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The studies of blood transfusion and the attempts of its implementation into medical practice in 1800–1875: the fate of J.-A. Roussel's device in Russia

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Abstract. Since the beginning of the 19th century, physicians' interest to the study of blood transfusion has increased significantly. The experimental researchers of the first half of the 19th century paid special attention to the issues of intra- and interspecific blood transfusion. In 1860s numerous military conflicts in Europe led to the necessity of studying the issues of blood transfusion's practical application in medicine. A choice of donor's blood source (animal or human), type of blood for transfusion (whole or defibrinated blood), methods of preservation, stock and storage of blood became the main priorities of research during this period. Both blood transfusion experimental studies and human-to-human transfusions conducted in Europe and Russia in 1800-1875 have become historical, scientific and technical ground which preceded and largely determined the promotion and distribution of the first device for blood transfusion which had a commercial success. In 1873 the apparatus invented by a Swiss doctor Joseph-Antoine Roussel took the first prize at the Vienna World's Fair. Roussel managed to sell hundreds of copies of his invention to the armies of Austria-Hungary, Belgium, and Russia, taking advantage of the situation of political tension in Europe. The article presents the key circumstances of the implementation of Roussel's device in Russia in 1874, such as the results of its clinical trials, some financial aspects of the apparatus' acquisition by the Main Military Medical Department, etc.

Key words: blood transfusion, J.-A. Roussel, Russia

Introduction

For many centuries physicians, scientists, philosophers, religion leaders around the world saw amazing opportunities in blood transfusion for treating patients, rescuing dying men as well as for not such trivial purposes as youth regeneration, transferring talents, skills, and knowledge from old people to young ones (1). The unpredictability of the initial blood transfusions performed in the second half of the XVII century led to the prohibition of this procedure. In 1678, the Royal Society in London prohibited transfusions and the French parliament ruled it to be a criminal act. In 1679 the Pope also announced the ban on the procedure (2). The revival of the interest to blood transfusion in the XIX century is associated with the development of obstetrics, experimental physiology, and military surgery.

Statistic data accumulated during military conflicts in Europe in 1850-70s, such as Crimean war (1853–1856), Austro-Prussian war (1866), Franco-Prussian war (1870–1871) by the leading European and Russian physicians inexorably indicated that mortality from hemorrhage reached almost 75 percent of total mortality on the battlefield (3). Therefore, massive loss of blood became the most important issue of military medicine. We presume that the urgent need of blood transfusion practical application resulted in success of the Geneva physician Joseph-Antoine Roussel

(1837–1901) and his apparatus at the Vienna World's Fair in 1873. Roussel's "transfuser", which allowed, as its inventor claimed, to successfully apply blood transfusion in medical practice, became one of the winners of the exhibition in the in the section "Precise scientific devices and instruments of surgery". Taking advantage of the tense international relationships and the agreements between the leading European states (Russia, France, Austria-Hungary, and Germany) in 1873, Roussel managed to gain state orders and become the first official supplier of transfusion devices in the armies of Russia, Austria-Hungary and Belgium (4). For his services he was awarded the national Orders of Franz Joseph (Austria), Leopold (Belgium) and the Holy Prince Vladimir of the fourth degree (Russia) (5).

This study aims to determine the circumstances of Roussel's device acquisition in 1874 by the Main Military Medical Department of Russia for using the apparatus in Russian military institutions as a unique attempt of blood transfusion's mass practical application in medicine during the "pre-Landsteiner's" era.

Blood transfusion in Europe

The short survey of blood transfusion experimental studies and the first human-to-human transfusions in Europe and Russia in 1800–1875 reveals the development of historical, scientific and technical backgrounds which preceded and largely determined the promotion and distribution of the Roussel's device.

Blood transfusion in the XIX century was defined as an infusion of arterial or venous blood of one animal or human to another subject through intermediate tubes under the influence of natural blood positive pressure of donor or using device in which previously this blood had been collected (6, 7).

