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E.N. Banzelyuk, V.A. Loginov

**The military surgeon who taught the whole world to measure blood pressure**

**Nikolai Sergeevich Korotkov (1874–1920)**

“Who would have thought that Korotkov, a well-known name in clinical medicine, could have been ignored by medical historians.” Mark Leier, Yoyne O’Brien, 1982

[Translated from Russian]

Everyone who goes to the doctor experiences this simple procedure - measuring blood pressure. Medical workers all over the world perform millions of such procedures every day and remember the name of the Russian surgeon Nikolai Korotkov, to whom we owe the invention of this simple and at the same time most important examination method.

Nikolai Sergeyevich Korotkov was born on February 14 (262), 1874 in the house No 40 on Mileninskaya Street (now Sovetskaya) of the city of Kursk, into a wealthy merchant family of Sergei Ivanovich and Alexandra Mikhailovna Korotkov. Sergei Ivanovich was forced to devote a lot of time to his work, which is why less attention was paid to his family. Nikolai's father was on the city council, his uncle, Ivan Ivanovich, was a member of the Kursk district presence; Nikolai’s brother Vladimir also became a merchant, the owner of a store and a small soap factory, and before the revolution, he became the mayor of the city3. Unfortunately, during the civil war, Korotkov’s home was destroyed.

Young Korotkov studied at the Kursk Men's Classical Gymnasium, from which he graduated in 1893 with excellent marks in all disciplines except the law of God4. In his characterization it was written: “Being under good family influence, Korotkov was always efficient in everything and always was among the pupils of the gymnasium that were different in behavior. Beloved by everyone at home and at school, he found a meek and accommodating character, and due to his good manners, he respects order, and legality in everything.”5

In the same year, Nikolai entered the medical faculty of the Imperial Kharkov University, where he showed excellent knowledge, having received excellent marks in preclinical subjects: botany, zoology, inorganic chemistry, mineralogy, anatomy and comparative anatomy6. After three semesters, in early 1895, Korotkov managed to get a transfer to Moscow University, where the level of medical education was higher. During this period, such remarkable professors as Alexander Bogdanovich Fokht and Mikhail Nikiforovich Nikiforov (general and private pathology) taught in Moscow; Grigory Antonovich Zakharyin, Alexey Alexandrovich Ostroumov and Konstantin Mikhailovich Pavlinov (internal diseases), Alexander Alekseevich Bobrov and Fedor Ivanovich Sinitsyn (surgery) and others.

At the end of the five-year course, Nikolai Korotkov submited an application for admission to the tests for the medicinal rank and passes examinations in 24 subjects in 2 months, most of them are “very satisfactory,” that is, the highest mark. On October 31, 1898, the test commission awarded Korotkov “a doctor’s degree with honors, with all rights and advantages”7. In anticipation of an official medical diploma (received at the end of December), Nikolai Sergeevich is also passing exams for the title of “district doctor” - a special academic rank that allowed him to occupy a leading position in the zemstvo healthcare system. The county doctor was simultaneously a therapist, operator (but without the right to perform “important operations”), an epidemiologist, a medical doctor, a forensic expert, a veterinarian, and a representative of the provincial medical administration. Therefore, in addition to medical district doctors, knowledge of medical law, record keeping and a wide range of medical and related disciplines was still needed8.

Since Korotkov studied at the university as a “self-paid student” (that is, without receiving a scholarship), he did not have any obligations to the treasury - he did not need to serve a mandatory term in the military or civilian department9. Teachers of the medical faculty during the training noted a talented student, and by their patronage he was left at Moscow University as a freelance (that is, without salary) resident physician at the faculty surgical clinic of Professor Aleksandr Alekseevich Bobrov (1850-1904). The year before, the faculty of therapeutic and surgical clinics moved to a new building in the University Clinical campus on Maiden Field (current address: 2 Bolshaya Pirogovskaya St., Building 1). Having inherited the clinic and the department from N.V. Sklifosovsky, Bobrov was one of the first to apply the resection of the appendix in the treatment of appendicitis, and developed surgery for hernia of the abdominal wall and liver echinococcosis. In 1898, Bobrov was the first in Russia to organize an X-ray room in his clinic10.

In parallel with the free work in a surgical clinic that allowed him to gain experience and a name, Korotkov translated from German one of the best surgery manuals at that time - the 7th edition of the 300-page textbook Diagnosis of Surgical Diseases by Professor Albert. Without a doubt, careful work on this text significantly increased both the translator's medical knowledge and his authority in the medical environment.

