Nikolay Ivanovich Pirogov and his contribution to medicine in 19th Century Imperial Russia

Hendriks, I.F.

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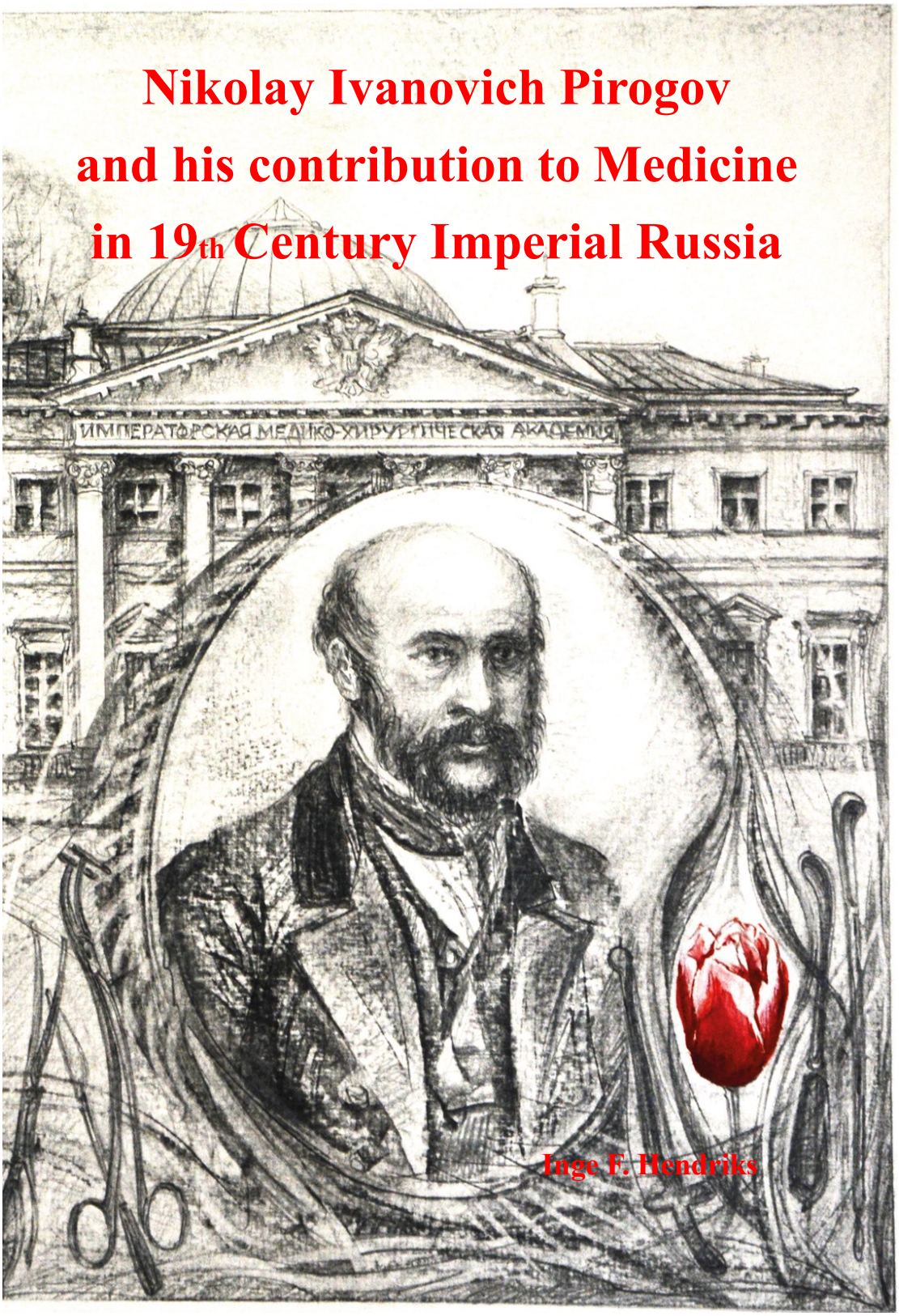

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	Prof.dr. E.S. Houwaart (University Maastricht)
	Prof.dr. E.V. Kryukov (Military Medical Academy named S.M. Kirov)
	Prof.dr. A.A. Budko (Military Medical Museum)

Without knowledge of the past there is no future
Wim Grommen
In: Civis Mundi, Tijdschrift voor Politieke Filosofie en Cultuur, 2013

With love for
my Dutch mam Elizabeth
and
my Russian godmother Galina

Contents

Chapter 1

General introduction

General Introduction

During my study of Slavic language and literature (1992-2001) at the University of Leiden an elective could be filled. The chosen theme was Healthcare spearheaded on hospitals in the Russian Federation, which was even more narrowed to the "*history of nursing*". For the desk research of this article, it soon occurred that hardly any articles on the subject could be found in English scientific literature. Even in the library of the Royal Dutch Academy of Science, English literature was hardly available except for a few articles in Russian in some not complete volumes of Russian medical journals. More and more, it became clear that the subject and theme "the development of the medical profession and the contribution in Russia" were unknown and unexplored areas, especially in the English language. It needed attention to be discovered. To do such research requires some knowledge of Medicine and proficiency in several languages and especially in Russian.

My dissertation is about the profession of Medicine, particularly the medical substantive developments and organisation of medical care initiated by Nikolay I. Pirogov. To refine the research, it was decided to describe the development of the medical profession of a barber-surgeon to a scientific physician based on solid study with the focus on Nikolay Pirogov. It is about the profession of Medicine, particularly the medical substantive developments and organisation of medical care initiated by Pirogov. It was decided to use as much as primary literature possible with regards to Pirogov.

The hypotheses or central question for my research on Nicolay I. Pirogov is a comparison with Herman Boerhaave.

Why becomes a(n) (inter)national scholar relatively unknown or well-known. Boerhaave was an innovator in the Netherlands and Europe. His furthest and the only journey was restricted to Harderwijk.

Pirogov was an innovator in Russia and the world. His journeys went all over Europa, and his furthest distant was to La Spezia in Italy.

To answer the central theme, other questions evolve:

- Why was the time ripe for a reformer/designer like Pirogov?
- What has been Pirogov's essential contribution from a national and international perspective?
- When we compare Pirogv with his well-known predecessor Boerhaave, co-indirect designer of the Russian medical school, what are the similarities and differences?
- Although Pirogov described breakthroughs and co-founded an international health organisation, why has his work not been recognised after the first world war outside Russia?

This manuscript does not include the social and political aspects surrounding the implementation and development of the profession of Medicine and solely focussed on the medical impact. This is a different approach often taken by historians in humanities.[1-3] An exciting approach but not in this context. For a reader interested in this approach, the secondary literature we would like to refer to Mark Turda in *The Oxford Handbook of History of Medicine.*

To understand why Nikolay Ivanovich Pirogov was important for the profession of Medicine in Imperial Russia of the 19th century, an overview of the medical development is given in this introductory chapter. During research it became obvious the prominent role the Netherlands had plaid. An additional question arose. Can Pirogov be considered a follower or a product of the Dutch Leiden medical school?

The birth of medicine in Russia

From the IX to the XVIII century, Medicine in Russia went through a long and complicated course. After Kievan Rus' conversion to Byzantium Christianity, monks provided rudimentary medical care in the monasteries, along with folk healers. Most of the population in Russia did not have access to qualified medical care and relied on traditional folk remedies, which consisted mainly of the use of herbs and ointments. When urbanisation and welfare became more common, the demand arose for a different and more extensive form of medicine, not only for external but also for internal medicine. Only rich people received qualified medical care, which foreign physicians provided.

Tsar Mikhail Fyodorovich (1613-1645), the first reigning Romanov, instituted improvements in social welfare and healthcare. Around 1620 he established the Aptekarskiy Prikaz (Ministry of Pharmacy) in Moscow.[4] He also invited many foreign doctors to Russia. This institution was established and managed by pharmacists to supervise and organise the work of pharmacists, doctors medicinae and barber-surgeons. The "Minister" of Healthcare was an apothecary and not a doctor medicinae. The Prikaz opened the first medical school in 1654 with court physicians and foreign doctor medicinae providing education. Instructions included surgery, anatomy, pharmacology, practical diagnosis of internal diseases and ambulatory medicine.

Peter the Great visited the Netherlands and Leiden University

Peter the Great in 1682 became the Tsar of Russia at a very young age of ten years. He had many friends both among Russians and foreigners. One of his closest friends was the family doctor Johan Termont, an experienced Dutch barber-surgeon. He was the first teacher of Peter in theoretical and practical Medicine.[5-7] Peter's childhood friends and his travels abroad influenced his views on the modernisation of Russia.[4,8]

Before Peter the Great a classical medical school did not exist, only the barber-surgeon school of the Aptekarskiy Prikaz mentioned above. Tsar Peter, with his great interest in medicine and science, was well aware of the need for the training of a medical corps for the navy and land force. If he wanted to take his country out of isolation and transfer it into modern civilisation, he knew he had to travel to Europe to develop his visions and ideas. In 1697 Peter made his first visit to Europe with the Grand Embassy (a diplomatic mission to strengthen Russia's alliance with several European countries). The Netherlands and especially Leiden University was an important centre of medicine in Europe in the 17th and 18th century. Eager to learn as much as possible he travelled two times in 1697-98 and a third time in 1717 to Leiden University and took with him the blueprints of the university statutes of the Leiden University. Leiden was a city of physician-scientists and instrument makers mostly located at the Rapenburg, one could say forerunner what is the current Leiden Bioscience Park. Amsterdam was from a medical perspective the city of barber-surgeons, apothecaries and merchants.

Tsar Peter, who needed a new court physician, invited Nicolaas Lambertus Bidloo (1673/4-1735), who graduated at Leiden University. Bidloo accepted the offer and started his work in Russia in 1702.[4,9,10] His father, Lambert Bidloo, was a pharmacist in Amsterdam. His uncle, and brother of his father, was Govert Bidloo, Rector Magnificus of Leiden University. One of his teachers was Carol Drelincourt (1633 - 1697), who was the mentor of Herman Boerhaave, so Bidloo and Boerhaave were fellow students and medical contemporaries.

After his first trip to Europe in 1703 Peter the Great founded Saint Petersburg, which became the capital of Imperial Russia. He also organised training of the most talented Russian students at Leiden University. Peter realised that this was not sufficient and together with Nicolaas Bidloo, he founded the first medical hospital school with an anatomical theatre and a botanical garden in Moscow. The "Bidloo school" in Moscow officially opened its doors in 1707 for Russians and Russians with foreign roots. It was the first higher education institute, that prepared students for a possible follow-up study to Doctor Medicinae abroad. After graduation, these scholars were sent mostly to Leiden University. The Bidloo school became the breeding school for Russian Doctor Medicinae (to compare with a PhD-degree). [10,11] Peter also opened ten hospitals in large strategic centres among others a garrison, a navy and a land force hospital in 1710 in Saint Petersburg, and navy hospitals in Kronstadt and Revel. These hospitals also contained schools, where after a period of practical work time in regiments a barber-surgeon title could be obtained.
The Aptekarskiy Prikaz grew in staff size. Gradually it changed from a court institution to a state institution.[8] Peter the Great decided in 1707 to rename the Aptekarskiy Prikaz to Aptekarskaya Kantselyariya (Pharmaceutical Chancellery). [4,8,12] The school belonging to the Aptekarskiy Prikaz was not a higher education institution but prepared barber-surgeons to serve in the military and the navy. Over 60 years of its existence the school functioned unevenly. In modern sense, it was not a school. Because Peter had established better alternatives, he decided to close the school of the Kantselyariya. The decision was consistent with the reforms initiated

by Peter the Great.

In 1712 a large part of the Aptekarskaya Kantselyariya was moved to the new capital Saint Petersburg. In 1716 Tsar Peter appointed instead of an apothecary a doctor medicinae head of the Chancellery. This doctor medicinae was for the first time by crown named Arkhiyater of the Chancellery (synonymous for Minister of Healthcare). Thus, from that time on the title "Arkhiyater" became reserved for the most senior civil servant or politician with responsibilities for health care. Before Peter's decision, any court physician was called an "Arkhiyater".

In 1725 the Aptekarskaya Kantselyariya underwent a name change again and was named Meditsinskaya Kantselyariya (Medical Chancellery). Till the reign of Catherine the Great the Arkhiyater, a doctor medicinae was Minister of Healthcare. (Table 1)

Members of the Romanov Dynasty, who played an important role in the development of Russian Medicine	
Tsar - Tsarina	***Reign***
Tsar Mikhail Fyodrovich	1613 – 1645
Tsar Peter the Great	1672 – 1725
Tsarina Catherine the First	1725 – 1727
Tsarina Anna Joannovna	1730 – 1740
Tsarina Elisabeth the Great	1741 – 1761
Tsarina Catherine the Great	1763 – 1796
Tsar Paul I	1796 – 1801
Tsar Aleksandre I	1801 – 1825
Tsar Nicholas I	1825 – 1855
Tsar Aleksandre II	1855 – 1881

Table 1 Overview of the reigns of the successive Tsars in the period of investigation

In 1755 Tsarina Elisabeth the Great (reign: 1741-1762), daughter of Peter the Great, founded the University in Moscow. The first generation of professors had Russian roots or were Russians of foreign origins. They were trained at the Bidloo school or the university of the Academy of Science and had obtained their Doctor Medicinae Degree at Leiden University.
A pupil of Herman Boerhaave, Pavel Zakharyevich Kondoidi, became director of the Meditsinskaya Kantselyariya (1753-1760). Kondoidi succeeded the oldest nephew of Herman Boerhaave, Herman Kaau-Boerhaave after his death. Pavel reformed the education and examination system.
The first Russian professor in the medical faculty of the Moscow University was

Semyon G. Zybelin. He graduated in 1758 at the Moscow University in Philosophy. Subsequently, he studied some time at the Imperial Academy of Science, but he received a doctorate in medicine in Leiden in 1764. He taught at the Moscow University theoretic medicine.

The two-track policy for medical education of Peter the Great continued till the third quarter of the 18th century, even though when Tsarina Catherina the Great (reign: 1762-1796) remained in these footsteps. In 1763 she transformed the name of the Meditsinskaya Kantselyariya into the Meditsinskaya Kollegiya (Medical Collegium) with extended powers. She installed a board of three directors (Collegium) with a doctor medicinae as one of the members. In 1764 it was given the right to confer the degree of Doctor Medicinae, although it rarely used this right. Catherine the Great institutionalised healthcare more, and during her reign, Russia became increasingly self-sufficient in the field of trained medical professionals. She elaborated on the modernisation of Peter the Great. (Table. 2)

Name	**Founder or Renamer**	**Founding or renaming year**	**In charge**
Aptekarskiy Prikaz	Mikhail Fyodorovich	1620	Apothecary
Aptekarskaya Kantselaryariya	Peter the Great	1707	Doctor medicinae (Arkhiyater)
Meditsinskaya Kantselaryariya	Peter the Great	1725	Doctor medicinae (Arkhiyater)
Meditsinskaya Kollegiya	Catherine the Great	1763	board of three directors (Collegium) inclusive doctor medicinae
Meditsinkaya Kollegiya	Aleksandre I	1802	Ministry of Internal Affairs with a Medical Department
			Ministry of Education with department Medical education

Table 2 Overview of the development of the "Ministry of Health", with the names that were used, the founder of the governmental structure, the founding year and the individual or collective that was in charge.

In 1786, the schools of both medical hospital schools were separated and converted into independent medico-surgical schools (the Bidloo school and the navy and land force hospital school in Saint Petersburg). They obtained the right to educate own students and "to lead them to the doctoral degree" together with the University of Moscow. Till that moment this right belonged only to the Medical Office. In 1798,

12 years later, the medico-surgical schools of Moscow and St. Petersburg have been renamed to Imperial Medico-Surgical Academies. The Moscow Medico-Surgical Academy existed until 1804. Not only its 45 students but also all the medical instruments and the library were transferred to the Imperial Medico-Surgical Academy (now the Military Medical Academy named S.M. Kirov) in St.Petersburg. Nicolaas Bidloo in Moscow and Herman Boerhaave with his Leiden colleagues and their students rolled out the scientific basis for medical education and healthcare in Russia. (Table 3)

<table>
<tr><th></th><th colspan="3">Moscow</th><th colspan="2">Saint Petersburg</th></tr>
<tr><th>Year</th><th>Entity</th><th>Entity</th><th>Entity</th><th>Entity</th><th>Entity</th></tr>
<tr><td>1654 – 1714</td><td colspan="5">Barber-surgeon school at the Aptekarskiy Prikraz</td></tr>
<tr><td>1707</td><td colspan="2" rowspan="3">'Bidloo school', anatomical theatre, botanical garden, hospital, preparatory school for postdoc PhD-title</td><td></td><td></td><td></td></tr>
<tr><td>1710</td><td></td><td rowspan="2">Navy hospital with school Preparation for barber-surgeon in military service</td><td rowspan="2">Landforce hospital with school Preparation for barber-surgeon in military service</td></tr>
<tr><td>1755</td><td>Establishment of the Lomonosov University of Moscow</td></tr>
<tr><td>1786</td><td colspan="5">As well as in Moscow as in Saint Petersburg
the schools were separated from the hospitals</td></tr>
<tr><td>1786</td><td colspan="2">Medico-surgical Academy</td><td>Lomonosov University</td><td colspan="2">Medico-surgical Academy</td></tr>
<tr><td>1798</td><td colspan="5">Merger of the Moscow Medico-surgical Academy with the Saint Petersburg Medico-surgical Academy</td></tr>
<tr><td>1798 - now</td><td colspan="3">Lomonosov University</td><td colspan="2">Imperial Medico-surgical Academy
(since 1881 Military Medical Academy named S.M. Kirov)</td></tr>
</table>

Table 3 Simultaneous development of the medical education in Moscow and Saint Petersburg.

The Kunstkamera, museum of anthropology and ethnography. The purchase of the collections of Frederik Ruysch and Albert Seba

Tsar Peter had an above-average interest in surgery and the management of trauma, on which he in part was taught by his private physician, Termont.[2] During his first Grand Embassy to the Netherlands Peter, most of his time lived in Amsterdam and visited more than once the anatomist Frederik Ruysch, who became his second teacher in medicine. He taught Peter how to carry out a phlebotomy, surgical incisions, suture wounds, extract teeth and to perform post mortems. After his return from the first Grand Embassy to Moscow in 1699, Peter carried out a series of lectures on anatomy for the boyars (noblemen) with demonstrations on cadavers. [13,14]

Since 1672 Ruysch had perfected the preparation technique of anatomical specimens and blood vessels by injection of dyes and resins. He invented an original way of embalming corpses. He sampled a unique collection of museum exhibits

(congenital abnormalities and malformations) and created the first anatomical museum in Amsterdam. His museum possessed a rich collection of anatomical objects, dried plants, insects and birds. All were carefully described in great detail by Ruysch. Twice a week, Ruysch's museum was open to the public. Peter the Great greatly admired the anatomical specimens of humans and animals on his visits to the museum. In 1698 he obtained his first collection of these specimens, including among other anatomical preparations. These anatomical objects are known as the private "small collection" of 26 dry and wet human specimens of Fredrik Ruysch. This first collection became part of the Aptekarsky Prikaz in Moscow awaiting the settlement of St.Petersburg. The collection was transferred in 1798 to the Imperial Medico-Surgical Academy (now the Military Medical Academy named S.M. Kirov) in St.Petersburg.

Peter the Great wanted his own museum with curiosities and founded the Kustkamera in 1714. Meanwhile, Peter again travelled in 1716-1717with his second Grand Embassy through Europe among others to France and the Netherlands. When given a chance, he bought the famous Ruysch collection of anatomical preparations for his new Kunstkamera.[15,16] The Tsar managed to get Ruijsch to reveal to him the secrets of embalming the dry and preserving the wet specimens. Peter passed on this knowledge to his court physician Laurentius L. Blumentrost (1676-1756) as the chief supervisor of the Ruijsch collection, so that he could care for the collection. Blumentrost, in turn, passed on the secret to doctor Rieger who finally put it in writing and made the secret public. From February 1718 on Peter's orders, the Kustkamera extended to contain all examples of birth deformations of both humans and animals in Russia. The Tsar also bought in 1716 the natural history collection of the apothecary Albert Seba.[15,17] It contained 340 jars with animals kept in the spirit of wine, a quantity of fish and other marine products, and without counting a collection of several artificial and curious pieces.

The Kunstkamera opened for public in 1719. In 1721 a complete medical library and a rich collection of other rare items such as minerals and shells that had belonged to Peter's physician Robert Areskine were also added to the Kunstkamera. [4]

Peter the Great established the Imperial Academy of Science in 1724, and the Kunstkamera became a part of the Academy.[18]

The Imperial Academy of Science

Science in the post-enlightenment period

During his second Grand Embassy Tsar Peter visited France and the Academy of Science in Paris, of which he became a member.[4-8,19,20] To become more connected with science in Europe, Peter decided to establish in 1724 an Academy of Sciences in St. Petersburg along the lines of the French Academy. After Peter died in 1725, during her short reign Tsarina Catherine the First (1625-1727) continued the work of her husband Peter. The first meeting of the Academy took place on 27 December 1725 in the presence of the Tsarina. At the end it lasted two years before the official grand opening took place on 27 December 1726.

The Academy of Science contained a gymnasium (grammar school) for the preparation of future students, and a university with three faculties (law, medicine and philosophy). Already before his death, Peter donated his library and the

Kunstkamera to the newly created Academy of Sciences.
In 1726, the first year the Academy functioned, its gymnasium received 120 students and in the second year 58. The university of the Academy not only received students from its own gymnasium but also grand-aided students from other religious, educational institutes, where Latin was taught. The mastery of Latin was necessary since the education at the university was given in Latin by the invited foreign professors. The university contained a library, curiosities, an astronomical observatory, an anatomical theatre and a botanical garden.

Attracting followers of Boerhaave as the basis of the medical school and expansion. Education in connection with wonderment and science

Laurentius Lavrentevich Blumentrost (1692-1755), court-physician of Peter I and his successors, who had studied at the Leiden University, became the first president of the Academy of Sciences. In the years 1726 and 1727, more experienced doctors came to Russia and enrolled in the Academy. These also included his older brother Johannes Deodatus Blumentrost (1676-1756), president of the Meditsinskaya Kantselyariya (Ministry of Healthcare). (Table 4)

Family Blumentrost				
First and fathers name	***Family ties***	***Tsar/tsarina***	***Education***	***Profession***
Laurentius	Father	Aleksey Mikhailovich Fyodor Alekseevich Peter the Great	Mühlhausen	Arkhiyater (court physician)
	Oldest son played no role in healthcare and migrated not to Russia.			
Laurentius Christian	Second son	Imperial princesses	unknown	court physician
Johannes Deodatus (Ivan Lavrentevich)	Third son	Peter the Great Catherina the First Anna Ivanovna (Joannovna) Elisabeth the Great	Königsberg Halle **Leiden**	• court physician • army surgeon • Arkhiyater (Minister Healthcare)
Laurentius Lavrentevich	Fourth and youngest son	Peter the Great Catherina the First Anna Ivanovna (Joannovna) Elisabeth the Great	Halle **Leiden**	• court physician • President Academy of Science • Director of Military Hospital in Moscow • State Councillor • Curator Moscow University

Table 4 Overview of the influential family Blumentrost, whose members occupied important positions in the administration of healthcare.

During the 18th century, 46 Russians or Russians with foreign roots studied in Leiden, where they were awarded the doctor medicinae degree. Of them, three studied in Leiden before the appointment of Herman Boerhaave, 11 during Herman's Boerhaave time and 32 after Boerhaave's death. All kept contact with their former Leiden teachers. Most of them played a crucial role in the development of medicine and held high positions. They were able to offer their Dutch teachers also vital positions at the Russian court or in the Academy of sciences. Herman Kaau-Boerhaave, nephew of Herman Boerhaave became minister of healthcare (1748-1753) during the reign of Elisabeth the Great. His younger brother Abraham Kaau-Boerhaave became a member of the Imperial Academy of Science of St. Petersburg in 1744, when he was still practising as a physician in The Hague. In 1746 he came to St. Petersburg where he first got a position at the Admirality hospital. In 1748 he was appointed Professor of Anatomy and Physiology. He had studied at Leiden University and enjoyed lessons among others from his uncle Herman Boerhaave. When Abraham Kaau-Boerhaave died in 1758 in Russian, he left eight manuscripts behind. Abraham Kaau-Boerhaave was the teacher and maecenas of Alexius Protassiev, who first studied in Leiden and afterwards anatomy at the Imperial Academy of Science. Protassiev was one of the first native Russians who specialised in this subject and was appointed Professor of Anatomy.[9;14] Another Russian who became a member of the Academy was Mikhail V. Lomonosov, who was appointed professor of chemistry. He had studied in Marburg, Germany. He suggested the establishment of the Moscow University.

Other well-known Dutch professors from Leiden were invited to become a member of the Imperial Academy, but they did not always accept the offered positions. Herman Boerhaave declined the invitation of Tsarina Anna Joannovna. Also, Bernard Siegfried Albinus and Hieronymus Davides Gaubius thanked for the honour.
In the Russian annals are also mentioned father Johannes and son David de Gorter. Johannes studied medicine in Leiden and discussed various physiological and pathological theories under the chairmanship of Bernhard Siegfried Albinus, professor of anatomy and rector of the Leiden University. Another member of the Academy was the German Carl Friedrich Kruse who also had studied medicine in Leiden. He for a long time served as the chief physician of the Imperial Lifeguards in St. Petersburg. During the reign of Catherine the Great he was in 1770 appointed as an assistant personal physician and State Councillor by the court. His wife was the daughter of Herman Kaau-Boerhaave and heir to the Boerhaave heritage.
Not until the Russian economy became more developed other universities were established at the beginning of the 19th century.

The long period of near silence in Russian medical science
It took Russia approximately 130 years to build up a self-sufficient medical training since Peter the Great started reforms of Russia. By the beginning of the 19th century, Russia had already 1519 doctors and barber-surgeon of Russian origin. Four hundred twenty-two were in the army, 128 in the navy and 879 in hospitals and

medical boards.
Also Tsar Paul I (reign: 1796-1801) and his both sons, Aleksandre I (reign: 1801-1825) and Nicholas I (reign: 1825-1855), continued the reforms of educational enlightenment of their ancestors. Both brothers wanted to become more and more independent from foreign medical doctors but also understood that Russia as a great European power, could not afford to be left far behind Europe after the Napoleonic War in 1812.[21,22]

Under Tsar Aleksandre I and Nicholas I the Russian economy developed further, which resulted in a significant increase in the number of higher education institutions with medical faculties.[15,17] By 1860, Russia had eight universities, as part of which the opening and medical faculties in Dorpat (now Tartu in the Republic Estonia, 1802), Vilnius (1803), Kazan (1804), Kharkov (1805), and Kiev (1841).[4,8]
Tsar Aleksander I (reign: 1801-1825) established the Ministry of Internal Affairs in 1802, and the Meditsinskaya Kollegiya (Medical Collegium) became the Medial Department part of this Ministry. It became the main body for medical and sanitary control. Medical education was placed under the Ministry of Education.
According to the university ruling of 1804, the universities have the use of the right to autonomy (the election of the rector, deans, professors, etc.). Some universities were transmitters of advanced democratic ideas, and the government actively stifled the freedom-loving sentiments in the higher educational institutions. In 1820 the government announced audits of universities. Such an audit in the Kazan University caused the closure of the anatomical theatre and museum, and autopsies were no longer allowed. All the anatomical specimens were made unrecognisable and buried in a church ceremony.
During the reign of Nicholas I a new university charter was released in 1835 that banned the autonomy of universities and the authorities subjected them to the Board of Trustees, appointed by the tsarist government.

Breaking the silence: Pirogov stands up as a designer of modern Russian medicine

The Tsars and Tsarinas have laid the foundations and created the conditions for healthcare reform, which took about 130 years from Peter the Great on. However, the doctors had to shape the house and its contents. Above all, it also asked for indispensable chief supervisors with a well-trained medical knowledge. Tsar Nicholas I (reign: 1825-1855) understood this very well, especially after the Napoleonic War in 1812. He continued with the enlightenment and reforms in healthcare. He invited talented students of different disciplines of Russian universities to volunteer to go abroad for a further PhD-study at the German-Baltic University of Dorpat (now Tartu in the Republic Estonia), one of the best of that time in the German-speaking area and Russia. The aim of this study in Dorpat and their traineeship of two more years at foreign universities in Europe was to prepare these Russian students as staff members in the Department of the Ministry of Public Education and as professors of Universities. The first group of talented students was sent out in 1828, including Nikolay Ivanovich Pirogov (1810-1881). To raise the medical skills in Russia to a level equal to that of the advanced countries of Europe

another 30 years was needed, in which Pirogov played a crucial role.