In the first half of XIX century mainly interspecific blood transfusions between cats, sheep, calves and dogs were practiced. Only by the second part of XIX century French surgeons J.-L. Prevost and J.-B. Dumas had associated the phenomena often observed during unsuccessful transfusions, such as uneven heartbeat, blood in urine and excrements, formation of transudates with the "poisonous" effect of foreign blood. The researchers proposed different explanations of toxic effects of such blood: J. Muller linked it with various shape and size of "blood balls", X.-M. Bishat – with the lack of oxygen in blood (7), Prevost and Dumas considered fibrin as a poison, Ch.-E. Brown-Sequard – carbon dioxide and obsolete parts of body (6), P.L. Panum – decomposition products of donor's "blood balls".

The other area of research was the identification of the factors that determine effectiveness of blood transfusions. The complications of human-to-human blood transfusion caused among researchers the discussions about two methodological issues of this procedure: the sources of donor's blood (human or animal) and what kind of blood – whole or defibrinated – is better to use. Bishat, F. Magendie, E. Martin claimed that animal blood must not be used for transfusions to human (7). Their opponents Muller, Brown-Sequard, Prevost, Dumas, Panum believed that interspecies transfusions are allowed after previous defibrinating of donor's blood.

The works of German Doctor of medicine and surgery Franz Fedorovych Gezellius (1840–1900) who lived in St. Petersburg (8) and British obstetrician Charles Egerton Jennings (1859–1930), member of the Royal College of physicians of London (9) have become two significant sources that allowed us to assess the scope and direction of blood transfusion studies and, especially, their application in medicine during 1800–1875 in Europe and Russia. Both physicians compiled the detailed bibliographic lists of the published papers and reports describing the blood transfusion experimental studies and human-to-human transfusions within this period. Also, in his research Gezellius conducted the statistical analysis of the particularities and outcomes of human-to-human blood transfusion which were carried out from 1819 to 1871 in Europe and Russia. Having analyzed both Gezellius' and Jennings' lists which contain more than 300 published academic papers and newspaper articles, we can assert that about 200 researchers had been studying different issues of blood transfusion and 248 blood transfusions of human blood had been performed in Europe and Russia since the beginning till the last quarter of XIX century (8, 9).

According to Gezellius' statistic data, 146 whole human blood transfusions were performed within

1818–1871, among which 79 were successful and 67 led patients to death (8). In 1818, the British obstetrician James Blundell (1790–1878) was the first one who carried out human-to-human blood transfusion in the 19th century (10). Twelve ounces of whole blood were transfused to the patient, dying of stomach cancer. The patient died approximately in 24 hours. The first successful human blood transfusion Blundell performed in 1825 to the parturient woman to prevent her death from postpartum hemorrhage (11).

The transfusion of defibrinated blood started to be applied in medical practice from 1850s. Gezellius reports that 102 such kind of operations were performed in Europe from 1851 to 1873. However, only 36 of them were successful (8). The high rates of mortality and the complexity of defibrinating procedure limited the spread of this method.

During the XIX century, the technique of blood transfusion was constantly improving, new apparatus and devices appeared, yet all of them were based on the principles developed by Blundell. In direct transfusion, the blood vessels of the donor and recipient were connected by tubes, the donor's blood pressure was the driving force. The formation of blood thrombus, clogging blood vessels, the inability to determine accurately the volume of transfused blood were the main drawbacks of this method. To increase the rate of infusion, various devices (syphons, syringes or cylinders) were used, in which the donor's blood was previously collected, and then it was transferred into the patient's veins under the influence of external (hydraulic or mechanical) pressure. These devices enabled to define the exact volume of transferred blood, but they increased its coagulating. In case with defibrinated blood, it was easier to transfuse and dispense it, but highly qualified assistants and extra time were required (3).