But the career of the young surgeon was interrupted. In the late 1890s, China developed the patriotic Ihetuan movement, better known as the "Boxer Rebellion." In 1900, the regular units of the "Alliance of Eight Powers", including Russia, began actively suppressing the uprising. The Russian government appealed to the Russian Red Cross Society to provide assistance to the wounded and sick in the war zone. Bobrov’s assistant, Ivan Pavlovich Aleksinsky, as the senior doctor of the Iveron community of Red Cross sisters of mercy, was sent as the head of the orderly unit, and Korotkov signed up for him as a volunteer, asking for a vacation at the university with keeping his job. There is no evidence of the reasons for such an act of a novice surgeon; it is possible that, in addition to patriotic feelings and ideas about medical duty, prospects played a role in gaining rich clinical experience and (finally!) salary. However, subsequent events showed that the monetary side of the issue was definitely not the main one.

On July 23, 1900, an orderly detachment departed from Moscow along the Kursk Railway. The staff and inventory were designated to set a hospital with 50 beds. Three weeks later, the train reached the shore of Lake Baikal, ferryboat crossed to the east coast, and after another 10 days, people and property on the ship arrived in Blagoveshchensk. In the two-story house allocated for the infirmary, as soon as possible, a surgical department was set with 40 beds, and a therapeutic department with 10. From two to five operations were performed per day.

From the very first days, patients who suffered gunshot and shrapnel wounds to the limbs began to arrive. As a result of such a wound, a large artery was often damaged, and a decision had to be made to dress the vessel so that the patient would not die from bleeding.

However, after arterial ligation, another danger arose: if the blood supply to the limb along the collaterals (indirect path) was insufficient, gangrene (necrosis) of the limb developed, which ended with the amputation of a part of the body or even the death of the patient. The young surgeon Korotkov started to think about how to determine the “strength of collaterals [arteries]” and choose the right surgical tactics.

A month later, the infirmary was transferred to Khabarovsk and began to receive mainly typhoid patients. Due to their large numbers, the infirmary was soon increased to 100 beds. Surgeons, including Korotkov, had to temporarily become infectious disease doctors. Thanks to the dedicated work of doctors and nurses, the Red Cross infirmary managed to cope with this scourge. By winter, the epidemic subsided. In January, the unit on a steamboat circled back. After two months of sailing along the southern seas, the sanitary detachment arrived in Feodossia, and then in full force, without losses, returned to Moscow. Many of its participants were awarded prizes, including Korotkov, the Order of St. Anne of the III degree and the right to wear the Red Cross sign11.

After an eight-month break, Nikolai Sergeyevich again began to work in the surgical clinic of A.A. Bobrov: operations, detours, on duty. Korotkov worked shoulder to shoulder with his classmate Nikolai Fedorovich Lezhnev (1873–1932), one of the pioneers of Russian urology, and future professor of the 2nd MMI. However, in May 1903, Korotkov and Lezhnev were dismissed from the post of residents due to "the end of the term of residency"12. It was necessary to look for a new place.

In the same place, in the Bobrov Clinic, Sergei Petrovich Fedorov (1869–1936), the founder of Russian urology, worked for twelve years. The young surgeons Korotkov and Lezhnev made a favorable impression on Sergei Petrovich, he even spoke of the first in the letter as “outstanding in any respect ”13. Therefore, when in 1903 S.P. Fedorov was invited to St. Petersburg to head the department at the Imperial Military Medical Academy, he requested positions for the department for Korotkov and Lezhnev, but again without being paid.

In the summer of 1903, Korotkov moved to St. Petersburg and settled in house 11/9 on Bolshaya Dvoryanskaya Street (now Kuibyshev Street). After starting work in a new place, Korotkov filed a request for admission to take exams for the degree of doctor of medicine. All the time left after the “free” work in the clinic, Nikolai Sergeyevich devoted his training to theoretical exams. In physiology, he was personally examined by academician Ivan Petrovich Pavlov. An interesting characteristic is preserved in the memoirs of assistant Pavlov, the future professor B.P. Babkin: Korotkov is a tall, slender, diligent young man14.

After theoretical exams, practical ones should be taken. But at the beginning of 1904, the Russo-Japanese War broke out and again military infirmaries were needed. Nikolay Korotkov again signed up as a volunteer, and, taking into account past experience, he was appointed to the post of senior doctor of the orderly unit. Before the unit was sent, there was quite a lot of time that Nikolai Sergeyevich, preparing for a trip, spent studying works on military field surgery, as well as on getting to know the methods of functional research of the vascular system.

