

REVIEW

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Subject: Dissertation by Dr. Svetoslav Kirilov Todorov, supervised by Prof. Dr. Yavor Enchev, on the topic "Organization of Neurosurgical Care in Bulgaria – Comparative Analysis" for the awarding of the educational and scientific degree "Doctor" in the scientific specialty "Neurosurgery"

According to Order No. R – 109 – 185 dated April 8, 2025, issued by the Rector of the Medical University "Prof. Dr. Paraskev Stoyanov" – Varna, and based on a report by Prof. Yavor Enchev, D.Sc. – Head of the Department of "Neurosurgery and ENT Diseases" (Protocol No. 37 dated March 31, 2025, of the Faculty Council and report with incoming No. 103-1748/02.04.2025 from the Dean of the Faculty of Medicine at the Medical University – Varna).

All conditions and deadlines required by the Law on the Development of the Academic Staff in the Republic of Bulgaria have been observed, as well as the Regulations of the Medical University "Prof. Dr. Paraskev Stoyanov" – Varna for the development of the academic staff at the university.

Dr. Svetoslav Todorov was born in 1988 in the city of Pazardzhik, where he completed his secondary education at the Bertolt Brecht Language High School with excellent success. In 2014, he completed his medical education at the Medical University in the city of Pleven and began work in the multidisciplinary emergency department at UMHAT Burgas, and a year later he was already a doctor in the Neurosurgery Department at the same hospital. After a competition in 2024, he was appointed as a part-time assistant in the same department, but now at the Faculty of Medicine of the University "Prof. Dr. Asen Zlatarov." Since February 2005, he has been appointed as a full-time assistant at the same university, in the Department of "Anesthesiology, Obstetrics and Gynecology, Surgery, Orthopedics and Traumatology, Urology, Neurosurgery, Emergency and Intensive Medicine." Meanwhile, in 2021, he was recognized with the specialty Neurosurgery. He is actively involved in the surgical, consultative, and scientific activities of the Faculty of Medicine. At the beginning of 2022, he was appointed Deputy Director of UMHAT Burgas, JSC. On 16.03.2023, he was enrolled as a doctoral student in independent form of education with scientific supervisor Prof. Yavor Enchev at the Medical University Varna with the topic "Organization of Neurosurgical Care in Bulgaria – Comparative Analysis," which he is currently presenting for public defense. He also holds a recognized Master's degree in "Public Health and Health Management." He is a member of the "Bulgarian Society of Neurosurgery" and the "Bulgarian Association of Spinal Surgeons." He uses English and French, both written and spoken. He has undergone additional medical training through courses in "Skull Base Surgery," "Clinical Electroencephalography," "Basics of Degenerative Deformities," "Pediatric Neurosurgery," "Biomedical Imaging – Varna." Participation with presentations and verified by printed

abstracts at national conferences and congresses – presented 19, scientific articles published in full – presented 11.

The dissertation is current and of significant social importance. The chosen topic covers the state of neurosurgical care in Bulgaria, which suffers from a number of serious problems related to the distribution of healthcare facilities, the organization of consultative care, the material provision of individual units, the grading of the activity of the individual units, the quantitative and qualitative assessment of neurosurgical activity. These are problems that have remained unchanged for years and are an obstacle to proper forecasting, regional planning, and financing of neurosurgical care in Bulgaria.

The presented dissertation is written on 129 pages, contains 6 tables and 48 figures. The literature review includes 104 titles, of which 14 are in Cyrillic, the rest – in Latin script. The literature sources are related to the topic of the dissertation and are adequately selected in accordance with the content of the dissertation. The dissertation itself is written in grammatically and stylistically correct Bulgarian. In connection with the dissertation, two full-length articles and two summarized poster presentations at congresses have been submitted.

The aim of the dissertation is to present, analyze, and compare the current state and organization of neurosurgical care in Bulgaria. To develop perspectives and recommendations for its improvement. The working conditions and organization of various healthcare institutions are compared, as well as with a country that has a well-developed and socially oriented healthcare system – Germany, as well as with other countries facing similar problems but with a significantly higher financial standard.

The set tasks are five and are adequate for the defined goal:

- To analyze neurosurgical care in Bulgaria and its distribution across regions in the country.
- To examine and analyze the current state of neurosurgical care offered in Bulgaria from the perspective of technical equipment.
- To conduct a comparative analysis of the parameters of the organization of neurosurgical care in Bulgaria with those in Germany.
- To develop recommendations for system changes aimed at improving the quality and accessibility of the neurosurgical care provided.
- To propose and implement artificial intelligence systems for reporting, analyzing, and forecasting neurosurgical care for various medical conditions.

