurotoxin; spasticity; models (patterns) of spasticity; post-stroke rehabilitation.*
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Spasticity is one of the most frequent phenomena that occurs after damage to the central nervous system (CNS) [1, 2]. One of the generally recognized methods of its treatment is intramuscular targeted injection of botulinum neurotoxin (BoNT). To date, the effectiveness of this method is beyond doubt, and the main attention of botulinum therapy specialists is attracted to the development of navigational methods for controlling injections and improving the specialists' skills [3, 4]. At the same time, the problem of identification and differential diagnosis of spastic muscles is still ignored.

The choice of target muscles for botulinum therapy is usually based on inconsistent and incomplete knowledge of anatomy, manual therapy techniques and formalized lists of muscles attributed to a particular pattern of spasticity. An example of the latter is a well-known work by H. Hefter (2009), who identified and classified patterns of upper limb spasticity, for each of which a general list of muscles was composed [4, 5]. At the same time, in the case of spasticity of the lower limb, there is no list of specific patterns of spasticity, nor a basic list of the muscles involved [6, 7]. When choosing muscles for injections, as a rule, functional anatomy and mutual influence of muscles are not taken into account, and the available methodological literature mainly considers ways of testing muscles in a healthy person [8–10].

It is important that full-fledged diagnostic data on the increase in muscle tone after a stroke can help to adjust the schemes of injection of BoNT and become prerequisites for the creation of clinical models of patients with spasticity, allowing to develop rehabilitation programs, predict the consumption of the drug and the cost of treatment. At the same time, incorrect diagnosis and, as a result, low effectiveness of treatment with irrational use of BoNT negatively affect the outcomes and cost of rehabilitation of patients with CNS injuries [11, 12].

The aim of the study was to develop clinical models of spasticity syndrome for the use of BoNT based on the assessment of the frequency of development of spastic syndrome in limb muscles in patients after stroke.

Patients and methods. We examined 129 patients (81 men and 48 women) aged 61.2±8.0 years, with post-stroke spasticity (median time since the stroke was 4.6±2.2 years). Twenty-seven muscles were tested for spasticity, including: shoulder girdle (n=3), upper (n=9) and lower extremity (n=15). The following methods were used: the original technique of manual muscle testing (MMT) for spasticity, the Tardieu scale (TS) [4, 13, 14]. We

used BoNT-containing drug – incobotulotoxin (Xeomin). The choice of the drug was due to its proven safety in doses up to 800 units, which is necessary for complete treatment of hemisyndrome of spasticity [15, 16].

Table 1. *Muscles responsible for upper and lower extremities spasticity in patients with post-stroke spasticity*

Upper limb muscles	Involvement in spasticity syndrome (n=120), n (%)
Pectoralis major	97 (80.8)
Subscapularis	72 (60)
*Teres major – latissimus dorsi**	11 (9.2)
Brachialis	67 (55.8)
Biceps brachii	42 (35)
Brachioradialis	95 (79.2)
Flexor carpi ulnaris	2 (1.6)
Flexor carpi radialis	102 (85)
Pronator teres	90 (75)
Flexor digitorum superficialis	115 (95.8)
Flexor digitorum profundus	108 (90)
Flexor pollicis longus	102 (85)
Lower limb muscles	**Involvement in spasticity syndrome (n=113), n (%)**
Semitendinosus	60 (53)
Semimembranosus	60 (53)
Biceps femoris	1 (0.8)
Rectus femoris	1 (0.8)
Vastus lateralis, medialis et intermedius	0
Gastrocnemius	66 (58.4)
Soleus	28 (25)
Tibialis posterior	55 (49)
Tibialis anterior	7 (6)
Flexor digitorum longus	39 (34.5)
Flexor hallucis longus	34 (30)
Flexor digitorum brevis	11 (9.7)
Flexor hallucis brevis	9 (8)
Gracilis	36 (32)
Adductor magnus	0
Adductor brevis	0

Note: **M. teres major* and *m. latissimus dorsi* act as a single functional unit.