In the latter, he was assisted by the staff of the department of Mikhail Vladimirovich Yanovsky (1854–1927), the largest domestic specialist in this field at the beginning of the twentieth century. M.V. Yanovsky was a student of S.P. Botkin, the founder of his own large scientific school [a new research direction]; for almost 30 years he headed the Department of Diagnostics and General Therapy of the Military Medical Academy.

In June, the detachment, already known to Korotkov, departed east. Upon arrival a month later in Harbin, the detachment was immediately sent to the front line, where he was engaged in the evacuation of the wounded. At the same time, a hospital for 120 and then 250 beds was deployed in Harbin itself. Weather conditions in the summer of 1904 did not facilitate the work of doctors and nurses: heavy rains gave way to intense heat with a dusty atmosphere. Poor sanitary conditions and overpopulation contributed to infectious diseases, the squad again faced typhoid fever.

But still, the main task of the infirmary was the treatment of the wounded. The Russo-Japanese War was the first major war in several decades using new weapons, including long-range artillery. Therefore, many patients with shrapnel and gunshot wounds to the limbs were admitted to the infirmary. During transportation, internal bleeding from a damaged vessel often led to the formation of a swelling filled with blood (the so-called traumatic aneurysm). Outwardly, such a swelling could resemble a large abscess. To distinguish the aneurysm from an abscess or other formation, Nikolai Ivanovich Pirogov recommended using a stethoscope - noises caused by the movement of blood can be heard in the projection of the aneurysm15.

Aneurysms often burst with the development of massive, often fatal external bleeding. To avoid this, it was customary to bandage the vessel feeding the aneurysm, since they were not yet able to sew vessels. However, the same problem arose as on Korotkov’s previous trip: would the bypass vessels (collaterals) prove to be sufficient to nourish the limb during ligation of the main artery? Korotkov later writes in his doctoral dissertation: “With each ligation of a large artery of a limb, we have no idea what will happen to the limb, whether it will remain alive or dead ... I could not vouch for the preservation of the limb ... Such ignorance of the result of the operation is unpleasant for physician and even more unpleasant and harder for the patient. ”16.

Nikolai Sergeyevich began to look for ways to determine the “strength of collaterals” in order to assess the risk of vessel ligation. To do this, he moved from the post of senior physician of the St. George Community Hospital to the lower-paid resident post in the nearby 1st Combined Military Hospital, which included patients with aneurysms with whole front. Here Korotkov personally performed 35 operations on aneurysms, each time trying to determine the "strength of the collaterals" before surgery. At the same time, he not only listened to aneurysms with a phonendoscope (which is much more convenient than the stethoscope used by Pirogov), but also recorded graphs of pulse waves (sphygmograms) and tried to determine the blood pressure in the vessels by methods known at that time.

Such methods included measuring systolic (“upper”) blood pressure with the Riva-Rocci apparatus. To do this, a rubber cuff was attached to the limb, connected by tubes with a pear to pump pressure and with a mercury barometer (sphygmomanometer). After increasing the pressure in the cuff above a known level, which led to a complete compression of the vessel, the doctor gradually reduced the pressure and tried to determine the moment of pulsation in the artery below the point of compression. The sphygmomanometer at this moment was taken equal to the systolic blood pressure in the vessel.

Repeatedly listening to the arteries of the injured and healthy limb under various conditions, including cuff compression, Korotkov found that if you put the Riva-Rocci sleeve on the brachial artery and pump up the pressure until the pulse disappears, no sounds below the cuff are heard. If one would then gradually reduce the pressure in the cuff, in the brachial artery tones begin to appear, coinciding with the pulse, and then replaced by systolic murmurs. With a further decrease in pressure, the noises are again replaced by tones and at some point sharply weaken and disappear17. From here, there was already one step to the conclusion: by the time the tones appeared, systolic pressure can be determined, and by the disappearance - diastolic pressure (at that time they were called the "maximum" and "minimum" level of pressure). It was also important for Korotkov that when decompressing the cuff, the pulse below the clamping point appears later than the first tones - which means that the Riva-Rocci method gives underestimated rates!

However, Nikolai Sergeevich considered the main result to be the development of an algorithm for determining the “strength of collaterals” for determining surgical tactics. This is what he sought to inform the medical community after returning from a business trip. And I had to return earlier than planned, due to personal circumstances.