Nikolay Pirogov was a well-educated physician of Russian origin, who studied at the Moscow University, at the German-Baltic University of Dorpat and at the universities in Berlin and Gottingen. During his postdoc, he also visited Paris and met there with other foreign colleagues. He kept developing himself and was very interest in new developments in medical health care. He would reorganise the medical education, introduce a new curriculum for medical students, which from then on for the first time included the teaching of topographical and applied anatomy. He extended surgery from a craft to a science, equipping doctors with scientifically based techniques of surgical intervention. His contributions reached beyond the boundaries of surgery. He was a dedicated teacher who encouraged students to excel clinically and guided them in scientific endeavours.

To offer Pirogov the right stage in the history of world medicine, we decided to compare him with Herman Boerhaave. This Dutch physician, with his Leiden colleagues, his Dutch and Russian students, including his nephews, stood at the cradle of health care and medical education in Russia. Can we conclude that Pirogov was influenced by the Dutch medical school and does his name and work subsequently belong in the range of his well-known medical predecessors?

The research questions for this thesis were:
The central question is why becomes a(n) (inter)national scholar relatively unknown or well-known among others Herman Boerhaave?

- Why was the time was ripe for a reformer/designer like Pirogov.
- Why has the recognition of his work been left behind outside Russia, although he described major breakthroughs and co-founded an international health organisation?
- What has been his essential contributions from a national and international perspective?
- When we compare Pirogv with his well-known predecessor Boerhaave, co-indirect designer of the Russian medical school, what are the similarities and differences?

Chapter Two of the thesis describes the development of Russian medicine from the 9th to the beginning of the 19th century. It details the role of physicians trained in the Netherlands. In this chapter, the reader gains insight into the position of Russia in Medicine before Pirogov became a medical student at the University of Moscow in 1824.

In **Chapter Three,** we illustrate the role of Pirogov as a pioneering Russian surgeon and medical scientist and show how in Russia he elevated surgery to science and that his name was attached to medical interventions.

In **Chapter Four,** we describe the contribution of Pirogov to anatomy. Pirogov passionately believed in the importance of anatomy for surgeons. He was appointed Professor of Applied Anatomy and Surgery at the Imperial Medico-Surgical Academy in Saint Petersburg. In that capacity, he introduced the teaching of microscopy and histology to the medical Curriculum. In 1846 he formed the Institute for Applied Anatomy within the Academy, where in addition to teaching medical students future teachers of anatomy in Russia were trained. Pirogov published extensively on anatomy, including several anatomical atlases and contributed to the introduction of anatomy into surgery.

In **Chapter Five,** we focus on his contribution to military and civilian anaesthesia. In his time anaesthesia was evolving into a science. It became crucial for the subsequent development of surgery both for civilians as well as on the battlefield. We hypothesise that he was very ahead in thinking about anaesthesia. Pirogov was well aware of the international literature on anaesthetic risks, for instance, what was written about the death of Hanna Green, and he commented on it with facts and arguments.

In **Chapter Six,** we explored what motivated Pirogov to employ women in health care, and how he was able to stand up for it together with Grand Duchess Elena Pavlovna (sister-in-law of Tsar Nicholas I). They both committed to train and deploy women in health care during wars and later in hospitals. We also investigated the background of these women and what education they received.

In **Chapter Seven,** we investigate what Pirogov intended as one of the founders of the Red Cross, what he has contributed as a consultant and how he was appreciated as a fellow physician in August 1897 during the International Medical Congress in Moscow.

In **Chapter Eight, we compare** the contributions of Pirogov and Boerhaave in light of the development of modern Medicine in Russia. We compare their innovations, quantify their bibliography both locally as well as international and investigate their international network and analyse their connection with Anglo-Saxon literature through the ages. We hypothesise that, despite scientific excellence, a scholar can remain or become largely unknown due to unfavourable environmental factors, which lead to the fact that the work is no longer quoted and therefore ends up in oblivion. Furthermore, it appeared that in particular alumni of Leiden University, especially since Peter the Great, had played a major role in the development of medicine in Russia throughout the 18th century. Can in that perspective Nikolay Pirogov be seen as a belated student of “the Medical School”?

In **Chapter Nine,** the findings are summarised and concluding remarks are made.

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Chapter 2

Development of Russian Medicine from the 9th to the beginning of 19th century. The role of physicians trained in the Netherlands.

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Abstract

The development of medicine in Russia is discussed from the beginning of the ninth century until the end of the eighteenth century. Before 1613 most of the population had little access to qualified medical care, but relied on traditional folk remedies. After conversion of Kievan Rus' to Byzantium Christianity, monks in the monasteries provided basic medical care in addition to folk healers. In contrast, the ruling classes had access to qualified foreign physicians. From the first Romanov Tsar, Mikhail Fyodrovich (1613-1645), on many foreign doctors were recruited including Dutch graduates of Leiden University. Talented Russian-born students of the Moscow Medical Hospital School, founded by Peter the Great and his Dutch court physician Nicolaas Bidloo, were sent to Leiden on state scholarship. Especially during the eighteenth century, Leiden trained physicians made very significant contributions to medicine and helped strongly to develop the medical faculty of the Moscow university.

Folk medicine and the role of the monasteries during Kievan Rus'

An open society

To better understand the history of medicine in Russia it is helpful to understand the history and the geography of that nation.[1,2] Throughout its history Russia varied between an open and an isolated country, and this is also reflected in the development of medicine. Ancient Russia was connected by a river in the north with Scandinavia and in the south with Byzantium. The country name dates from the second half of the ninth century when it was called Kievian Rus', a feudal state with Kiev as the capital.[3,4]

During its early history the majority of Russians had little or no access to qualified medical care, but relied on traditional folk and herbal remedies.[1,3,5] With the conversion of the Kievan Rus' state to Byzantium Christianity in 988 many monasteries were established, some of which also functioned as centers of education. They also offered basic medical care for the poor and needy. Ancient and early medieval manuscripts came to Kiev through Bulgaria and Byzantium. Monks and chroniclers like Nestor, who knew Latin and Greek not only collected Greek and Byzantine manuscripts, but also translated them to the Slavic language, to which they added their own knowledge based on local folk experience.

The oldest and most famous monastery was the Pecherskaya Monastery[1] or "Monastery of the Caves" in Kiev.[1,3-9] It received wounded and needy with all kinds of diseases from all over Kievan Rus'. For the most serious cases the monastery hospital had a special ward, where monks on duty provided the basic care for the sick.

Some monks specialized in the treatment of specific diseases; for example Alimpiy treated patients with skin diseases and Demyan treated children. In the eleventh century, many monks spent time in the monastery on the Mount Athos in Greece. On their return they put into practice the rudimentary medical skills they had learned there. The monks were not the only practicing healers. A distinct secular medical tradition had also evolved by the mid-eleventh century. In cities and at the courts of princes and boyars (noblemen) there were secular Russian and foreign folk healers called lechtsy (*лечцы*). Two known foreigners were Armenian and Peter the Syrian.

These healers used traditional medicine and passed their medical knowledge and secrets from generation to generation, from father to son in the so-called family medical schools. Widespread use was made of herbal remedies derived from plants

[1] We have used common English transcription for Russian among others the names 'Печерская лавра' and 'Алимпий'.

such as sage, nettle, plantain or wild rosemary, and from animals, e.g. honey and cod liver oil.
Folk healers were well aware of the healing power of the banya (sauna), which was the cleanest room in the house and was used for caring and cleaning the body, phlebotomy, massage, delivering a child and caring for the new-born, etc. Banya's are even nowadays in use in Russia.

In the oldest Russian law, the [*Russian Truth*], framed between 1113-1125 is written that a person who inflicted damage to another person's health, had to pay a sum of money to the state treasury so the victim could pay for the treatment of their injuries. Thus the law indirectly recognized for the first time the work of folk healers.

An isolated society during the Mongol Yoke
Kievian Rus' had existed for three centuries when in 1132 after the death of the last Prince of Kiev the country broke up into several small feudal regions. It lost its political independence and was isolated from Europe as a result of the invasion of the Mongol-Tatars named the Golden Horde. However, ongoing struggles made it impossible for the Moguls to create a strong Mongol government. The princes of the Grand Duchy of Moscow at the head of gathering the Russian regions steadily increased its power. The unification was completed by Tsar Ivan III (1462-1505) after the final overthrow of the Mongol yoke at the Battle of Moscow in 1480 and Moscow replaced Kiev as the political capital of the country then named Muscovy.
During the Mongol yoke foreign physicians virtually disappeared and they did not begin to return until the reign of Tsar Ivan III (1462-1505).

From rural to pharmaceutical medication during Muscovy (1481-1662)

One again an open society
After the victory over the Mongols the new state of Muscovy sought reconnection with Europe through the free port of Archangelsk. The first Muscovite emperor, Tsar Vasily Ivanovich III (1505-1533) appointed as his court-physicians some foreign doctors, among them Nikolay Lyuev (Nicolaus Bülow) from Lübeck, the brothers Marquart from Königsberg and Theophil, a captured Prussian doctor. [4,7,10,11]
But from letter exchanges between the Grand Duke and his wife it was apparent that for the illness of their children they had more trust in the empirical experience of the Grand Duchess than in doctors. Thus, the children were treated with the traditional folk remedies supplied by the home pharmacy.

Vasily's successor Tsar Ivan Vasilievich IV (1534-1584), known as Ivan the

Terrible, developed trade with England and other countries.[4,12,13] Widespread connections with other countries ensued and modern-drugs became more readily available. From 1550 more hospitals were built in many cities to cater for the elderly and sick. Ivan IV invited the first Doctors Medicinae (comparable to a PhD-physician) to Russia, including the brothers Arnold and Robert Lindsay and the pharmacist James Frencham from England. He also recruited in 1557 the pharmacist Arend Claessen van Stellingwerff from Holland. Even though Van Stellingwerff arrived first and became the court pharmacist for 40 years, it was the Englishmen James Frencham, who was appointed head of the first Imperial Pharmacy opened in Moscow in 1581. Frencham returned to England in 1583 but was again brought to Russia in 1602 by Tsar Boris Fyodrovich Gudonov (1598-1605), bringing with him a valuable collection of both common and less common drugs such as opium, camphor and Senna leaves. Between the death of Tsar Boris and the accession of the first Romanov Tsar, Mikhail Fyodorovich (1613-1645), there was a period of seven years' unrest and civil war.

With the development of book printing scientific sources of European knowledge, such as the manuscripts of Aristoteles, Hippocrates, Celsus and Galen, became available. Tsar Ivan IV and other Russian noblemen installed printing presses.[7] The first handwritten book on medicine of Roman origin was translated in 1423 to Polish and appeared in a Russian translation by Thomas A. Buturlin in 1588.[4,5,7] This textbook of 1561 pages contained copied drawings of herbs, trees, animals, distillation of brandy wine, philosophical education, phlebotomy and pharmacy. By 1616 German herb catalogues with colour pictures, which had existed since 1534, had been translated into Russian. In 1661 these books were presented to the Aptekarskiy Prikaz (Ministry of Pharmacy)[2] and came available to medical doctors, surgeons and pharmacists.
In 1812 like many other things during the invasion of Moscow by Napoleon these rare books and a big part of the archive of the Aptekarskiy Prikaz were destroyed by fire.[4,14]

Tsar Aleksey Mikhailovich (1645-1676) owned two Imperial Pharmacies in Moscow. The old pharmacy was located in the Kremlin and served the Imperial family and supplied almost nothing to private individuals.[5,12,13] The new second pharmacy, located in the city centre, had a significant turnover and employed several qualified pharmacists who were responsible to the Aptekarskiy Prikaz. The tsar had three herb gardens laid out in Moscow most with widely used herbs. Fresh herbs were also obtained from the surrounding villages. The gardeners were

[2] Historical meaning for 'Приказ' is 'Ministry' according to the dictionaries of S.I. Ozhegov – N.Yu. Chedova and of V. Dal'.

required on the first of April to inform in writing the Aptekarskiy Prikaz which seeds and quantity were needed, and in November provide a written report of the functioning of the gardens. The Imperial pharmacies now provided native herbs such as Symphytum majus, Helleborus Niger, Hypericum, Anisum stellatum, saltpetre and rhubarb. However, herbs still had to be imported from abroad for the Imperial pharmacies. In the 1660s two wars broke out between England and Holland among others about Russian trade[9] this resulted in the latter half of the seventeenth century the Dutch taking over the leading market position from the English for exporting and selling pharmaceutical products and herbs. Special staff members of the Prikaz were appointed to deal with deliveries and supplies, and the bookkeeping. They also were responsible for supplying the pharmacist or doctor medicinae the correct items as provided in the signed prescription, and were also responsible for making the end-of-year financial statement to the Aptekarskiy Prikaz.[14]

Tsar Peter the Great (1662-1725) inherited the both pharmacies and had the central pharmacy replaced by a new stone building and refurbished along European standards. In 1705 he allowed eight private pharmacies to be established in Moscow. Their owners held a free license and could sell all types of medicines with the exception of wine and other sorts of non-medical liquids to the general public. Pharmacies were also opened in Kazan, Gluchow, Riga and Reval (now Tallinn in Estonia). A pharmacy in Saint Petersburg, which in 1703 became the new capital of Russia, was not opened until 1760 because of the dominance of the state pharmacy system and the slow growth of population in the city.[12,13] The Tsar also had garrison pharmacies opened in several small villages. Following his second visit to Europe in 1717 Peter had two medicinal herb gardens established in Saint Petersburg and invested in obtaining and producing native medicines and medical products in several new, purpose built factories.[6,12]

Advances in medicine leads to changes in governance

Tsar Mikhail Fyodorovich (1613-1645), the first reigning Romanov, instituted improvements in social welfare and healthcare. Around 1620 he established the Aptekarskiy Prikaz (Ministry of Pharmacy) in Moscow.[4,5,7,13] (Fig. 1) An aristocratic landowner and member of the feudal aristocracy (Boyar) was appointed as minister and a secretary was responsible for day-to-day matters.

The Prikaz became responsible for the advancement of medicine and public health:

- It comprised three professional groups, pharmacists, doctors medicinae and barber surgeons (lekars). It examined pharmacists and doctors medicinae and supervised their registration. Foreign doctors could only be admitted to Russia following approval by the Prikaz after they had shown their diplomas and had successfully passed an examination to confirm their competence to practice.

Fig. 1. The building of the Aptekarskiy Prikaz in the Moscow Kremlin, pen and ink drawing, artist Margarita V. Apraksina, Saint Petersburg, 2016. Private collection, with permission

- It was also responsible for the daily stock of medical supplies as well as organizing the military pharmacies, paying medical administrators and settling legal cases.[12] One person within the Prikaz was authorized to purchase medical instruments and drugs from abroad, most often from Great Britain, the Netherlands[3] and Germany.[7,13,15]
- Another important task of the Prikaz was protecting the population against epidemics such as the bubonic plague, but the steps taken were often insufficient and weak.
- For soldiers, civil servants and boyars a standard care with treatment protocols was developed.[5,12] After investigation by a barber/surgeon, patients took their written injury report together with the prescription to the Prikaz to get the medication, which was paid by the state.
- The Prikaz opened the first medical school in 1654 with court physicians and foreign doctor medicinae providing the education.[6,16,17] Instructions were given in surgery, anatomy, pharmacology, practical diagnosis of internal diseases and ambulatory medicine. From the 30 students selected only 13 graduated in 1658. This school was closed in 1717 by Tsar Peter the Great.

In Russia in the sixteenth and seventeenth centuries pharmacists had the primary responsibility for healthcare. Medicine became more complicated. It changed from

[3] We have chosen for today's names of countries..

external application of herbs to herbal and drug prescriptions in combination with surgical treatments. Following his visits to Europe Peter the Great introduced several innovations, including appointing doctors medicinae as decision makers in the healthcare system. This was continued by his successors. In 1707 Peter the Tsar renamed the Aptekarskiy Prikaz to Aptekarskaya Kantselyariya[4] (Pharmaceutical Chancellery). In 1725 it underwent yet name change to Meditsinskaya Kantselyariya (Medical Chancellery).[6,7,17] In 1712 a large part of the Aptekarskaya Kantselyariya was moved to the new capital Saint Petersburg and the budget was also increased to cover the staff salaries and the higher prices of imported drugs. In 1716 Tsar Peter appointed by crown the first Arkhiyater of the Chancellery (synonymous for Minister of Healthcare). Thus, from that time the title "Arkhiyater" became reserved for the senior civil servant or politician with responsibilities for health care.
The first of these new style Arkhiyaters was the Scotsman Robert Erskine, who from 1713 had been court physician to Peter the Great. The Tsar elevated him to a privy councilor for his "many and most faithful services" - a mark of high distinction. Erskine had studied in Paris before moving to the Netherlands, where he graduated as *Doctor Medicinae* from Utrecht University in 1700. Erskine and his successors were tasked with the responsibility for all health care activities in Russia and all doctors, surgeons and pharmacists working for the state came under their jurisdiction.

Along with the renaming of the Aptekarskiy Prikaz to first Aptekarskaya Kantselyariya and in 1725 to Meditsinskaya Kantselyariya the title of governors also changed first from Arkhiyater to General Director in 1725.[6,18] From 1716 till 1763 Russia counted four Arkhiyaters and four General Directors of whom four were graduates of Leiden University. They radically transformed Russian medicine.

On the recommendation of the Portuguese António Nunes Ribeiro Sanchez, personal physician of Tsarina Anna Ivanovna (1730-1740), Herman Kaau-Boerhaave was invited to become the court physician of the Tsarina.[5,6,18] Sanchez was a graduate of Leiden and a pupil of Herman Boerhaave. Herman Kaau accepted the invitation and travelled to St. Petersburg with his family at the end of 1741. He was one of the four general directors of the Meditsinskaya Kantselyaria. His parents were, Margriet Boerhaave, sister of Herman Boerhaave and doctor Jacob Kaau. Herman became the heir of his uncle Herman Boerhaave, who had only a daughter, so he attached the family name Boerhaave to his surname.

[4] Historical meaning for 'Канцелария' is 'Chancellery' by the dictionaries of S.I. Ozhegov – N.Yu. Chvedova and V. Dal'.

In 1744 Herman Kaau-Boerhaave was appointed to the state council and on 7 December 1748 appointed by Tsarina Elizabeth the Great (1741-1761) as a member of the Privy Council, as first personal physician and General Director of the Meditsinskaya Kantselyariya. He died in Moscow on 7 October 1753 and on the express order of the Tsarina his body was interred in a vaulted crypt in the Old Dutch Church. His remains were moved to the Moscow cemetery on May 20, 1815 when the Old church was moved.
Herman Kaau-Boerhaave, like his uncle, had no male heirs and his younger brother Abraham Kaau became his only heir. In 1740 with the permission of the daughter of Herman Boerhaave, countess De Thoms-Boerhaave, Abraham also changed his surname to Kaau-Boerhaave. Both brothers had studied medicine in Leiden under their uncle Herman Boerhaave and both made successful careers in Russia.

Pavel Zakharievich Condoidi (1710-1760) of Greek roots travelled from Russia to Leiden to study medicine, where he graduated as a doctor in 1733.[6,17,19] On his return to Russia he initially worked as a military doctor, then as a general staff physician. As an honorary member of the Imperial Academy of Science he succeeded Herman Kaau-Boerhaave in 1753 as General Director of the Meditsinskaya Kantselyariya, a post he held until his death in 1760. During his tenure he introduced a seven-year's period of study, a new examination system and introduced in the curriculum of the medical schools teaching of physiology, obstetrics, women's and children's diseases. Another of his achievements was the establishment of the first Russian Library of Medicine in 1756.

Tsarina Elizabeth the Great (1741-1762) issued in 1756 a law that only doctors who had been examined and officially registered by the Meditsinskaya Kantselyariya were allowed to practice medicine.[5,6] It was expressly forbidden to provide any oral drugs without the signature of a qualified doctor. The practice of medicine was now forbidden to non-qualified doctors (folk healers). The Meditsinskaya Kantselyariya distinguished between scientifically trained foreign doctors (Doctor Medicinae) and empirically trained doctors. The first group were doctors who after their basic medical training had completed postgraduate studies and research culminating in the defence of a scientific thesis. The second group were referred to as barber/surgeons лекарь (lekar), and this distinction was also reflected in the level of salary.

Tsarina Catherine the Great (1763-1796) made significant changes in the management of medical affairs in Russia.[6,17,19,20] In 1763 the Meditsinskaya Kantselyariya was transformed into the Meditsinskaya Kollegiya (Medical Collegium) with extended powers. She installed a board of directors (Collegium) with a doctor medicinae as one of the members. In 1764 it was given the right to

confer the degree of Doctor Medicinae, although it rarely used this right. Provincial medical charitable councils were created in all provinces of the Russian Empire in 1775. The councils, which were formed to supervise rural medical affairs, included representatives of all sections of society. Their functions include organizing orphanages, alms-houses, hospitals and pharmacies. They fell under the supervision of the Meditsinskaya Kollegiya. The number of physicians (also those of Russian origin) steadily increased. (Table 1)

In 1801 Tsar Aleksander the First, who had succeeded his father Paul, instituted further far-reaching reforms in the management of health care and abolished the Meditsinskaya Kollegiya.[5,6,21] The management of civil medicine became the responsibility of the Ministry of Internal Affairs. Military medicine became the responsibility of the Ministry of Defence and the management of medical education was transferred to the Ministry of National Education.

Transformation to scientific medicine

The window to Europe

Peter the Great became Tsar of Russia at the young age of ten years, together with his handicapped half-brother Ivan Alekseevich (1682-1696); his half-sister Sophia acted as regent. This dual rule lasted until 1696, when Ivan Alekseevich died. [6,12,20,22]

One of their first acts of the two youngsters was to send a letter in Latin to the German emperor Leopold requesting him to search for two suitably experienced doctors who could take care of their health. Gregorius Carbonarius von Bisenegg [10,12] of Austrian roots and Jakob Pelarino[10,12] of Greek roots were found and arrived two years later.

As a child Peter the Great had many friends in the Slobodova, the foreigner's area, in Moscow. One of his closest friends was the family's court physician, Johan (Ivan) Termont, a skilled Dutch barber-surgeon and his first teacher on theoretical and practical medicine.[20,21] After the death of his brother Ivan, Peter made his first visit to Europe with the Grand Embassy (a diplomatic mission to strengthen Russia's alliance with a number of European countries) during1697-1698, which he again repeated in 1716-1717. His childhood friends and his travels abroad influenced Peters vision for the modernization of Russia.[5,6]

In the seventeenth century the centre of anatomical studies moved from Italy to France, England, and particularly to the Netherlands (Holland), because Papal edict excluded all non-Catholics at Italian universities; A consequence of the Reformation, which took place in the seventeenth century. The Leiden university, founded in 1575 by Stadtholder Willem the Silent, was open to all students

Fig. 2. Peter I provides medical care in Azov 1696, watercolour, artist V.I. Peredery, 1950, Image OF-35880. Military Medical Museum of Defence Ministry of Russian Federation, Saint Petersburg.

irrespective of race, nationality or religion and became famous for its anatomical and medical school.[23-25] In October 1698 Tsar Peter the Great visited by carriage Leiden university and the anatomical theatre. He was very interested in the establishment and laws of this university and Govert Bidloo, Professor-director of the university and president of the board of directors (Rector Magnificus), presented him with a Latin general description of everything concerning the university.[26-28] On March 17, 1717 Peter the Great visited, now by yacht, again Leiden and its university. The city welcomed him with cannon firing. He stayed two days. The Rector Magnificus, Herman Boerhaave, and the collective of professors received him. Peter wrote down the establishment of the university, the curriculum, and everything of use in his notebook. He examined the library and all kinds of mathematical and mechanical machines and tools. When leaving the University, Peter was told about its history and its didactic presentations. After that, Peter examined all the factories and manufactories in Leiden and talked into the most details with the masters [29].

Tsar Peter met with Herman Boerhaave, but it was tsarina Anna Joannovna (1730-1740), who invited him to become Arkiyater. In a letter to his former student Laurentius Blumentrost dated from 1730, Boerhaave officially thanked for the

invitation but refused the position.[30]

In Amsterdam Peter visited the anatomical theatre and attended lectures by Ruysch and even participated himself, carrying out anatomical dissections. Frederik Ruysch (1638-1731), was a Leiden graduate who became professor of anatomy to the guild of surgeons of Amsterdam and chief instructor of midwifes.[5,25,31,32]

He had accumulated a unique and famous collection of anatomical preparations. He had derived a technique for preserving specimens based on what he had learned when working with Jan Swammerdam, another Leiden medical graduate who made important contributions to the study of anatomy. Swammerdam injected blood vessels with coloured liquid wax to investigate the circulation and Ruysch introduced the use of the microscope developed by Antoni van Leeuwenhoek to enable him to inject the wax into the very smallest blood vessels.
Ruysch also taught Peter how to diagnose patients, prescribe medicines and carry out surgery. (Fig. 2) At Ruysch's home he admired his large collection of anatomical specimens and Ruysch presented the Tsar with a gift of 25 of his specimens. He also visited the city Delft. On his visit to Antoni van Leeuwenhoek the Tsar was fascinated by how the microscope of Van Leeuwenhoek allowed him

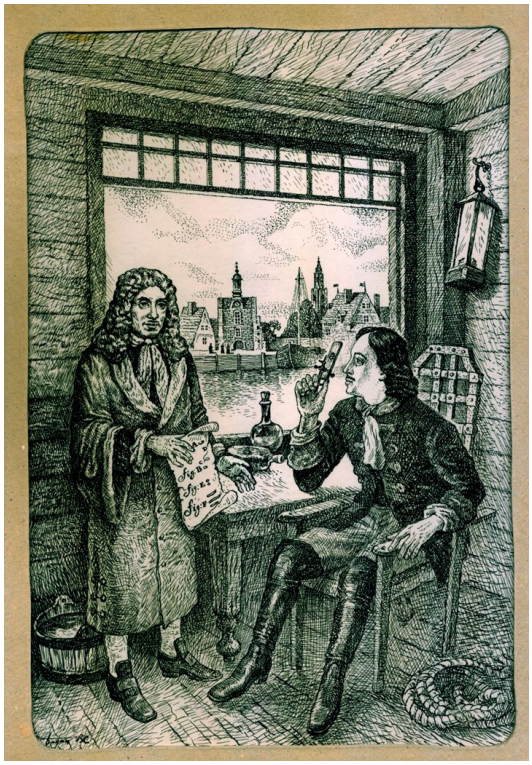

Fig. 3. Peter I and Antoni van Leeuwenhoek in the city Delft, pen-and-ink drawing, artist V.S. Bedin, 2004, Image OF-87224. Military Medical Museum of Defence Ministry of Russian Federation, Saint Petersburg.

'*...to see such tiny objects...*' and he took one of the microscopes back with him to Russia.[21,27] (Fig. 3) The Tsar had an above average interest in surgery and management of trauma. He was able to carry out post mortems, make surgical incisions, perform phlebotomy, suture wounds and extract teeth. After Peter's first Grand Embassy to Europe, he gave a series of lectures in Moscow in 1699 for the boyars (noble men) on anatomy, with demonstrations on cadavers.

What the Tsar learned and observed during his European Tour had a significant influence on the development of modern medicine in Russia. Tsar Peter's reign transformed the Russian economy, which also contributed to the development of medicine and the establishment of education.[5-7] He was well aware of the need for training of medical personnel for the Russian army and navy. Russia had an acute shortage of local *Doctor Medicinae* and barber-surgeons, most acute in the army and navy which was served almost exclusively by foreign doctors. Peter had two solutions for this problem; send Russians abroad for higher education and establish medical schools in Russia. Both solutions ran in parallel until the third quarter of the eighteenth century. He recruited several foreign doctors from the Netherlands, Germany and France, mainly because of the shortage of doctors in the army and navy.[6,12,21]
One of these was the Scotsman John Brock, a graduate of Cambridge University who had also studied in Holland. The personal physician of the Imperial family since 1668, Laurentius Alferov Blumentrost senior, considered Brock an empirical doctor and not a *Doctor Medicinae* because he could not converse in Latin, which at that time was the language of teaching in European and British universities. Nonetheless, because of his extensive medical experience, Brock was admitted to the Aptekarskiy Prikaz with the proviso that he maintained a diary with details of his patients.