The system of testing and diagnosis of spastic muscles, including qualitative assessment using manual techniques, and quantitative analysis using the original method of TS, was developed on the basis of clinical practice and literature sources [8–10, 13, 17–20].

When designing the MMT methodology, the following basic principles of spasticity testing were formulated:

1. Differentiation of muscles:
- by the number of joints involved;
- by the number of available functions.

2. Methods of assessment used:
- visually;
- palpation;
- under ultrasound control.

3. Testing techniques used:
- performing a movement in a certain plane;
- performing a movement specific only for a particular muscle;
- performing a movement to provoke the stretch reflex;
- performing a series of movements involving different number of joints.

Table 2. *Muscles that form upper limb spasticity patterns according to H. Hefter*

Muscle	Spasticity pattern (n=120), n (%)	Frequency of muscle s pasticity within the pattern, n (%)
Pectoralis major	**Type I** – 38 (31.6)	33 (86.8)
Subscapularis		20 (52.6)
Teres major - latissimus dorsi		2 (5.2)
Brachialis		17 (44.7)
Biceps brachii		12 (31.6)
Brachioradialis		27 (71)
Flexor carpi ulnaris		0
Flexor carpi radialis		27 (71.1)
Pronator teres		23 (60.5)
Flexor digitorum superficialis		38 (100)
Flexor digitorum profundus		36 (94.7)
Flexor pollicis longus		35 (92.1)
Pectoralis major	**Type III** – 51 (42.5)	41 (80.4)
Subscapularis		36 (70.6)
Teres major – latissimus dorsi		5 (9.8)
Brachialis		30 (58.8)
Biceps brachii		15 (29.4)
Brachioradialis		45 (88.2)
Flexor carpi ulnaris		0
Flexor carpi radialis		46 (90.2)
Pronator teres		37 (72.5)
Flexor digitorum superficialis		51 (100)
Flexor digitorum profundus		50 (98)
Flexor pollicis longus		47 (92.1)
Pectoralis major	**Type IV** – 21 (17,5)	13 (61.9)
Subscapularis		10 (47.6)
Teres major - latissimus dorsi		3 (14.3)
Brachialis		13 (61.9)
Biceps brachii		9 (16.9)
Brachioradialis		11 (42.3)
Flexor carpi ulnaris		1 (4.7)
Flexor carpi radialis		21 (100)
Pronator teres		21 (100)
Flexor digitorum superficialis		21 (100)
Flexor digitorum profundus		18 (85.7)
Flexor pollicis longus		17 (80.1)

MMT methods were formed for each muscle. To create a full-fledged testing system, we used methods of differential diagnosis well-known in medical practice (gracilis test, Silfverskiöld, Ellie Duncan tests, etc.) and their original modifications (test for spasticity in the medial head of the calf muscle), as well as our own original developments (test for spasticity of the posterior tibial muscle, algorithm for detecting spasticity in the flexors of fingers, etc.) [8–10, 17–20].

We propose an original method of testing the muscles of the upper and lower extremities: the scapular muscle *(m. subscapularis)*, the shoulder muscle *(m. brachialis)*, flexors of the hand *(m. flexor carpi radialis, m. flexor carpi ulnaris)*, flexors of fingers and the long flexor of the thumb *(m. flexor digitorum superficialis, m. flexor digitorum profundus, m. flexor pollicis longus)*, adductors *(m. adductor magnus, m. adductor longus, m. adductor brevis)*, the calf muscle *(m. gastrocnemius)*, posterior tibial muscle *(m. tibialis posterior)* and flexors of toes *(m. flexor digitorum longus, m. flexor hallucis longus, m. flexor digitorum brevis, m. flexor hallucis brevis)* [4, 17–21]. We have developed original algorithms for differential diagnosis of spasticity of the forearm muscles, hip adductor muscles, and foot support muscles [4, 21–23]. We have collected and adapted previously published techniques for muscles of the forearm *(m. flexor carpi radialis, m. pronator teres)*, hand muscles *(m. flexor pollicis brevis, m. adductor pollicis, m. opponens pollicis)*, and muscles of the lower extremity *(m. gracilis, m. iliopsoas, m. gluteus maximus, m. quadriceps femoris, m. soleus and m. gastrocnemius)* [14, 17–20, 22, 23].

