Original Articles

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"3DT" concept as a model for integrating trauma and orthopedic services into priority areas of development and national projects of the Russian Federation

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Introduction In the year of anniversaries of two leading national centers for traumatology and orthopedics, the authors analyzed the main problems and current challenges in specialized trauma and orthopedic care (TOC). Historical parallels in the development of TOC in our country and its problems and trends abroad motivated the authors to conduct an analysis while the need for their comparative assessment determined the purpose of the work which is a brief analysis of the organizational model of TOC and substantiation of a "3DT" concept as a contemporary organizational model of trauma and orthopedic service in the Russian Federation. **Results and discussion** The analysis of current trends in the trauma and orthopedic (TO) service showed its variability over the past three decades. However, the original organizational structure of specialized TO care remained almost the same. A comparative assessment of organizational models has shown that the models for providing specialized care in developed countries are extremely diverse. The availability of assistance does not depend on the population density and tariffs even in the regions of developed countries. In addition, the monetary assessment of treatment of spinal pathology, as an example, has not been standardized and harmonized across countries and regions. It is also important to evaluate the steady increase in high technology care with the use of more developed systems of diagnosis, treatment, rehabilitation and, accordingly, its growing costs. The challenges that our specialty faces may be conditionally divided into technical, socio-economic and organizational ones with the need to create a clear vertical structure of organization, control and referral of patients with organizational decisions for selection of patients with a TO profile according to flows within various areas of subspecialties, the need for justification and feed-back control of financing systems for various types of TO assistance. The challenges described above motivated us to propose a new "3DT" organizational concept as a basis for a more stable and understandable model for the functioning of the national trauma and orthopedic service. The proposed basic model includes 4 direction sectors: D1 (pediatric diseases of the musculoskeletal system and their outcomes); D2 (degenerative and involuntary pathology of the musculoskeletal system); D3 (destructive diseases of the musculoskeletal system of tumor or infectious origin); T (trauma of the musculoskeletal system and its consequences), that all have fundamentally different approaches to organization and planning. The main requirement for the model is its simple application by all participants directly or indirectly involved in the provision of care: orthopedic and trauma specialists, doctors of other specialties, authorities and financial institutions, patients, their relatives and patient communities. **Conclusion** The advantages of the 3DT model lie in the possibility of extrapolating this concept to any region of the Russian Federation, taking into account the difference in their resources. The integral criterion of its effectiveness may be the assessment of the development of these areas as a whole, rather than separate types of assistance. In each sector, it is necessary to indicate the basic, additional and optional amount of assistance. All regions must have the basic level, while the state funding of additional and, moreover, optional assistance should not be carried out without providing the basic one.

Keywords: orthopedics, traumatology, organizational issues, amount of care, stages, care grading, socio-economic problems, patient routes

INTRODUCTION

In 2021, in the anniversary year for traumatology and orthopedics in Russia, the authors considered it correct to trace the success, problems and trends in the organization and management of the trauma and orthopedic (TO) service in the Russian Federation.

Two leading national medical specialized TO centers of the country, the Ilizarov Center and the Priorov Center, celebrate their anniversary dates.

On June 15, 2021, the world orthopedic community will celebrate the 100th anniversary of Gavriil Abramovich Ilizarov. The laws he had discovered and the method he had developed did not originate by chance in the difficult post-war years in the conditions of scarce resources and a huge need for care. Organizationally, Academician G.A. Ilizarov proposed the most adequate system for that historical period not only due to the

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medical technology but also to provision of resources, or, in the modern sense, services. It included a unified scientific, clinical, educational and production unit able to expand, and not only in the USSR. The Ilizarov method should be recognized as the first domestic concept of a personalized approach based on a set of unified tools, cheap to manufacture, which enabled to solve the most acute problems of specialized TO assistance at that time. Treatment of injuries and their consequences were clear priorities for the state and industry. The issues of quality of life and treatment of degenerative diseases of the musculoskeletal system were "hidden" within the specialty and did not have the status of "significant" issues in the development of the country in general and in the TO specialty in particular.

Founded by Nikolai Nikolaevich Priorov in 1921, the Medical Prosthetic Institute of the Moscow Department for Public Health became the Central Institute for Traumatology and Orthopedics in (CITO) in 1940. Research institutes set up across the country provided what we today call high-tech assistance. Each of them developed their own scientific schools, which became the basis of current orthopedic subspecialties. In 2019, CITO became the first specialized center entrusted with large-scale tasks in the development of a national network of research centers.