Peter the Great also sent Russians to the universities of Padua, Gottingen, Haller and especially to Leiden in Holland. In the seventeenth and eighteenth century there were close relations between Russia and Holland in the medical field and many Dutch physicians came to practice and help to advance medical education in Russia.[6,19,22] The first two Russians sent abroad to study medicine on a scholarship were Pyotr Vasilievich Posnikov and Johann (Ivan) Deodatus Blumentrost. Both returned as Doctors of Medicine and Philosophy.
Pyotr Vasilievich Posnikov (1676 - 1716), a student of the Moscow Slavic-Greek-Latin Academy, was the first to benefit from the decision to send promising young Russians to be educated abroad at the states expense.[6,17,33] In 1692 he was sent to study medicine at the University of Padua, where after two years of intensive study he was awarded the degree of Doctor of Medicine and Philosophy. He then

further developed his medical expertise in Venice, Paris, Brussels and Leiden. In Leiden, he attended the clinics of Herman Boerhaave and studied with Fredrick Ruysch, the famous Dutch anatomist. Although he became the first Russian doctor to enrol with the Apthekarskiy Prikaz, he never practiced medicine. Instead, because he had mastered several languages, he spent much of his time as an interpreter and translator in the services of the Tsar. He died in 1716 at the age of 43. The second Russian to be sent abroad was Johann Deodatus Blumentrost (1692-1756), the third son of the old court physician Laurentius Alferov Blumentrost. After studying in Germany and France he completed his medical studies in Leiden in 1713. He succeeded Robert Erskine as Arkhiyater of the Aptekarskaya Kantselyariya (1719-1731), the supreme body for the management of medical affairs in Russia. [5,6,17,19]

The establishment of a hospital with a school and an anatomical theatre

Sending young Russians abroad to train as doctors did not solve the shortage of native Russian doctors. Until the time of Peter the Great there was no classical scientific medical school in Russia, only a school training barber-surgeons for the army and navy opened in 1654 by the Aptekarskiy Prikaz.[6,16,21,34] The first anatomical book used for medical education was "Epitome, Amsterdam 1642" by Andreas Vesalius, which was translated in 1658 by the monk Epiphany Slavinetsky and was named [*Vrachevskaya Anatomy*].[5] The development of medical education along European lines relied heavily on foreign physicians, in particular those from the Netherlands. At the beginning of the eighteenth century the Dutch University of Leiden was at the forefront in the development and implementation of the clinical method in Europe, mainly due to one man, Hermann Boerhaave (1668-1738), who was a convinced follower of Hippocrates and Thomas Sydenham, who believed that diseases should be studied and observed in a systematic and accurate manner.[35] Boerhaave was appointed as a lecturer in 1701 to cover for Govert Bidloo, professor of anatomy, medicine and practical medicine, during his absence as personal physician to King-stadtholder William III.[28,36] In 1709 Boerhaave was appointed as professor of medicine and botany and in 1718 also professor of chemistry.[35] Boerhaave emphasised the importance of visiting the patient at the bedside, combining a careful physical examination of the patient with a physiological and anatomically rational diagnosis, methods introduced earlier in Leiden by Johannes van Heurnius (1543-1601)[37] and Franciscus de le Boe Sylvius (1614-1672)[38]. [39] His lectures attracted not only students like A. Haller and G. van Swieten, but also Russians who played a prominent role in Russian healthcare. Among them was Tsar Peter the Great during his second visit to Leiden in 1717.[40,41] During the 18th century approximately 46 Russians and Russians with foreign roots studied in Leiden. Of this number 25% studied during the time of Herman Boerhaave.
(Appendix I)

Peter the Great sought another court-physician and invited Nicolaas Lambertus Bidloo (1673/4-1735). (Fig. 4) He accepted Peter's invitation in 1702 and became *physician in ordinary* to his Imperial Majesty in 1703. Before moving to Russia he held a successful medical practice in Amsterdam.[6,42]
His father was Lambert Bidloo a pharmacist in Amsterdam and brother of Govert Bidloo. He graduated and defended his thesis at the Leiden university in 1696. Among his teachers were Carolus Drelincourt (1633-1697), who was also a tutor of Herman Boerhaave, and his uncle Govert Bidloo since 1694 professor of anatomy, medicine and practical medicine and from 1696 also Rector Magnificus of the Leiden University. Govert Bidloo was the personal court physician of Willem III Dutch Stadtholder and King of England, who in 1691 appointed him superintendent of all civil and military doctors, pharmacists, surgeons, and hospitals in the Netherlands and England. Peter the Great became befriended with the Stadtholder and visited him in the Netherlands as well as in England. Govert Bidloo recommended his nephew Nicolaas as court-physician to the Tsar.[18,36]

As his personal physician Bidloo accompanied the Tsar on his campaigns and

Fig. 4. Nicolaas Bidloo standing at the table with a book, watercolor, artists of Lenfront Masterskie VSULF, December 1943, Image OF 7787. Military Medical Museum of Defence Ministry of Russian Federation, Saint Petersburg.

travels within Russia and on his trips to Europe. Peter was, however, a healthy individual so Bidloo had little to occupy him in a professional capacity and after some time became dissatisfied with his function and asked the Tsar to be relieved of his duties as his personal physician "... *due to my indisposition and weakness*...", although from his workload in subsequent years there was little evidence of "...*indisposition and weakness*..."[6,16,42,43] Peter agreed to his request and commanded him by a decree of 1706 to build a hospital near the German settlement on the banks of the Jauza river in Moscow with a school to teach students anatomy and surgery.[44] Bidloo was not only a renowned physician but also a talented architect and he himself drew up the plans for the hospital, medical school, a botanical garden and an anatomical theatre, where the Tsar regularly attended dissections.[6,17,43,45,46] (Fig. 5)
The medical hospital school was officially opened on November 21, 1707 by Peter the Great himself.

The curriculum at the hospital school included anatomy conducted on corpses in the anatomical theatre, surgery, internal medicine, autopsy, chemistry, drawing and Latin. Pharmacy was studied in the Botanical Garden. The hospital complex was the first for modern education in Russia.
Bidloo became the director of the hospital, professor of anatomy and surgery at the school and manager of the anatomical theatre until his death on March 23, 1735.
There were no textbooks and Bidloo taught the students using his handwritten books in Latin, including *Speculum anatomiae* [Mirror of anatomy] *Praelectoris thesaurus*

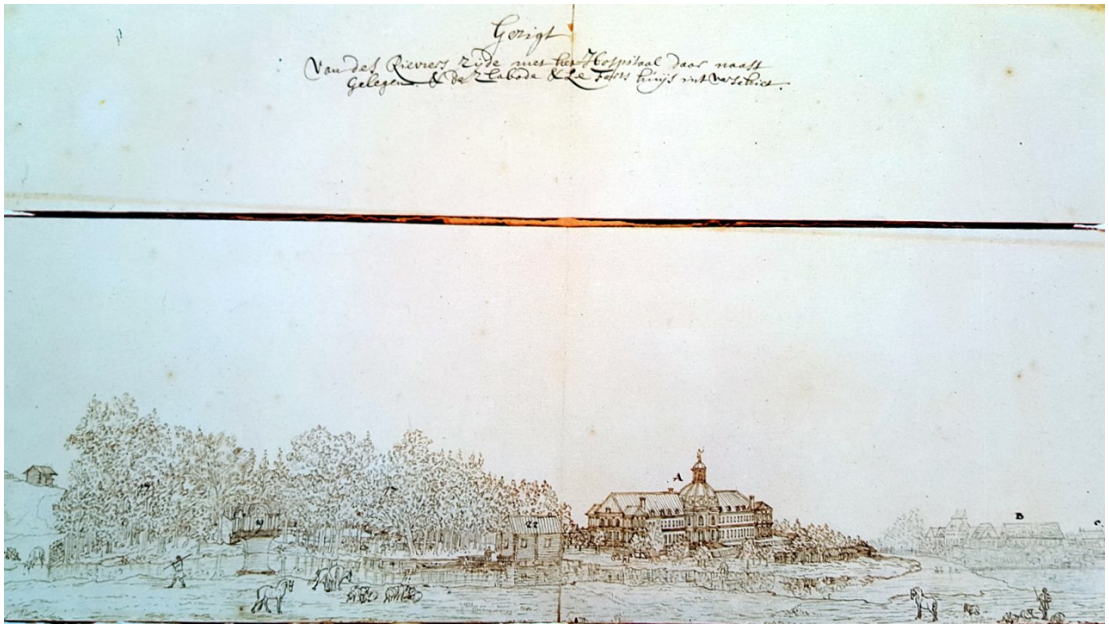

Fig. 5. A view of Nicolaas Bidloo's garden and the adjacent hospital, drawing by Nicolaas Bidloo, Moscow, beginning of the 18th century. In public domain.

medico-practicus [Treasure of medical and practical lectures], *Instructio de chirurgia in theatro anatomico studiosis proposita* [Surgical instruction in the anatomical theatre for students.] Only in 1976 the latter was for the first time translated to Russian and published.[34]
Bidloo also used the book of *Anatomia humani corporis, 1687* [Anatomy of the human body] by Govert Bidloo, that was translated especially for Peter the Great as well as the atlas *Outleding des menschlyken Lichaams, Amsterdam,1690* [Dissection of the human body].
The trainees, graduates from the Slavic-Greek-Latin Academy of the Holy Synod, were Russians and foreigners from all levels of the population. Their education was paid for by the State.[5,6]
After the death of Nicolaas Bidloo, Antonius de Theyls, a Russian of Dutch origin, who studied at Leiden university, became his successor.[6,17,19]

The budget for building the complex, purchasing of medicines, the salaries of the doctors, barber-surgeons and the apprentices came from contribution from the Holy Synod of the Orthodox Church based on a percentage of the weekly collections taken at the church services. This was specially arranged so Bidloo could govern independent from the Aptekarskaya Kantselyariya. The daughter of Tsar Peter, Tsarina Elizabeth the Great (1741-1762), continued this arrangement and also introduced a law whereby 1 kopeck was withheld from the salaries of civil servants for every ruble earned (1 ruble = 100 kopeks); this was used for the maintenance of hospitals and the care of the sick.[6]
Over a period of almost 70 years the school trained many barber-surgeons for the army and navy and prepared talented graduates for a PhD degree abroad. (Table. 1)

Peter the Great also paid special attention to the armed services, building hospitals for the army and navy in Moscow and Petersburg.[6,21] In Saint Petersburg in 1715 he established the Second Landforce Hospital and the Navy Hospital on the banks of the Neva along the lines of the medical hospital school in Moscow. In 1716 the Tsar himself wrote military regulations in Russian and Dutch stipulating the number of doctors, surgeons and pharmacists required for the army.[12,47] Every division had to have an academically qualified doctor and poddoctor (staff surgeon), every regiment a lekar (wound surgeon), and every company a feldsher/tsiryulnik (barber/ phlebotomist). Two military pharmacies were established for the army, one each for the infantry and the cavalry. Each to be staffed by one pharmacist, two assistants and four trainees. Graduates of the medical hospital school were mainly sent to the regiments, where after a certain period of practical work, they received the title of assistant barber-surgeon (podlekar) or barber-surgeon (lekar). The *doctor medicinae* appointed by the hospitals were supported by experienced surgeons and also assistant-surgeons and trainees.[5-7,12]

In an effort to increase the number of medical students Tsarina Elizabeth the Great (1741-1761) in 1748 instructed the church schools in Moscow to send more pupils to the medical hospital school.[5] The teaching was expanded and more surgical subjects were taught, a more appropriate curriculum for the surgical examination was introduced and subject-orientated medical textbooks were specially written in Russian. The first ethnic Russian to be appointed the chief doctor of the hospital was the Muscovite Martin Ivanovich Shein (1712-1762), who taught surgery at the hospital school.[6,17,19] He was a graduate of the Moscow medical hospital school. Another ethnic Russian, Konstantin Shchepin (1728-1770), also a graduate who had completed his postgraduate studies in Leiden, became the first Russian director of the medical hospital school in Moscow in 1762.

The medical hospital school of Bidloo in Moscow was initially a civilian hospital. In 1757 the hospital was renamed to the "General Moscow First Landforce Hospital" (now the Main Military Clinical Hospital named after N.N. Burdenko).[5] In 1786 both military medical schools (in Moscow and Saint Petersburg) were separated from the hospitals and converted into independent medical schools and were given the right to award their students a doctoral degree. Up to then that had been the exclusive right of the Meditsinskaya Kantselyariya. In 1798, 12 years later, the two medical schools were renamed Medico-Surgical Academies. The Moscow Medico-Surgical Academy existed until 1804, when its 45 students, and all the medical instruments, anatomical preparations and the library were transferred to the Medico-Surgical Academy in St. Petersburg.

Development of science in Imperial Russia

Academy of Science

In 1716-1717 Peter the Great again travelled to Europe, visiting among other countries, France and the Netherlands. Again he visited Fredrik Ruysch in Amsterdam, but this time he was more interested in purchasing Ruysch's anatomical collection for his Kunstkamera in St. Petersburg.[6,31,48] The sale was finally agreed for the sum of 30.000 Guilders, an enormous amount in the eighteenth century.[29] Peter also managed to worm out of Ruysch his secrets for embalming his specimens. The Tsar passed on this knowledge to his personal physician Johann D. Blumentrost as the chief supervisor of the obtained collection, so that he could care for and maintain the preparations. Blumentrost in turn passed on the secret to his successor as Arkhiyater, the Dutch Johan Ch. Rieger, who finally put it in writing and made the secret public. The Ruysch collection was placed in the first Russian museum of the former Academy of Science (now known as Kunstkamera, Museum of Anthropology and Ethnography) in Saint Petersburg. On Peter's orders, starting in February 1718 the Kunstkamera was extended to contain all examples of

birth deformations of both humans and animals in Russia. The Tsar also bought in 1716 the natural history collection of the apothecary Albert Seba. In 1721 a complete medical library and a rich collection of other rare items such as minerals and shells that had belonged to Peter's court physician Robert Erskine were added to the Kunstkamera.[5,6,31,32]

University education in Russia dates from 1724, when Peter the Great established the Academy of Sciences in Saint Petersburg along the lines of the French Academy, which he had visited in 1717. His idea was for the Academy to function both as a scientific and an educational institute. He donated his library and the Kunstkamera to the Academy. For the maintenance of the Academy Peter identified each year a proportion of the custom revenues from Dorpat, Narva and Ahrensburg. Unfortunately, Peter failed to see his creation as he died on February 1725, before it opened in 1726. After his death his widow, Catherine the First (1725-1727), continued the work of her husband. The first meeting of the Academy took place on 27 December 27, 1725 in the presence of the Tsarina and its grand opening was held on August 1, 1726. The Academy established a grammar school and a university with three faculties (medicine, philosophy and law). In 1726 the grammar school was opened and received 120 students in the first year; and in the second year 58.[5-7] Its university also admitted grand-aided students from religious institutes because of their knowledge of Latin, the language in which the education was given in the university. The university contained a library, curiosities, an astronomical observatory, an anatomical theatre and a botanical garden.

The court-physician of Tsar Peter, Laurentius Lavrentovich Blumentrost (1692-1755), the youngest son of Blumentrost senior, and like his brothers also a graduate of Leiden university, became the first president of the Academy of Sciences. In the years 1726 and 1727 several experienced doctors came to Russia and were admitted to the Academy. These included the president's older brother Johannes Deodatus Blumentrost, general director of the Meditsinskaya Kantselyariya, and Michael Burger, both alumni of Leiden University. The youngest of the two brothers Kaau-Boerhaave, Abraham, also became a member of the Imperial Academy of Science of St. Petersburg in 1744, when he was still a practicing physician in the Hague. He came to St. Petersburg in 1746 where he first got a position at the Admiralty hospital. In 1748 Abraham succeeded Josias Weitbrecht, who had died in February 1747 as professor of Anatomy and Physiology and left eight scientific manuscripts in Latin.[6] One night in 1736 Abraham suddenly became deaf and could only express himself with the help of sign language or by writing. Despite this handicap he was able to defend his thesis in beautifully written Latin and graduated as doctor of medicine in 1738. The curators of the Leiden university were so surprised at this feat that they had a special golden medal made and presented this gift to him in the

name of the university. He died in 1758 in Russia and the family name Boerhaave died with him.

Someone worth mentioning is Alexius Protassiev, who first studied medicine in Leiden and afterwards anatomy at the Imperial Academy of Science, where his teacher and mentor was Abraham Kaau-Boerhaave. Protassiev was one of the first native Russians to specialise in this subject and he was appointed Professor of Anatomy at the Academy.[6,18,22] The barber-surgeon Johan Friedrich Mautt, born in Saint Petersburg, was appointed as assistant and interpreter for Herman Kaau-Boerhaave at the Imperial Academy of Science. Mautt went on to study medicine in Leiden and graduated as doctor of medicine and philosophy in 1760.[6,17]

Other Dutch members of the Imperial Academy of Science were father and son de Gorter. Father Johannes de Gorter studied medicine in Leiden and discussed various physiological and pathological theories under the chairmanship of Bernhard Siegfried Albinus (1697-1770), professor of anatomy and rector of the Leiden university. In 1725 Johannes de Gorter became city physician and professor of medicine at the university of Harderwijk. His son David a student of Leiden but graduated from Harderwijk where he became professor of medicine and botany at Harderwijk. Both accepted the positions of second and third court physician to Tsarina Elizabeth and were also elected member of the Academy of Science. After the death of his Johannes returned in 1758 to the Netherlands, already an old man. He left 23 scientific manuscripts in Russia.[6,17] Another member of the Academy was the German Carl Friedrich Kruse who had also studied medicine in Leiden. He had for a long time served as the chief physician of the Imperial Lifeguards in St. Petersburg. During the reign of Catherine the Great he was appointed in 1770 as assistant personal physician and State Councillor by the court. His wife was the daughter of Herman Kaau-Boerhaave and heir to the Boerhaave heritage.[6,18,49] Other famous Dutch professors from Leiden were invited during the eighteenth century to Russia and not always accepted the offered position among others Bernard Siegfried Albinus[50] and Hieronymus Davides Gaubius[51].

The establishment of the first university for a further development of science

On January 24, 1755 Tsarina Elizabeth the Great (1741-1762) gave orders for the establishment of Moscow University headed by a board of Governors, that consisted of two curators Ivan I. Shuvalov of the Security Council and Laurentius Lavrentovich Blumentrost president of the Academy of Sciences, and the general director (later renamed to Rector Magnificus) Aleksei M. Argamasov a member of the city council.[5]

It was during the reign of Tsarina Catherine the Great, born a German princess, that

the medical improvements inside Russia made by her predecessor began to flourish. The first professor of the Moscow University was the native Russian, S.G. Zibelin, who studied at the Moscow medical hospital school of Bidloo and then at Leiden University graduated Doctor Medicinae in 1764. The university medical faculty in Moscow attracted many lecturers who contributed to a new batch of well qualified doctors. These included Mikhail à Skiadan, Theodor Kurika and Theodor Politkovsky who after completing their studies in Russia were sent to Leiden University to round off their studies and obtain a PhD.[17,19,22] Among the more important academic staff on the medical faculty was Professor Ephraim Mukhin, professor of anatomy, physiology and forensic medicine and Matheus Mudrov, professor of pathology and therapeutics.[5,17,21,52]

At the beginning of the eighteenth century Peter the Great and Nicolaas Bidloo in Moscow and Herman Boerhaave in Leiden in the Netherlands (re)introduced didactic teaching of medicine and surgery with practical, hands-on experience at the patient's bedside, and exposure of young students to scientific principles.

In Russia around 1800 a significant gap existed between the medically trained scientists using experimental research methods and the practicing doctors. The latter still relied on traditional folk remedies.[5,6] Nonetheless, the nineteenth century became the "*golden age*" of Russian scientific and medical schools with internationally renowned names such as the surgeon Nikolay Ivanovich Pirogov (1810-1881)[53] and Sergey Petrovich Botkin (1832—1889) who organized systematic studies in clinical pharmacology and experimental therapy, both novelties in Russian research at the time[54] and Ivan Petrovich Pavlov (1849-1936), a physiologist best known in psychology for his discovery of classical conditioning for which he was awarded the Nobel Prize in 1904[55].

At the end of the nineteenth century, two centres of medical science existed, the Medico-Surgical Academy in St. Petersburg and the Medical Faculty of the Moscow. Moscow University concentrated on general pathology, therapy and physiology, whereas the Medico-Surgical Academy occupied a leading position in the development of anatomy, topographical anatomy and surgery. As a former student of Moscow University, Nikolay Ivanovich Pirogov was appointed in 1841 as Professor of Hospital surgery and Applied anatomy at the Medico-Surgical Academy and became chief surgeon of the Second Landforce Hospital (with 1000 beds).[5,53,56] Pirogov initiated the move towards modern science based medicine in nineteenth century Russia.
His approach to medical education was very much in keeping with the teaching of the Dutch physicians such as Herman Boerhaave whom he most admired. As a surgeon Pirogov introduced experimental trends and transformed surgery from a

craft to a science. He was a founder of topographical anatomy, was the first to use anaesthesia on the battlefield and was one of the founders of military surgery, as well as an educator and a social activist.[52,53,57-59]

Quantitative contribution of Leiden University to healthcare in Russia through the ages

Based on the data from Richter.[4,6,12] Chistovich, the student register of the Leiden University and the catalogue of the Leiden University Library [7,17,19,20,22] we constructed a table detailing the origins of doctors medicinae and barber-surgeons over the period 1505-1796. A total of 962 healthcare workers was documented. We did not subdivide as barber-surgeons, barber-obstetricians, barber-stonecutters, but grouped them under the main heading of barbers.
Our data is not completely comparable to the data given by Dumschat for the period 1480-1696.[10] In contrast to Dumschat who grouped healthcare workers into decades we used the reigns of the tsars to document the presence of healthcare. We registered for each healthcare workers their presence during that reign thus avoiding in our data. This explains that we have significant smaller numbers of registered healthcare workers during the periods described by Dumschat.

Countries of birth and highest education attained by healthcare workers during the individual reigns are shown in table 1. For a minority, the country of birth (18%) and/or country where they obtained the highest education (20%) was unknown, whereas it was available for the majority of medical doctors (95%) and professors (96%). Of note is that Holland contributed significantly to the training of medical personnel but that the number of healthcare workers of Dutch birth was much lower (7%). Apparently 122 individuals were foreigners trained in Holland, contributing 13% to the healthcare force in Russia. Barbers studied in Germany, Holland and Russia, doctors medicinae were **in**frequently born in the Netherlands (35; 20%) but were trained foreigners particularly in the Dutch city Leiden. On the other hand, 239 (64%) doctors born and trained in Germany, worked as doctors in Russia. Of the Russian-born doctors (154) 64 had trained in the Netherlands, 58 in Germany and 20 in Russia, the remaining in other countries. Professors studied largely in Russia itself, but they also were trained in Germany and Holland. Seventy-five percent of the professors were Russia born.

We further studied the origin of the healthcare personnel during the various reigns of the Tsars over the ages. During the reigns of Peter the First, Anna Ivanovna, Elizabeth the Great and Catherina the Great a significant number of barbers worked in Russia. During the reign of Peter the Great they were largely trained in Germany and in particular the Netherlands (42%). During the reigns of Anna Ivanovna and Elizabeth the Great the countries of training were often not recorded. (Fig. 6) The

largest increases in the accredited doctors medicinae (PhD) occurred during the reigns of Anna Ivanovna, Elizabeth the Great and in particular during the reign of Catherina the Great. (Fig. 7) The percentage of doctors who had a PhD from the Netherlands gradually increased from 19% during Peter the Second to 33% during

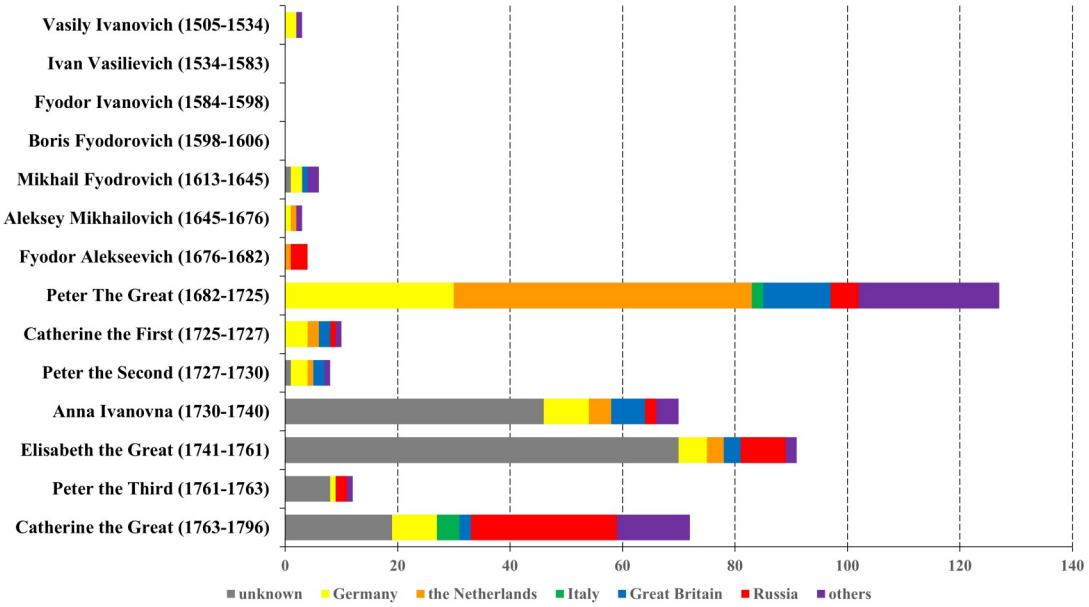

Fig. 6 (upper). Numbers of *barbers* and their country of the highest medical education during the reigns of the rulers of Russia.

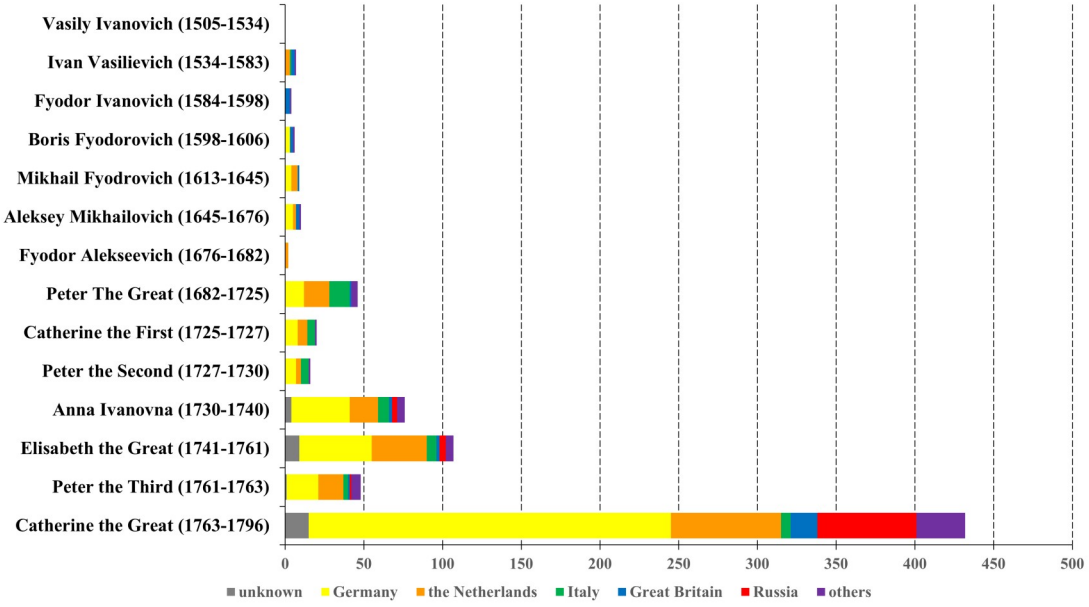

Fig. 7 (lower). Number of *doctors medicinae* (number of professors included) and their country where they obtained their highest education during the reigns of the rulers of Russia.

the reigns of Elizabeth the Great, Peter the Third and Catherina the Great. Meanwhile the doctors with a PhD from a German University decreased from 49 to 42%. During the reign of Catherina the Great a considerable number obtained their PhD in Russia (63; 15%). From the 61 professors 54 were appointed during the reign of Catherina the Great (including 4 so-called assistant professors). The professors appointed during the reign of Catherina the Great had studied in Russia (25), Holland (13) and Germany (8) Russia could now establish its own medical curriculum and was longer depend on other countries.

Based on the quantitative findings in the literature we conclude that, next to Germany, the Netherlands had a significant influence on the medical training of doctors medicinae from the reign of Peter the First on. This influence increased and became particularly pronounced during the reign of Elizabeth the Great. The influence of Holland on the training of barbers was evident during Peter the Great, who needed a massive number of barbers as a result of regulations within the army.

Conclusion

Between the eleventeenth and early nineteenth centuries Russia relied heavily on foreign doctors, barber/surgeons, pharmacists and other health care workers for the provision of medical care. They came mainly from Germany and Holland. The most significant advances in Russian health care occurred during the reign of Peter the Great and his successors. Peter stimulated young Russians to travel abroad to centres of medical excellence such as Padua, Göttingen, Halle and especially to Leiden in Holland. Perhaps even of greater long-term importance was the decision by Peter and subsequent Tsarinas and Tsars to establish institutes within Russia, where talented young Russians could get the highest level of training in their own country; institutes such as the Medico-Surgical Academy, the Academy of Sciences in St. Petersburg and the Moscow University. In the seventeenth and eighteenth centuries close relation existed in the medical field between Russia and Holland. A significant number of Dutch physicians came to practice in Russia and occupied very senior positions in Russian medical services and helped advance medical services and medical education. Leiden University in particular made an outstanding contribution to the advancement of medicine in Russia. In total six members of the Academy of Sciences, seven professors of medicine and sciences and more than thirty doctors of medicine were Leiden graduates or had trained in Leiden at some time during their career.