When analyzing the spastic muscles of the lower limb, we used two main patterns proposed by us in 2017, which occur in patients with stroke consequences – dynamic pattern (DP) and static pattern (SP) [21].

Table 3. *Muscles that form lower limb spasticity patterns*

Muscle	Spasticity pattern (n=120), n (%)	Frequency of muscle spasticity within the pattern, n (%)
Semitendinosus	Dynamic – 60 (53)	60 (100)
Semimembranosus		60 (100)
Gracilis		36 (60)
Biceps femoris		1 (1.6)
Rectus femoris		1 (1/6)
Gracilis	Hip adduction – 36 (32)	36 (100)
Gastrocnemius	Static – 81 (71.7)	65 (80.2)
Soleus		28 (34.6)
Tibialis posterior		55 (68)
Tibialis anterior		7 (8.6)
Flexor digitorum longus	Flexion of toes – 49 (43.4)	39 (79.6)
Flexor hallucis longus		34 (69.4)
Flexor digitorum brevis		11 (22.4)
Flexor hallucis brevis		9 (18.4)

Table 4. *Frequency of spasticity in different muscles and their combinations with the calculation of the frequency of choosing mean doses*

Muscle	Spasticity pattern	Muscle spasticity frequency, %	Amount of Xeomin, U	Pattern frequency %	Average doses Xeomin, U
Flexor digitorum superficialis	Flexion of fingers	96	60	88	113
Flexor digitorum profundus		90	60		
Flexor pollicis longus		85	20		
Flexor carpi radialis	Pronation of the forearm	85	60	57	42
Pronator teres		75	30		
Brachialis	Elbow flexion	56	80	90	143
Brachioradialis		79	100		
Biceps brachii		35	100		
Pectoralis major	Adduction, flexion of the shoulder	81	100	90	116
Subscapularis		60	80		
Semitendinosus	Hip extension, knee flexion	53	70	53	79
Semimembranosus		53	80		
Gracilis	Knee flexion, hip adduction	32	60	32	19
Gastrocnemius caput mediale	Equinovarus	58	100	62	66
Tibialis posterior		49	100		
Soleus	Flexion of the foot	25	80	25	20
Flexor digitorum longus	Flexion of the II–V toes	35	40	43	24
Flexor digitorum brevis		10	100		
Flexor hallucis longus	Flexion of the I toe	32	40		
Flexor hallucis brevis		8	25		

Note. The average costs (doses) of the drug were calculated using the formula: $(\sum (Dose_{inc} \times MSF) \times PF = ADP$, where the $Dose_{inc}$ – the dose of incobotulotoxin (ED), MSF – the frequency of occurrence of muscle spasticity, PF – the frequency of occurrence of the pattern, ADP – the average dose of BoNT per pattern.

