INFLUENCE OF ADMINISTRATIVE FACTORS ON THE EFFECTIVENESS OF HEALTH CARE DELIVERY TO VICTIMS WITH ACUTE SPINE AND SPINAL CORD INJURIES

Regional Retrospective Study as a Base for Improving National Clinical Guidelines

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Objective. To identify key organizational factors that determine the effectiveness of the system for delivering medical care to victims with acute spinal cord injury in the setting of large constituent entity of the Russian Federation, and to develop appropriate proposals for improving the national clinical guidelines.

Material and Methods. The study included data on 2,283 patients with acute spinal cord injury who were treated within the framework of three successively existed organizational models of the health care delivery system: I — decentralized unprofiled (306 patients); II — decentralized profiled (454 patients); and III — centralized profiled (1523 patients). Using the methods of nonparametric statistics, the medical and statistical indicators were compared in patients examined when evaluating the results of treatment: 44, 75 and 148 patients from each organizational model, respectively ($p > 0.05$).

Results. The effectiveness of the treatment of victims with acute spinal cord injury depends on the interaction of organizational factors that determine the structure and operation of the health care system at the level of the federation subject as a whole (centralization factor) and at the level of the relevant hospital (profiling factor). Specialized departments/centers for emergency spine surgery housed by multidisciplinary emergency hospitals — level I trauma centers (profiling factor) operate to maximum effect only when a centralized model of health care is organized in the subject of the federation (centralization factor).

Conclusion. Within the framework of national clinical guidelines for the treatment of patients with acute spinal cord injury, the principles of their routing and the requirements to be met by the involved hospitals should be clearly regulated.

Key Words: spine and spinal cord injury, clinical guidelines, organization of health care, specialized health care, spine surgery, trauma centers.

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Standardization of approaches to the treatment of patients with injuries and diseases, in terms of the choice of therapeutic options and the tactics of their use, is an urgent task for all branches of medicine. In Russia, the development of this trend has led to an understanding of the need to develop national clinical guidelines that are becoming increasingly important in the regulation of medical care delivery to the population.

Today, the issues of choosing the optimal place, tactics, and option for treatment of patients with traumatic spinal cord injury (TSCI) have no definitive answers [1–3]. The main cause for this is that the capabilities of full (wide, stable, and effective) use of a modern range of technologies for conservative and, most importantly, surgical treatment are quite often limited by the features of medical care system organization [4, 5]. For this reason, the need for clear regulation of the organizational issues of medical care related to the development of national clinical guidelines has been legally approved in Russia [6].

The purpose of this study is to identify the key organizational factors that determine the efficacy of the system for medical care delivery to TSCI patients on the territory of a large constituent entity of the Russian Federation (Saint-Petersburg) and develop appropriate proposals for improving the national clinical guidelines.

Publication type: original article.

Evidence level of the study: 3 (Ministry of Health of the Russian Federation); 2c (Oxford Center for Evidence-Based Medicine).

Material and Methods

In Saint-Petersburg, the development of the modern organizational system for treatment of TSCI patients has passed successively through three stages (Table 1). A distinctive feature of the first stage was the lack of principles for medical triage and evacuation of patients as well as the absence of a specialized surgical unit focused on their treatment; a distinctive feature of the second stage was the presence of this unit (factor of system profiling) in the absence of legislatively approved centralization of patients' flow; the third was characterized by the full functioning of these two organizational components, centralization and profiling, of the system. According to organizational models I and II, patients were admitted to the nearest medical institution with a neurosurgical department; according to model III, they were admitted to the nearest profiled hospital. The source of information on activities of the type I system was reporting documentation of the Commission of the Health Committee of Saint-Petersburg that was established to analyze functioning of neurosurgical departments of city multidisciplinary hospitals during 2009. Data on the two other organizational systems were received from records and reports of the City Center for Emergency Spinal Surgery (CCESS) for 2010–2016. Therefore, the study included data of 2,283 TSCI patients; of these, 1,723 underwent surgery, and 267 patients were examined upon evaluation of the long-term surgical treatment outcomes.