As part of the detachment, created from members of the St. George community of sisters of mercy of the Red Cross Society, was a nurse Elena Alekseevna Grigoryeva, who became Korotkova's life partner. By the spring of 1905, she was already expecting a baby. Overpopulated, devoid of many basic amenities, Harbin was an inappropriate place for the baby.

They returned by rail. On the way, Nikolai Sergeyevich probably systematized the experience gained and reviewed copies of medical histories and sphygmograms taken with him. Already at the end of April, Korotkov reported to his surgeon colleagues in Fedorov’s clinic about a method he developed for determining the “strength of collaterals,” which he later called Korotkov’s test. The message was received with great interest due to the importance and relevance of the issue. Immediately in the clinic they found a wounded man with aneurysm. Nikolai Sergeevich conducted an examination according to his methodology and predicted the sufficient development of collaterals, allowing to bandage the artery. The operation, which the next day did Fedorov himself, was successful, blood supply to the limbs was sufficient. On this and subsequent clinical examples, the fidelity of the proposed technique was brilliantly confirmed. As the leading surgeon of the Fedorov Clinic, V. A. Oppel, later wrote, “it is now that the significance of the numerous studies conducted by Dr. N. S. Korotkov is clearly apparent ... I have no doubt that the method ... will become even more widespread in surgery ”18.

The success prompted Fedorov to recommend Korotkov to make a presentation at a meeting of the Russian Surgical Society. On May 10, 1905, Nikolai Sergeevich made a report where he described the main points of his methodology for determining surgical tactics by assessing the “strength of collaterals” and the preferred options for the operation of traumatic aneurysms to reduce the risk of limb necrosis, while mentioning the method he used to determine blood pressure. The report caused a lively discussion, at the end of which the student of M.V. Yanovsky, doctor V.G. Bozhovsky, spoke. Bozhovsky was critical of the possibility of determining the diastolic blood pressure, because neither he, nor Yanovsky himself, nor other colleagues could achieve this.

Critical remarks forced Korotkov to continue clinical research and conduct experiments on dogs. Soon he was ready to answer the questions of his opponents, and in November 1905 made a message “On the question of methods of studying blood pressure”. However, this time too, opponents disputed Korotkov’s explanations. It took another, the so-called "second preliminary" message in December 1905. This time, M.V. Yanovsky, summing up the report, said to Korotkov: “I completely agree with your conclusions ... I must say that in your observations you found a certain talent and wit. You easily noticed a fact that many researchers passed by ... ”19.

Abstracts of both reports have been published. Supported by Yanovsky, the method of sound pressure determination began to gain fame and popularity. And only with the advent of this method, doctors began to pay great attention to blood pressure and its deviations20. But Nikolai Sergeevich could not participate in this work. Seven years of work in the clinic without being paid, the need for additional part-time jobs, and two exhausting trips to the military front weakened Korotkov’s health and led to the development of a typical illness of that era - consumptions (tuberculosis). In December 1905, Korotkov was admitted to the clinic of the Military Medical Academy, where he was diagnosed with "tuberculosis of the tops of both lungs, left-sided dry pleurisy"21. After long-term treatment, Nikolai Sergeyevich was forced to leave his job at Fedorov’s clinic and went to his mother in Kursk for a year and a half.

In mid-1907, Korotkov returned to St. Petersburg and proceeded to the second part of the doctoral exam - the practical one, which he completed by the beginning of the next year. However, somewhat recovering in Kursk, his health began to deteriorate again. The raw climate of St. Petersburg for consumption was very poor. Korotkov did not have the opportunity to go to an alpine sanatorium where it was customary to treat tuberculosis, so he decided to act differently: he went as a doctor to Transbaikalia, to the Lena gold mines.

Here, over one year, the dry and very cold winter air and other natural conditions contributed to the reduction of inflammatory processes in the lungs so much that in the beginning of 1910 Korotkov was able to return to Petersburg, having successfully defended his dissertation thesis on the topic “Experience in determining the strength of arterial collaterals” and finally got a doctor’s degree in medicine. In addition, in 1908 he was approved as a titular adviser, and in 1909 as a college assessor22.

However, his career again did not work out. In the summer, Nikolai Sergeyevich received a referral to the North Caucasus, to the Terek region, to combat the cholera epidemic, and could not refuse this socially significant assignment. As a result, the exhausting work of the infectious disease doctor, and before that, the efforts to defend the dissertation, again led to the intensification of tuberculosis. Having already experienced the healing effects of the Siberian climate, Korotkov signed a two-year contract to work as a doctor in the Lena goldfields.