Table 5. *Models of post-stroke patients with arm spasticity*

Model	Spasticity pattern	Muscle		Xeomin, U
1A	Flexion of the wrist, the II–V fingers, and the thumb	*Flexor digitorum superficialis*		60
		Flexor digitorum profundus		60
		Flexor pollicis longus		20
				140–180
2A	Flexion of the wrist, the II–V fingers, and the thumb	*Flexor digitorum superficialis*		60
		Flexor digitorum profundus		60
		Flexor pollicis longus		20
	Pronation of the forearm	*Flexor carpi radialis*	Sometimes one of the two	60
		Pronator teres		30
				220–270
3A	Flexion of the wrist, the II–V fingers, and the thumb	*Flexor digitorum superficialis*		60
		Flexor digitorum profundus		60
		Flexor pollicis longus		20
	Pronation of the forearm	*Flexor carpi radialis*	Sometimes one of the two	60
		Pronator teres		30
	Elbow flexion	*Brachialis*	More often one or two out of three	80
		Brachioradialis		100
		Biceps brachii	Less often than others	100
		Very rarely all muscles are involved, so most often the average dose is		300–400
4A	Flexion of the wrist, the II–V fingers, and the thumb	*Flexor digitorum superficialis*		60
		Flexor digitorum profundus		60
		Flexor pollicis longus		20
	Pronation of the forearm	*Flexor carpi radialis*	Sometimes one of the two	60
		Pronator teres		30
	Elbow flexion	*Brachialis*	More often one or two out of three	80
		Brachioradialis		100
		Biceps brachii		100
	Inability of shoulder abduction and arm extension	*Pectoralis major*	More often one of the two	100
		Subscapularis		80
		Very rarely all muscles are involved, so most often the average dose is		400–450

The techniques included in the Tardieu Paresis and Spasticity Assessment System were used in our work to confirm the spasticity detected by MMT [13]. A quantitative analysis of spasticity according to the Tardieu scale is not presented in this publication.

To optimize the calculation of the drug consumption and its use in practice, we have developed patients' models [24].

These data were obtained as part of a research work (R&D) of the 2nd category, the code «Spasticity». The research protocol was approved by the local Ethics Committee of the Military Medical Academy. The participants were informed about the objectives of the study and signed the informed consent [16]. The publication presents data processed by descriptive statistics methods.

Results. We identified 104 patients (80.6%) with hemisyndrome of spasticity, 16 (12.4%) patients with spasticity only in the arm and 9 (7%) patients with spasticity only in the leg.

During MMT, the frequency of involvement in spasticity syndrome was calculated for each muscle (Table 1).

A low frequency of spasticity is revealed: *m. flexor carpi ulnaris, m. biceps femoris, m. rectus femoris, m. vastus lateralis, m. vastus medialis, m. vastus intermedius, m. adductor magnus, m. adductor brevis* (less than 4–5% of cases) and *m. teres major – m. latissimus dorsi, m. tibialis anterior, m. flexor digitorum brevis, m. flexor hallucis brevis* (from 6% to 9.7%; see Table 1). In the presence of spasticity in this segment, the following muscles almost always participate in it and have the frequency of involvement above 50–60% in the arm, and 20–30% in the leg: *m. pectoralis major, m. subscapularis, m. brachioradialis, m. brachialis, m. flexor carpi radialis, m. pronator teres, m. flexor digitorum superficialis, m. flexor digitorum profundus, m. flexor pollicis longus, m. semitendinosus, m. semimembranosus, m. gracilis, m. gastrocnemius, m. tibialis posterior, m. flexor digitorum longus, m. flexor hallucis longus.*

When examining patients (n=120) according to H. Hefter's spasticity patterns, we found that the frequency of occurrence of types II and V in patients with stroke consequences was 7 (5.8%) and 3 (2.5%), respectively, which made it possible to exclude these data from the analysis. The distribution of the remaining types of spasticity in the arm was as follows: I – 38 (31.6%), III – 51 (42.5%) and IV – 21 (17.5%) (Table 2).

The high frequency of spasticity of *m. brachioradialis* of all three types (52.6%; 93.3%; 66.7%) and all flexors of fingers (from 80% to 100%) allows to consider them the main target muscles for BoNT injections. The frequency of spasticity in the muscles involved in pronator spasticity is also high: *m. flexor carpi radialis* (71–100%) and *m. pronator teres* (60–100%). Movement restriction associated with spasticity of *m. subscapularis* and *m. pectoralis major* in the shoulder joint was quite common in all three patterns (from 61% to 86%).

After excluding patients with isolated arm spasticity syndrome, the total number of patients was 113. The basis of the clinical picture of DP is step shortening associated with spasticity of the muscles of the posterior surface of the thigh. The basis of SP is equinovarus foot caused by spasticity of the muscles of the posterior surface of the lower leg (Table 3).