Despite the difficulties which arose and the contradictions among the supporters of different methods of blood transfusion, physicians and researchers were confident in prospects of using this procedure in medical practice. Jennings cited the results of human-to-human blood transfusions performed by Roussel in 1865–1877 as indisputable evidence in favor of using this procedure into medical practice. Roussel's results indicated a nearly 80 percent success rate of his device. The swiss physician claimed in his book that out of 50 direct blood transfusions performed by him, 26 cases were completely successful and 14 – partially (4, 9).

Blood transfusion in Russia

The study of blood transfusion in Russia was based on European research and largely repeated them. However, Russian physicians were wary of applying this method in practice: out of 248 human blood transfusions performed between 1818 and 1871, which were mentioned in published reports, only 5 were carried out in Russia.

Professor of obstetrics of the Imperial Medical and Surgical Academy in St. Petersburg (nowadays – Military Medical Academy named after S.M. Kirov) Stepan Fomich Khotovitsky (1796–1885) was one of the first Russian physicians who proposed using of blood transfusion in medical practice (12). His pupil Andrei Martynovich Volf (1791–1852), Russian obstetrician of German origin, performed the first in Russia human-to-human blood transfusion to a woman suffered from postpartum hemorrhage in St. Petersburg in 1832 using Blundell's method and device (13, 14). He described his successful experience of blood transfusion in the report of the Society of German physicians in St. Petersburg in 1832. However, the paper was published only in 1842 (15). Other researchers, such as academician Ilya Vasilyevich Buyalsky (1789–1866) and F. Gezellius doubted the scientific reliability of results claimed by Volf because he did not specify the important details of this procedure (the amount of transfused blood, the exact duration of the procedure, etc.) in the paper[1].

In 1830s, the inception of experimental studies of blood transfusion in Russia is associated with Buyalsky, a prominent surgeon, medical Academician, Professor Emeritus of Imperial Medical and Surgical Academy in St. Petersburg. Being aware of European prohibitions of blood transfusion, he previously obtained the permission of Medical Council of the Ministry of Internal Affairs[2] that "such kind of operation is allowed

[1] However, nowadays April 20, the date of the Volf's successful human-to-human transfusion, is celebrated annually in Russia as the national day of blood donor.

[2] The main purposes of this institution were evaluation and implementation of scientific medical research.

and can be conducted (performed)" (16). As most European researchers of that time, he recommended to transfuse the whole venous blood using Blundell's device. Moreover, Buyalsky improved it: he immersed a siphon in warm water to maintain the normal temperature and fluidity of blood which coagulating clogged the tubes, cannulas and holes.

Following Buyalsky Professor of physiology of Imperial Moscow University Alexey Matveyevich Filomafitsky (1807–1849) started to conduct experimental studies in hemotransfusion. The first fundamental work in Russia named "A treatise on blood transfusion as a single mean in many cases to save a dying life, complied in historical, physiological and surgical relations…" was published in 1848 as a result of his 13 years studies (17). Unlike Buyalsky its author was a proponent of transfusion of defibrinated blood.

Filomafitsky explained the cautious attitude of Russian physicians to blood transfusions in medical practice by the lack of knowledge of the blood's physiological functions and unpredictability of the consequences of this procedure. "Before surgery can come up with the easiest and the safest way of blood transfusion from a healthy man to a suffering one… physiology must solve two important questions… should we consider *(blood – auth. note)* simply as a nutrient… or… as the main seat of material life principle, carrying it to all organs", - Filomafitsky wrote (17).

During 1860s, two dissertations with the same title "On blood transfusion" being performed and defended by Vasily Vasilyevich Sutugin (1839–1900) and William Mikhailovich Rautenberg (1840–1879) at Imperial Medical and Surgical Academy in St. Petersburg. On experiments with animals they aimed to explore the possibilities of blood transfusion's application in obstetrics (Sutugin, 1865), in acute anemia and poisoning (Rautenberg, 1867). Sutugin was a supporter of transfusion of defibrinated blood (7), Rautenberg – the whole one (6). Both surgeons performed human-to-human transfusions: Rautenberg carried out transfusions of whole blood in 1867 and 1868, Sutugin – defibrinated one in 1868 (8).