The destination of Nikolai Sergeyevich was St. Andrew's Hospital, located north of Bodaibo. The hospital served six mines and about one and a half thousand people. Twice a day Korotkov, with a coachman, traveled in a cab around the mines, doing dozens of miles. In the summer of 1911, his wife Elena Alekseevna came to him with her six-year-old son Serezha.

The situation in the Lena mines was extremely difficult. The miners' disenfranchised position, their working and living conditions, low and incomplete wages led to unrest of workers and, in 1912, to a full-scale strike. For its suppression, there were troops sent. On April 4 (17), a peaceful procession of workers was shot, at least 250 people were killed, several hundred were injured.

Korotkov severely endured this brutal reprisal, but was forced to work out the contract until the end. Only in the spring of 1913 he and his son managed to go to Petersburg (his wife returned earlier). There were no good vacancies, for several months the talented surgeon worked as a junior doctor, until the medical council elected him to the position of senior doctor of the newly built Peter the Great Clinical Hospital. For the first time in his life, Korotkov was able to feel himself a wealthy person, devoted his free time to reading and painting, and even considered returning to scientific research.

Unfortunately, fate did not provide for Nikolai Sergeyevich Korotkov a safe and peaceful life. In July 1914, the First World War began, and in October Korotkov entered the hospital as a military doctor located in Tsarskoye Selo. Every day he went there to work from the troubled Petrograd, including during the February and October revolutions. In 1918, Korotkov worked in the Red Army hospital, and a year later he was able to return to the Peter the Great Hospital (now named after Mechnikov), where he was in charge of a large department.

Life in the Northern capital (Moscow became the capital of the state again in 1918) was very difficult: hunger, small portions of bread exchanged for coupons, and no central heating. Korotkov lived in house number 6 on Zelenkov Lane23. In the summer of 1919, he developed tuberculous pleurisy (inflammation and accumulation of fluid in the lung area and larynx) with prolonged treatment in a hospital. From that moment on, he started to fade away. By March next year, he was so weak that a friend who visited him immediately issued a referral to the clinic. The next day, Nikolai Sergeyevich was taken to the emergency department, where he developed bleeding from a tuberculosis, and on March 14, 1920, at the age of 46, he died. He was buried at the Theological Cemetery.

Thus ended the life of a graduate of Moscow University, a military surgeon, patriot, and a true minister of medicine, Nikolai Sergeyevich Korotkov, who “combined a sphygmomanometer and a stethoscope with a happy marriage” and thereby gave colleagues a simple and accurate method of measuring blood pressure. This discovery contributed to the fact that "the development of cardiology reached the first cosmic speed", and in its significance is comparable to the discovery of another great doctor, who lived a century earlier - the Frenchman Rene Laennec (1781-1826). Laannek invented the method of auscultation (listening) of patients and the stethoscope itself. A characteristic detail - Laannek also suffered from tuberculosis from a young age, from which he supposedly died at 45. Anton Pavlovich Chekhov (1860–1904), Korotkov’s senior colleague (and one of his favorite writers), who graduated from the medical faculty of Moscow University in 1884, also died from tuberculosis. Only, unlike Chekhov and Laennec, the name of Korotkov in his homeland was forgotten for many decades. His grave was lost. His wife Elena Alekseevna died in the besieged Leningrad24. His son, Sergei Nikolayevich Korotkov, learned to be a doctor, but for a long time did not know that the method of measuring blood pressure, that he used daily, was invented by his father.

It was only in the second half of the 20th century that Korotkov's name began to sound again in his homeland. Foreign historians of medicine who came to the USSR in attempts to obtain information about the discoverer of the method, as well as an employee of the Military Medical Academy Sergey Egorovich Popov, who discovered the only surviving photograph of Korotkov and published his biography, played a large role in this.

In 1998, the N. S. Korotkov Memorial Society was established and a memorial plaque was opened on the facade of the building, where the clinic of faculty surgery named after S. P. Fedorov is located (St. Petersburg, Pirogovskaya embankment). In 1999, the Scientific Council of the Military Medical Academy decided to establish the International Prize and Gold Medal named after N. S. Korotkov. In 2007, the passage next to Botkin Street in St. Petersburg was named “Doctor Korotkov Street”. The name Korotkov was also assigned to the Kursk City Hospital No. 1. Today, the Korotkov method is a universally recognized standard for measuring blood pressure, approved by the World Health Organization and national medical organizations.

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