To comprehensively assess a potential effect of each of the organizational factors of system functioning on the system efficacy and treatment outcomes, comparative statistical analysis of the obtained data was carried out according to the so-called sequential principle, in accordance with which the indicators of each subsequent model were compared with those of the previous one.

A comparative analysis of the medical and statistical characteristics of hospital treatment of patients within the framework of each model was performed for all patients (Table 2). In this case, the statistical significance of differences in the mean duration of stay of the TSCI patient (mean bed day) between the compared sets of patients was not assessed because they were calculated as a derivative of the total number of days that patients stayed in a hospital, but not of the duration of hospitalization of each patient. However, the data on this parameter are presented in the resulting part of the article to clearly illustrate the observed changes.

To analyze the treatment outcomes (24 months after surgery), three patient groups homogeneous with regard to gender, age, and localization and type of injury were formed from the appropriate general sets of cases (Table 3). The quality of patients' life was assessed using an adapted Russian translation of the Oswestry questionnaire (ODI), version 2.1a [7]. Neurological status was assessed using the ASIA scale. Comprehensive assessment of the treatment outcome was performed using a modified MacNab scale.

Statistical processing of the data was performed using Microsoft Excel and Statistica for Windows 6.0 software packages as well as an online calculator "Analysis of arbitrary contingency tables using the chi-square test" (http://medstatistic.ru/calculators/calchit.html). Nonparametric statistics was used to analyze medical and statistical indicators and clinical treatment outcomes. Distributions of quantitative indicators were characterized by a median and quartiles. The presence of statistically significant differences in quantitative indicators between the patient groups – comparison of two independent (unrelated) samples – was analyzed using the Mann-Whitney test; qualitative indicators were analyzed by the Pearson χ^2 test, χ^2 test with Yates' correction for continuity, and one- or two-sided exact Fisher's test. The results of this analysis were used to conclude about statistically significant differences at $p < 0.05$.

Results

The results of comparing the main indicators of activities of city multidisciplinary hospitals in the field of spine surgery within the framework of various organizational models of the medical care system are presented in Tables 4 and 5.

Comparative analysis of the structure of overall flow of hospitalized patients was possible only for organizational models II and III. The cause for impossibility of the analysis for model I was the lack of relevant information because collection of such information was beyond the mandate of the Commission of the Health Committee of Saint-Petersburg (see above). However, despite this fact, the analysis of available data on activities of specialists from the City Center for Emergency Spinal Surgery (CCESS) reveals that centralization of the entire city-wide system of treatment has had a rather strong effect on the profile of their activity, significantly shifting it to the area of spinal pathology ($p < 0.0001$).

A comparative analysis of the structure of hospitalized patients flow (Table 4) showed that the influence of each of the two considered factors significantly increased the percentage of TSCI patients in the flow ($p < 0.0001$). Furthermore, this happened due to a reduction in the absolute and relative numbers of patients with spinal pathology admitted for elective treatment, whose prevalence was typical of the overwhelming majority of large medical institutions within organizational model I. On the other hand, profiling of one of the trauma centers for treatment of TSCI patients, accompanied by appropriate changes in the organization of its activities, equipping with the necessary facilities, and staffing with qualified medical personnel in the absence of centralized intracity flow of such patients has not led to either acceptable results for their entire population or to effective use of city medical resources: within the framework of model II, a fraction of patients continue receiving treatment under the same organizational, material, and technical conditions and previous treatment regimens.