The 100-year history of CITO marked with the world's first endoprostheses developed by K.M. Sivash, an ultrasonic system for cutting bones, assistance to patients with systemic and oncological diseases of the skeleton, as well as the famous clinic of sports and ballet trauma, proves that the USSR and later the Russian Federation remain in the main trend in the development of world orthopedics. At the same time, resources and technological support as well as technology expansion were at a low level. Understanding how many people in need could be provided with 2–3 thousand operations per year in each of the leading centers of the country, we must admit that this low availability of high-tech TO care was compensated by a developed network of sanatoriums, health resorts and outpatient care, developed social support and the generally lower expectations of the population.

Historical parallels in the development of TO care in our country along with its problems and trends abroad motivated the authors to conduct an analysis, while the need for their comparative assessment determined the **purpose** of the work which is a *brief analysis of the organizational model of TO assistance and substantiation of a "3DT" concept as a contemporary organizational model of trauma and orthopedic service in the Russian Federation*.

RESULTS AND DISCUSSION

Current trends in TO service

Healthcare modernization programs and the reality of society's expectations in contemporary Russia have changed the "traumatological and orthopedic map" of the country. The number of federal research institutes has dropped sharply. Various institutions, including private clinics, have been actively providing high-tech care, and the number of such operations has increased immensely. Foreign medical devices or domestically produced implants manufactured as imported analogs have been mostly used. New opportunities, as has always happened in history, multiply and complicate problems, especially organizational ones. The interests of society and the modern rhythm of life have shifted the emphasis from reconstructive interventions in acute trauma and its consequences to the treatment of degenerative pathology of large joints and the spine using high-tech implants.

Current comparative evaluation of organizational models

Models of providing specialized care in developed countries are extremely diverse. It is interesting that the system of patient routes and tariffs and costs of care is extremely diverse even within one country. Of course, the organization of TO service is determined by the state structure in general and the health care system in particular, but the latter varies much and depends on population density and the availability of specialized and high-tech care [1]. Thus, in the United States, it depends to a greater extent on the population density of each state with the standardization of cost rates for treatment by insurance companies. In the states with a high population density, even at large centers providing all types of TO care, a large choice of patients determines a lower probability of selection for treatment of patients with a priori more severe pathology. In less populated states, less choice means a higher likelihood of timely selection for treatment and vertical routing of patients to a specialized care center [2–7]. Interestingly, but the seemingly logical decision to increase treatment costs and their regulation in different states cannot not solve this problem [8, 9].

Studies show that there is no dependence on the growth of tariffs for the provision of specialized care and even the expansion of coverage with insurance programs with the effectiveness of treatment [10]. In addition, the monetary value of treatment, for example, for spinal pathology, is not standardized and

not consistent across countries and regions [11].

It is necessary to note the steady increase in the technology of care with the use of more developed systems for diagnosis, treatment, rehabilitation and, accordingly, an increase in its cost.

The trend towards the use of evidence-based treatment methods has led to a clear planning of surgical actions and control through the integration of medical optic, neuromonitoring, navigation, robotic systems and artificial intelligence ("Intelligence-Based Model Care") [12–16].

However, the evidence-based model, based on the analysis of evidence, suffers from a lack of high-level (I–II) evidence (eg. randomized controlled trials), especially in highly specialized areas, and, as a result, underreported, such as trauma and pediatric orthopedics, outcomes of pediatric pathology in adulthood [17].

It is necessary to use models based on the control of results and their evaluation (outcomes-based model and value-based model), which can be used to calibrate the amount of funds spent on treatment. Lower expenditures may disproportionately favor less expensive and less effective treatments.

The current state of medicine is defined by the 4 "P" format: personalized (an individual approach to each patient), predictive (prediction probability of health condition), preventive (preventing the occurrence of diseases), participatory (motivated patient's participation) [18–22].

In general, the challenges facing our specialty may be conditionally divided into technical, socio-economic and organizational.