Rautenberg and Sutugin made some important discoveries in blood transfusion experimental studies that were necessary for its application to medical practice. Sutugin determined that fibrin is easily restored in blood within 24 hours (7). Also, Sutugin defined the connection of fatal hemotransfusion with infection caused by donor's blood, which can transmit "common diseases, such as syphilis, scrofula, etc." Experimenting with temperature of donor's blood, Rautenberg found that infusion chilled blood into vein is harmless for animals. This contributed to the solving the problem of donor's blood storage: it became possible to store blood in defibrinated form and keep it at 0°C for a week (7). To prevent blood coagulation Rautenberg developed the method of chemical preservation by adding "small amounts of sodium carbonate", which "delaying coagulation… does not deprive it of the qualities necessary for blood transfusion" (6).

Thus, until 1874, the year of Roussel's arrival to St. Petersburg, blood transfusions in Russia had been mainly experimental. The main purpose of the research was finding optimal conditions for using this procedure in medical practice. The fact that most of Russian researchers belonged to the main military medical educational institute of the country – Imperial Medical and Surgical Academy in St. Petersburg – indicates the high relevance of this procedure for Russian military medicine in the second part of 19th century.

Dr. Roussel and his invention

The first model of blood transfusion device was constructed and tested by Joseph-Antoine Roussel in 1864 (18). In 1867, he presented its procedure in front of general medical community at the Paris International Exposition in 1867. Roussel's specific transfusion technique consisted of using a water filled glass tube connecting the donor's afferent radial artery to the recipient's efferent forearm vein. The contraction of the donor's heart and his arterial pressure moved the transfused blood, while water allowed to keep its rheology. Nevertheless, arterial pressure wasn't enough to stop blood coagulation completely (19). Moreover, opening the donor's arteries was associated with additional risks to his life and health. In this regard, Roussel's apparatus for blood transfusion did not receive approval among the medical community of France (19).

After some upgrading, Roussel presented his invention again at the 1873 Vienna World's Fair. From

the description it followed that the device allowed "to transfuse from 150 to 300 g. of live blood from a healthy man to a sick patient without any changes in its composition, without contacts with air, without clots in 2–3 minutes". At the same time this blood maintained its normal temperature and the rate of blood injection in the patient's vein was regulated by the surgeon. This time the doctor used whole venous blood and an "artificial heart" – a ball-shaped rubber balloon (4).

Roussel's "transfuser" had three fundamental distinctions from other similar devices (18) (Fig. 1). Firstly, the entire apparatus was made of natural rubber, even silver cannulas and probes were replaced with rubber ones. Roussel presumed that the diversity of materials led to the formation of blood clots: "Any contact with metal, as well as with glass, ivory, etc., is harmful for blood and provokes its coagulation… My transfuser is composed entirely of pure caoutchouc: natural, non-sulphurised, hard neutral substance, which has no effect upon blood, contact with which alters neither the tissues nor the animal liquids" - the author described his invention (4). Secondly, the entire device was filled with warm water (20–25 C°) with sodium bicarbonate. Water, on one hand, heated the apparatus and retained the rheological properties of the blood, on the other, it protected the patient's veins from air penetration. According to Roussel, this improvement had other advantages: it helped to combine transfusion with drug injections and using electricity for stimulating effects. Roussel wrote: "It is quite easy to blend the blood with a certain dosage of medicated water in prescribed solution in the apparatus itself," or "enclose in the transfuser a current of direct electricity, and bring it together with the blood into contact with the heart itself in order to reawaken that organ in the case of apparent death" (4). Thirdly, the procedure of blood sampling from the donor was similar to bloodletting and was performed without a surgeon. Roussel placed a sealed "cupping-cup" filled with water on the donor's arm instead of a cannula in the donor's vein. Two lancets were fixed in the cup, which cut the donor's vein if pressed. As a result, the blood flowed freely into the cup, replacing the water from the system and filling the balloon. After releasing the water, the surgeon pushed a portion of blood into the patient's vein by mechanically pressing the balloon. The balloon had an exact volume, so it allowed maintaining control of the blood transfusion and measuring the amount of flowing blood (20).