The influence of the two considered organizational factors on composition of hospitalized patients was reflected in changes in the structure of both all surgical interventions and spine surgeries. The influence of the profiling factor on the first indicator could not be reliably

Table 1

Stages of establishing the system of medical care delivery to patients with traumatic spinal cord injury (TSCI) in Saint-Petersburg

System characteristics	Organizational model of the medical care system		
	type I: decentralized non-profiled	type II: decentralized profiled	type III: centralized profiled
Period of system functioning	Through 2009	2010–2012	2013 through the present
System organization principle	Hospitalization to the nearest medical institution with a neurosurgical department (5 hospitals and 1 research institute in the city)		Hospitalization to the nearest specialized hospital
Presence of a specialized unit for emergency spine surgery	No	CCESS	CCESS (main flow); a neurosurgical department of one of the city hospitals
Surgical activity for TSCI	In the city – 40.8%; depends on a particular hospital	In the city – 80.2% (70.4–100.0% depending on the TSCI type)	In the city – 83.1% (73.2-100.0% depending on the TSCI type)
Spine surgery technique	Open surgery	Predominantly open surgery	Predominantly minimally invasive surgery
Centralized financing of HTMC	No	For CCESS: compulsory medical insurance funds, regional and federal quotas	Compulsory medical insurance funds: regional and federal quotas
Number of patients, N/n/n" (period of inclusion in the study)	306/125/44 (2009)	454/342/75 (2010–2012)	1.523/1.256/148 (2013–2016)

CCESS – city center for emergency spine surgery; HTMC – high-tech medical care; N –number of hospitalized patients; n –number of operated patients; n" – number of patients examined upon evaluating treatment outcomes.

assessed due to the lack of relevant data on the decentralized non-profiled model of medical care delivery, but analysis of this information for the other two models showed that the centralized profiled system provides concentration of patients with TSCI as well as acute non-traumatic spinal pathology in a specialized medical institution, which creates opportunities for maintaining a significantly higher qualification of its medical personnel in terms of urgent spinal surgery compared with employees of medical departments who mainly provide elective care.

Similarly, the influence of each of the factors also provided fundamental changes in the structure of spinal surgical interventions, which was reflected in a significant increase in the percentage of surgeries for TSCI and acute spinal diseases and in an appropriate decrease in this indicator in the case of chronic spinal pathology (Table 5). Of great importance is also analysis of mean annual indicators of the structure of spine surgeries in each medical institution: e.g., the mean annual number of TSCI operations performed in only one newly established specialized medical unit (CCESS) turned out to be incomparably higher than that in any of the hospitals of the non-specialized system.

Transition to the decentralized profiled system led to a significant increase ($p < 0.0001$) in the surgical activity level (Table 6) in all categories of TSCI patients compared with the previous system in the whole and any of the large multidisciplinary medical institutions (the so-called thousand-bed hospitals) constituting the system. In turn, implementation of centralization of specialized medical care had almost no effect on the surgical activity indicator. Changes in surgical tactics in TSCI patients during transition to the profiled system resulted in an increase in the percentage of emergency spine surgery in the whole, but first of all, in isolated uncomplicated injuries (almost 8-fold increase) and in polytrauma patients who, for the first time, began to undergo surgery in the immediate post-traumatic period.

A comparative analysis of the mean hospital stay of TSCI patients using medical statistics was impossible (see Materials and Methods); however, it should be noted that the profiling of a medical institution for emergency spine surgery, even within the framework of a decentralized city system, contributed to 1.65-fold reduction of hospital stay (from 17.7 to 10.7 days) due to more intense use of beds. Implementation of flow centralization further reduced this indicator to 8.7 days.

An analysis of the rate of local surgical complications in TSCI patients revealed no statistically significant differences among different medical care models (Table 7).