Table 6. *Models of post-stroke patients with leg spasticity*

Model	Spasticity pattern	Muscle		Xeomin, U
1L	Dynamic	*Semitendinosus*		80
		Semimembranosus		100
		Gracilis	Often	80
		Biceps femoris	Very rarely	140
		Very rarely all muscles are involved, so most often the average dose is		**200–260**
2L	Static	*Gastrocnemius caput mediale*	Almost always	100
		Tibialis posterior	More often one of the muscles in combination	100
		Soleus	with *m. gastrocnemius caput mediale*	80
		Tibialis anterior	Very rarely	80
		Very rarely all muscles are involved, so most often the average dose is		**200–250**
3L	Dynamic	*Semitendinosus*		80
		Semimembranosus		100
	+	*Gracilis*	Often	80
		Biceps femoris	Very rarely	140
	Static	*Gastrocnemius caput mediale*	Almost always	100
		Tibialis posterior	Usually one of the muscles in combination	100
		Soleus	with *m. gastrocnemius caput mediale*	80
		Tibialis anterior	Very rarely	80
		All muscles are never involved, so the average dose is		**400–450**
4L	Static	*Gastrocnemius caput mediale*	Almost always	100
		Tibialis posterior	Usually one of the muscles in combination	100
	+	*Soleus*	with *m. gastrocnemius caput mediale*	80
		Tibialis anterior	Very rarely	80
	Flexion of fingers and the big toe	*Flexor digitorum longus*	In general, more often than short flexors,	40
		Flexor halucis longus	and *m. flexor digitorum longus* more often than *m. flexor hallucis longus*	40
		Flexor digitorum brevis	Rarely a combination	100
		Flexor halucis brevis	of long and short flexors	30
		All muscles are never involved, so the average dose is		**250–300**
5L	Dynamic	*Semitendinosus*		80
		Semimembranosus		100
	+	*Gracilis*	Often	80
		Biceps femoris	Very rarely	140
	Static	*Gastrocnemius caput mediale*	Almost always	100
		Tibialis posterior	Usually one of the muscles in combination	100
	+	*Soleus*	with *m. gastrocnemius caput mediale*	80
		Tibialis anterior	Very rarely	80
	Flexion of the fingers and the big toe	*Flexor digitorum longus*	In general, more often than short flexors,	40
		Flexor halucis longus	*m. flexor digitorum longus* more often than *m. flexor hallucis longus*	40
		Flexor digitorum brevis	Rarely a combination	100
		Flexor halucis brevis	of long and short flexors	30
		All muscles are never involved, so the average dose is		**400–500**

In 25% of cases, SP and DP are combined with each other. Spasticity in the flexors of toes can occur with both patterns, but in 75% of cases it is combined with SP. DP is based on an increased tone and/or muscle-tendon contracture in *m. semitendinosus* and *m. semimembranosus*, in 36 (60%) patients it is combined with spasticity in *m. gracilis*. In SP, spasticity was most often detected in the medial head of *m. gastrocnemius* (80%) and *m. tibialis posterior* (68%), nevertheless, this pattern also involves *m. flexor digitorum longus, m. flexor hallucis longus, and m. soleus* (34%) in which spasticity is predominantly (up to 90%) combined with spasticity in *m. gastrocnemius*.

Using the obtained data, we calculated the average doses of incobotulotoxin (Xeomin) and their shares in the total cost of treatment (Table 4). The data for the analysis were distributed separately for each segment of the limb or the type of movement characteristic of spasticity.

Thus, in the case of spasticity, depending on the individual pattern or pattern combinations, the following doses are required: for the muscles of the upper limb – from 140 to 450 units of Xeomine (on average – 414 units); for the muscles of the lower limb - from 150 to 450 units of Xeomine (on average – 208 units) or, in the case of hemisyndrome of spasticity, from 350 to 800 units of Xeomine (on average - 622 units).

A certain model was selected after assessing the position of the limb by segments or the type of movement characteristic of spasticity in a single joint (Tables 5, 6).