The effectiveness of the device was demonstrated with experiments during Vienna World's Fair in 1873 to the Vienna Society of Physicians and International Medical Commission led by Theodor Billroth (1829–1894). This Commission was created specifically for collegial discussion and practical testing of "models for military and sanitary purposes" taking into account the experience of the past Franco-Prussian war (1870–1871) (21). It consisted of prominent researchers, including those who studied blood transfusion in experiments (I.J. Neudorfer, R. Virchow and other), specialists in the organization of sanitary affairs in the army (R. von Volkmann, B.R. K. von Langenbeck, K.von Bardeleben and others). The Russian delegation in this commission was represented by the heads of Main Military Medical Department Nikolai Illarionovich Kozlov (1814–1889), Christian Bogdanovich Ritter (1814–1885), generals Mikhail Nikolaevich Annenkov (1835–1899) and Alexander Karlovich Baumgarten (1815–1883), military doctors Joseph Vasilyevich Bertenson (1833–1895) and Hippolit Osipovich Korzeniowsky (1827–1879) (21). As a result of numerous experiments, this Commission came to a conclusion that "Roussel's transfuser was the ideal practical device for direct blood transfusion, and that it must have been introduced into the arsenal of military surgery" (18). On the base of this decision Austrian military ministry signed a contract with the inventor and included his apparatus into the "surgical tools for army" for war and peace during the Fair (22).

Roussel made significant efforts for promoting his device. With his direct participation the big article describing in a positive light all the advantages of the device and the relevance of blood transfusion in military medicine was published in the Viennese newspaper Militar-Zeitung on the 13th of September 1873 (23). Furthermore, in December 1873, he sent a letter with the application of this article to the Russian Main Military Inspector N. Kozlov. The letter included a "proposal to introduce his invention to military doctors ... in order to demonstrate all the details of the implementation of the tool on patients" (22).

Also, Roussel published French (1876) and English (1877) editions of his book "Blood transfusion" adding the laudatory reviews of the leading surgeons of Britain, Austria and Russia, such as the President of the Clinical Society of London James Paget (1814–1899), the head of Austrian garrison hospital, Staff physician, Professor Ignaz Josef Neudorfer (1825–1898) and Oscar Ferdinandovich Heyfelder (1828–1890) German surgeon, member of the Paris Society of surgery, who practiced in Russia in 1854–1884 (4, 18).

In January 1874, Roussel was invited to Russia, where he signed a contract for the supply of 200 devices and was given the order of St. Vladimir of the fourth degree. He couldn't achieve similar success in France and Britain. According to Jennings, in 1880s Roussel's device was not disturbed and actually used in hospitals or in private practice. This apparatus was especially criticized for its difficult construction and a special procedure of bloodletting that lay at the basis of its work. Jennings wrote: "There can be no certainty that the lancet will not perforate the posterior wall of the vein and injure subjacent structures" (9). He was sure that "many stopcocks, its india-rubber bags, and other complex contrivances" complicated the device and required special skills from surgeons to use it (9).

J. Roussel in Russia

In February 1874, Roussel worked in various hospitals and clinics in St. Petersburg, such as the Surgical clinic of the Imperial Medical and Surgical Academy; Maternity clinic; the Naval clinic, and the Prison hospital in St. Petersburg. During this time, he performed public procedures of blood transfusion, which were attended by the leading Russian specialists in blood transfusion, members of the Medical Council of the Ministry of Internal Affairs: Gezellius, Rautenberg, Korzeniowsky and others; military and civilian doctors; students of the Imperial Medical and Surgical Academy, and even the Duke Alexander Constantine Frederick Peter of Oldenburg (18, 20).