The *technical* ones include:

– Tendency towards surgical methods in a shortage of evidence-based methods of conservative treatment for a quick return of patients to work;

– Necessity to use expensive equipment for examination, treatment and rehabilitation;

– Growing complexity of treatment with a long learning curve of medical and nursing staff and their superspecialization;

– Increase in the number of post-implantation complications, including those requiring revision interventions.

Social and economic challenges include:

– Increased demands on the part of patients for quality and volume of medical care;

– Growth in the number of patients while state funding for specialized care is stagnant;

– Aging of the population associated with a natural deterioration in health and increased demands for treatment of musculoskeletal system diseases accompanied by concomitant diseases;

– Growing costs of treating both the underlying disease and complications;

– Shift of the organizational and financial issues of planning towards the use of expensive short-term high-tech treatment methods without long-term hospitalization and inpatient rehabilitation in the absence of a direct dependence of short-term targeted surgical treatment using high-tech methods (reducing surgical aggression with clear control of surgical actions) with the integral cost of the actual treatment provided;

– Uneven development of the issues of legal regulation of doctor's activities and patient's responsibility;

– Sharp inequality in personnel, resources and financial support between regions and clinics;

– Growth in economic and status differences between specialists within the specialty ("proletarianization" of personnel).

Organizational challenges include:

– Need for a wider coverage of high-quality advisory specialized assistance, which requires the development of translational medicine or telemedicine [23, 24];

– Substantiation of the stages of regulatory documents introduction (recommendations, procedures, standards) with temporary and organizational and legal approval of the status of temporary ones, their pilot testing in the regions, adjustment with subsequent approval;

– Possibility of generating statistical forms integrated into vertically integrated medical information systems (VIMIS);

– Organizational justification of the levels of "technology safety", which requires a clear standardized registration of complications, justification of criteria for assessing the quality of medical care;

– Drawing parallels with the procedures for organizing medical care, establishment of the professional standard of a trauma and orthopedic surgeon;

– Integration of grounded competences (professional standard) and types of their control (clinical guidelines) into educational programs and certification.

Thus, the first is to raise the question on the need *for a clear vertical structure of organization, control and routing of patients. Second, organizational decisions are required for the selection of patients with a TO profile according to flows within various areas of a subspecialty; and third, the need to substantiate and reverse control of funding systems for various types of TO care*.

The challenges described above motivated us to propose a new concept as a basis for a more stable and understandable model for functioning of the national trauma and orthopedic service.

The proposed basic model identifies 4 sectors-directions that have fundamentally different approaches to organization and planning. The main requirement for the model is its simple use by all participants directly or indirectly involved in the provision of care: orthopedic and trauma surgeons, doctors of other specialties, authorities and financial institutions, patients, their relatives and patient communities.

Concepts

We present a brief characterization of the model, which we called "3DT", an acronym for the main directions of the specialized care model (Table 1).