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Appendix I

Dutch and Russian students of the Leiden University, who played a significant role in the 17th and 18th century in the development of medicine in Imperial Russia

Nr.	Year	Surname - First name	Title dissertation
1	1695	Dohnell Joh.Just	Disputatio medica inauguralis de paralysi
2	1697	Bidloo Nicolaas	Disputatio medica inauguralis de menstruorum suppressione
3	1699	Brescius Zacharias	Disputatio physico-medica inauguralis de lumbricis
4	1712	Burger Michael	Dissertatio medica inauguralis de morbis ossium
5	1712	Gorter Johan de	Disputatio medica inauguralis de obstructione
6	1713	Blumentrost Laurentius	Disputatio medica inauguralis de secretione animali
7	1717	Hulst Arnoldus van der	Disputatio medica inauguralis, de circulatione sanguinis in foetu
8	1718	Ardinois Franciscus	Dissertatio medica inauguralis de fundamento totius medicinae anatomica
9	1724	Rieger Joh. Christiaan	Dissertatio medica inauguralis de anxietate
10	1728	Schreiber Joann Friedrich	Meditationes philosophico-medicae de fletu
11	1729	Kaau-Boerhaave Herman	Dissertation inauguralis de argento vivo
12	1732	Condoidi Panajota	Dissertatio medica inauguralis de morbis aetatum
13	1738	Barckhuysen Otto	Dissertatio medica inauguralis sistens considerationem terrori pathologico-therapeucitam
14	1738	Kaau-Boerhaave Abraham	Perspiratio dicta Hippocrati per universum corpus anatomice illustrata
15	1740	Gregory Joannes Godofr	Dissertatio medica inauguralis de parte medicinae consultatoria
16	1743	Fischer Johannes Benja-min	Disseratio osteologica de modo, quo ossa se vicinis accommodant partibus
17	1744	Theyls Johannes	Dissertatio medica inauguralis de sanguinis evacatione per inferiora, quam haemorrhoidem vacant: ut causu fistulae an
18	1745	Heister Lorenz et al.	Fasciculus disseratonum medicarum quarum Ima De tunica choroidea
19	1748	Lups Johannes	Dissertatio physiologico medica inauguralis de irribilitate
20	1749	Kruse Carulos Fridericus	Dissertatio medica inauguralis de causis acidi in primis viis
21	1749	Sevasto Andreas	Dissertatio medica inauguralis de lithogenesi

22	1750	Bacherat Henricus	Dissertatio medica inauguralis de morbis ligamentorum
23	1752	Klanke Franciscus	Dissertatio medica inauguralis, de usu venarum
24	1753	Staehlin Joann	Dissertatio chirugico-medica inauguralis, sistens partum cum haemorrhagia uteri conjunctum
25	1754	Poletyka Joannes de	Dissertatio medica inauguralis, de morbis haereditariis
26	1756	Rauschert Joachimus	Dissertatio chirurgico-medica inauguralis, de carie ossium
27	1757	Jever Rudolphus	Specimen medicum de causis haemorrhagiarum
28	1758	Scepin Constatinus	Schediasma chemico-medicum inaugurale de acido vegetabili, quod … cum annotationibus botanicus
29	1760	Mautt Johannes Fridericus	Dissertatio medica inauguralis de cortice Peruviano
30	1761	Melle Chritophoris Andreas de	Med.Doct. Dissertatio medica de vi vitali quoad medicinam et ex illa morbi oriuntes
31	1764	Thorvath Joannes Guilielmus	Dissertatio practico-medica inauguralis de lactis defectu
32	1764	Zibelin Simeon	Disseratio chemico-medica inauguralis, de saponibus medicis nativis, ex triplici regno petitis, eorumque a chemicis differentia, principiis, indole, ac usu in medicina
33	1765	Fialkouski Stephanus	Dissertatio medica inauguralis de actione ventriculi in ingesta
34	1765	Jagelski Cassianus	Dissertatio medico-practica inauguralis de passione hysterica
35	1765	Kruten Matthias	Spec.med. Inaug. De manducatione
36	1765	Mitrofanov Sila Mitrifanovic	Disp. Phys.-med. Inaug. De spontaneo aeris introitu in pulmonem
37	1765	Pogoretski Petr	Specimen chemicum inaugurale sistens aliqua de semimetallo nickel, cui accedit examen medicum modi, quo vulgus expilare ulcera solt
38	1765	Roschalyn Cosmas	Dissertatio medica inauguralis se scorbuto
39	1765	Timkousky Josephus	Dissertatio medica inauguralis de peripneumonia notha
40	1765	Tychorski Thomas	Dissertatio medica inauguralis de vera sive proxima caussa podagrae
41	1767	Knobloch Georgius Ludovicus	Dissertatio medico-practica inauguralis de entero mesocolocele suffocata
42	1771	à Skiada Mikhael	Specimen physico-medicum inaugurale de solidid artis salutaris fundamentis
43	1780	Kurika Theodos	Theses med. inaug
44	1780	Samoilowitz Daniil	Dissertatio medico-chirurgico inauguralis sistens compara-tionem inter sectionem symphyseos ossium pubis et sectionem caesaream
45	1781	Politkovsky Theodorus	Dissertation inauguralis, de pyogenia seu formatione puris
46	1790	Kolokolnikov Vasily	Theses med. inaug

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Chapter 3

Nikolay Ivanovich Pirogov (1810–1881): A pioneering Russian surgeon and medical scientist

I.F. Hendriks, J.G. Bovill, P.A. van Luijt, P.C.W. Hogendoorn

J Med Biogr, 2016; 26 (1): 10-22

Abstract

Nikolay Pirogov qualified as a physician from Moscow University in 1828 and then studied surgery and anatomy at University of Dorpat. He developed new surgical techniques, including the eponymous osteoplastic foot amputation. His application of scientifically based techniques extended surgery from a craft to a science. During the Crimean War he initiated the deployment of women as nurses and used triage for dealing with mass casualties. His textbook on field surgery became the standard reference on the subject and his principles remained virtually unchanged until the Second World War. Pirogov died on 5 December 1881 at his estate in Vishnya.

Introduction

Nikolay Ivanovich Pirogov[1] (Fig. 1) was one of the most talented Russian surgeons and medical scientists of the 19th century and among the greatest military surgeons of all times. He devised a number of surgical operations, of which the eponymous osteoplastic foot amputation is the best known. He was passionate about the importance of anatomy for surgeons. His work on topographical anatomy laid a firm foundation for that field with great practical significance for surgery enhanced his reputation as a distinguished surgeon and anatomist. Several anatomical structures are named after him, including the Pirogov angle (the junction of the internal jugular and subclavian veins), the Pirogov aponeurosis and the Pirogov triangle, an area located between the mylohyoid muscle, the intermediate tendon of the digastric muscle and the hypoglossal nerve. He extended surgery from a craft to a science, equipping doctors with scientifically based techniques of surgical intervention.

From childhood to professor of surgery

Nikolay Ivanovich Pirogov was born on 13 November 1810[2] in Moscow. From an early age he showed evidence of exceptional talent. A family friend, Efrem Osipovich Mukhin, Professor of Anatomy and Physiology at Moscow University,

Fig. 1. Portrait of Nikolay Ivanovich Pirogov, 1836, by an unknown photographer. Military Medical Museum, Saint Petersburg, Russian Federation (OF 21290, reproduced with permission).

[1] In the text we have used common English transcription. See for example 'Pirogov' for the Russian surname 'Пирогов'. Other transcriptions such as 'Pirogoff' and 'Pirogow' also occur.

was aware of his interest in medicine and suggested that he enter Moscow University as a medical student.[1,2]

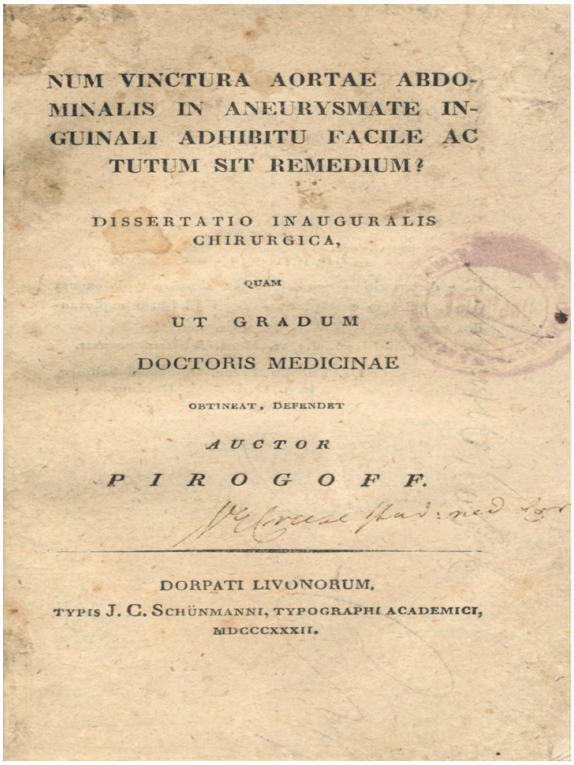
Young Nikolay passed the university entrance examination and began his studies a few weeks before his 14th birthday, when the accepted admission age was 16 years. One teacher who inspired Pirogov was the anatomist, Professor Loder, who encouraged him to study anatomy seriously. The physician Professor Mudrov also made a deep impression; he taught students to treat not only the disease or the causes of disease, but the whole patient. Putting the patient's interest central became the cornerstone of Pirogov's approach to his patients throughout his professional career.

Pirogov qualified as a physician in May 1828, only 17 years old.[1] Professor Mukhin, then dean of the faculty of Medicine, encouraged him to enter as a candidate for the prestigious postgraduate institute of the German-Baltic University of Dorpat (now Tartu in Estonia).[1,3] Only 20 Russian students, from all disciplines of the five Russian universities, were admitted to Dorpat each year. Pirogov passed the entrance examination and, on a scholarship sponsored by the Russian Government, began his training in Dorpat in July 1828. His first choice of subject, physiology, was not available in Dorpat so instead he chose to specialize in surgery and anatomy under the mentorship of Professor Johann Christian Moier, a student of the famous Italian anatomist Antonio Scarpa.

Pirogov combined his practical work as a surgeon with theoretical and experimental anatomical research. In 1829, the Medical Faculty freed him from compulsory attendance at some lectures, so that he could work on his doctoral thesis, the feasibility of treating aneurysms of the inguinal artery by ligation of the abdominal aorta.[1,4] Pirogov realised that a detailed knowledge of the anatomy of the region, in particular of the vascular system, would be essential for his investigation, and conducted a series of animal experiments to determine the topography of the relevant blood vessels, with particular attention to the abdominal aorta. He then investigated how animals responded to a gradual tightening of a ligature around the aorta, stimulating the development of an improved collateral circulation. He was the first to prove the feasibility of this technique, which achieved a gradual obliteration of the aorta while avoiding paralysis of the hind limbs and pelvis. Finally he carried out a number of operations in which he ligated the abdominal aorta of patients with

[2] There are uncertainties about the dates cited as it is not always known whether the Julian or the Gregorian calendar was used in the original source literature. We have used the old dates as far as we can determine.

aneurysms of the inguinal artery. He completed his studies at Dorpat and received his doctorate after defending his thesis on the 27 August 1832 (Fig. 2).[5] His thesis


NUM VINCTURA AORTAE ABDOMINALIS IN ANEURYSMATE INGUINALI ADHIBITU FACILE AC TUTUM SIT REMEDIUM?

DISSERTATIO INAUGURALIS CHIRURGICA,

QUAM

UT GRADUM

DOCTORIS MEDICINAE

OBTINEAT, DEFENDET

AUCTOR

P I R O G O F F.

DORPATI LIVONORUM,
TYPIS J. C. SCHÜNMANNI, TYPOGRAPHI ACADEMICI,
MDCCCXXXII.

Fig. 2. The front cover of the doctoral thesis by Nikolay Ivanovich Pirogov, University of Dorpat, 1832.

was shortly thereafter published in German.

In May 1833 Pirogov went to Berlin to broaden his knowledge of anatomy and surgery at the Charité University Hospital. Among his tutors were Friedrich Schlemm, professor of anatomy and Johann Friedrich Dieffenbach, professor of surgery specialising in skin transplantation and plastic surgery. Pirogov spent the summer of 1834 at the University of Göttingen where he attended lectures by Konrad Langenbeck, famous for his speed and precision as a surgeon. He taught Pirogov how achieve the most efficient movements during surgery and how to use a scalpel '*...do not pressure the scalpel but move it slowly, playing it as a bow over the violin…* '[1]

From his time in Berlin and Göttingen Pirogov was amazed to discover that even the great German surgeons had little knowledge of anatomy or physiology. Fortunately Professor Schlemm of the Charité Hospital in Berlin was convinced of the importance of anatomy for a surgeon and gave Pirogov the opportunity to dissect

hundreds of cadavers for his anatomical research. For Pirogov knowledge of anatomy was essential for a surgeon '... *It is advisable that only someone who is familiar with the body, the position of the organs in their unaltered state and the painful changes, should operate on a person*…'5] and without a thorough knowledge of anatomy and physiology, surgery could never rise to the level of a science but would remain a craft.[4,5]

Pirogov left Berlin in May 1835 to travel to Saint Petersburg, but during the trip he contracted typhus and was forced to stay in Riga until September of that year. On his delayed journey to Saint Petersburg he visited his former mentor, professor Moier, in Dorpat, from whom he learned that the chair of surgery at Moscow University had gone to a former fellow student, Fedor I. Inozemtsev. This was a bitter disappointment for Pirogov who had hoped that he might be appointed as professor at his Alma Mater. He decided to remain in Dorpat and Professor Moier, who was now rector, appointed him as Ordinary Professor and Director of the Surgical Clinic.

In April 1836 Pirogov was appointed as a full professor of theoretical, operational and clinical surgery at Dorpat University and successor to professor Moier. Before taking up his appointment, he visited Saint Petersburg, where he gave a lecture to the Academy of Sciences [*About plastic surgery in general, and about rhinoplasty in particular*][6]. He used a face made of paper Mache to demonstrate the Indian rhinoplastic method as modified by Dieffenbach (Fig. 3). The original Indian methods for total rhinoplasty remains the basis for most reconstructive rhinoplastic procedures to the present day.[7] During his career Pirogov carried out forty rhinoplasties.

Pirogov encouraged his students to become actively involved in his research projects. Between 1836 and 1841 he supervised the preparation of 12 scientific theses by students in Dorpat. He continued to encourage his students when he moved to Saint Petersburg, where between 1841 to 1860, he supervised the dissertations of a further ten students. These dissertations belong to the scientific heritage of Nikolay Pirogov.[8]

In addition to his extensive clinical, teaching and research duties, Pirogov published two volumes detailing the activities of the surgical department.[9,10] In the preface to the first volume he wrote:

[3] Saint Petersburg was until 1917, the capitol of Imperial Russia.

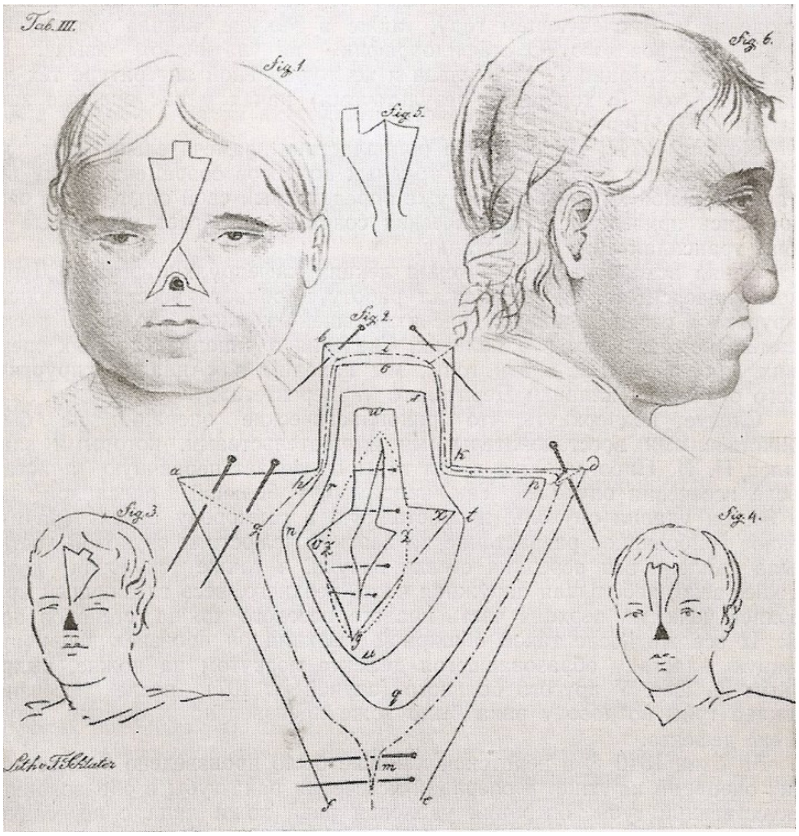


Fig. 3. A series of drawings showing stages in the restoration of the nose by a skin graft taken from the forehead following rhinoplasty, according to the method of N.I. Pirogov. Figures 1 and 6 illustrate the final result; figures 3-5 the technique of forming the skin flaps and figure 2 how the flaps are attached using pins. From the Doctoral thesis Quaedam ad rhinoplasticen, Dorpati Livonorum, 1836 of G.H. Schultz, a student of Pirogov.

> '*...I consider it my sacred duty to openly inform the public about my medical activities and their results. As an always honest man, especially as a teacher, you must have some sort of inner need to disclose your mistakes to warn others of maybe less knowledge*…'9

The work was intended to teach how *not* to act! He also published an extensively illustrated textbook of arterial trunks and fascia in which he stated that: '*...A real anatomical-surgical image must be for the surgeon what a map is for the traveller*…'[11] The book was published twice, first by Pirogov in 1837, and later by Julius Szymanovski in 1860, who re-edited it and added one new drawing for the external anatomy.[12]

Pirogov continued working on plastic and reconstructive surgery, improving on the methods of his teacher Johann Friedrich Dieffenbach. In one patient with an

invasive tumour in the maxillary sinus, he removed the entire front wall of the maxillary, the lower eyelid and a small outer portion of the upper eyelid, the upper part of the right nasal cartilage and the salivary duct (Fig. 4). After this extensive resection, he performed primary skin transplantation using a flap taken from the neck.[10] It is almost impossible to imagine how such a massive procedure was carried out and how the patient survived in the days before anaesthesia. As other surgeons became aware of the Pirogov's methods plastic surgery expanded in Russia.

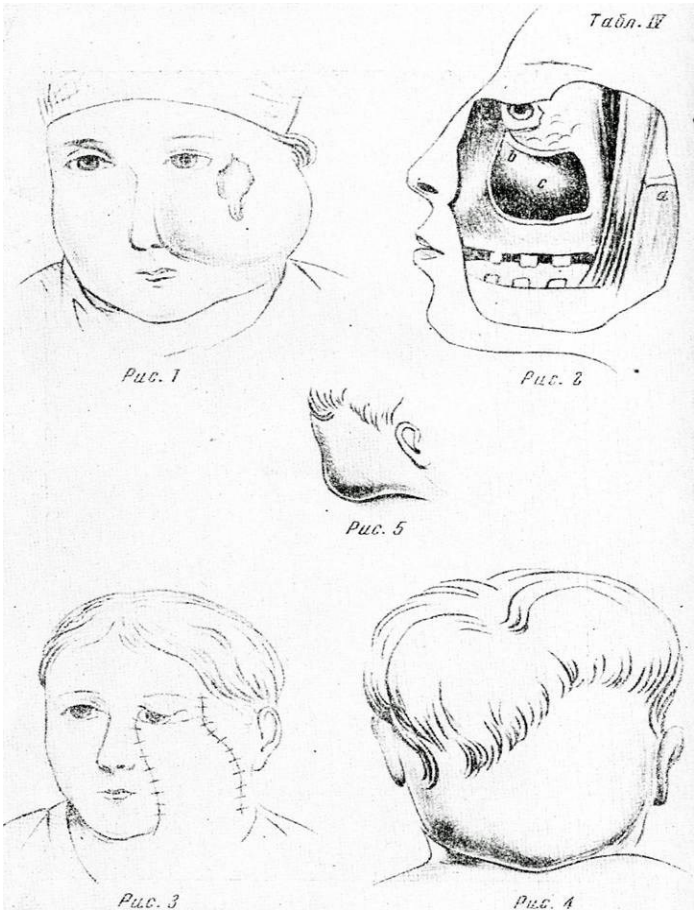


Fig. 4. Drawings by N.I. Pirogov illustrating the stages in the resection of a tumour of the maxilla showing how he finished the repair using a skin graft from the neck.

In 1836 Pirogov performed his first tenotomy on a 14-year old girl with a club-foot, a procedure he considered as one of the most therapeutically effective operations.
He was aware of the work of Stromeyer, Valpeau and others who had pioneered this new orthopaedic procedures.[13] However, before using the technique he investigated the anatomy of the Achilles tendon, the processes involved in the

regeneration of a severed tendon and the recovery of its function. He carried out numerous experiments on animals, and developed and perfected the technique of tenotomy on cadavers. He discovered that the Achilles tendon is surrounded by two sheaths not by one as previously thought, and that a satisfactory regeneration of the tendon following tenotomy required maintaining a blood supply to and a blood clot in the tendon sheath. He performed an Achilles tenotomy on forty patients and published his results in 1840.[13]

The merger of surgery and surgical anatomy

In 1838 the Medical-Surgical Academy in Saint Petersburg[3] was transferred to the Ministry of Defence. This created a new chair of surgery, which was offered to Pirogov. Before accepting the post he suggested the establishment of a new Department of Hospital Surgery in the Academy.[14] He wanted to combine the didactic teaching of surgery with practical, hands-on experience at the bedside of the sick, and exposure of young students to scientific principles. In this respect Pirogov's approach to medical education was very much in keeping with the teaching of the Dutch physician, Herman Boerhaave, who had introduced bedside teaching in Leiden in the Netherlands in the early 18th century.[15] Pirogov considered Boerhaave, the English physician Thomas Sydenham and the French barber-surgeon, Ambroise Paré, as medical geniuses. He did not consider himself an equal to these men '...*We are not Boerhaave, nor Sydenham or Paré*…'[10] However, history will certainly judge Pirogov to be at least an equal to these men.

It took some time and much discussion but on 3 March 1841 all Pirogov's proposals were finally accepted and he was appointed as Professor of Hospital Surgery and Applied Anatomy at the Medical-Surgical Academy and chief surgeon of the Second Military Landforce hospital (with 1000 beds) in Saint Petersburg. He also worked as a consultant-surgeon in three other hospitals in the city and ran a busy private practice. His aim was: '...*To assist in raising the medical skills in Russia to a level equal of that of the advanced countries of Europe*…'[1,16] He reorganised medical education, introducing a new curriculum for medical students, which now for the first time included the teaching of topographical and applied anatomy.

He also made significant improvements in the hospital management. Pirogov also became secretary for the Academy of Science and director of the St. Petersburg technical tool factory. More importantly, he became a member of the Committee under the Ministry of Public Education for the transformation of the medical curriculum at universities, as well as one of the four members of the Medical Council of the Ministry of the Internal affairs.[17]

During his first years in Saint Petersburg Pirogov worked on a textbook on Applied Anatomy.[18] It was his wish to form an Anatomical Institute, which would combine practical training on operative surgery with the study of surgical and pathological anatomy. Before this could be his wife, Ekatarina Dmitrievna Berezina, died after the birth of their second son. To help him get over his grief the University granted him leave to travel to Europe for several months. On his return the Academy agreed to the establishment of an Anatomical Institute with Pirogov as its director.[4,19]

When visiting the local meat market Pirogov noticed that when butchers cut frozen pig's carcasses the positions of the internal organs were clearly seen.[20] He realised he could use a similar method and taking advantage of the cold Russian winters he froze cadavers "to the density of the thickest wood" and cut them into thin plates. This allowed him to describe the topographical anatomy of the human body in a detail never before attempted. After eight years work he published his atlas of topographical anatomy.[21] The atlas had become a rarity by the beginning of the 20th century but was reprinted in 1997 for a limited edition of 500 copies.[22]

The Caucasian War as a surgical laboratory

In 1847, mountain tribes rebelled against the Russian government and thousands of Russian soldiers were maimed and killed in bloody battles with the rebels. Tsar Nicolas I send Pirogov in June 1847 to the Caucasus to demonstrate the use of the recently discovered ether anaesthesia during surgery, of which he was the leading exponent in Russia. During the war, Pirogov anaesthetised 100 wounded soldiers on the open battle field, 47 by Pirogov himself, 35 by his assistant, Peter Y. Nemmert, fine under the supervision of Pirogov by the local physician Dukshinsky, and the remaining 13 under Pirogov's supervision by regimental battalion doctors.[23,24] This was the first time that ether anaesthesia had been used on a battlefield. After the war, Nemmert was appointed as an Associate Professor, assistant to Pirogov in 1848, and in 1853, he became Pirogov's successor as Professor of Surgery in St. Petersburg. Because Pirogov wanted to convince other wounded soldiers of the analgesic effect of ether he carried out operations in their presence. This visual propaganda had a profound effect on the soldiers, who now fearlessly came to be operated. During that period he also performed a number of thyroid resections under general anaesthesia, for that time an unusual procedure.[25] In the fortified village Salta he organized his headquarters in a primitive field hospital consisting of huts made from tree branches with a straw roof and tables of stones covered with straw. Surgeons had to kneel to perform operations.[24]

Firearms Injuries.

Pirogov dealt with over 2000 firearm injuries and the outcome in most cases was either amputation or the death of the victim. Pirogov was determined to find a better surgical approach. The rebels used small and light bullets (12 g), which travelled at high speeds, the entry and exit wounds were small, sometimes barely perceptible. They caused considerably less tissue damage than the heavier Russian bullets (56.8 g), which caused considerably larger exit wounds than entry wounds and with more extensive tissue damage. Pirogov experimented and analysed the relationship between the velocity of the bullets of different firearms and bullets, and the characteristics of the entry and exit wounds on animal carcasses, guided by observations and his knowledge of anatomy. In this respect Pirogov can be considered to have laid a foundation for the scientific methods used by forensic pathologists today.[24]

Disarticulation and resection

Pirogov introduced disarticulation of joints and resection of bones as a means of saving limbs, in particular the upper limbs, instead of amputations, then the only method of surgical treatment for gunshot fractures. Pirogov believed that in selected cases these procedures could save a limb with fractured bones, provided that major blood vessels or nerves were not damaged. In these cases resection of the shattered bone should be immediately undertaken and the limb should be immobilised. However amputation was sometimes unavoidable.[24]

Forerunner of the plaster of Paris cast

The choice of treatment for fractures caused by bullets was often immediate amputation or immobilization in the hope that the fracture would heal. The accepted method of immobilization was that developed by the Belgium army surgeon Louis Seutin (1793–1865).[26,27] Seutin's method used cardboard splints and bandages soaked in starch dissolved in hot water and applied wet. Because cardboard was not readily available on the battlefield Pirogov used straw mixed with starch. A major disadvantage of these dressings was that hot water was seldom available on a battlefield, and they took two to three days to dry. Although not quite satisfied with the "fixed bandage", their use together with anaesthesia created for Pirogov new possibilities for the development of surgery.[4,24,28] He continued to develop the starched cast and its implementation, because he was no longer willing to amputate when this was not absolutely necessary.

Surgical Developments between the wars

During a trip to Germany and France in 1847, Pirogov observed two patients who had undergone a foot amputation following the Syme method, and who were able to walk without discomfort. He was so impressed that he determined to use this operation on his return to Russia. As always, Pirogov did not immediately use the method on his patients. Because experiments on cadavers revealed several problems with the Syme method, he devised his own approach to amputation of the foot, now known as the Pirogov amputation, and the world's first osteoplastic surgery.[17] Pirogov's method differs from Syme's in that the posterior part of the calcaneus with the insertion of the Achilles tendon remains attached to the posterior flap. The advantage was that there is only a minor shortening of the limb and the patient could walk without needing a prosthesis due to the maintenance of the calcaneal fragment fused to the tibia. This results in a high loading capacity stump not dissimilar to a natural heel. Pirogov described his method in the first volume of his textbooks on Clinical Surgery, a collection of monographs in three volumes.[17] He also published a detailed description of his technique in the medical journal *Voenno-Meditsinskiy Zhurnal*.[29]

Pirogov's surgical method was so innovative that it initially met with harsh and often unfounded criticism by some contemporary colleagues. About these criticisms Pirogov wrote '*...Although Stromeyer doubts the success of my foot osteotomy plastic surgery, Fergusson makes me an apostate and Syme rejects it as an anti-surgical procedure, so it deserves but special consideration on the part of the war surgeons…*''17] However, in Pirogov's support, Theodor Billroth confirmed that he had applied Pirogov's method to the satisfaction of his patients: '*...(They) go admirably on their stumps…*'[30] Pirogov's method is still used today although modifications have been made to improve outcome and reduce risks of complications (Fig. 5).[31-33]

Also in volume 1, Pirogov described mistakes and misdiagnoses of tumours using case reports. In his opinion it was impossible to study a tumour without auscultation for murmurs and the use of a microscope. In patients with tissue tumours Pirogov carried out palliative operations (Fig. 6).[17]
The second volume of Pirogov's monographs on clinical surgery dealt with fractures and dressings.[34] As discussed earlier, Pirogov was dissatisfied with the starched cast based on the method of Seutin. Antonius Mathijssen could also not satisfy him with two layers of bandages pre-impregnated with dry plaster powder stored in sealed containers. This method was also time-consuming and the dressings of the dry plaster crumbled easily.