A comparative analysis of the final treatment outcomes in these patients revealed that it was the profiling factor

Table 2

Results of assessing the homogeneity of total sets of patients with traumatic spinal cord injury (n = 2,283)

TSCI characteristics	Organizational model of the medical care system			P-value (assessment of set homogeneity)	
	type I (n = 306)	type II (n = 454)	type III (n = 1523)	types I and II	types II and III
Localization of spinal injury, n (%)					
Lower cervical spine (C3–C7)	45 (14.7)	51 (11.2)	166 (10.9)	0.158	0.842
Thoracic and lumbar spine	261 (85.3)	403 (88.8)	1357 (89.1)		
Type and severity of injury, n (%)					
Isolated uncomplicated	208 (68.0)	301 (66.3)	948 (62.2)	0.167	0.272
Isolated complicated	81 (26.4)	111 (24.4)	426 (28.0)		
Traumatic spinal cord injury among polytrauma cases	17 (5.6)	42 (9.3)	149 (9.8)		

Table 3

Assessing the homogeneity of patient groups at the stage of analyzing treatment outcomes (n = 267)

Characteristics of groups of patients	Organizational model of the medical care system			p-value (assessment of group homogeneity)	
	typeI (n = 44)	type II (n = 75)	type III (n = 148)	types I and II	types II and III
Gender, n (%)					
Female	23 (52.3)	34 (45.3)	53 (35.8)	0.465	0.168
Male	21 (47.7)	41 (54.7)	95 (64.2)		
Age, years					
Min/Max	19/78	18/77	19/76	0.954	0.784
Me ($25^{th} - 75^{th}$ percentile)	35.5 (30–56)	39 (31–46)	38(30–46)		
Overall severity of injury (ISS scale), n (%)					
17 or less points	40 (90.9)	69 (92.0)	132 (89.2)	1.000	0.669
More than 17 points	4 (9.1)	6 (8.0)	16 (10.8)		
Localization of spinal injury, n (%)					
Lower cervical spine (C3–C7)	4 (9.1)	8 (10.7)	17 (11.5)	0.841	0.660
Thoracic spine	12 (27.3)	17 (22.6)	26 (17.6)		
Lumbar spine	28 (63.6)	50 (66.7)	105 (70.9)		
Type of spinal injury (AO classification), n (%)					
A (A3–A4)	36 (81.8)	63 (84.0)	123 (83.1)	0.794	0.898
B	5 (11.4)	9 (12.0)	17 (11.5)		
C	3 (6.8)	3 (4.0)	8 (5.4)		
Severity of neurological disorders (ASIA scale), n (%)					
A	2 (4.5)	2 (2.7)	7 (4.7)	0.915	0.844
B	5 (11.4)	12 (16.0)	19 (12.8)		
C	4 (9.1)	8 (10.7)	13 (8.8)		
D	1 (2.3)	1 (1.3)	1 (0.7)		
E	32 (72.7)	52 (69.3)	108 (73.0)		

that provided improvement in the quality of life, neurological status, and patient satisfaction with the outcome (Table 8). The centralization factor had no significant effect on these parameters.

Discussion

The key goal of national clinical guidelines is to achieve high treatment outcomes in patients. Therefore, the discussion of organizational factors of the system for medical care delivery to TSCI patients should give a clear answer to the question of which of them (profiling of medical institutions or centralization of

Table 4
Structure of in-patient flows

Groups of neurosurgical pathology	Organizational model of the medical care system					
	type I		type II		type III	
	n	%	n	%	n	%
Structure of overall flow of hospitalized patients						
Spinal pathology	1033	N/C	960	75.7	2405	95.2
Other pathology	No data		308	24.3	121	4.8
p-value	p (I vs II) — N/C; p (II vs III) < 0.0001					
Structure of incoming flow of spinal patients						
TSCI	306	29.6	454	47.3	1523	63.3
ANTSP	431	41.7	302	31.5	786	32.7
Spinal diseases*	296	28.7	204	21.3	96	4.0
p-value	p (I vs II) < 0.0001; p (II vs III) < 0.0001					

n — number of patients; N/C — not calculated; TSCI — traumatic spinal cord injury; ANTSP — acute non-traumatic spinal pathology; *elective hospitalization.

patient flows) has a primary influence on the maximum system efficacy. Centralization of emergency spinal care within a constituent entity of the Russian Federation is undoubtedly important for the rational use of medical care resources, but the primary role is entirely played by the profiling of a medical institution that provides specialized medical care to patients of this category.