The curator of Roussel in Russia was a military surgeon of German O.F. Heyfelder, who was acquainted with Roussel since the Paris International Exposition of 1867 (18, 20). He assisted Roussel in the trials of his device and drew up a detailed report about their results and possibility of application Roussel's method in the military field. Besides, Russian surgeons, such as I.O. Korzhenevsky, Eduard Yakovlevich Krassovsky (1821–1898) performed transfusions using Roussel's device independently and under his supervision. Roussel noted that they categorically refused to transfuse animals' blood to humans (18). However, Heyfelder supported the idea of animal blood transfusion to human. In 1874 he "proposed to the European government to have flocks of sheep on the battlefields for the emergency transfusions of the soldiers" (24).

According to Heyfelder's report, Roussel performed 23 operations of blood transfusion in Russia. Four operations were carried out for training purposes on people dying in agony to "familiarize doctors with the details of the application and operation of the device" (25). It should be noted that the fact of using dying patients as a live training manual to study medicine as well as the unperturbed attitude of the medical community to it were characteristic for this era. Four successful blood transfusions to patients with scurvy (25), one successful transfusion of venous blood of a lamb and one unsuccessful transfusion of a mixture of blood and water to the patient with suspected cholera were carried out as experimental ones (26). The remaining 15 blood transfusions were performed in patients, whose anemia was the result of one of the diseases: tumors in the pharynx or uterus, red diarrhea; suppuration of an elbow or knee joints or a lumbar muscle; "cancer thinness", inflammation of the kidneys, "thoracic dropsy", consumption of the lungs and peritoneum, typhoid, catarrhal inflammation of the lungs, intestinal ulcers, insanity or a "paralytic state" and others. Healthy young peasants of 30-40 years old, the patients' wives or hospital employees were the donors. As a result of all 15 cases, blood transfusion led to "fast palliative and radical help" (25). However, the serious conditions of three patients with long-term suppuration of a knee joint, pulmonary tubercle and typhoid determined the temporary nature of the improvement, after which all patients died (25).

In general, Heyfelder's report on the results of clinical trials of Roussel's device in Russia was positive. He noted that the introduction of this method into medical practice required further experimental study.

Heyfelder wrote: "The physiological effect and indications for the operation should be explained by further observations" (20). Nevertheless, Heyfelder acknowledged that Roussel's device "might be called the best of the currently known and very suitable for military medical practice" (20). Heyfelder's report became one of the reasons why the Russian Main Military Medical Department recommended to equip all military medical institutions and district military medical offices with these devices (27).

There was one important aspect of Roussel's contract with the Russian Military Ministry. Roussel wanted to become a monopolist in supplying the devices for blood transfusion in Russia. He demanded the Main Military Medical Department not to buy and produce devices that are the similar to his apparatus and purchase new improved devices only from Roussel himself (28). It shows that Roussel was keen to make his invention a constant source of his own income (27). The Main Military Medical Department agreed to all Roussel's demands, and soon after that 200 "transfusers" in the amount of 10,000 rubles were bought from Roussel and sent to the military hospitals in all Russian districts. The necessary rubber parts for his device were produced by the Russian-American rubber manufactory in St. Petersburg, which signed a contract with the inventor (29).

However, using Roussel's devices as "common methods of surgical care" in mass practice faced a number of difficulties. At first, the conditions and duration of the device's storage were unknown because it consisted of single rubber, a new material of that time (30). Therefore, additional research of the technical characteristics of the device was required. Secondly, it was necessary to train military surgeons to use the apparatus correctly, and to provide it with detailed specification for using it in hospital practice. The members of the Main Military Medical Department Alexander Alexandrovich Kiter (1813–1879) and Christian Bogdanovich Ritter (1814–1885) were assigned to write the instruction for Roussel's transfuser (30). However, we haven't found any confirmation that these guidelines were developed and published.