Table 1

Description of the main directions of 3DT model of specialized care

Direction	Main age group	Incidence	Characteristics	Priority of actions	Participants (sequence is important)
D1 Pediatric disorders, developmental diseases (malformations of the musculoskeletal system)	0 – ∞	Approximately 5–10 % of the population; statistics require study Confusion in concepts and terminology Staged prenatal diagnosis and multidisciplinary support The real need for surgical treatment is about 1 %	Primary: malformations; osteochondropathy; idiopathic pathology. Secondary: genetic diseases; dysplasia; accumulation diseases; rheumatic diseases; orthopedic complications of neurological lesions (cerebral palsy, spinabifida, trauma of the brain, spinal cord, nerves).	Early diagnosis Surgery as an element of complex rehabilitation or a procedure due to despair Family-oriented approach Help with career guidance, hobby choices and physical activity The principle of "age continuity" as a standard in the provision of care Integration with NMRC in other specialties Formation of uniform registries with passports of regions Development of draft registers integrated into VIMIS Timely treatment Conservative treatment Orthotics	Parents Social organizations Educational institutions Pediatricians Pediatric surgeons orthopedic surgeons Rehabilitation specialists Neurologists Specialists in genetics Physicians
D2 degenerative diseases and involuntary changes of the musculoskeletal system)	40 – ∞	100 % of the population in the old, senior and elderly age groups Clarification and unification of terminology is required	Degenerative joint diseases: – hip – knee – shoulder etc. Degenerative diseases of the spine: – spinal stenosis – deforming spondylosis – herniated discs – degenerative scoliosis Pathological fractures associated with osteoporosis: – femoral neck – vertebral bodies Age-related periarticular deformities Rheumatoid diseases Foot deformities.	Advocacy and creating conditions for a healthy lifestyle Family-oriented approach Prevention of occupational diseases Treatment of concomitant diseases Psychological health Patient Schools Conservative treatment Surgical interventions delaying joint arthroplasty Endoprosthetic and decompression and stabilization interventions on the spine Criteria for evaluating indications for surgical treatment and its effectiveness Selection of treatment methods	Patients Employer Mass media Specialist in pain care Physicians Rehabilitation specialists (including nurses, specialists in non-traditional medicine, fitness, physical exercises therapist) Orthopedist Neurosurgeon
D3 Destructive diseases of tumor or infectious origin affecting the musculoskeletal system	0 – ∞	Less than 1 % of the population Accurate registration is possible Terminology is generally established	Metastases Primary tumors Osteomyelitis	Timely diagnosis (including schools for doctors and the public to identify "red flags") Development of highly specialized surgical centers and departments	Physicians and Pediatricians Surgeons Oncologists Orthopedists Neurosurgeons
T njuries of the musculoskeletal system and their consequences	0 – ∞	About 10 % of the population, mostly minimal damage Accurate registration is possible Uniform terminology has not been established (different classifications, terms or descriptive concepts are used)	Isolated injuries Combined injuries Pediatric trauma (specific features for diagnosis and treatment exist on average up to 12 years, then as in adults)	Prevention of sports, traffic and occupational injuries First aid training for the public and emergency services The trend towards minimally invasive and fast treatment on an outpatient basis or with a short inpatient stay and early activation of patients Polytrauma centers for severe and concomitant injuries A traumatologist as an organizer of a multidisciplinary team in polytrauma Referral to highly specialized clinics (reconstructive orthopedics and treatment of spinal trauma) in case of consequences Adoption of a single classification, unified with the international one (AO)	Accessible and Safe Habitat Specialists Traumatologists and paramedics of trauma centers and primary care Ambulance workers Resuscitators Trauma surgeons (not orthopedists) Orthopedists specializing in the provision of emergency orthopedic care (osteosynthesis) Podiatrists specialized in reconstructive surgery Burn surgeons Plastic surgeons

Notes: MSS – musculoskeletal system; CP – cerebral palsy; NMITS for TO – national medical centers for traumatology and orthopedics; VIMIS – vertically integrated medical information systems

D1 (**Pediatric** diseases of the musculoskeletal system and their outcomes) malformations and developmental disorders that occur in the course of human growth and development, as well as orthopedic complications of hereditary and systemic diseases. In most cases, they are detected in childhood; however, the clinical signs may appear also in adulthood. They are classified as civilizational diseases with a tendency to gradual growth of incidence, both due to the improvement of diagnostic methods and criteria, and the use of targeted therapy for major diseases that increase life expectancy, but do not prevent the development of pathology of the musculoskeletal system. For their management, it is necessary to implement the principles of interinstitutional, interdisciplinary and age continuity in treatment. Most of the D1 syndromes and nosologies, such as scoliosis, cerebral palsy, spinabifida, clubfoot, require development of national assistance programs and patient-oriented rehabilitation, including surgical, and their treatment cannot be limited by an insured event. The key criteria of the efficiency are a decrease in child mortality rates, an improvement in the functional status and quality of life of patients and their parents. It is possible to register patients of this group within the framework of registers for the implementation of medical and social assistance programs. It is also very important to work with patients, their parents and loved ones in the format of patient organizations, inclusive education and social. This sector may only be partially introduced in insured events.

D2 (**degenerative and involuntary pathology** of the musculoskeletal system) autonomously develops in the population with manifestations most frequently after 40 years of age. The group is supplemented by earlier types from D1 and post-traumatic arthrosis, as well as osteoporosis causing low-energy fractures and their consequences in elderly and senile people. It refers to civilizational diseases with a steady tendency towards an increase in clinical manifestations. It is the main consumer of the health care system resources, including the TO care. Not a single system of assistance in the world can provide this segment with high quality without co-funding.