Speaking about the profiling of a hospital in the field of emergency spine surgery, it is very important to set clear criteria that should be met by a conventional department of spine surgery or a functional center. The leading position in this list is occupied by an indicator such as the profile of its surgical activity in the field of traumatology, orthopedics, and neurosurgery. Our findings confidently suggest that it is determined by the structure and minimum annual number of performed surgical interventions: in our opinion, the total percentage of spinal interventions should be at least 90 %; of these, the percentage of operations for acute surgical pathology should be at least 75 %, and the number of surgeries for acute TSCI should be at least 100 per year.

The role of other criteria entirely follows from the profiling of a medical unit and, accordingly, the medical institution comprising the unit. This includes four requirements listed below. Their identification was not included in the objectives of this study because they had been previously presented in publications of some authors of this paper as well as in reports of other specialists [8–14]. However, given the need for improving the current national clinical guidelines, it is

Table 5
Structure of surgical interventions

Surgical groups	Organizational model of the medical care system					
	type I		type II		type III	
	n (n'/n")	%	n (n")	%	n (n")	%
Overall structure of surgeries						
Spine surgery	516 (516/86)	N/C	805 (268)	72.3	2049 (512)	94.4
Other surgeries	No data		308 (103)	27.7	121 (30)	5.6
p-value	p (I vs II) — N/C; p (II vs III) < 0.0001					
Structure of spine surgeries						
TSCI	125 (125/21)	24.2	364 (121)	45.3	1265 (316)	61.7
ANTSP	97 (97/16)	18.8	237 (79)	29.4	688 (172)	33.6
Spinal diseases*	294 (294/49)	57.0	204 (68)	25.3	96 (24)	4.7
p-value	p (I vs II) < 0.0001; p (II vs III) < 0.0001					

n — total number of operations; n' — mean annual number of operations in the city; n" — mean annual number of operations per hospital; N/C — not calculated; TSCI — traumatic spinal cord injury; ANTSP — acute non-traumatic spinal pathology; *elective hospitalization.

Table 6

Indicators of surgical activity in treatment of patients with traumatic spinal cord injury (TSCI) within the framework of various organizational models of the medical care system

Organizational model of the medical care system	TSCI variant						Total	
	isolated uncomplicated		isolated complicated		among polytrauma cases			
	n	%	n	%	n	%	n	%
Total number of operations (surgical activity, %)								
Type I (N = 306)	34	16.3	78	96.3	13	76.5	125	40.8
Type II (N = 454)	212	70.4	111	100.0	41	97.6	364	80.2
Type III (N = 1,523)	694	73.2	426	100.0	145	97.3	1265	83.1
p-value (I vs II)	<0.0001		0.0735		0.0212		<0.0001	
p-value (II vs III)	0.3474		—		1.0000		0.1568	
*Number of urgent operations**								
Type I (N = 306)	3	8.8	29	37.2	0	0.0	32	25.6
Type II (N = 454)	132	62.3	93	83.8	21	51.2	246	67.6
Type III (N = 1,523)	465	67.0	365	85.7	93	64.1	923	73.0
p-value (I vs II)	<0.0001		<0.0001		0.0007		<0.0001	
p-value (II vs III)	0.2027		0.6153		0.1338		0.0444	

N — number of hospitalized patients; n — number of operated patients; *percentage of the total operations.

advisable, on the one hand, to reiterate their names and main content and, on the other hand, supply them with some new fundamentally important points arising from this study.