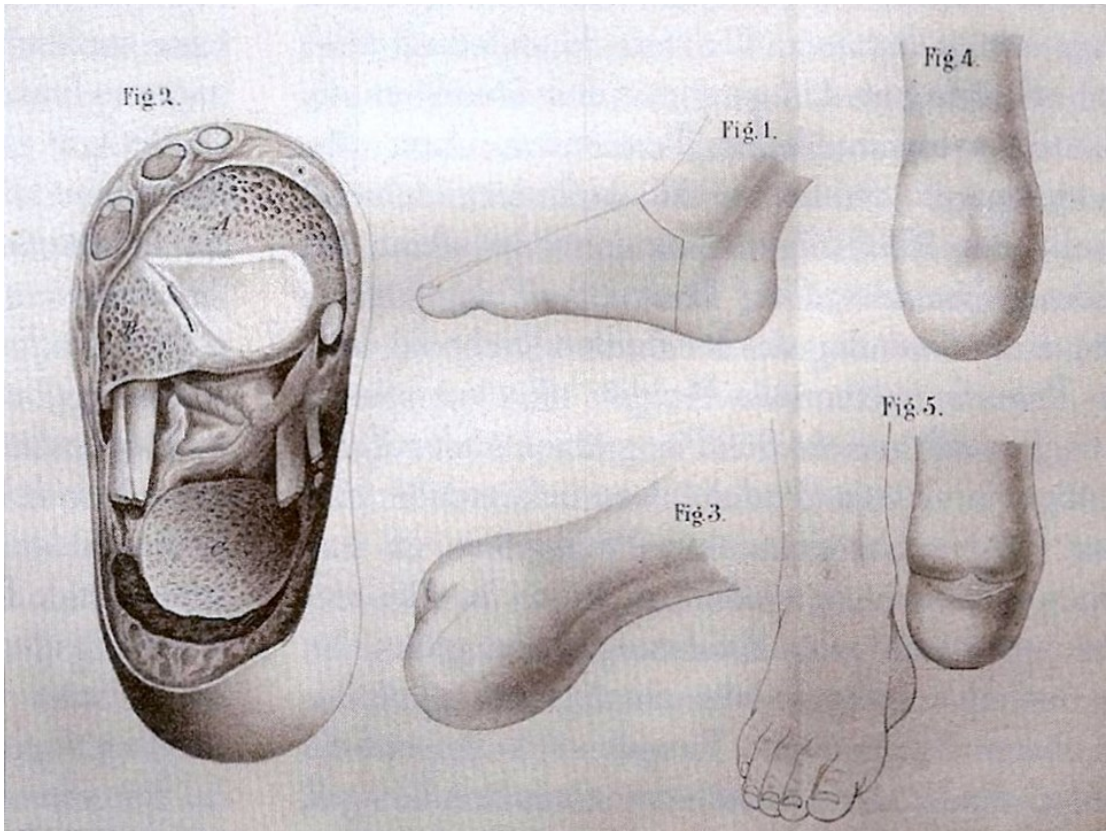


Fig. 5. Drawings showing the stages in Pirogov's foot amputation. Figure 1 in the drawing shows the cut surfaces from the side, Figure 2 the surface after disarticulation of the foot, figures 3 & 4 views of the stump and figure 5 the stump as viewed from the front. The difference in length between the two legs is only 1-1.5 inches (5.54 - 3.8 cm).

Returned from the Caucuses to St. Petersburg Pirogov observed how sculptors used strips of linen soaked in liquid plaster of Paris for making models. Based on this observation, in 1851/1852, he developed his own method for immobilization of fractures, using canvas soaked in a plaster of Paris mixture immediately before application to the limbs, which were protected either by stockings or cotton pads. The preparation of plaster cast required no boiling water, and it hardened immediately and was so hard that splints were not needed, even when large drainage windows were created. Pirogov, as a good manager, was well aware of the treatment costs involved and stated '*...The simpler, faster and cheaper the creation of such a bandage is as a replacement for the manual action, so suitable and advantageous it is for the hospital practice. Even old rags would not be lost, they could be washed clean…*'[34]

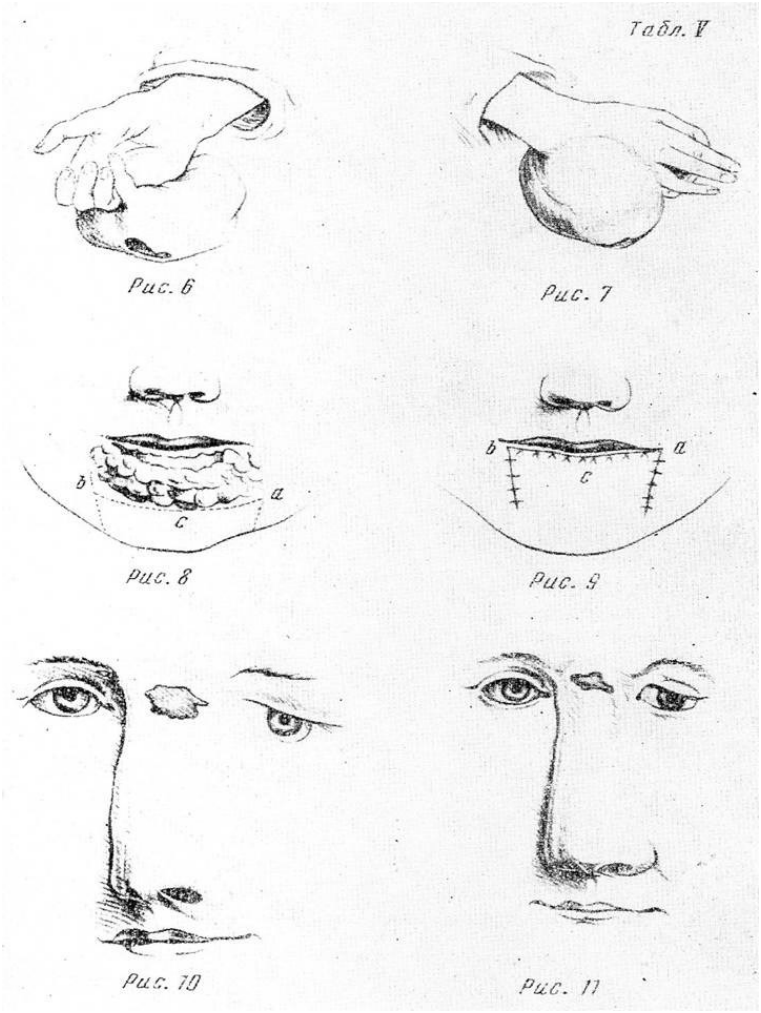


Fig. 6. Palliative operations on tumours. Drawings by N.I. Pirogov showing various forms of palliative surgery for tumours.

The Crimean War, (1853-1856) a turning point in medical practice

The Crimean War arose from a conflict between the Russians and the Ottoman Turks, the French and the British.[35] Pirogov offered his medical knowledge, clinical skill, experience, and his management insight to the Tsar for this war. His offer was finally accepted, thanks in part to the intervention on his behalf by the Grand Duchess Elena Pavlovna, sister-in-law of Tsar Nicholas I.[36] Pirogov was appointed by decree of the Tsar as the overall head of the army medical services, something completely new in Russian history. He would work not only as a surgeon but more importantly use his skills as an organizer of medical facilities. Pirogov considered war as a traumatic epidemic and was convinced that successful treatment of mass casualties depended as much or even more on good administration as on the skill of the surgeons.[35,36] During the conflict, he was assisted by his senior

physician I. Kalashnikov and the surgeons Obermiller and Sokhranichev. Although often thwarted in his attempts to improve the organization of the medical services, he did find substantial support from Admiral Nakhimov (Fig. 7) and his naval officers and from the Sevastopol garrison commander Vasilchikov.[28,36]
Before Pirogov was sent to the Crimea, Grand Duchess Elena Pavlovna had outlined

Fig. 7. N.I. Pirogov and Admiral P.S. Nakhimov at the crossing of the wounded in Sevastopol. Oil on Canvas, by M.F. Verbov, 1943. Military Medical Museum, Saint Petersburg, Russian Federation (reproduced with permission).

her plan to establish a women's aid organisation for the sick and wounded on the battlefield, and requested his support. Pirogov was convinced of the great significance of women's participation and he readily agreed to her request and initiated the deployment of women to be trained as nurses and surgical assistants. [36,37] At the expense of Elena Pavlovna, Pirogov also organised a small group of independent physician-surgeons and he was appointed chief surgeon of the besieged city of Sevastopol.[36] In November 1854 the first group of nurses arrived, followed in the succeeding weeks by a regular flow of new female staff. Most were well-educated, speaking several languages, and were able to interpret for the wounded foreign prisoners. During quiet times about 7000 wounded would arrive at the field hospitals and first aid stations daily; at the height of battle as many as 13,000 injured soldiers could be received.[35]
To deal with this massive influx of injured, Pirogov introduced the triage system

where casualties were classified into four groups depending on the degree of injuries. This was the first ever use of triage in the management of mass casualties. One of his other principles was not to carry out unnecessary amputation. Nonetheless, Pirogov and his team often carried out about 30 amputations a day. To cope with this workload, Pirogov used three teams of doctors, each dealing with only one part of the procedure, rather like a production line, i.e. fictionalism of surgery.[36]
The assistance of the nurses under such extreme situations was invaluable, with each nurse caring for 100 to 200 casualties.[35,38,39] Unlike the British nurses under Florence Nightingale, the Russian nurses worked under shellfire in the field and in small field medical units on the Crimean Peninsula.[36,40,41] Seventeen Russian nurses died on duty during the Crimean War, six in the town of Simferopol alone.[42] After the war the nurses returned to several cities where they continued their nursing work in military hospitals.[38,42] This group of women became the foundation for what later became the Russian Red Cross.[40,43]

During the war almost all Russian medical students and doctors entered military service, but there was still had a shortfall of medical staff and the government was forced to employ foreign doctors from allied countries, mainly Germans and Americans.[35] Long before the Crimean War America and Russia considered themselves befriended nations. About 30 Americans doctors volunteered to work for the Russian Army. Almost half of the Americans fell victim to typhus fever, cholera, and small-pox, diseases which swept away more human lives than were lost on the battle field. Ten died in the war and one disappeared without trace. Those who returned to America settled to a peace-ful medical practice, or used their invaluable and new-found skills in the hospitals of the Civil War.[44,45]

Pirogov did not publish his experiences and impressions about the Crimean War for several years after it ended. But finally when he became aware of reports from foreign medical services '*... he decided to recollect the experiences and to analyse the gathered and already neglected material, to remind European and Russian doctors that we were not so behind in science in the Crimean War…*'[4] In 1864 he published this textbook in German which became the standard reference for field surgery.[35] The principles of battlefield medicine established by Pirogov remained virtually unchanged until the outbreak of the Second World War. Pirogov's work during the Crimean War is of such importance that he may be considered the founder of field surgery.

The suffering Pirogov witnessed during the Crimean War profoundly influenced his

outlook on life. His way of thinking changed more toward humanitarian goals and education. Because of his liberal views and stubborn personality, he could no longer tolerate intrigues and corruption. Appreciated and respected by the Academy, but tired of the disagreements with the officials, he resigned in July 1856 from the Medical-Surgical Academy in 1860. He devoted his latter days to advancing the cause of medical education in Russia and actively reported and consulted on European regional conflicts for the International Red Cross. He finally retired to his estate in Vishnya (now Vinnytsia) in Ukraine, where he died on 23 November 1881. Pirogov's body was preserved by the surgeon and anatomist, David Ilyich Vyvodstev, who used an embalming technique he himself developed. [46-48] The body of Pirogov still rests in a glass-lid coffin in a special designed mausoleum in Pirogov's former estate, which is now a museum dedicated to his life and works.

Conclusion

In conclusion, Nikolay Ivanovich Pirogov is acknowledged as one of the greatest Russian surgeons and medical scientists of the 19th. He believed passionately that a thorough knowledge of anatomy was essential for a surgeon. His atlas of topographical anatomy received widespread acclaim and several anatomical structures are named after him. From his work during the Caucasian and Crimean wars, he can be considered the founder of field surgery. He invented a number of surgical operations, the best known of which, the osteoplastic foot amputation, is named after him. Pirogov extended surgery from an craft to a science, equipping doctors with scientifically based techniques of surgical intervention. But his contributions reached beyond the boundaries of surgery. He was a dedicated teacher who encouraged students to excel clinically and guided them in scientific endeavours. His managerial skills proved invaluable during the Caucasian and Crimean wars.

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Chapter 4

Nikolay Ivanovich Pirogov (1810-1881): Anatomical research to develop surgery.

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Abstract

The nineteenth century Russian surgeon Nikolay Ivanovich Pirogov believed passionately in the importance of anatomy for surgeons. His interest in anatomy began as a medical student in Moscow. After graduating in 1828 Pirogov as a PhD-student entered the German-Baltic University of Dorpat (now Tartu in Estonia) to study anatomy and surgery. He studied for his doctoral thesis the consequences of ligation of the aorta in a series of animal experiments. He wanted to determine the feasibility of aortic ligation as a treatment for patients with an aneurysm of the aorta or iliac artery. Success was only likely when the aorta was ligated between the two mesenteric arteries and the ligature gradually tightened, an approach surgically difficult in humans. Pirogov then spent two years at the Charité Hospital in Berlin before returning to Russia. In 1841 he was appointed Professor of Applied Anatomy and Surgery at the Imperial Medico-Surgical Academy in Saint Petersburg. He instituted the teaching of microscopy and histology to the medical curriculum and in 1846 formed the Institute for Applied Anatomy within the academy, where in addition to teaching medical students future teachers of anatomy in Russia were trained. Pirogov published extensively on anatomy, including several anatomical atlases, the most notable his three-dimensional atlas of topographical anatomy published in four volumes between 1852 and 1859. Today Pirogov's contributions to anatomy are remembered in a number of anatomical structures named after him.

Introduction

During the early history of Russia the majority of its citizens had little or no access to qualified medical care, but relied on traditional folk and herbal remedies.[1-3] Up until 1700 there was not a single medical doctor of Russian origin in the country. It was Tsar Peter the Great (1672-1725) who radically reformed the health care system and medical education. With his Dutch court physician Nicolaas Bidloo Peter founded the first Medical Hospital and medical school in Moscow in 1717 and in 1725 the Academy of Sciences in St. Petersburg.[3-6] His successors established the first university in Moscow in 1755 and in 1798 the Medico-Surgical Academy, now named the S.M. Kirov Military Medical Academy. But it would be another 100 years after the changes introduced by Peter the Great before medical education in Russia reached the standards elsewhere in Europe. It was the Russian physician Nikolay Ivanovich Pirogov who helped develop a modern scientific approach to medicine. He was the first to emphasize the importance of anatomy and its application in surgery.

Nikolay Pirogov was born in Moscow on November 13 (25), 1810 the youngest of thirteen children.[7,8] As a child one of the family friends, Efrem Osipovich Mukhin, Professor of Medicine at the Medical Faculty of the Imperial University of Moscow, made a deep impression on the young Pirogov. One of his older brothers was bedridden with rheumatic fever. He was treated by several doctors, but nothing helped. Finally the family called in Efrem Osipovich Mukhin, and within a few days under his care the patient started to recover. This made a lasting impression on the young Pirogov and stimulated an interest in medicine.

Later, when Pirogov was 13 years old, Professor Mukhin, aware of Pirogov's interest in medicine, suggested that he enter Moscow University as a medical student.[7] Nikolay sat and passed the university entrance examination and began his studies three years earlier than the conventional age of sixteen. Pirogov later wrote about the method of teaching in the medical faculty, '*…it was a rather theoretical education based on textbooks from the 1750's…*'[7] However, during his time as a medical student one teacher really inspired him, the anatomist Professor Loder, who encouraged Pirogov to study anatomy seriously. Pirogov graduated as a physician in May 1828 at the age of seventeen.

Pirogov's time in Dorpat

After qualifying as a physician, Professor Mukhin, now Dean of the Moscow University Medical Faculty, was once again to influence the young Pirogov in a way that would define his future career. Aware of his considerable talent Mukhin persuaded Pirogov to enter as a candidate for the prestigious postgraduate institute of the German-Baltic University of Dorpat (nowadays called Tartu in Estonia) with the chance to study there for two years and a further two years elsewhere in Europe.

Only twenty students from all Russian universities were admitted to Dorpat each year. Pirogov passed the University entrance examination and, on a scholarship granted by the Russian Government, began his postgraduate training in July 1828. He had originally wanted to study physiology, since he believed that anatomy and physiology were intimately related, but unfortunately physiology was not available as a subject at Dorpat. He therefore chose to specialize in surgery and anatomy under the mentorship of Professor Johann Christian Moier, a student of the famous Italian surgeon and anatomist Antonio Scarpa. Moier gave genuine help to all his students and worked along with them for long hours in the anatomical theatre, teaching them the skills needed for dissecting cadavers.[7]

Students of the medical faculty in their first year at Dorpat were required to write an essay based on research on an allocated topic. The author of the best essay was awarded a Gold Medal. Pirogov's topic was [*What is observed when a large artery is ligated?*] and his essay won him the Gold Medal.[9] The government scholarship to study in Dorpat was only for a period of two-three years, after which students were expected to spend a further period in another European country. However, because of the outbreak of hostilities between Russia and Poland in 1830-1831 Russians were not allowed by the government to travel outside Russia (the current Republic of Estonia was then part of Russia). Pirogov was thus forced to remain in Dorpat for a further two years. At that time there was also an outbreak of cholera epidemic in Russia and Pirogov went daily to the mortuary to autopsy the victims of cholera. His autopsies were attended by some visiting French professors who were astonished at the ability of the young Russian and invited him to France. Pirogov declined their offer and remained at Dorpat for a further two years to work on a research project [*Is ligation of an aneurysm of the abdominal aorta in the groin a feasible and safe intervention?*], that would lead to his doctoral thesis; the subject was perhaps not a surprising one in view of his prizewinning essay.[10]
From the available literature he was aware of a number of publications on the topic, including those by the French surgeons Jacques Lisfranc de St. Martin and Alfred Velpeau, and Sir Astely Cooper, a London surgeon and anatomist and professor of comparative anatomy at the Royal College of Surgeons in London. In 1808 Cooper had attempted ligation of the external iliac artery in a patient with an aneurysm and in 1816 he was the first to ligate the abdominal aorta for treatment of an iliac aneurysm.[11-13] Pirogov wrote '…*This interested me with respect to both its surgical and physiological aspects*…'[7] Although the patient died '… *It remained to be decided whether, in fact, such an operation could be carried out with a hope of success*…'[7] In his animal experiments Cooper had only investigated the effects of ligation of the aorta in medium-sized dogs.[10] Pirogov suspected that the results of such an operation might depend both on the size of the animal and the species studied. He therefore set out to investigate this in a series of animal experiments.

His objectives were:

- to get a clear and accurate insight into the structure and function of the abdominal aorta.
- to perform a thorough study of the position of the abdominal aorta in relationship to the surrounding organs.
- to get a detailed understanding of the circumstances leading to collateral formation after ligation of the abdominal aorta.
- to determine the impact of the ligation on the artery and the surrounding tissues, on the lateral branches of the aorta, and finally which changes the body underwent in general.

Pirogov spent long hours in the anatomy theatre conducting 28 experiments involving dogs, cats, sheep or calves; the results of which form the core of his doctoral thesis.[10] In his biography Pirogov wrote:

> *I was so surprised at my indifference to the torments of animals during vivisection, that with a knife in my hand, I turned toward an assisting colleague, and exclaimed: The way we go about things, perhaps it is just as easy to cut open a human being!*[8]

In his zeal and youthful passion he was indifferent to suffering and operated on both dead and living animals to learn as much as possible about their anatomy and how they reacted to ligation of the aorta.[8]

In most of the early experiments he placed a ligature around the aorta close to its bifurcation, and immediately tightened it.[10] In other animals the ligature was placed just below the inferior mesenteric artery. He then checked for the effect on blood flow through the femoral arteries, in most cases this was either absent or markedly reduced. When some femoral flow remained Pirogov concluded that in these animals there was enough collateral circulation to allow some restoration of blood flow distal to the site of the aortic ligation. After the first four experiments he remarked that the abdominal aorta appears not to follow the general surgical rule, that the further from the heart an artery is ligated, the greater the chance of blood supply distal to the ligature via collateral vessels. In contrast, he found that the chance of a collateral circulation is a greater when the ligature is placed between the mesenteric arteries since then blood can flow from the superior mesenteric artery to the inferior mesenteric arteries thus providing a blood supply to the lower abdominal organs and the lower limbs.

In his sixth experiment, in a large dog, Pirogov suppressed the aorta under the lower mesenteric artery with a ligature. A second ligature was placed on the aorta in

between the two mesenteric arteries, but not tied. After amputation of the thigh, blood spurted from the femoral artery. The first ligature was loosened, the last one tightened. The blood spurted stronger for a while, but then flowed as before. In order to destroy the anastomoses of the epigastric artery, he incised the anterior abdominal walls, but still the blood spurted from the amputated thigh. A third ligature was applied, the aorta was incised between them, but the femoral blood flow remained as before. Pirogov pointed out that this result did not conform with the above-mentioned theory, but that should be noted that the inferior mesenteric artery is relatively small in dogs, about the size of the lumbar arteries, which might explain this result.

In the discussion that follows Pirogov hints at a possible motive for his research, namely the treatment of patients with an aneurysm of the iliac artery where ligation of the abdominal aorta could be considered a feasible option. He discusses the circumstances that could have a special impact on the outcome of such a procedure. He also describes in some detail the various anastomoses/branches of the aorta between the superior mesenteric artery and its bifurcation and how these vessels are related to the abdominal organs and nerve networks such as the coeliac plexus, which cover the whole external surface of the aorta in this area, ((see page 129 in his German publication[14]). He then asks, '...*Which part of the abdominal aorta is the most suitable for ligation, between the two mesenteric arteries or between the inferior mesenteric artery and the bifurcation*…'[10] He concludes that the region between the two mesenteric arteries at first sight might have preference because of the important branches that would favour collateral circulation. However, he pointed out that for the surgeon this has significant disadvantages, as it is covered by the stomach, duodenum, pancreas and several large arteries and nerve networks, making access to the aorta difficult. He explained it as follows:

> *As for the position of the abdominal aorta, it is covered on the second lumbar vertebra by the thigh of the diaphragm, the stomach, pancreas, and solar plexus. The celiac trunk and superior mesenteric artery, which with a dense network of nerves, the celiac plexus and mesenteric superior are covered, leave the aorta with small interspaces. For us as surgeons only the space between the second and fourth or fifth lumbar vertebrae remains, thus that part of the aorta, that is located between the shunt of the superior mesenteric artery and its bifurcation. This lower part of the abdominal aorta, which I will call Portio ileo-mesenteric, is in the adult about 4 inches long, and gives off the following arteries: the inferior mesenteric artery, the two renal arteries, the arteria sacra media, and 4 or 6 lumbar arteries. The peritoneum, occupies the posterior part of the abdominal cavity, goes from both sides forward, covers the vertebral column, and closes between its two plates a triangular*

space, and then forms *the mesentery. This space, that can be compared with the mediastinum in the thoracic cavity, is filled by the aorta, the lower vena cava, the thoracic duct, and the branches of the nervus sympathicus. Because the peritoneum here only adheres to the abdominal walls due to weak cellular tissue, it can easy be separated. So you can get to that room in two ways. Either one of these two peritoneum plates must be cut, from which the mediastinum consists, or one can, if one penetrates laterally and leaves the peritoneal bag unharmed, separate it from the abdominal muscles. So either with incision in the peritoneum or without it.*[14]

Thus, for Pirogov the best option is ligation of the abdominal aorta between the inferior mesenteric artery and the aortic bifurcation.

In the majority of the animals, paralysis of the hind legs was present soon after recovery from the surgery although there were a few exceptions. While many of the animals died soon after the operation a cat (experiment 15) and dog (experiment 16) lived for one year and one calf (experiment 19) lived for 60 days, all without signs of paralysis. The cat was killed by Pirogov by decapitation, the manner of killing for the dog and the calf is unknown. After their death Pirogov performed postmortems. In all animals, who died soon after surgery a common finding at postmortem was the presence of significant amounts of thrombi in the vena cava and the right ventricle, together with a virtually empty left ventricle. This suggests that the animal was severely hypovolemic, with stagnation of the circulation, prior to death. This is perhaps not surprising in view of the nature of the surgical trauma and the accompanying shock, with probably little attempt to minimize surgical bleeding. It is also possible that there would have been significant blood loss when the femoral arteries were opened to ascertain the extent of the femoral blood flow. The large amount of thrombi in vena cava indicates unwanted surgical venous occlusion during suturing of the descending aorta. In some animals Pirogov simply amputated the limb to determine the effect of ligation on the flow of blood from the femoral artery. Together these could have contributed to considerable blood loss, especially in the smaller animals. In addition, in some animals, Pirogov removes quantities of blood varying from 90 to 150 ml during surgery or in one dog six units of blood (unknown volume) was withdrawn from the jugular vein before the start of surgery. No reason is given for this, but phlebotomy was at that time an accepted of treatment for many ills.

After describing his first 17 experiments Pirogov performed a few additional experiments in calves (number not reported), with in most cases similar results to the earlier experiments. However, in some animals the changes after ligation of the aorta were hardly noticeable; he wrote '*...the reasons were not obvious to*

me…'[10,15] He mentions one example of a calf in which there was little evidence of paralysis of the hind legs and that after 16 days it had been restored to perfect health. But for some unexplained reason eight days after the first operation Pirogov tied both the animal's carotid arteries (which should have led to the animal's immediate death). It is amazing then that Pirogov could claim that the animal continued to be healthy.

In the opening discussion of part two of his German article[16], based on his Latin thesis, the principle objective of Pirogov's research is made clear, to determine the applicability of ligation of the aorta in the treatment of patients with an aneurysm of the aorta or the iliac artery. Based on his observations from the first 17 experiments, he reiterated that ligation of the aorta can only be considered reliable if the ligature is placed between the two mesenteric arteries but the approach to this area makes it very difficult for a surgeon. Modern surgeons, however, would not have this difficulty, partly due to the use of anaesthesia and muscle relaxation that were not available in the 1830s. Pirogov believed that the only surgical alternative was the approach used by Brasdor and Wardrop.[15,17] Pierre Brasdor (1721 –1797) was a French surgeon and anatomist who developed a method for the treatment of arterial aneurysms by ligation of the artery immediately below the aneurysm, which became known as the Brasdor method. James Wardrop (1782–1869), a Scottish surgeon working in London, proposed a modification of the Brasdor method for the treatment of aneurysms, described in a monograph published in London in 1828 *On aneurism and its cure by a new operation*[15] Like Brasdor, Wardrop had treated patients with aneurysms of the innominate artery by ligation of the carotid artery. [15,18] However, based on the findings from his animal experiments and what others had observed in patients in whom this procedure was performed, Pirogov had considerable reservations about the safety of this procedure in humans. He was concerned that much of the available evidence came either from a limited number of animal experiments or from findings based on autopsies in humans. He remarked that the ligation of the abdominal aorta in small animals is more likely to be successful because the ligature is almost always placed between the two mesenteric arteries and secondly because the anastomoses from the aorta to the lower parts of the body (i.e. greater ability to form a collateral circulation) plays a much more important role in the smaller animal. In larger animals the sudden obstruction of the aorta beneath the mesenteric arteries is seldom associated with a successful outcome. Today it is accepted that, at least in humans, there are numerous branches of the aorta arising between the mesenteric arteries that form an extensive network of collateral blood vessels.