In March 1875, Roussel's 200 devices were received from Geneva. They were examined at the Factory of Military-Medical Preparations in St. Petersburg by doctors Korzeniowsky and Heyfelder and distributed to all Russian military hospitals (31, 32). In addition, the Roussel's devices were recommended for using in civilian hospitals by the Ministry of Internal Affairs. However, local authorities in Russian regions were not always ready to follow this recommendation. We found the evidence that Trans-Baikal regional administration refused to buy the devices due to its high cost of 50 rubles and unpredictability of blood transfusion procedure itself (33).

Besides the outstanding Russian military surgeon of that time Nikolay Ivanovich Pirogov (1810-1881) wrote that Russian military doctors did not practice blood transfusions en masse during the next Russian-Turkish War (1877–1878) (34).

On the basis of available sources, it can be argued that only military field surgeon Sergei Petrovich Kolomnin (1842–1886) practiced blood transfusion during this period in Russia. During the Serbian-Turkish War (1876–1877) and Russian-Turkish War (1877–1878), he transfused defibrinated human blood to "support the dying life of the sick... or ... strengthen weak patients" (35). In total, he performed 12 operations, but the method he used was fundamentally different from Roussel's one. Kolomnin transfused defibrinated human blood into the patient's radial artery with the using of another kind of apparatus (35). In 1879, he described this experience in the report "On arterial transfusion of defibrinated blood" at the meeting of the Society of Russian doctors.

Thus, despite the fact that Roussel's devices were purchased and delivered to Russian military hospitals, they were not widely used in Russian military field surgery in 1870s.

Conclusion

Thereby, at the beginning of the 19th century, the studies of blood transfusion were mainly limited by the frame of intra- and inter-specific physiological experiments. During the second part of the 19th century, both European and Russian scholars were especially interested in the issues of blood transfusion practical application: the effectiveness of the use of whole or defibrinated blood, ways to preserve a donor's blood, the

choice of an optimal donor - human or animal. Russian researchers made a number of important discoveries in the study of practical aspects of blood transfusion. Sutugin discovered the ability of fibrin to recover in the blood within 24 hours and the possibility to store defibrillated blood at 0°C for a week. Rautenberg invented a method of chemical blood conservation by adding small amounts of sodium carbonate.

The success of Roussel's device at the 1873 Vienna World's Fair and its acquisition by the governments of Russia, Belgium and Austria-Hungary for their armies indicated the immediate needs of blood transfusion application in medicine, especially, in military field surgery. Roussel managed to use this situation having offered his device to the military and medical community. He conducted a successful "promotional company" of the device (the letter to the Russian Military Ministry; his book "The blood transfusion" where he described not only the apparatus itself, but also its awards; the book's French and English translations; public clinical trials of his device in the leading European states (Russia, France, Austria-Hungary, and Germany), during and after the Vienna World's Fair). Moreover, he became a monopoly supplier of his devices in Russia. All this reveals Roussel's self-serving desire to make his invention the mean of his income. It is hard not to admit that Roussel's power of persuasion and communication skills which allowed him to enlist support of the prominent European surgeons James Paget and Ignaz Josef Neudorfer, as well as establishing and maintaining good relationships with Russian military surgeons interested in issues of blood transfusion application, were truly extraordinary. Apart from Roussel's unique abilities, this story also reveals how much the needs of practical medicine outstripped the technical capabilities of their implementation. Roussel's efforts were successful in financial terms and fruitless in a medical way. As we know now, in the 19th century blood transfusion still had been an unpredictable and unsafe method, which began its large-scale application only in the next century, after the discoveries of K. Landsteiner.

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