1. The multidisciplinary medical institution comprising the emergency spine surgery unit. For TSCI patients, this circumstance is essential because only the conditions of this hospital provide an urgent solution to all the necessary diagnostic and therapeutic tasks. This medical institution should provide round-the-clock admission of patients with urgent conditions, including those with polytrauma, their examination using highly informative diagnostic technologies (CT and MRI), and subsequent provision of them with all the necessary urgent specialized medical care. Given the modern organization of the domestic system of medical care delivery to injury patients, only a level I trauma center can operate as such a hospital. On the other hand, not every level I trauma center should be profiled in emergency spine surgery: during this study, we proved importance of the centralization factor within a constituent entity of the Federation. In turn, the number of level I trauma centers comprising the discussed profiled units should be determined by the specific local conditions for each constituent entity of the Federation: the size and density of the population of both the given region and adjacent territories, their possible fluctuations, rate of TSCI, location of medical institutions, their transport accessibility, etc.

The question of reasonability of establishing a similar profiled medical unit within a mono-disciplinary medical institution operating in the field of traumatology and orthopedics or neurosurgery (usually, a federal center or research institute) is ambiguous. On the one hand, such clinics have the widest range of modern diagnostic and treatment technologies in their arsenal, their activities are supported with sustainable federal funding, and highly professional medical personnel are concentrated there. However, their activities are largely focused on elective surgical treatment of profiled patients; for this reason, their ability to provide comprehensive urgent care to patients with acute, and especially multiple and concomitant, injuries is rather limited.

2. Adequate material and technical resources of the hospital. To provide early and comprehensive specialized surgical care to TSCI patients, it is necessary to allocate a specialized operating unit equipped with modern equipment, instruments, and consumables, which are essential to enable the main types of spine surgeries, primarily in an emergency.

3. Special training of medical personnel implies not only a high professional level of doctors directly involved in spine surgery but also specialists of the anesthesiological and intensive care service and radiologic diagnostics, as well as nursing and paramedical stuff involved in the treatment of patients. However, it should be remembered that in the current domestic health care, it is rather difficult to distinct between the responsibilities of spinal surgeons with education in traumatology/orthopedics and neurosurgery. As a solution, we may suggest that an appropriate treatment unit should include specialists with basic (in the form of clinical residency or internship) education in both neurosurgery and traumatology/orthopedics. However, both of them should have additional skills in

Table 7

Rate of local surgical complications in patients with traumatic spinal cord injury in different models of the medical care system

Complication	Organizational model of the medical care system					
	type I (n = 44)		type II (n = 75)		type III (n = 148)	
	n	%	n	%	n	%
Infectious-necrotic, total	2	4.5	5	6.7	6	4.1
including marginal wound necrosis	1	2.3	2	2.7	3	2.0
superficial wound infection	1	2.3	2	2.7	2	1.4
deep wound infection	0	0.0	1	1.3	1	0.7
Fracture/migration of implants	1	2.3	1	1.3	2	1.4
Local complications, (total)	3	6.8	6	8.0	8	5.4
p-value						
all complications	p (I vs II) = 1.0000;		p (II vs III) = 0.6437			
infectious complications complications	p (I vs II) = 1.0000;		p (II vs III) = 0.6003			
due to internal constructs	p (I vs II) = 1.0000;		p (II vs III) = 1.0000			

emergency spine surgery in the form of short-term training courses provided by the modern domestic system of continuous medical education, experience in participating/performing operations for urgent spinal pathology, and permit to work with radiation in the X-ray operating room.

4. Sustainable financing of high-tech medical care within the framework of federal and regional quotas, which is sufficient for the use of modern diagnostic and surgical technologies in the amount of at least 150 operations per year. Traditionally, it is believed that this requirement applies only to the procurement of implants for spine surgery, but in practice it also includes the costs of procurement, repair, maintenance, and modernization of equipment and instruments, as well as consumables for them (in particular, disposable or short-term use parts). In addition, an important difference between modern spine surgery and most other areas of traumatology, orthopedics, and neurosurgery is that the funding scheme should enable high-tech surgical interventions not only in an elective or delayed manner but also in the framework of emergency specialized care.