In all subsequent experiments Pirogov used a modified version of the method described by the French surgeon and anatomist, Antoine Dubois (1756-1837) in

Bulletin de la Faculté de Médecine de Paris, 1810.[15] He inserted a ligature, consisting of 7-8 inch long silk threads composed of six to eight strands, around the aorta and attached both ends of the ligature to a device known as the compressor (Fig. 1) which had been developed by Buyalsky, and which allowed the ligature to be gradually tightened over a period of several days.
For example, a ligature was placed around the aorta of a sheep and tightened with

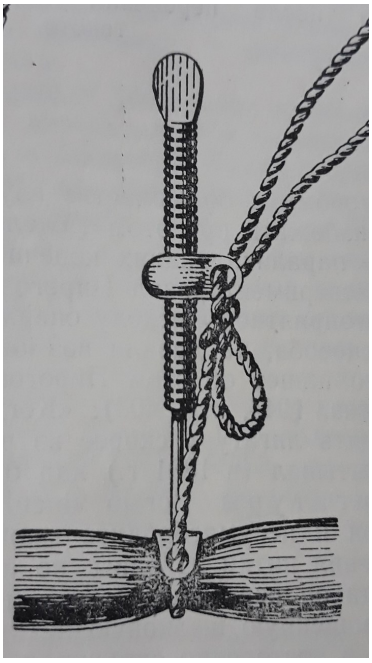

Fig. 1. Tourniquet (or compressor) designed by Ivan V. Buyalsky, used by Nikolay Pirogov to narrow the aorta by tightening a ligature.[15] Reproduced with the permission from the Military Medical Museum of the Ministry of Defence of the Russian Federation, Saint Petersburg.

the compressor so that it lay just taut against the surface of the vessel. It was then slowly tightened over eight days, but within 30 hours the sheep had obvious paralysis of its hindlegs. Pirogov loosened the ligature a little and muscle power was restored. Forty-five hours after the operation the sheep was able to walk without signs of paralysis, but when the ligature was further tightened it again fell, with difficult breathing. When again the ligature was made a little looser it again regained full use of its hind legs. This procedure was repeated several times until the animal died 12 days after the operation. At postmortem the atria and pulmonary blood vessels were partially filled with thrombi, but there was only a small amount of thrombus in the right ventricle and none in the left ventricle. The ligature, three fingers above the bifurcation, was covered with lymph and pus, but the lumen of the aorta at the site of the ligature was not completely occluded. What Pirogov observed in this animals and others treated using the same method, was that after gradually occluding of the aorta, the results were very different from those in earlier

experiments where the aorta was immediately and completely occluded. Pirogov concluded that to carry out this procedure successfully in living animals the following three conditions must be absolutely adhered to:

- Gradually tighten the ligature over not less than one week.
- Moisten ligature before each adjustment.
- The ligature must be made from at least four lengths of extremely strong silk strands.

Pirogov believed, however, that preventing the full blood flow to the lower limbs cannot be the whole story. He believed that there were two reasons for the paralysis, disturbed blood circulation to the lower limbs and changes in the spinal cord due a lack of blood supply, as shown by Legallois. Julien Jean César Legallois (1770-1814) was the first of the great French physiologists. From his experiments on living animals he concluded that sensation and motility could only reside in the spinal cord, and that the brain acts on the spinal cord in the same way that the spinal cord acts on the muscles. Legallois's works were posthumously collected and edited by his son Eugéne as *Oeuvres de J. J. C. Legallois avec des notes de M. Pariset,* 2 vols. (Paris, 1824; 2nd ed., 1830). Legallois believed that the paralysis of the hind limbs following ligation of the abdominal aorta in the lumbar region was caused by loss of blood supply to the spinal cord. To explore this further Pirogov carried out a number of experiments to determine the cause or causes of the paralysis seen in his earlier experiments.

Following the method of Legallois he placed a ligature round the aorta of a cat; the animal sprung immediately up but after a few minutes movement in the hind legs diminished. He then opened the right femoral artery and immediately blood gushed out. Pirogov then placed a second ligature around the aorta and cut the vessel between them. He then opened the spinal canal and inserted an iron rod into the lower part of the spinal canal. Contractions of the thigh muscles appeared immediately. Again, he pushed the rod into the spinal canal destroying the cord; now there were no muscle contractions. He repeated the experiment in a dog with the same results. In each of the above experiments the aorta was ligated just above the bifurcation thus maintaining blood flow via the lumbar arteries to allow a sufficient supply to the cord. Pirogov speculated that this explained why his results differed from those of Legallois. Legallois destroyed the spinal cord 15 minutes after ligating the aorta whereas Pirogov did so after only eight minutes, when paralysis had not yet occurred. Secondly Legallois cut through the abdominal muscles to reach the spinal cord, and this would have destroyed the internal mammary and the epigastric arteries while Pirogov approached the spinal cord from the back, thus leaving those anastomoses intact.

Pirogov concluded that, based on the results of his experiments:

- Immediate ligation of the aorta beneath the inferior mesenteric artery is not a reliable method.
- Success with this procedure is only possibility when the aorta is ligated between the two mesenteric arteries (which is hardly possible in humans) and the ligature gradually tightened.
- When death occurs it is due to congestion of the lungs and heart.
- There are sufficient branches from the aorta above the site of the ligature to allow an adequate flow of blood to the regions supplied by the lower aorta.
- The cause of the paralysis is most likely to be found in the spinal cord.

Pirogov successfully defended his thesis *Num vinctura aortae abdominalis in aneurysmate inguinali adhibitu facile ac tutum sit remedium* and was awarded his doctorate in 1832.[15] He published a German translation in 1838.[14,16] A Russian translation was published much later, in 1957.[15] He opened his thesis with a quotation from François Magendie (1783 –1855)[19-21], a French pharmacologist and physiologist. He, together with the German physiologist Johan Müller, one of Pirogov's teachers in Dorpat, laid the foundations of experimental physiology. Magendie wrote '…*Expressing or believing an opinion in science without evidence is nothing else than ignoring the truth*…'[10] Pirogov included this quotation as it emphasized his core belief that in science nothing should be taken for granted, a principle that permeated his whole career and characterized his approach not only to science but to every aspect of his life. For him, like Magendie, '...*Science is not built from what people think, but from what people have discovered*…'[10]

In his thesis Pirogov criticized his fellow scientists because he considered many of their descriptions of anatomical details and surgical procedures to be inadequate. In his opinion their main focus was to obtain the most accurate measurement of the dimensions, location, shapes and directions of anatomical structures. But for Pirogov surgery was much more than just finding a path to a particular structure, be it a nerve, vein, artery or an internal organ. Surgery must be based on an intimate knowledge of anatomy and the topography of the relevant structures as well as the changes caused by pathological processes. An operation performed without this basic knowledge cannot be fully successful.

Pirogov added an appendix to his thesis (not included in the German article of 1838 but it is in the Russian translation of the Latin thesis of 1957) in which he summarized the most important results of his latter experiments (21-28). He also stated the main objectives of his experiments were to show that:

- After ligation of the abdominal aorta, collateral arteries can provide adequate blood supply to those regions beneath the ligation site
- I have tried to find the actual cause of the paralysis in the hind limbs, which is almost always present after ligation of the abdominal aorta.

- Gradual compression of the ligature is the only means of preventing the congestion I observed at post-mortem.

He finishes the appendix with a summary of the most important results of his latter experiments (21-28).

Time in Berlin

After gaining his doctorate Pirogov had to wait some time for permission from the Ministry of National Education (also named Ministry of Enlightenment) to travel to Germany to complete a further two years post-doctoral study of anatomy and surgery at the Charité Hospital in Berlin in 1833.[7] During his first semester in Berlin he was assigned the following mentors;

- Professor Friedrich Schlemm for anatomy and for surgical studies on cadavers.
- Professor Johan Nepomuk Rust for clinical lectures.
- Professor Karl Ferdinand von Gräfe for ophthalmology.
- Professor Johann Friedrich Dieffenbach for surgery.

He also attended many of the lectures by the physiologist Johann Müller, who conducted demonstrations on animals (mainly frogs), often making use of a microscope.

Before Pirogov came to Germany he could not imagine that a skilled surgeon could doubt the importance of anatomy, but this was indeed what he found in Berlin. He was surprised that neither Rust, Gräfe nor Dieffenbach, all highly respected German surgeons, had only a very basic knowledge of anatomy.[7] Surgery seemed to be isolated from its most important basis, anatomy and physiology; all three disciplines were considered independent of each other. He wrote '*…who of my compatriots will believe me when I say that in Germany, in the educated Germany, famous teachers proclaim that anatomical knowledge is of no use to surgeons*....'[7] The only surgeon to perform surgical experiments on human corpses was professor Schlemm, who allowed Pirogov to work with him on these experiments. The other person with whom Pirogov cooperated was the former midwife, madame Vogelsang, who was devoted to anatomy.[7] She provided Pirogov with large numbers of cadavers against payment; one thaler for one cadaver to carry any operation on it (nowadays the equivalent of approximately 80 Euro's) and 15 silbergroschen (nowadays the equivalent of about 29 Euro's) for dissecting the arteries in the limbs, and for opening up the joints.[7] They spent long hours together in the Charité Hospital in Berlin, during early morning and late evening, when she taught Pirogov the intricacies of anatomy. In 1834 Pirogov spent his summer holidays in Göttingen where he attended lectures by the surgeon-anatomist Konrad Langenbeck.

Pirogov felt passionately that a good knowledge of anatomy was an essential prerequisite for a surgeon, but he realized that a surgeons approach to anatomy must

differ from that of an anatomist or pathologist. Even though the anatomist has a thorough knowledge of the human body, the surgeon was the expert in the application of that anatomy. Pirogov pointed out that when the surgeon makes his incisions, he needs to have a detailed knowledge of the location of the various fascia, muscles, arteries, and nerves within the layers lying under his knife in order to avoid damaging them, or at least causing minimum damage. He went on to say that none of the anatomical-surgical manuscripts that he had read reflected this opinion. He considered the papers published by French surgeon-anatomists such as Alfred-Armand-Louis-Marie Velpeau and Philippe-Frédéric Blandin were incomplete because they did not show the brachial artery (a. brachialis) or the femoral artery (a. femoralis) in their manuscripts.[22] He advocated that the chair of surgical anatomy should be held by the professor of surgery, *not* by the professor of anatomy.

Return to Dorpat

In May 1835 Pirogov returned to Dorpat where Professor Moier asked him to join his department as professor extraordinary, a proposal that was unanimously supported by all the staff members.[7] However, such an appointed needed to be confirmed by the Ministry of National Education, necessitating Pirogov travel to St. Petersburg, then the capital of Russia. While he waited for the confirmation Pirogov gave, over a period of six weeks, a number of anatomy demonstrations, held in the mortuary of the Obukhov hospital. They were attended by 20 or more of his fellow surgeons and doctors from the Obukhov hospital and the Imperial Medico-Surgical Academy (since renamed the SM Kirov Military Medical Academy).

Pirogov liked to share his knowledge and when teaching he tried to involve his audience in the discussions, something that was quite different from the education he experienced at the university of Moscow.[7,9,15] During an operation, Pirogov would ask the students to name the different anatomical structures, thereby enhancing their knowledge of the relevant topographical area. He used the same method for his students during his experimental research involving animals. In addition to his clinical duties Pirogov spent eight hours each day carrying out and analysing anatomical experiments. During these experiments he made at least two or three drawings of his dissections as he believed that these would be useful to surgeons in helping them during operations in patients. One image represented the relative position of the fascia in relation to the arteries, the second and third represent those of the muscles, veins and nerves. His interest in the fasciae stands well within the tradition of the nineteenth century.[23] The branches of nerves, arteries, lymph vessels and glands as well as bundles of fibrous tissues were saved in his preparations. These all served to define the detailed topography of an area. The result of these experiments was published, in black and white, in an atlas first in

German in 1837, in 1838 in Latin[22] and in 1840 in Russian.[9] (Fig.2) It was re-published with the permission of Pirogov by Julius Szymanowski in 1860, who added one extra page, a drawing of the total body, and also coloured the arteries red and the veins blue.[24] (Fig.3)

In 1837 Pirogov was given a grant to visit Paris, where he met a number of surgeons, among them Alfred-Armand-Louis-Marie Velpeau, a skilled surgeon and renowned for his knowledge of surgical anatomy. Velpeau was at that time assessing Pirogov's publication Surgical Anatomy of the Arteries and Fasciae, with a view to have it acknowledged by the Paris Academy.[7,22] He praised Pirogov for

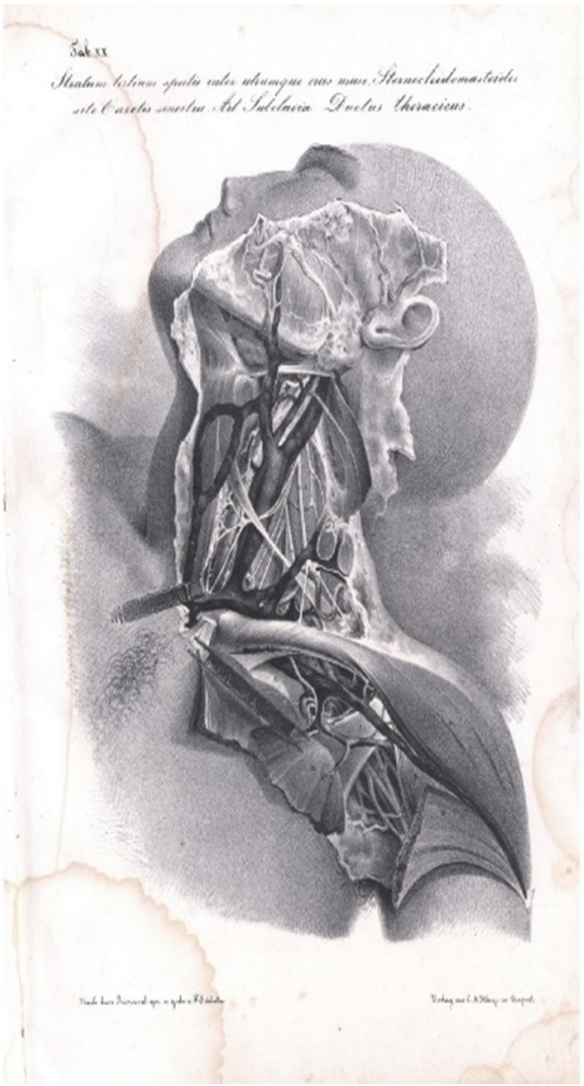

Fig.2. Plate XX, Illustration of the neck and shoulder region (Stralum tertium spatii inter untrumque crus muze Sternocleidomastoides site Carotis sinister Arteri Subclavia. Ductus Thoracicus), by Nikolay Ivanovich Pirogov, *Anatomica Chirurgica truncorum arterialium nec non fasciarum fibrosarum,* Dorpat, Imperial Russia: C.A. Kluge, 1838. In public domain.

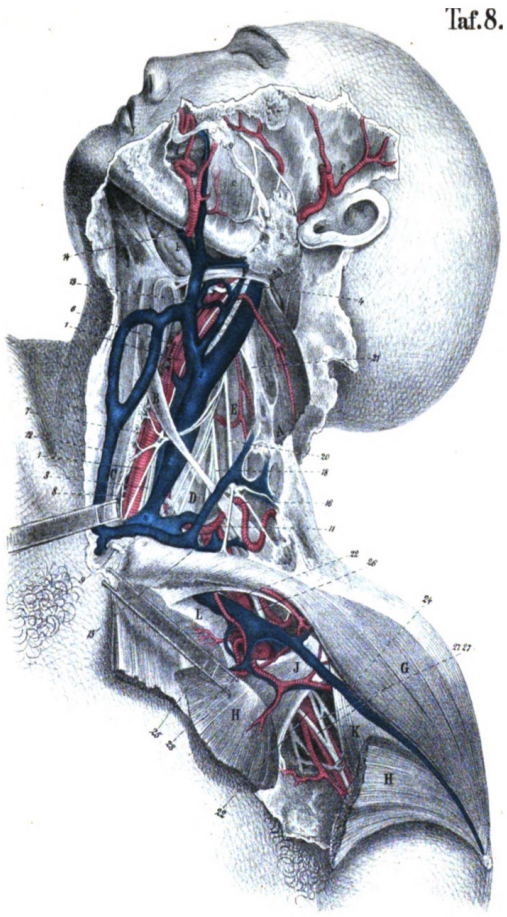

Fig. 3. Plate 8, Illustration of the neck and shoulder region (Stralum tertium spatii inter untrumque crus muze Sternocleidomastoides site Carotis sinister Arteri Subclavia. Ductus Thoracicus), by Julius Szymanovski, *Nicol. Pirogoff's Anatomia chirurgica truncorum arterialum nec non faciarum fibrodarum*, Leipzig und Heidelberg, C.F. Winter'sche Verlangshandlung, 1860. In public domain.

his work on surgery and his research into facias and on his drawings. Pirogov was invited by the surgeon Jean Zuleman Amussat to his home where met fellow surgeons Astley Cooper, Dieffenbach, Roux and Lisfranc. During a discussion on the urinary tract, Amussat spoke of his conviction that the urinary tract in men was totally straight. Pirogov disagreed and told him about his findings in frozen corpses. They continued to disagree on this subject, so Pirogov showed them specimens that he had previously prepared to prove his findings. He also brought pelvis sections to prove the absurdity of Amussat's view on the relationship of the urinary tract with the prostate gland. Despite Pirogov's visual proofs Amussat kept disagreeing. Pirogov stated '…*People, particularly scientists and more so the vain French, with preconceived notions, never admit their errors and mistakes*…'[7]

Orthopaedic treatment: the transection of the Achilles tendon.
Nikolay Pirogov's first encounter with orthopaedic surgery was a 14 year old female patient with a clubfoot.[25] Until then he was only aware of the specialty through the publications of the German surgeon Georg Friedrich Louis Stromeyer (1804 – 1876), a pioneer in orthopaedic surgery. In 1831 Stromeyer performed the first subcutaneous tenotomy of the Achilles tendon on a patient with a club foot.[26,27] Pirogov considered the operation of tenotomy, the transection of the Achilles tendon advocated by Stromeyer, as one possible treatment for his patient, although he thought it rather risky. Nonetheless he decided to proceed and cut the tendon. Fortunately the operation was successful. From what he read about the procedure in the available literature, no one had until then investigated by animal experiments the reason why the operation was successful, or what the exact consequences were of cutting the tendon. Thus in 1837 he began his own research into the anatomy of the Achilles tendon and changes induced by its transection. He carried out 80 experiments using various species of animal and subsequently performed 40 tenotomies in humans, applying the knowledge he had learned from his animal experiments.

From his research and his observations during operations on his patients Pirogov reported that the Achilles tendon was enclosed in a double sheath and not by a single one as previously thought. One is the aponeurotic sheath, - the continuation of the fascia cruris - the other a peculiar cellular-synovial tissue. He believed that a satisfactory regeneration of the tendon following tenotomy appeared to require maintaining a blood supply to and a blood clot in the tendon sheath. He published his results, which included seven plates with drawings, in 1840.[25] (Fig. 4) Pirogov faithfully believed in impartial research and considered surgery to be successful only if the theory is firmly confirmed by experiments, and anatomical-physiological and pathological studies.[25]

Professor in Saint Petersburg

In 1839 Nikolay Pirogov was invited to become professor of applied anatomy and surgery in the Imperial Medico-Surgical Academy in St. Petersburg.[7,15] Before he accepted the appointment he negotiated his terms, which included improvements in medical education with a greater emphasis on the practical aspects of patient treatment and the application of scientific advances. It took Pirogov two years before he got what he asked for and was officially appointed in March 1841 as Professor of Applied Anatomy and Hospital Surgery at the Imperial Medico-Surgical Academy and chief surgeon of the Second Military Landforce hospital in Saint Petersburg.[7,15] Immediately after taking up his new post Pirogov was also appointed as Technical Director of the Medical Instruments Factory, a member of the committee to improve the medical curriculum for students under the Ministry of

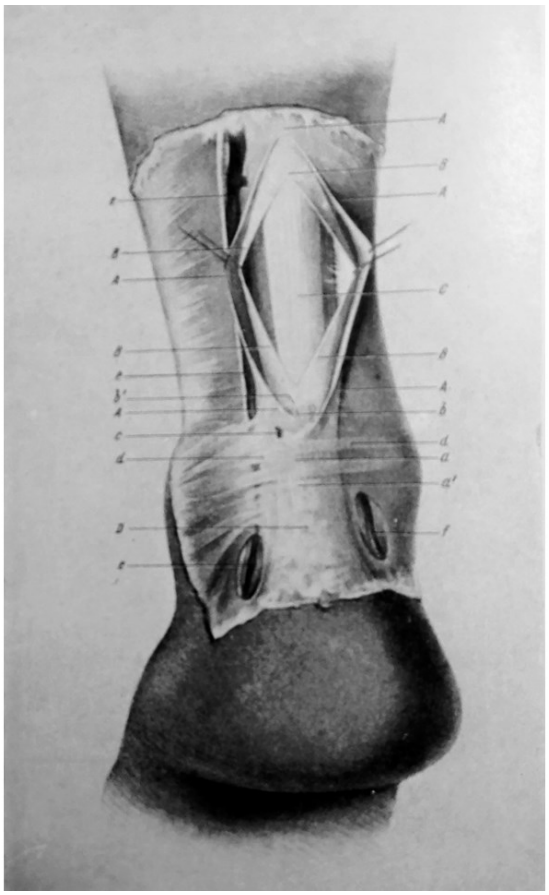

Figure 4
It shows both sheaths of the Achilles tendon after the subcutaneous tenotomy (according to Stromeyer), freed from the skin.
A, A, A, A, A - incision in the posterior wall of the aponeurotic sheath of the Achilles tendon;
B, B, B, B - incision in the connective-synovial sheath of the tendon;
C - the upper end of the cut tendon;
D - its lower end;
a - a gap (2.5 cm long), which remained after the cut of the tendon in the aponeurotic sheath between the ends of the tendon;
b - the same gap in the cellular sheath;
a ', b' - the edges of the incised tendon, which are visible through the translucent sheath;
c - place of the puncture in the sheath;
d, d - ray-shaped fibres of the fascia of the tibia in the grooves lateral to the Achilles tendon;
e, e, e - vena saphena parva;
f – posterior tibial artery.

Public Education and a member of the Medical Council of the Ministry of the Internal Affairs.[28]

Introduction of the microscope

In 1825, while Pirogov was still studying in Berlin, practical and theoretical courses in microscopy were introduced in the main medical institutes of the city.[29] Since then, Pirogov had attached great educational value to practical studies in microscopic anatomy and histology and introduced this to the Medico-Surgical Academy.[29] The anatomy department was the proud owner of the best available achromatic microscope at that time, manufactured by Simon Plössel (1794-1868) and a optical instrument maker, who started his own workshop in 1823, but was trained by the Voigtlander company. (en.wikipedia.org/wiki/Simon Plössel) In a book published in 1839[29] Pirogov described the importance of the microscope for investigating the influence of altered blood corpuscles on the capillary system. In 1841 Pirogov, with his new colleague Karl Ernst von Baer, presented the case to the Academy for the teaching of microscopy and histology in order to acquaint students with the latest developments in medical science. Pirogov even promoted the creation of a histology chair, but this only came to fruition in 1857. Von Baer was an naturalist, biologist, and a founding father of embryology, who like Pirogov had studied at the University of Dorpat.(en.wikipedia.org/wiki/Karl_Ernst_von_Baer) In 1817 he was appointed professor of zoology and anatomy at Königsberg University (now Kaliningrad). In 1929 he taught briefly in Saint Petersburg, but soon returned to Königsberg. In 1834, Baer returned to Saint Petersburg and joined the St Petersburg Academy of Sciences, first in zoology (1834–46) and then in comparative anatomy and physiology (1846–62).

In the first of his series of monographs on clinical surgery, published in 1854, Pirogov argued that microscopic examination is indispensable in distinguishing the various forms of lip carcinoma from trivial injuries like a burn from a cigarette or a neglected tear of the lip. He wrote that '…*The microscope is much more indispensable than the stethoscope, which in most cases can be replaced by a practiced ear*…'[30] He recommended the Brunner pocket microscope to his readers as it magnifies up to 400X and a field of view nearly as wide as portable field microscope which Pirogov always carried with him.

The Anatomical Institute

In 1844 Pirogov wanted to add an Anatomical Institute to the Academy.[15] The Academy agreed with the idea, but not without a struggle, and it took another two years before permission was granted. In 1846 Pirogov, together with Carl Johann von Seidlitz and Karl Baer, formed the Institute for Applied Anatomy, with Pirogov as the director. Von Seidlitz was also a former student of the German-Baltic University of Dorpat, graduating in 1819. From 1836 to 1846 he was professor of therapeutics at the Medico-Surgical Academy in St. Petersburg. The original correspondence and other documents concerning the decision making for the Institute are still held in the original library of the Academy. Unfortunately, at the

end of January 1846 before Pirogov could take up his post as director his wife died after the birth of their second son.[15] To help overcome his grief the Academy gave him a grant to visit anatomical departments in Italy, France, Switzerland and Austria. During his travels he met Wencheslav Leopoldovich (Wenzel) Gruber, a former student of the Viennese anatomist Josef Hyrtl (1810-1894) and an outstanding anatomist in his own right.[15,31] In 1847 Pirogov invited Gruber to become his first prosector at the Imperial Medico-Surgical Academy. The prosector is a skilled person, comparable to the present-day mortuary technician, but who undertakes the special task of preparing the dissection of a cadaver for demonstration purposes, usually in medical schools or hospitals. Many important anatomists began their careers as prosectors. The combined skill of Pirogov and Gruber worked out as a marriage made in heaven. After Pirogov's resignation in 1855 Gruber took over the leadership of the Anatomical Institute and in 1858 he became a full professor.

In the anatomical institute Pirogov instructed medical students in pathological and surgical anatomy, combining practical work, teaching them and doctors surgical procedures on cadavers. Teaching was done in rooms specially designed for microscopy studies and for experimental work on animals He also created a museum to provide a visual presentation to help the students learn the subjects. The institute also functioned as a postgraduate education centre for those who wanted to

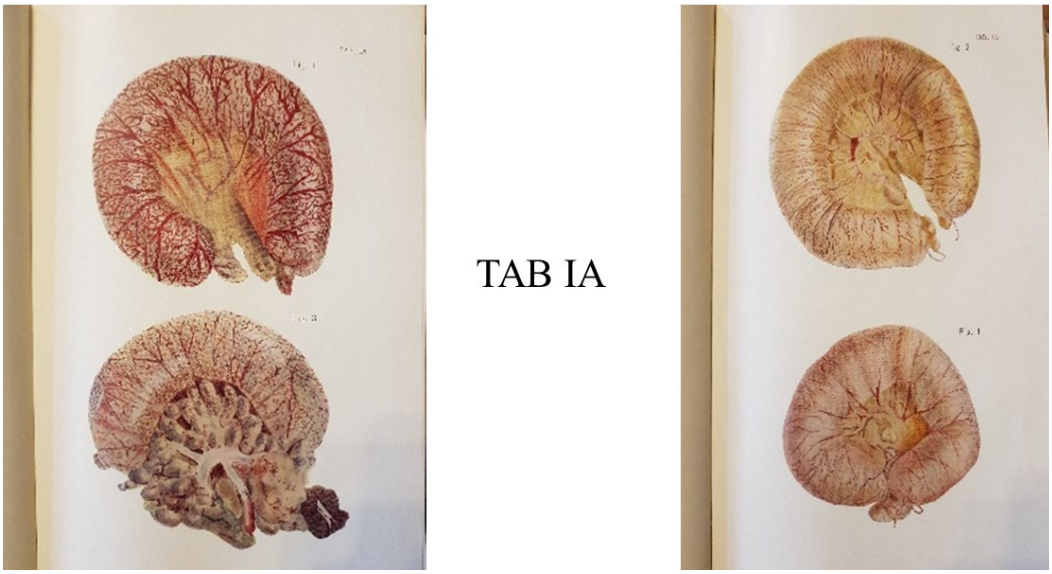

Fig. 5. Pathological Anatomy of the Asian Cholera. External views of the intestines affected by cholera. From N.I.Pirogov.[34]. In public domain.
The four images depict the main degrees of blood-filled subserosal and auxillary vascular networks of the intestines. The change in colour of the outer surface of the intestines is caused by the altered distribution of blood in the subserosal and auxillary vascular network. This change is so characteristic of the disease that it can help identify cholera as the cause of death at postmortem.

improve their knowledge both in the field of surgery and of surgical and pathological anatomy. Further the institute had a function to train future teachers of anatomy, not only for the Academy but also for other educational and medical institutions in Russia. Other Russian medical institutes later followed the path taken by the Imperial Medico-Surgical Academy. During his 15 years at the Academy Pirogov performed about 12,000 autopsies, which he carried out or supervised on all patients who died in the hospital clinics of the Academy. The introduction of the new diagnostics methods in the clinic and the practical microscopic courses, histology, anatomy and symptomatology were important new steps in medical teaching in the 1840s in Russia.[32]

The cholera epidemic of 1847

During the war in the Caucasus (1847) Pirogov travelled to the war zone to provide surgical services for the wounded soldiers during the Siege of Salty.[33] When he returned to Saint Petersburg later that winter an epidemic of Asian cholera raged in Russia. Pirogov observed the disease at the various stages of the epidemic and was able to study the progress, symptoms and treatment of the disease. He developed an atlas of the pathological anatomy of the disease[34], together with a textbook on the

Fig. 6. This is a reproduction of Figure XII from N.I. Pirogov's Atlas on Pathological Anatomy of the Asian Cholera.[34] It represents a rare example of what Pirogov referred to as 'diphtheria-cholera' in the gastric mucosa. The mucous membrane of the stomach is hyperaemic and swollen, covered with a thin layer of grey coloured exudate with a granular structure.

subject[35], based on the approximately 500 autopsies that he had carried out or supervised. His objective was to provide clear pictures that would help his colleagues better understand the disease (Fig. 5, 6). The drawings for both were done by Mr. Terebeniev and Mr. Meyer and with the significant financial support of the Imperial Medico-Surgical Academy in Saint Petersburg. Most of the atlas depicted pathological changes in the intestinal mucosa. Pirogov believed that the damage caused by cholera was largely to the intestinal canal. The atlas of the Asian Cholera was extensively reviewed by Virchow in 1852.[36] He praised the quality of the atlas, although he expressed some reservations about what he thought was a lack of detail in some areas. However, Virchow[35] did not have access to Pirogov's textbook that extensively described the plates and the systematic analysis of the Asian cholera.