To achieve the goals and tasks, searches were conducted in Medline, PubMed, Google Scholar, Web of Science, and Embase for studies related to neurosurgical care in Bulgaria. The seven main clinical pathways in 135 medical institutions in Bulgaria, through which surgeries and therapy in neurosurgery are performed over a seven-year period, were analyzed. Data were extracted from a conducted survey (from June 3, 2024 – October 31, 2024) among

medical institutions providing neurosurgical care in Bulgaria. An electronic survey form was developed to determine the current state of neurosurgical care in Bulgaria, containing four main sections. The results are presented in the form of graphs and tables summarizing the information from the survey of the participants. A study was conducted covering a comparative analysis between the organization of neurosurgical care in a developed European country – Germany – and the current state of the organization of neurosurgical care in Bulgaria. Statistical methods were used for processing and analysis.

The following results are presented:

1. An analysis of medical institutions with established neurosurgery units in the Republic of Bulgaria reveals an uneven distribution of neurosurgery clinics and departments across the country. The allocation of doctors working in these neurosurgery clinics and departments is also highly disproportionate. There is a marked imbalance, with certain regions having a higher proportion of neurosurgery units but a comparatively lower number of doctors working within those units and regions.
2. Analysis and trends of neurosurgical operations in Bulgaria – After examining neurosurgical operations in 135 medical institutions in Bulgaria for the period 2017–2023 across the seven main clinical pathways, the results show that the highest number of operations was recorded in 2019 (28,289), and the lowest in 2020 (24,348), reflecting the impact of the COVID-19 pandemic. A detailed discussion was conducted on brain surgeries not caused by trauma, treatment of head injuries, surgeries on peripheral and cranial nerves, and an analysis of spinal cord surgeries.
3. Discussion of neurosurgical operations in the city of Burgas demonstrates that neurosurgical procedures are performed in five medical institutions, some of which do not have established neurosurgery units. For the period 2017–2023, the lowest number of operations was recorded in 2017, and the highest in 2023. The largest share of operations—41%—were performed at “UMHAT-Burgas” JSC.
4. Discussion of the conducted survey regarding:
 - Staffing shows that the highest number of neurosurgeons is at the Neurosurgery Clinic of UMHAT “St. Ivan Rilski” Sofia (27), followed by the Neurosurgery Clinic of UMHATSM Pirogov Sofia (23). The lowest numbers are in the surveyed neurosurgery departments in Burgas and Veliko Tarnovo. There is a clear uneven distribution of neurosurgeons across cities and medical institutions. The percentage of working retired neurosurgeons is 8.2%. The largest number of neurosurgery residents is at the Neurosurgery Clinic of UMHATSM Pirogov Sofia – 7, followed by the Neurosurgery Clinic of MBAL “Heart and Brain” Pleven – 5. The highest number of female neurosurgeons is at the Neurosurgery Clinic of UMHATSM Pirogov, Sofia – 5, followed by the Neurosurgery Clinics of MBAL “St. Anna” Varna and UMHAT “Sofamed,” each with 3. Also, UMHATSM Pirogov has the highest number of female neurosurgery residents. The largest number of neurosurgical beds is at the Neurosurgery Clinic of UMHATSM Pirogov, Sofia – 80, followed by UMHAT “St. Ivan Rilski” Sofia, Neurosurgery Clinic – 70, and UMHAT “St. George” Plovdiv,

Neurosurgery Clinic – 48. The number of neurosurgical intensive care/resuscitation beds is highest at the Neurosurgery Clinic of UMHAT “St. Ivan Rilski” Sofia – 16. The conclusion is that staffing is sufficient in only 30.8% of neurosurgery clinics/departments in the country.