Table 8

Final results of treatment of patients with spinal cord injury in different models of system for delivering medical care (24 months after surgery)

Evaluation criteria	Organizational model of the care delivery system		
	type I (n = 44)	type II (n = 75)	type III (n = 148)
Quality of life according to ODI, points			
Median	26.4	15.6	15.6
25th percentile	24.0	13.3	13.3
75th percentile	30.0	17.8	16.0
p-value*	p (I vs II) < 0.0001		p (II vs III) = 0.8075
Neurological status according to ASIA, n /%			
Improvement ≥ grade 1	5/41.7	20/87.0	32/80.0
No change	7/58.3	3/13.0	8/20.0
p-value*	p (I vs II) = 0.0146		p (II vs III) = 0.7319
Comprehensive assessment of treatment outcome according to the MacNab scale, n /%			
Excellent or good	25/56.8	61/81.3	124/83.8
Satisfactory	15/34.1	13/17.4	23/15.5
Unsatisfactory	4/9.1	1/1.3	1/0.7
p-value*	p (I vs II) = 0.0039		p (II vs III) = 0.6457

*comparison of the frequency of (excellent + good) results relative to others.

Conclusions

1. The treatment efficacy of acute TSCI patients largely depends on the effect of centralization and profiling factors that determine the structure and organization of the medical care system at the level of a federal subject and a hospital where patients are admitted for treatment.

2. Despite the fact that establishment of specialized departments (or centers) of emergency spine surgery as part of multidisciplinary ambulance hospitals – level I trauma centers (profiling factor) – provides high treatment outcomes in TSCI patients, it does not contribute to the effective organization of activities of the involved medical institution. An indispensable condition for effective organization of activities is the introduction of a centralized organizational model for medical care delivery at the level of a constituent entity of the Federation, which encompasses all essential elements of the entity's health care system.

3. A clear definition of the evacuation purpose and formulation of the requirements to be met by a medical institution involved the treatment of TSCI patients are the main directions for improving the relevant national clinical guidelines.

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On the basis of the study results, the authors have brought up the following version of Section X "Organization of medical care delivery" of the national clinical guidelines for the treatment of patients with any TSCI variants in terms of the stages of medical care delivery for an open discussion by the professional community of spinal surgeons of the Russian Federation.

Recommendations

After providing all the necessary medical care at the scene of the accident, the patient with suspected TSCI is delivered by ambulance to the nearest medical institution – a level I trauma center comprising a conventional medical department of emergency spine surgery, or to a similar functional center, which meet the following requirements:

– total percentage of spine surgeries accounts for at least 90 % of all interventions, with surgeries for acute spinal pathology amounting to at least 75 % and for acute TSCI amounting to at least 100 operations per year;

– medical staff of the department (center) includes specialists with basic postgraduate medical education to the extent of clinical residency (or, as an exception, internship) both in neurosurgery and in traumatology and orthopedics, with additional specialization in emergency spine surgery mandatory for each of them;

– presence of a separate X-ray operating room available 24 hours a day and provided with equipment, instruments, implants, and consumables necessary to perform modern high-tech spine surgeries in the amount of at least decompression of neurovascular structures and instrumented fixation of the spine through traditional open and (according to indications) extended posterior approaches.

If evacuation of the patient with suspected TSCI to a specified medical institution is impossible, the patient can be hospitalized and treated in other level I trauma centers as well as in level II trauma centers, provided that the following conditions are met:

– they comprise conventional neurosurgical and trauma (traumatology and orthopedics) departments whose specialists have additional specialization in emergency spine surgery;

– total number of operations for acute TSCI is at least 100 per year;

– volume of surgical care provided for acute TSCI should not go beyond the scope of traditional open surgery for decompression of neurovascular structures and instrumental fixation of the spine, including the use of (if indicated) extended posterior approaches.

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