It requires multidisciplinary management and continuity at the intersection of reconstructive orthopedics, rehabilitation, therapy, geriatrics. Orthopedic reconstructive treatment should be targeted. It should be noted that deviation from this principle leads to a progressive increase in the number of complications and a steady increase in revision interventions in the current period. The main criterion for efficiency is maintaining the level of functional activity and quality of life. The provision of assistance within the framework of the insurance system alone leads to an observed deterioration in the availability and quality of care. At the moment, it manifests itself in the chaotic expansion in the use of primary arthroplasty with the impossibility, however, to shorten the extensive waiting list, as well as to control the quality and growth of complications and revisions. This profile group serves as example of the continuing degradation of the remnants of the conservative treatment system in polyclinics and sanatoriums, since it is extremely difficult to introduce them into payment for an insured event in the absence of an interdisciplinary concept of rehabilitation. We emphasize that surgical rehabilitation may only be its stationary stage with reasonable control points of observation. Interdepartmental and interdisciplinary programs are needed with the involvement of the media and the education system. To date, only one program has started to help elderly patients with low-energy injury of the proximal femur. D2 cannot be immersed only in regional aid systems, since regions with a large percentage of the elderly population will significantly lag behind, and their most often deficient compulsory medical insurance funds will simply not be able to cope with the load. This requires a different concept of planning specialized care and its interdisciplinary continuity. The potentially total occurrence of this "supernosological" direction (clinical manifestation determines the extreme variability of the statistical frequency) determines the impossibility and senselessness of formal statistical counting. Registration of patients is possible only with clear clinical manifestations within the framework of vertically integrated medical information systems and registers, and the emphasis of rehabilitation should be shifted towards improving functional adaptation and quality of life.

D3 (**destructive diseases** of the musculoskeletal system of tumor or infectious origin) A well-defined, predominantly surgical and a relatively small group of patients. There is a constant increase in the number of patients with post-implantation infectious complications. Personalized registration of patients of this group is possible (registries). The main criterion for effectiveness is a 5-year or more survival, as well as a decrease in the disability rate. At the same time, assistance should be provided only in specialized centers. It can be completely included into insurance events and removed from the competition for surgical assistance at the expense of the D2 sector.

T (musculoskeletal system **trauma** and its consequences) It is actually a classical direction of surgical work, and abroad it is urgent orthopedics. This group requires strict standardization in terms of equipment and types of assistance provided. The main criterion of effectiveness is a decrease in mortality and disability after injuries in regard to the number of consequences of injuries. The main Russian and world tendency is an early minimally invasive surgical care (osteosynthesis) followed by active inpatient and outpatient rehabilitation. This group has clearly "measurable" pre- and postoperative criteria for assessing functional status and quality of life. It should be fully included into insurance events and removed from the competition for surgical assistance at the expense of the D2 sector.

CONCLUSION

Thus, the 3DT model may be fundamentally divided into 2 main groups: D1–D2 requiring implementation through national (federal) programs with a priority on the 4P concept and D3–T requiring a greater emphasis on standardization and inclusion into the compulsory medical insurance.

In contrast to patients in groups D3 and T, for group D2, the inclusion criteria and indications for surgery can be easily substituted, "blurred" and, with more favorable payments per case and greater resource intensity, will inevitably lead to an unregulated increase in cases due to the summation of efforts to find "profitable patients" on the part of medical organizations with increasing demands from the society. This will lead to an even more serious imbalance in the work of the health insurance system. Thus, it is required to register patients of group D2 through registers, and the provision of high-tech care for degenerative diseases of large joints and the spine must be strictly regulated. To help this group of patients, it is necessary to actively involve conservative treatment and prevention programs. The D2 sector will most urgently need co-financing due to the high cost of high-quality and innovative implants and the difficulty of ensuring equal quality of care with high levels of social inequality.

The advantages of the 3DT model lie in the possibility of extrapolating this concept to any region of the Russian Federation, taking into account the difference in their resources. The integral criterion of its effectiveness may be the assessment of the development of these areas as a whole, rather than separate types of assistance.

In each sector, it is necessary to indicate the basic, additional and optional amount of assistance. All regions must have the basic level, while the state funding of additional and, moreover, optional assistance cannot be carried out without providing the basic one.

These circumstances might require revision of both the federal clinical guidelines, procedures and standards of care and their integration into the professional education platform.

Authors' comment *The authors will be grateful for any feedback and look forward to an open and constructive dialogue about the prospects for the development of specialized TO care.*

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