- Equipment availability shows the following results — the highest availability of 7 operating microscopes is in the Neurosurgery Clinic at UMHAT “St. Ivan Rilski” Sofia, followed by the Neurosurgery Clinic at UMHATSM Pirogov, Sofia. Regarding the use of neuroendoscopes, 19 out of the surveyed 23 medical institutions responded. Fourteen operate with one neuroendoscope each (73.7%); only one institution has two (MBAL “Heart and Brain” Burgas). Four (almost 21.1%) do not have a neuroendoscope. Eleven (64.7%) of the institutions use intraoperative ultrasound, while four (23.5%) do not, with 15 institutions responding. Three (16.7%) of the surveyed clinics/departments do not use neuronavigation; 11 (61.1%) operate with one unit; only three institutions (16.7%) have two, and UMHAT “St. Ivan Rilski” Sofia has three. Eighteen respondents provided answers. All analyzed clinics/departments (22 respondents) have a C-arm; 18 (just over 81.8%) have one, three clinics have two (just over 13.6%), and only one clinic has C-arms purchased in 2021, 2022, or 2023. More than 50% of respondents consider the equipment availability to be sufficient.
 - Operative activity, for which the conducted interventions were analyzed, includes: cranial trauma; spinal trauma; cranial neuro-oncology; spinal neuro-oncology; vascular neurosurgery; endovascular neurosurgery; spinal neurosurgery; minimally invasive neurosurgery; pediatric neurosurgery; functional neurosurgery, specifically DBS; peripheral nerves. The possibility of inclusion on a waiting list was also examined, as well as the respondents’ opinions on the need to establish new neurosurgical structures within their city or region.
 - Accessibility of imaging diagnostics – for the analysis of accessibility to imaging diagnostics, the availability of imaging devices was examined: X-ray machine, computed tomography (CT) scanner, and magnetic resonance imaging (MRI) scanner. All 23 medical institutions participating in the survey have an X-ray machine. All 23 medical institutions participating in the survey have a computed tomography scanner. Regarding the availability of MRI scanners, 19 out of the 23 medical institutions participating in the survey responded. Of these, 15 possess an MRI scanner (almost 80%).
5. A comparative analysis of the parameters of the organization of neurosurgical care in Bulgaria with those in Germany was conducted, showing significant differences between the two countries. The number of neurosurgical clinics/departments per 100,000 population in Bulgaria is 0.35, while in Germany it is 0.23. The number of neurosurgeons per 100,000 population in Bulgaria is 2.73, whereas in Germany it is 3.11. The number of neurosurgical beds per 100,000 population in Bulgaria is 7.88, compared to 8.36 in Germany.
 6. Applications of Feedforward networks in neurosurgery are presented — the focus of the study is on medical institutions in Bulgaria, with operations and therapies in the field of neurosurgery over a six-year period. The analyzed data represent

neurosurgical treatments performed according to 7 clinical pathways in 135 medical institutions. The capability of this method to identify dependencies among the criteria used to evaluate multiple objects supports the research processes. The study highlights the significance of intelligent techniques in the field of neurosurgery, especially given the increasing global burden of neurological diseases.

In conclusion, the following findings can be made:

1. The analysis of the main medical institutions providing neurosurgical care in the Republic of Bulgaria reveals a pronounced asymmetry in their distribution across the regions of the country.
2. The analysis of neurosurgical operations performed nationwide shows a significant decrease in 2020, which is attributable to the onset of the COVID-19 pandemic. There is also a trend of performing neurosurgical interventions in medical institutions that do not have established neurosurgery clinics/departments.
3. The analysis of neurosurgical operations in the city of Burgas shows that 41% of these procedures were performed at "UMHAT-Burgas" JSC. Here too, the trend persists of neurosurgical interventions being performed in medical institutions without established neurosurgery clinics/departments.
4. The conducted survey analyzing staffing, equipment availability, operative activity, and access to imaging diagnostics confirms the uneven distribution of neurosurgery clinics/departments across the country's regions and the neurosurgeons working in them, with a concentration in the capital and a pronounced shortage in certain areas, such as Northern Bulgaria.
5. The comparative analysis of the organizational parameters of neurosurgical care in Bulgaria and Germany shows that there is a shortage of staff both in Bulgaria and in a developed European country like Germany. However, Germany has significantly more neurosurgeons per capita compared to Bulgaria. Additionally, access to neurosurgical care in Germany is evenly distributed throughout the country, ensuring prompt treatment for patients regardless of their location, whereas in Bulgaria, treatment for patients from areas distant from major cities may be delayed.

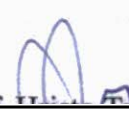
Dr. Todorov is a well-established neurosurgeon, prepared to provide high-level surgical and consultative care, possessing exceptional qualities as an administrator and organizer of medical activities on a national scale. Dr. Svetoslav Todorov presents a dissertation that meets the requirements of the "Law for the Development of Academic Staff" in the Republic of Bulgaria and the "Regulations for the Development of Academic Staff" at the Medical University "Prof. Dr. P. Stoyanov" in Varna. The dissertation analyzes serious problems related to the organization and provision of neurosurgical care in Bulgaria. It is recommended that the funding of neurosurgical services be linked not only to quantitative but also to

qualitative evaluation of the services. It is also recommended that the conclusions drawn be made available to the Ministry of Health, which should take the necessary measures to eliminate the disproportions indicated in the dissertation. In summary, the dissertation contains significant scientific-applied and scientific-practical contributions, worthy of awarding the educational and scientific degree of "Doctor" to its author.

I give a positive evaluation and vote "yes" for awarding the educational and scientific degree of "Doctor" to Dr. Svetoslav Todorov.

20.05.25

Sofia


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MD, PhD