Applied and Forensic Anatomy

Between 1843 and 1848 Pirogov worked on a book that reproduced natural

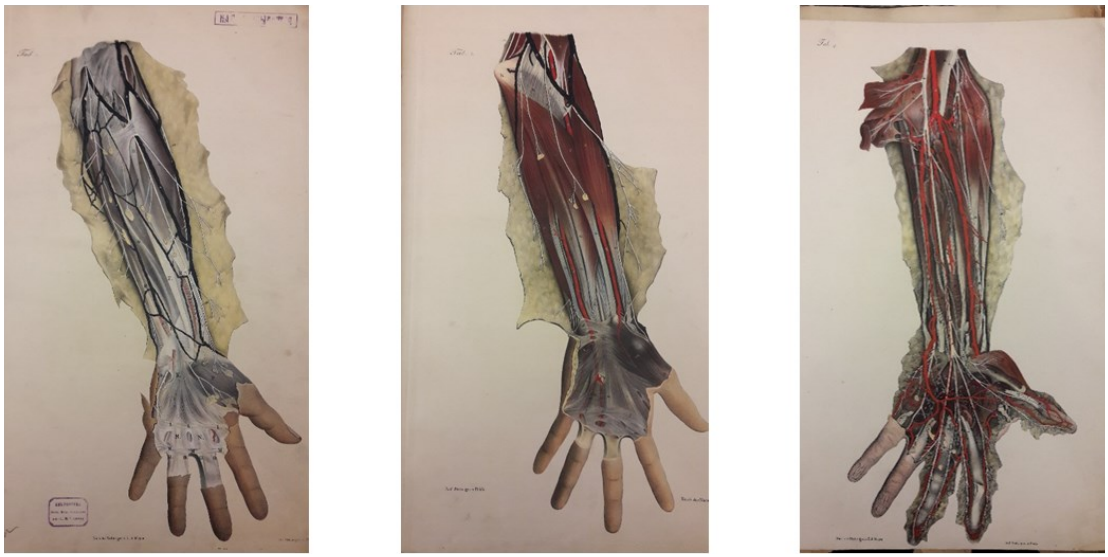

Fig. 7. Drawings of the anatomy of the lower arm and hand from N.I. Pirogov.[37] In public domain.

drawings of the human body with the objective of teaching physicians about applied anatomy.[37] (Fig. 7) The drawings in the book were layered so that readers could obtain a three-dimensional image of the structures. The fascial and synovial sheaths and inter-fascial spaces in the lower limbs were illustrated in detail. He published the book on the upper and lower limbs inclusive of the foot and the hand in several issues. In an accompanying textbook, printed in both Russian and German, a detailed one-and-a-half-page explanation was given of each illustration. His original

intention was to publish 25 issues but was only able to manage 12 issues because of the publisher was declared bankrupt.
Nikolay Pirogov was interested not only in anatomy and its application to surgery, but also in its value to forensic pathology.[15,33] During the Caucasian conflict in the summer and autumn of 1847 between insurgent rebels in Caucasus and the Russian army, Pirogov was sent by Tsar Nicolas I to use to provide surgical cover, and in particular to use the recently developed ether anaesthesia in surgical operations . This was the first-time anaesthesia was used under battle conditions. [38] Pirogov was able to observe and analyse the characteristics of the gunshot wounds (over 2,000). During his time in the Caucasus's he treated over 2000 wounds, of which only15 serious injuries were caused by large projectiles such as shells. All other injuries were the result of gunfire from Russian, Lesgian and Asian rifles. The differences he observed in the gunshot wounds he attributed to the weapons used and the size and weight of the bullets. The Russian bullets were larger and heavier with a low velocity in contrast to those used by the Lesgian and Asian troops. There rifles used bullets which were smaller and less heavy but with a high velocity. Pirogov noted that the entry and the exit wounds of these Asian bullets were similar, and the wounds were hardly visible. In contrast the lower velocity Russian bullets caused considerably greater damage. He considered a gunshot wound the headache of a surgeon, because '*... an injury produced by a bullet must be seen as the path of a fistula, which needs to be opened to give passage to the pus that constantly accumulates and let the law of hydraulics do its work…*'[33] The availability of anaesthesia allowed Pirogov to carry out a much greater examination of the soldiers with large bone fractures caused by gunshots.[28,33]

After the Caucasian conflict Pirogov was able to put the experience he had gained to good use. In 1862 he was asked for a consultation by the surgeons treating the Italian freedom fighter Giuseppe Garibaldi, who had been shot in his foot during the Italian unification conflict.[39] None of the surgeons from Italy, Britain or France could decide where the bullet was located and thus the best method of treatment. Pirogov was able to determine that the bullet was located at the lower part of the tibia close to the lateral malleolus. He advised a conservative treatment, i.e. no immediate surgical intervention to remove the bullet. Pirogov's advice was followed and within six weeks the bullet had spontaneously migrated to just under the skin and was easily removed. The patient made a full recovery and in a letter Garibaldi warmly thanked Pirogov [*My dear doctor Pirogov! My wound has almost healed. I feel the need to thank you for the cordial care that you lent me generously. Accept, dear doctor, my guarantees of devotion. Your Giuseppe Garibaldi*].

In 1850 Nikolay Pirogov produced an anatomical atlas with illustrations in colour, which was published by the Military Medical Journal, which still exists today.[40]

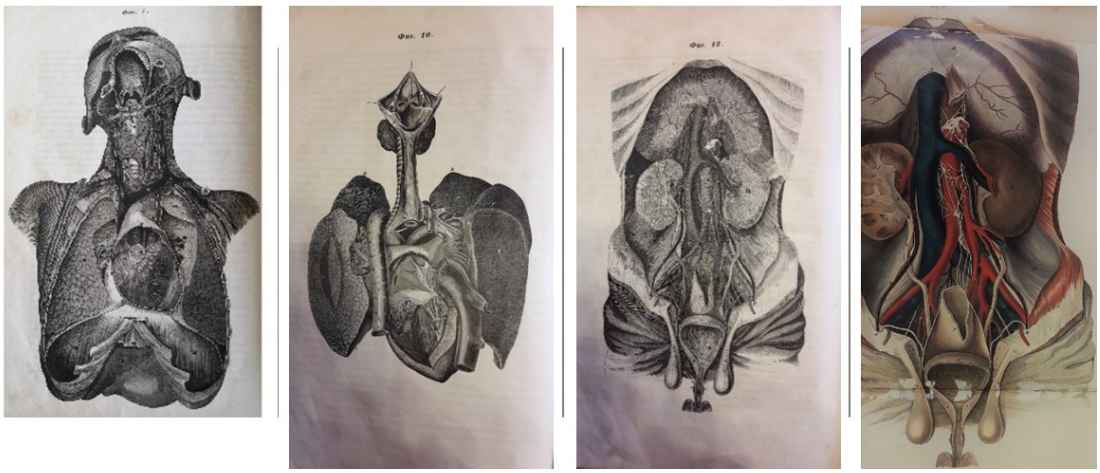

Fig. 8. Plates 7, 10 and 13 from N.I. Pirogov[40] showing the external appearance and positions of organs in the thoracic and abdominal cavities of the human body. In public domain.

(Fig. 8) The Journal editors decided to reproduce Pirogov's anatomical drawings using lithography in order to preserve the elegance and accuracy of the originals. However, because of the considerable costs involved in producing each individual lithograph it was published in only a very limited edition. This allowed the price to be kept lower and thus more affordable for those involved in anatomy, especially for the forensic specialist, as both Pirogov and the editors considered it a textbook for those carrying out autopsies. It was difficult to reproduce the lithographs in the atlas because of the small dimensions requested, not only for the journal itself but also for the five engravers involved.

Three-dimensional Topographic Anatomy of the human body

When visiting the local meat market during the very cold winter of 1846 Pirogov noticed in a butchers shop that the frozen carcasses of pigs on display and which had been sliced open, gave a clear view of the positions of the animals internal organs.[41] He realised that he could also take advantage of the cold Russian winters to freeze cadavers "to the density of the thickest wood" and then cut them into thin slices. This would allow him to describe the topographical anatomy of the human body in a detail never before attempted. It would allow him to overcome one of the problems associated with the standard approach to determining the exact location of organs within the living body. During an autopsy the incisions made in the corpse, and opening body, can cause the position of the organs to change. This is especially the case when the abdomen or the thoracic cavity is opened; the intestines fall away from the abdominal wall and in the thorax the lungs collapse.

Pirogov and his team studied cadavers that had been frozen to at least minus 15 degrees Celsius.[42] As director of the Medical Instruments Factory in St. Petersburg he was able to use its facilities to make a special mechanical saw, constructed along the lines of those used by furniture makers, allowing him to make cuts of 1; ½; or ¼ centimetre thickness. Pirogov was of course aware that thin cuts in only one direction would not allow the exact location of organs to be determined. What was needed was to make cuts in several directions and when the images were finally observed in the correct order the result would be a three-dimensional effect. Pirogov therefore made in different cadavers a series of transverse, longitudinal and anteroposterior cuts. A glass plate, on which was laid a sheet of paper on which rectangular grids were drawn, was placed over the cut. An accurate drawing was then made of the cut, allowing the detailed position and appearance of the various parts of the body to be recorded on marble in their natural position. (Fig. 9) To improve the separation of organs and structures such as plural folds, peritoneum, glands, heart valves, the cuts were first rinsed with warm water to remove frozen blood or serous fluids. The frozen layers were then allowed to thaw gradually, and

Fig. 9.
Plate I
The original drawings in their original seize and the handwritten explanation by Nikolay Pirogov, exhibited in the Nikolay I. Pirogov Museum in the Military Medical Museum in Saint Petersburg, Russian Federation. Reproduced with the permission from the Military Medical Museum of the Ministry of Defence of the Russian Federation, Saint Petersburg.
Plate II
The marble stone on which the body cuts are engraved in their original size, exhibited in the Nikolay I. Pirogov Museum in the Military Medical Museum in Saint Petersburg, Russian Federation. Reproduced with the permission from the Military Medical Museum of the Ministry of Defence of the Russian Federation, Saint Petersburg.
Plate III
The drawings as in plate I and II printed on page 18, Volume I of Pirogov's atlas of Topographic Anatomy.[43] In public domain.

pieces of ice carefully removed with an anatomical tweezer. In addition to the three-dimensional cuts they used another method, which Pirogov named the sculptural method, to display the very complex position of the abdominal organs. This involved using a chisel and hammer to carefully remove ice from areas frozen hard. After eight years work, Pirogov published his atlas of topographical anatomy in four volumes.[42-46] The fifth volume described and explained in detail the contents of plates in the first four volumes. The atlas had become a rarity by the beginning of the 20th century but was reprinted in 1997 for a limited edition of 500 copies.[47]

Pirogov did not claim originality in the use of his three-dimensional method; he was aware of the topographical atlases produced by earlier anatomists, based on the anatomy found at autopsies.[48] (Fig. 10) Later longitudinal cuts of the skull, the eye, ear, uterus, penis are found in the works of Valverde, A. Spigeli and Weselinga and others.[46] Other famous anatomists such as A. Haller and C.T. Semmering preferred simple drawings instead of the exact cuts made by Pirogov. Later in the eighteenth-century Peter Camper was the first to make copper engraving of a longitudinal cut of the male pelvis. The Edinburg anatomist John Lizars produced a

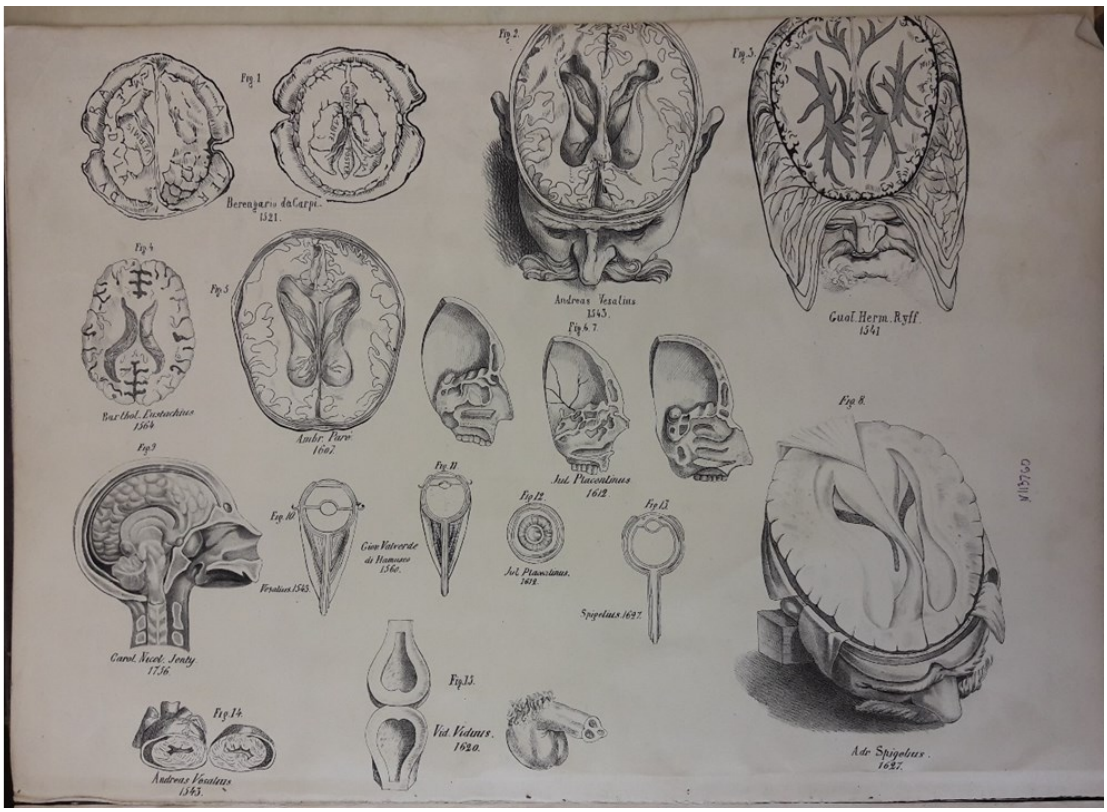

Fig.10. Reproduced from N.I. Pirogov[43] comparing anatomical drawings published by various anatomists; Berangario de Capri, Andreas Vesalius, Guaf. Herm. Ryff, Barthol Eustachius, Ambr. Parré, Julius Placentius, Carol. Nicol. Jenty, Giovan Valverde di Humasco, Adr. Spigelius, Vid. Viduus, plate 0053. In public domain.

topographical atlas with over 100 engraved coloured plates in 12 parts from 1822 to 1826 with a separate explanatory text. A later edition was published in 1840.[49] However, Pirogov did claim that nobody before him had used a method similar to his, namely making thin cuts a frozen human corpse to achieve a three-dimensional image. Nor did he claim that his method was the only sufficiently accurate method to locate the exact position of the organs. On the contrary he thought his method and the traditional methods should be used together for the most effective study of the position of organs. His method, however, was not only useful for topographical anatomy but also for histology and pathology. He therefore added drawings showing the position of organs whose location had been changed by disease.

The first drawings of the cuts using both methods, which he performed on frozen corpses in 1836, were published in St. Petersburg in 1852.[42] Two years later he submitted the first pages of the manuscript to the Parisian Academy of Sciences for their acknowledgement. This was the standard method to have a manuscript internationally accepted in the 19th century, the equivalent to the peer-review process today.[50] Four years later, the Parisian Academy announced that a French doctor had made numerous coupes of frozen corpses and won a prize named after the Montyon Foundation.[50]

Nikolay Pirogov received a letter dated August 10, 1862 about his three-dimensional topographic atlas from the renowned French surgeon Félix Hippolyte Larrey (1808-1895), in which he praised the quality of the atlas, and asked Pirogov's permission to discuss the atlas with his French medical colleagues.[51] In a second letter dated February 9, 1869 he informed Pirogov that after discussion with his colleagues they had decided to promote both the atlas and his textbook on military surgery[52] in France.

The topographical atlas was Pirogov's last work on medicine before he took part in the Crimean War during 1854-1856. After the Crimean War he resigned his position at the Imperial Medico-Surgical Academy and focused more on education and supervising students during their foreign internship in Germany. He also became very much involved with the development of and consultancy for the Red Cross Societies. Nikolay Pirogov died on December 5, 1881 at his estate in Vishnya (now Vinnytsia, Ukraine). In 1897 during the XII International Congress of Medicine in Moscow, attended by approximately 10 000 physicians from all over the world, Pirogov was posthumously honoured with the following statement and a monument:

> *For a long time two main directions existed in surgery: empiricism and theory. For centuries the practice of our art was in the hands of artisans, who in the barber shop climbed from apprentice to companion. There was no more*

theory here than with other crafts. The predominantly technical nature of surgery could not derive general concepts and scientific guidelines from its operations. This only took shape when lessons were learned from science, which so far had no connection with surgery, and this science organically learned to connect with surgery.

The first scientific principle that appeared in surgery after the development of the medical sciences was anatomy. Ambroise Pare, "the first barber of kings", as he called himself, who had also worked as a dissector on the anatomical floor, symbolizes the merger of barber-surgeon with anatomy. Jean Louis Petit, Desault and Bichat are then the other formidable landmarks in the scientific development of surgery. When we go outside to the Djevichje field here in Moscow, we are vividly reminded of this combination of surgery and anatomy. We can see from the beautiful and historical true monument of Pirogov that, among his many other accomplishments, he also had the great merit of contributing to the introduction of anatomy into surgery.[53]

Pirogov's passion for anatomy arose from his strongly held believe that surgery could only function if it was closely coupled to anatomy. Based on his knowledge of anatomy he invented a number of surgical operations, the best known of which, the osteoplastic foot amputation, is named after him. Today his contribution to anatomy is remembered in a number of anatomical structures named after him. The Pirogov triangle is a triangular area between the intermediate tendon of the digastric muscle and the hypoglossal nerve. The Pirogov angle (or venous angle) lies at the junction of the internal jugular and the subclavian veins and the Pirogov aponeurosis, also known as the biceps aponeurosis, a broad aponeurosis of the biceps muscle in the cubital fossa of the elbow and separates superficial from deep structures in much of the fossa.

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Chapter 5

Nikolay Ivanovich Pirogov: a surgeon's contribution to military and civilian anaesthesia

I.F. Hendriks, J.G. Bovill, F. Boer, E.S. Houwaart, P.C.W. Hogendoorn

Anaesthesia, 2015; 70 (2): 219-227

Abstract

A key figure in the development of anaesthesia in Russia was the surgeon Nikolay Ivanovich Pirogov (1810–1881). He experimented with ether and chloroform and organised the general introduction of anaesthesia in Russia for patients undergoing surgery. He was the first to perform systematic research into anaesthesia-related morbidity and mortality. More specifically, he was one of the first to administer ether anaesthesia on the battlefield, where the principles of military medicine that he established remained virtually unchanged until the outbreak of the Second World War.

Introduction

On the morning of Friday 16th October 1846, in the Bullfinch operating theatre of the Massachusetts General Hospital in Boston, William Morton carried out the first successful public demonstration of anaesthesia with ether in humans [1,2]. News of this discovery was reported in the Russian press early in 1847 [3,4]. Although B.F. Berenson, on the 15 January 1847 in Riga (at that time a region of Imperial Russia), and F.I. Inozemtsev, on 7 February 1847 in Moscow, were the first in Russia to use ether anaesthesia, it was the surgeon Nicolay Ivanovich Pirogov[1] (Fig. 1) who was to develop the widespread use of anaesthesia in that country [3,5,6].

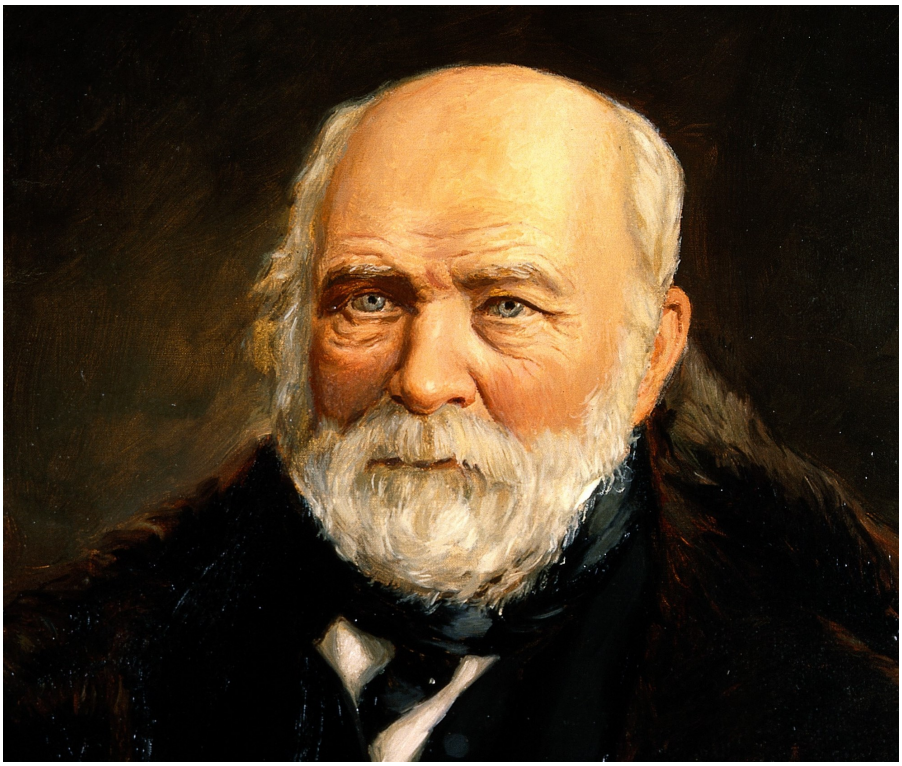

Fig. 1. Portrait of Nikolai Ivanovich Pirogov. Oil on canvas, artist and date unknown. Wellcome Library, London, Image V0018007.

Pirogov was born in Moscow on 13 November 1810[2]. He was a gifted child and by the age of six had taught himself to read Russian, and later was taught French and Latin by home tutors. When he was 11 years old, Pirogov entered a private boarding school; however within two years financial difficulties befell the family and there was insufficient money to keep him at the school. A family friend, Efrem Osipovich

[1] We have used common English transcription 'Pirogov' for the Russian surname 'Пирогов'. Other transcriptions such as 'Pirogoff' and 'Pirogow' also occur.

Mukhin, Professor of Anatomy and Physiology at Moscow University, arranged for the young Pirogov to be admitted to the Medical Faculty there, although he was three years younger than the usual entrance age of 16.[7] The teaching of medicine in Moscow at that time was extremely poor, with lectures based on outdated textbooks. During his four years at university, Pirogov did not carry out a single anatomical dissection and was present at only two operations. Nevertheless, he qualified as a physician in May 1828, only seventeen years old.

After graduating, Pirogov enrolled at the postgraduate institute of the German-Baltic University of Dorpat (now Tartu in Estonia) to continue his medical education. He completed his studies at Dorpat in August 1832, receiving a doctorate after defending his thesis *Num vinctura aortae abdominalis in aneurismate inhunali adhibitu facile ac tutum sit remedium* [Is the ligation of the ventral aorta an easy and effective therapy for inguinal aneurysm?]. Dorpat University kept in close contact with developments in Western Europe, and here Pirogov developed an international outlook in medicine. After graduation he studied for two years in Berlin and Göttingen. In March 1836, still only 25 years old, he was appointed Professor of Surgery at Dorpat University and the successor to his former teacher Professor Moier. Then, in March 1841, he was appointed Professor of Hospital Surgery and Applied Anatomy at the Military Medical Academy and chief surgeon of the Second Military Land Force Hospital in St. Petersburg (until 1917 the capital of Imperial Russia)[7-9]. His time in St. Petersburg was not altogether a happy one. From the start he met with a hostile opposition from an incompetent administration and visiting medical staff jealous of his reputation, so that life for him became a ceaseless struggle. Nonetheless, this failed to deter him from his hospital and teaching duties, private practice and scientific pursuits. This situation continued after his return from the Crimean War, and he resigned his position in St. Petersburg in April 1856, and moved first to Odessa and later to Kiev [8].

Pirogov probably learnt about Morton's demonstration of ether anaesthesia in the Russian newspapers and journals such as *Northern Bee*, the medical newspaper *Friend of Health*, *St. Petersburg Vedomosti* and others [4]. He was initially reluctant to use ether, as he was worried about the safety of the technique and concerned about possible excitatory effects during recovery from anaesthesia. However, the Russian government was interested in this new development and, in contrast to elsewhere in Europe and America, ordered and funded scientific research into ether.

[2] There are uncertainties about the dates cited as it is not always known whether the Julian or the Gregorian calendar was used in the original source literature. We have used the old dates as far as we can determine.

Pirogov began experimenting with ether in January 1847, and the results convinced him that his earlier misgivings were unfounded, and that ether anaesthesia was '....a *remedy, that in one sense can transform the whole of surgery...*'[10,11]. He published his first monograph on the subject on 17 May 1847 [4,11,12]. Pirogov recommended that a test anaesthetic should always be administered because the response to ether anaesthesia could vary considerably between individuals. For the patient who did not want to inhale ether, or could not cooperate, he preferred rectal administration [11,13].