Based on the data obtained, using as an example the price of one bottle of 100 units of incobotulotoxin (Xeomin) (10 thousand rubles), it is possible to calculate the cost of the drug to provide the treatment program for each spasticity model (Table 7).

Discussion. Over the past 10 years, the only example of proposed specific patterns of spasticity are the SP and DP iso-

Table 7. *An example of calculating treatment cost depending on the model of a patient with spasticity*

Model	The amount of Xeomin, U	The cost of the model, thousand rubles
1A	140	15,4
2A	230	25,3
3A	410	45,1
4A	530	58,3
1L	250	27,5
2L	200	22
3L	450	49,5
4L	300	33
5L	500	50

lated by us for the muscles of the lower extremity of stroke patients [21]. At the same time, in H. Hefter's patterns of arm spasticity [5], our analysis showed a coincidence of up to 80% of muscles, i.e. the patterns isolated by H. Hefter do not lead to proper differential diagnosis and do not allow to make a decision on the choice of target muscles. Thus, it seems more expedient to apply a modular (segmental) approach, considering each segment (joint and muscles affecting it) of the limb separately and forming an individual portrait of the patient, summing up the spasticity detected in each of the segments, but this can be achieved only by applying manual muscle testing of spasticity.

To date, no one has tried to formalize and systematize spasticity testing into a complete methodology. Basically, there are descriptions of individual techniques used for spasticity, or manuals devoted to testing the muscles of a healthy person [17–19]. The work of A.L. Kurenkov et al., 2014 [20] is the only publication that has collected in one edition a number of specific tests to assess spasticity in children with cerebral palsy. In literature there are no data on the frequency of spasticity of individual muscles, and there have been no attempts so far to form spasticity models, which is not surprising, given the lack of tools, such as MMT of spasticity.

This publication completes the cycle of our works, which included the development of diagnostics and metric assessment of spasticity, the method of treatment and control of its effectiveness, the developed methodology of navigation control, which allows us to speak about the development of a full-fledged medical technology for the treatment of spasticity [4, 13, 21–24].

In the course of this work, for the first time, a method of manual testing of spasticity of limb muscles was created. The developed diagnostic algorithm has shown that the choice of muscles for BoNT injections based on the anatomical description of their function and the type of pattern presented as a picture (photo or graphic image) is not applicable in practice.

Selection of the biceps brachii *(m. biceps brachii)*, elbow flexor of the hand *(m. flexor carpi ulnaris)*, rectus femoris *(m. rectus femoris)* and biceps femoris *(m. biceps femoris)*, adductor muscles *(mm. adductores femoris)*, anterior tibialis muscle *(m. tibialis anterior)* and short flexors of toes (*m. flexor digitorum brevis* and *m. flexor hallucis brevis*) as target muscles for injection of BoNT in a patient after a stroke is most often erroneous. The application of the developed diagnostic algorithm has shown that the syndrome of spasticity often involves the muscles, injections into which are rarely used in practice: the subcapular *(m. subscapularis)*, thin *(m. gracilis)*, long flexors of toes and the medial head of the calf muscle *(m. gastrocnemius caput mediale)*.

The proposed original tests and algorithms for differential diagnosis of spasticity in the muscles of the forearm and hand, tests of the scapular muscle, posterior tibial muscle, medial head of the calf muscle, flexors of toes, differentiation of adductors allow for qualitative differential diagnosis of the muscles involved in spasticity.

Conclusion. The developed clinical models of spasticity enable us to calculate the cost of treatment for a certain model of spasticity, take into account the frequency of involvement of certain muscles when making the diagnosis of spasticity, and track the rehabilitation dynamics of the patient's transition from one clinical model to another.

It should be noted that information on the frequency of occurrence of spastic syndrome in patients after stroke and the developed diagnostic algorithms cannot be correctly used in patients with spasticity that occurred after damage to the central nervous system of a different etiology. The results obtained can be regarded as a conceptual basis for further study of the issue.

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