Nikolay Pirogov investigated the clinical course of ether anaesthesia on himself and his assistants before using it on his patients. He carried out his first two operations under ether anaesthesia on 14 February, 1847 in the 2nd Military Land Force Hospital in St. Petersburg, using a simple green bottle with a rubber tube inserted into the patient's nose for inhalation of ether vapour.[10,11,14]

On 16 February 1847, Pirogov again operated using ether anaesthesia in the Obukhov Hospital, and his fourth operation with anaesthesia was on the 27 February in the Peter and Paul Hospital, St. Petersburg. The operation was a successful palliative procedure on a young girl who had developed a purulent stump following amputation of a leg. This time he replaced his earlier primitive equipment with the device invented by the Frenchman Charrière. However, not entirely satisfied with this inhaler, he constructed, together with master instrument maker L. Rookh, his own device with a mask for ether inhalation[3].[10,11] (Fig. 2)
The mask enabled Pirogov to administer ether while he was operating without the help of an assistant. The valve allowed adjustment of the mixture of ether and room air, allowing him to regulate the depth of anaesthesia. Within one year of Morton's demonstration of ether anaesthesia, Pirogov had operated on more than 300 patients using ether in his own surgical practice and on the battlefield.[10]

On the 30 March 1847, Pirogov submitted a paper to the Académie des Sciences in Paris describing his experiences with rectal ether; this was read on 5 May 1847.[12] On 21 June 1847 he presented a second paper to the Académie describing the results of his animal experiments with rectal administration of ether.[15] This paper was intended to accompany his book in which he described his experience of administering ether to 40 animals and 50 patients.[11] The purpose of the manual was to provide physicians with information about the effects of ether anaesthesia and details about the construction and use of the inhalation device for its administration. This book deserves to be added to the list of early textbooks on anaesthesia compiled by Secher and Dinnick.[15,16]

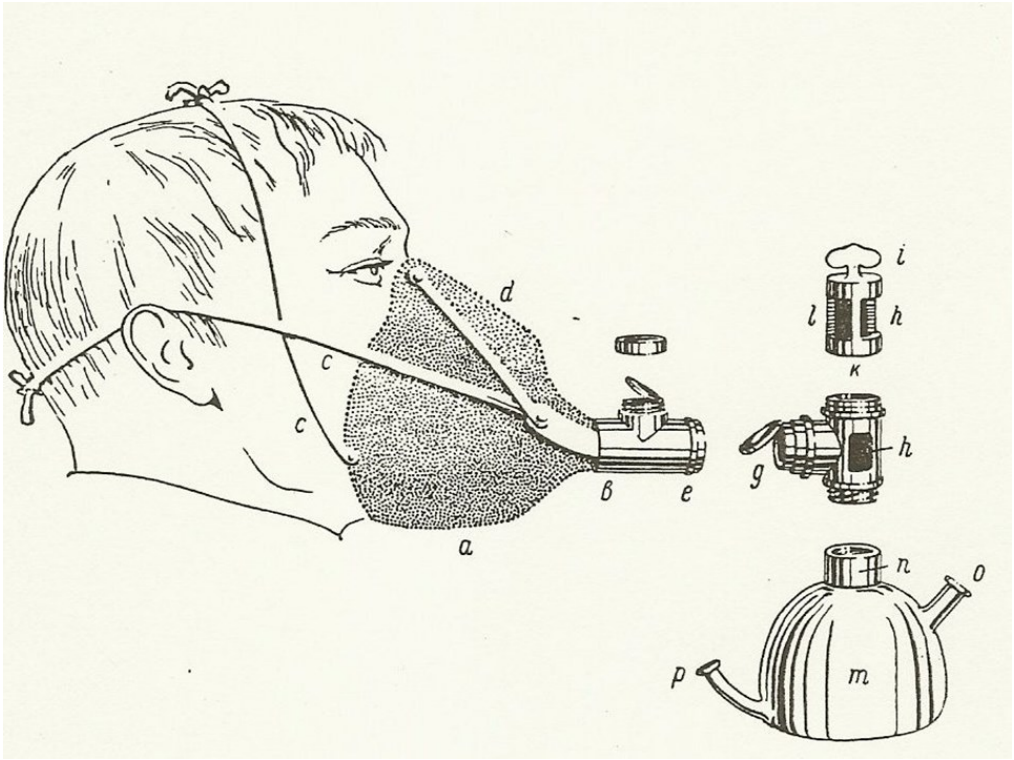

Fig. 2. Device for inhalation of ether vapour developed by N.I. Pirogov[11]. Ether vapour from flask (m) enters the inhalation valve (h) where it mixes with air inhaled through openings in the valve. The amount of mixing, and thus the inspired concentration of ether, was controlled by the tap (i) on the upper half of the inhalation valve. The ether/air mixture was inhaled by the patient via the tight fitting face mask connected to the inhalation valve by a length of tubing containing an exhalation valve. The face mask designed by Pirogov to fit snugly around the mouth and nose of the patient was an entirely new innovation at that time [11]. In the public domain according to the Russian Law.

The research Pirogov conducted with rectal administration of ether was on animals, mostly dogs, but also rats and rabbits. His idea was based on the work of the French physiologist François Magendie, who had performed experiments on animals using rectal ether.[11,17] Ether, introduced as a vapour into the rectum by means of an elastic tube[10,11], was rapidly absorbed into the blood, and could soon be detected in the exhaled air. Most patients lost consciousness within 2-3 minutes after the start of administration. Compared to the inhalation technique, the patients were more deeply anaesthetised, with better muscle relaxation. Anaesthesia also lasted longer (about 15-20 minutes) than inhalation anaesthesia, allowing more major operations to be carried out. Due to significant muscle relaxation, this type of anaesthesia was particularly suitable for strangulated hernias and chronic dislocations. The method

[3] *Pirogov* (in Russian: Пирогов) is a 1947 Soviet film directed by Grigori Kozintsev, based on the life of Nicolay Ivanovich Pirogov. Part of this film demonstrates the use of the Pirogov inhaler.

had, however, several drawbacks. Hot water was always needed to heat the delivery system, which made the technique unsuitable for use on the battlefield; furthermore, the colon had to be cleansed by enemas, and patients often complained of colic and diarrhoea as the ether vapour cooled and liquefied. Pirogov was initially enthusiastic about this method, but later he only used it as an antispasmodic in the management of urinary tract stones.[10,11] Indeed rectal ether never achieved widespread popularity, although it was used in London by Dr. Buxton at King's College Hospital for operations by Sir Joseph Lister and Sir Victor Horsley.[18] There is also one report from Canada of its use in obstetrics in the 1930s.[19]

Pirogov also carried out animal experiments injecting ether both intravenously and into different areas of the nervous system. He demonstrated that anaesthesia only occurred if the ether could be detected in the exhaled air: '*...Thus the arterial blood constitutes the transport medium of vapour, and thus the calming effect on the central nervous system is transmitted…*' [10,11] He promptly gave up the concept of intravenous administration of ether as hazardous. Pirogov also experimented with the use of direct intratracheal administration through a rubber tube inserted into a tracheotomy opening.[11]

The scientific work and inventiveness of Pirogov had an enormous impact on what was then in Russia called 'the etherisation process'[5]. Although he was convinced that the discovery of ether anaesthesia was one of the greatest achievements of science, he was also very much aware of its limitations and dangers: *'...This kind of anaesthesia can be destructive, or can significantly weaken the reflective activity; it is only one step away from death…*'[10,11].

The Caucasian War and military anaesthesia

In the spring of 1847, mountain tribes in the Caucasus rebelled anew against the Russian government; thousands of Russian soldiers were killed and maimed in bloody battles with the rebels. Field hospitals were overflowing with young men with horrendous injuries. The Tsar insisted that ether should be used in surgical operations during this campaign, not only for humanitarian but also for tactical reasons. He reasoned that soldiers would be better motivated to fight if they knew that, should they be wounded, they could avoid the excruciating pain usually associated with surgery.[10] Therefore, in a meeting of the Conference of the Medical-Surgical Academy on 25 May 1847, Pirogov was told that the Tsar, was pleased to send him, as the Ordinary Professor and State Councillor, to the Caucasus to instruct doctors of the Separate Caucasian Corps on the use of ether vapour during surgery. The Tsar appointed Doctor Peter Y. Nemmert as his assistant, and

also Ivan Kalashnikov, a senior paramedic of the Second Military Land Force Hospital. Their preparations for the journey took a week. They left Saint Petersburg in June by carriage to cross the country from the north to the war zone in the south. En route, Pirogov visited several towns and cities where he introduced ether anaesthesia to the local physicians.[4] From a factory producing surgical equipment (of which he was also director) he had brought 30 anaesthesia inhalers, and from the State Pharmacies of Stavropol and Tiflis he obtained 32 kg of ether. He had misgivings about transporting ether because of the high temperature (30-33 °C) in the Caucasus region, fearing that the liquid would vaporise. To his relief the entire volume of ether was transported without loss, despite the bumpy carriage journey, the narrow roads and the heat. When the ether arrived at its destination it was dispensed into individual bottles of thick glass, each holding about 800 g of liquid, and stored in specially designed boxes closed with matting and oil-cloth.[10] In the city of Pyatigorsk, in a military hospital, Pirogov organized theoretical and practical sessions for local doctors and, together with Nemmert, he performed 14 operations of varying complexity.[4]

In the city of Oglakh, the wounded were housed in tents. There was no separate room for operations, and because Pirogov wanted to convince other wounded soldiers of the analgesic effect of ether, he carried out operations in their presence. This visual propaganda had a profound effect on the wounded soldiers, who subsequently came for surgery without fear. In his Report on the journey to the Caucasus, he wrote:

> *For the first time operations were carried out without the moans and screams of the wounded…the most consoling effect of etherisation was that the operations performed by us in the presence of other wounded men did not frighten them, but, on the contrary, reassured them of their own plight.*

Finally, Pirogov arrived at the Samurtsky military detachment, which was located in the fortified village of Salta. Here in a primitive ‘field hospital ‘(a few huts made of tree branches with a roof of straw) he had to kneel to carry out operations on a table made of stones and covered with straw. During the war they anaesthetised 100 wounded soldiers on the battle field. Pirogov himself stated:

> *From the number of surgical operations performed with ether, 47 were carried out by me, 35 by my assistant Nemmert, five under my supervision by the local physician Dukshinsky, and the remaining 13 under my supervision by regimental battalion doctors.*[4]

Of these patients, only two received rectal ether because of the primitive conditions and the presence of an open fire. This was the first time in military history that wounded soldiers underwent operations and amputations with general anaesthesia. Pirogov also found time to demonstrate to local surgeons the technical aspects of ether anaesthesia.

During the period February 1847 – February 1848, with the help of his assistant

Table 1. Number of patients operated on by Nikolay Pirogov between February 1847 and February 1848, classified according to the types of anaesthesia and surgery [10].

Type of Anaesthesia		Type of Surgery		Deaths per surgical type	
		Major	Minor	Major	Minor
Ether by Inhalation	Adults	242	16	59	1
	Children	29	4	4	0
Rectal ether	Adults	58	14	13	1
	Children	8	1	1	0
Chloroform	Adults	104	74	25	1
	Children	18	12	3	0

Nemmert, he gathered data on operations performed under anaesthesia both on the battlefield and in military and civilian hospitals (Table 1).
Of the 580 operations for which sufficient data were available, 108 patients died, a mortality rate of 1 per 5.4 operations. Of these, 11 died within 48 hours after surgery, but a surgical cause was found in each patient. Pirogov described his Caucasian experiences and his statistical analysis in his book *Medical Report from a Trip to the Caucasus* [10,11] in which he stated:

> *Russia, ahead of Europe, shows the world by our actions in the siege of Salta not only the opportunity of the application, but the undeniable benefit of etherisation for the wounded on the battle field itself. We hope that from now on etherisation will be, just as the surgeon's knife, an indispensable attribute of each doctor during his action on the battle field.* [11]

This summarised his views about anaesthesia and its importance for surgery.

Pirogov and chloroform

After his return from the Caucasian War, Pirogov administered his first anaesthesia with chloroform on 21 December 1847 in Moscow; the subject was a large dog.[20,21] He meticulously recorded every detail of his operations and animal experiments and, in addition to the publication of surgical outcomes, he described the influence of anaesthesia on the postoperative course. As well as surgical mortality rates, he reported anaesthesia-related side effects, which he defined as prolonged loss of consciousness, vomiting, delirium, headache and abdominal discomfort. He spoke of 'anaesthesia-related mortality' if death occurred within 24-48 hours and at autopsy no surgical or other explanations for the death were found.
On the basis of his observations and analyses he was convinced that mortality was not increased by administration of ether or chloroform.[10] This was contrary to the observations of French and British doctors, (influenced partly by the famous case of Hannah Greener) that the administration of chloroform could lead to sudden cardiac death, or as Glover suggested, of intense lung congestion from the toxic action of the anaesthetic.[22] Pirogov surmised that the deaths described by the French and British doctors were the result of too rapid and excessive administration of chloroform.[10] Acute cardiac death was certainly not due to the occurrence of gas bubbles in the blood, as some had speculated, but to acute right heart failure caused by an overdose of chloroform. Pirogov had himself demonstrated this in dogs and cats.[10,13] John Snow reported similar findings in 1852.[23] Chloroform had obvious advantages over ether for use in the field. The quantity needed for effective anaesthesia was small; unlike ether it was not inflammable; and it did not require complicated equipment, since anaesthesia could easily be induced using a simple rag-and-bottle technique. Indeed, the French Army Medical Service used chloroform extensively during the Crimean War, and it was also used by some British Army surgeons.[24-26]

None of the deaths among the patients to whom Pirogov gave chloroform during the Crimean conflict were related to anaesthesia, nor were there any reports of chloroform related deaths in the Russian field hospitals. However, five of his patients developed 'deep shock' during anaesthesia. One patient died of severe blood loss; the other four made a full recovery within a few hours. One of these patients underwent a reduction of contracture of the knee under deep anaesthesia. After adding a small amount of chloroform to increase muscle relaxation, there was a sudden bradycardia. The patient was without a palpable pulse or respiration for 45 minutes despite all means of stimulation. There was marked dilatation of neck and arm veins. Pirogov performed a bloodletting of the median vein and observed a release of gas with an audible hiss but with little blood loss. Then, with rubbing of

the neck and arm veins, more blood appeared initially with gas bubbles and finally pure blood. Although Pirogov was meticulous in recording all his observations he was unable to provide an explanation for these extraordinary findings in this patient. Fortunately the patient made a full recovery.[13]

Pirogov formulated the following guidelines for the use of chloroform [10,13]:

- Chloroform must always be administered in divided doses, especially when used for major trauma. He ordered chloroform in small bottles containing 1 dram (~3.9 g).
- Patients should where possible be anaesthetised in the prone position.
- Patients should not undergo surgery immediately after a meal, or after prolonged fasting.
- Anaesthesia should be gradually induced by applying a handkerchief or sponge soaked in chloroform from a distance, gradually approaching the patient. In this way laryngospasm or coughing could be avoided.
- An experienced assistant, or the surgeon himself, should constantly monitor the pulse to guide anaesthesia. If bradycardia occurred, then the chloroform sponge should immediately be completely removed.
- The greatest caution should be exercised in anaemic patients, since they are especially prone to suddenly go into shock if chloroform is administered too rapidly.

Pirogov also made several recommendations about resuscitation, including compression of the thorax and lower body, opening the mouth, removal of accumulated mucus and blood from the throat, and full forward extraction of the tongue. Although now considered standard practice, these ideas were quite new in Pirogov's time. He also insisted that during surgery the surgeon should observe the colour and the amount of blood loss. If the arterial blood is black and the blood stream is weak, the administration of chloroform must be stopped. Pirogov suggested that the quantity of chloroform should be limited and usually 3 drams is enough, although in some patients larger doses must be used. Even when significant quantities of chloroform were used, shock never occurred in these cases, but was more likely in those patients where an insufficient amount was used, or when the chloroform was administered too rapidly. Pirogov also used chloroform: during strabismus operations in children; for childbirth; and for diagnostic procedures, such as diagnosis of latent fractures.[10,13]

The Crimean War (1853-1856)

Pirogov served as an army surgeon during the Crimean War, arriving in Simferopol

on 11 December 1854, and was appointed the chief surgeon of the besieged city of Sevastopol.[13,27] Shortly after his arrival in Sevastopol he initiated, with the assistance of Grand Duchess Elena Pavlovna Romanova-von Württemberg, sister-in-law of Tsar Nicholas I, the deployment of female nursing sisters, who became known as "The sisters of Mercy". Pirogov trained them to assist during operations and in the administration of anaesthesia, among other duties. This group of women became the foundation for what later became the Russian Red Cross. Unlike the British nurses of Florence Nightingale, the Russian nurses worked not only in small field medical units but also in the battlefield, often directly under shellfire.[28,29] Seventeen Russian nurses died on duty during the Crimean War, six in the town of Simferopol alone.[30]

During the defence of Sevastopol Pirogov introduced the widespread use of anaesthesia and gained considerable experience in its use during many thousands of operations. He built on his experiences during the Caucasian campaign of 1847, though now the Russian medical service performed every operation under chloroform, rather than ether, anaesthesia. Over the course of 9 months, he personally performed 5000 amputation that's 30 a day. But, probably as a result of overwork, he fell ill with typhoid fever and was close to death for three weeks. Fortunately he made a complete recovery. He described his experiences in field surgery, including a chapter on anaesthesia, in the book *Grundzüge der allgemeinen Kriegschirurgie usw*[13], published in 1864, which became the standard reference for field surgery. The principles of battlefield medicine established by Pirogov were soon followed by surgeons of other countries and remained virtually unchanged until the outbreak of the Second World War. Pirogov's work during the Crimean War is of such importance that he may be considered the founder of field surgery.

At the Crimean front, Russian soldiers were convinced that Pirogov possessed almost supernatural abilities as a surgeon. Soldiers would bring severely injured comrades, many with already fatal wounds, to his field hospital in the expectation that he could restore them to health. On one occasion a group of soldiers brought a wounded comrade to a medical post. Seeing that the man had no head, the doctor on duty exclaimed: '*...What are you doing? Where are you taking him, can't you see he's got no head? The head is coming behind us*…', the men responded, '*...Dr. Pirogov is here; he'll put it back on somehow...*'[31].

Civilian anaesthesiology as a medical speciality

From personal experience, Pirogov warned against the administration of anaesthesia by untrained assistants. Based on his military medical experience at Salta during the

Caucasian conflict, he became convinced of the effectiveness of physicians dedicated to administering anaesthesia, assisted by trained helpers.[5,10] His main argument was that operations under anaesthesia were often more complicated, and tended to last much longer, than those without anaesthesia, so that the surgeon could not concentrate on the surgery and at the same time provide adequate care for the anaesthetised patient. His experience of the use of anaesthesia had increased immeasurably during the Crimean War, where he administered about 10 000 anaesthetics. Again, after observing the work of health services during the Franco-Prussian War of 1870 and in Bulgaria in 1877-78, Pirogov spoke forcibly about the importance of anaesthesia not only during surgery but also to enable painful procedures such as wound dressings.[5,10,11,13] It took more than a century before his suggestion of professional anaesthetists was finally achieved in practice in Russia. In December 1938, the 24th All-Union Congress of Surgeons in the Soviet Union came to a special decision on the training of anaesthetists. This theme was a returning issue in subsequent congresses and finally, in 1955, at the 26th Congress of Surgeons in the USSR, it became a reality.[5]

The impact of military anaesthesia on civilian practice

The contribution made by Pirogov to the advancement of medical care of military personnel during war, including his extensive use of anaesthesia, has correctly earned him the title of founder of field medicine.[32] He was able to apply the knowledge and experience he had gained with ether anaesthesia in his civilian practice to the very different, and difficult, circumstances with which he was confronted during the Caucasian and Crimean conflicts. And we know from his writings, his experiences during these conflicts confirmed his belief in the utility of anaesthesia. It is also true that widespread use of anaesthesia in war surgery by Pirogov and his colleagues in the Russian army medical service was to have a most significant influence on the subsequent advancement of anaesthesia for the general population in Russia.[25] Nikolay Ivanovich Pirogov played a crucial and central role in this development.

During his travels from St. Petersburg to the different war zones, Pirogov made frequent stops at cities and towns along the routes, during which he took every opportunity to demonstrate the use of ether and to educate local surgeons and physicians in the technique and skills needed for the safe application of this new form of ‘painless surgery’. In the hospitals he visited he left anaesthetic masks and devices for rectal anaesthesia to enable the continued application of anaesthesia during surgery. This undoubtedly would have stimulated interest in the use of anaesthesia in these regions. Further the reports of the successes of emergency anaesthesia in the Russian newspapers contributed much to the development of

anaesthesia in the period immediately after the Crimean conflict. Army surgeons returned to civilian practice armed with the skill to use anaesthesia, and returning soldiers would have spread the news of this new and miraculous medical advance.

In conclusion, Nikolai Ivanovich Pirogov was the greatest of all Russian military surgeons and the most important figure in Russians medical history, and who played a key role in the development of anaesthesia in Russia.[33] He was that rare combination of scientist, skilled surgeon and an excellent teacher and taught his fellow doctors how to administer anaesthesia not only in hospitals but also on the battle field. He was one of the first to administer ether anaesthesia in the battle field. He developed an alternative technique for administering ether, the rectal method and investigated the use of chloroform in animals and then in humans. Pirogov was also the first to perform systematic research into anaesthesia-related morbidity and mortality. Although convinced that the discovery of anaesthesia was one of the greatest achievements of science, he was well aware of its limitations and dangers.

Pirogov died on 5th December 1881 in the village of Vishnya (now Vinnytsia, Ukraine). His body is preserved using embalming techniques he himself developed shortly before his death and rests in the village church in Vinnytsia. Many acknowledgements of his achievements have followed, including the naming in his honour of the Pirogov Glacier in Antarctica, the large Pirogov Hospital in Sofia, Bulgaria and the 2506 Pirogov asteroid, discovered in August 1976 by Russian astronomer Nikolai Chernykh. Stamps with his portrait were issued in the Soviet Union in 1949 and on his 150th anniversary in 1960 (Fig. 4). Further, the highest humanitarian prize in the Soviet Union was the Pirogov Gold Medal. However, we believe that Nikolai Ivanovich Pirogov deserves to be more widely recognised outside his native Russia for his contributions to the advancement of anaesthesia.

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Chapter 6

Women in healthcare in Imperial Russia:

The contribution of the surgeon Nikolay I Pirogov

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Abstract

Nikolay Ivanovich Pirogov, one of the greatest Russian surgeons of the 19th Century, was convinced of the importance of deploying nurses to care for the casualties of war. With the support of Grand Duchess Elena Pavlovna, sister-in-law of Tsar Nikolas I, Pirogov realised the idea during the Crimean war when Russia became the first country to send female nurses to the battle front. Later in the 19th century, large numbers of Russian women trained as nurses under the auspices of the Russian Red Cross, founded in 1867. In peacetime, their expertise was extremely valuable.

Introduction

In mid-eighteenth-century in Russia a limited role developed for women in the general care of patients in civilian hospitals.[1] In the Pavlov Hospital in Moscow and the Mariinsky Hospital in Saint Petersburg[2] wives of sick soldiers and soldier's widows worked as ward orderlies but were also allowed to admit patients, examine sick women and administer simple treatments. Under the influence of Nikolay Ivanovich Pirogov and the Grand Duchess Elena Pavlovna several women's Communities were formed whose members cared for the poor and sick. [3,4] During the Crimean War Russia became the first country to send well-trained female nurses to the battle front. After the Crimean and later the Russo-Turkish Wars (1877-1878) large numbers of women throughout Russia trained as nurses under the auspices of the Russian Red Cross and the number of women involved in medical care increased substantially.

Nikolay Ivanovich Pirogov, a medical reformer

Nikolay Ivanovich Pirogov[5] (1810-1881) (Fig. 1) became a medical student at the University of Moscow when only 13 years old.[6-8] After graduating in May1828 he, as an excellent graduated student, was sent on a state scholarship to the prestigious postgraduate university of Dorpat to specialise in surgery and applied

Fig.1. Nikolay Ivanovich Pirogov in the 1850's, photograph, Artist unknown, Image No. 20293 Military Medical Museum of the Ministry of Defense of the Russian Federation, Saint Petersburg. Reproduced with their permission.

anatomy.[9-11] In March 1841 he was appointed Professor of Surgery and applied Anatomy and head of the new Department of Hospital Surgery in the Imperial Medico-Surgical Academy in Saint Petersburg. Here he developed his managerial skills that were to become invaluable during the Caucasian and especially the Crimean Wars.

Grand Duchess Elena Pavlovna

Elena Pavlovna was born Princess Friederike Charlotte Marie von Württemberg on 7 January 1807 in the small southern German duchy of Württemberg. She died a Russian Grand Duchess in 1873.[12,13] (Fig. 2) She married Grand Duke Mikhail Pavlovich Romanov, the youngest son of Tsar Paul I and Tsarina Maria Fyodrovna in 1823. As the required first step towards her new identity as a Romanov she was received into the Russian Orthodox church and was given the name Elena Pavlovna; Elena as this was the closest saints feast in the Orthodox calendar to her birthday.
As sister-in-law of Tsar Nikolas I she had easy access to him and the highest circles of Russian and European society. She was a close friend of Pirogov's second wife, Baroness Aleksandra Bistrom. In 1828 after the death of her mother-in-law, Elena Pavlovna inherited the Mariinsky hospital.[14] After her own death in 1873 all her

Fig.2. Grand Duchess Elena Pavlovna Romanova – von Württemberg, lithography by L. Noel of the portrait of F. Vinnergalter, 1863, Image No. 2549, Military Medical Museum of the Ministry of Defense of the Russian Federation, Saint Petersburg. Reproduced with their permission.

charities were merged into a single Foundation named after her, including among others St. Elena college for girls, the Exaltation of the Holy Cross Community and the Mariinsky hospital.[9,14,15] Her first remarkable and entirely voluntary contribution to the Russian national cause was the creation of a community of nurses in 1854 shortly after the start of the Crimean War. Elena Pavlovna made very significant contributions to Russian society: in social welfare, medicine, science, music and the emancipation of the serfs, and she played a prominent role in the establishment of the Russian Red Cross.

Crimean War (1853 – 1856)

Nikolay Pirogov first met Elena Pavlovna in 1848 when, on his return to Saint Petersburg from the Caucasian War, she invited him to the Mikhailovsky Palace to learn more about the conflict and his involvement.[12,13] She showed considerable appreciation of his work and shared many of his ideas for managing the casualties of war. By the outbreak of the Crimean War they had come to know and respect each other and a long-lasting friendship had developed. During that war she enabled the surgeon Nikolay Pirogov to transform Russian medicine and rescue untold numbers of wounded soldiers. It was then that Pirogov, with the support of Grand Duchess Elena Pavlovna, achieved his goal of giving women a significant role as nurses in civilian and military hospitals, and at the battlefield.[16] Nikolay Pirogov declared that the honour of introducing women's role in healthcare belonged largely to her. [17] The role of Elena Pavlovna is extensively discussed in the book of M. Soroka and Ch.A. Ruud.[18]

From the Crimean War soon reports reached Saint Petersburg of the untold numbers of wounded waiting in the open air, untreated and covered in blood-soaked greatcoats.[16,19] During a visit to Paris in 1837 Nikolay Pirogov observed how women were involved in the care of hospital patients. He described his thoughts in his Sevastopol letters:[16]

> *I am forced to admit that at one moment in my life when, during a visit to a Paris hospital in 1837, by accident I saw women caring for patients. This was when I came to appreciate, more intuitively than by experience, the great significance of women participation in healthcare. Of course, women working in hospitals was not a new institution. Roman Catholic countries and later Protestant countries had established a role for women in the welfare of the sick. The participation of women was also accepted in Russia, where the compassionate widows worked in the Mariinsky Hospital. But up to now women have never been deployed in a theatre of war. The idea to send in force an organized group of women to the battle field was very risky. Nevertheless, the exceptional circumstances of the war and the distance to the war zone*

> *strengthened my resolve to form a group of educated nurses, and a few weeks later, they were sent.*[16]

This observation was the inspiration for him to consider developing a role for professional women in the Russian health care system.[6,7] However, this idea would only reach full fruition during the Crimean War, when large numbers of casualties and miserable conditions forced a reorganisation of nursing care.[14]
At a meeting early in October 1854 Pirogov and Elena Pavlovna discussed ways of helping the army in Sevastopol.[12] Pirogov blamed many unnecessary deaths and complications on the chaotic accumulation of the wounded at the dressing stations. To prevent it he wanted to introduce immediate triage of the wounded, but this would require considerable paramedical personnel close to the line of action. During their conversation it transpired that they both had considered that women would be ideal for filling this role.[12,19] The Grand Duchess told Pirogov of her plan to establish the Holy Cross Community of Nurses.[12,16] Pirogov immediately gave his wholehearted approval. He believed that the female presence in the military hospitals would improve the moral atmosphere and curb hospital administration's neglect of their duties, because women would be volunteers and therefore independent of officialdom. The following day the Tsar granted his consent to the Grand Duchess' plan and appointed Pirogov by Imperial degree the overall head of the army medical services. Pirogov wrote later about his meeting with Elena Pavlovna:

> *I had never seen the Grand Duchess in such an emotional state as on that day. With tears in her eyes … she said 'Why didn't you come to me sooner? Your request would have been granted and my plans would have been realised long ago … it is necessary to prepare quickly for departure because another large battle will likely take place within days.*[12]

Elena Pavlovna accepted Pirogov's view of how help for the wounded ought to be organised and agreed that the nurses 'should be placed in the hospitals most close to the enemy' in accordance with his conviction that immediate aid and triage would prevent unnecessary deaths among the wounded.[12,16,19] It was up to Pirogov, after consulting the military authorities, to decide where the nurses would be sent or transferred. The Grand Duchess discussed with Pirogov how a large-scale women's service to the wounded should be set up with transport points and mobile treatment centres.
In October 1854 Elena Pavlovna founded the Holy Cross Community of Nurses, a volunteer organisation.[13,20,21] The volunteers underwent a short (few weeks) intensive training at the St. Petersburg Imperial Medico-Surgical Academy and

other hospitals before they were sent to the Crimea, enabling them to lend support to surgeons working at the battlefront. They even attended operations carried out by well-known doctors, formers pupils of Pirogov.[14,20,22] The Community was a unique organization as the nurses worked in military and civilian hospitals. The only other comparable Russian women's organisation at the time was that of the Compassionate Widows, founded by Elena's mother-in-law, Tsarina Maria Fyodrovna, but its members only worked in civilian hospitals. Maria Fyodrovna opened shelters in St Petersburg in 1803 to provide a home for impoverished widows of the nobility and their unmarried daughters. In return these ladies cared for the sick in her hospital for the poor.

In the autumn of 1854 Elena Pavlovna made an appeal to Russian women to train as nurses, and she turned her Mikhailovsky Palace in the centre of St. Petersburg into a military medical back office.[14,20,22] Soon volunteers began to arrive at the Mikhailovsky Palace. They represented all sections of society. Although most were well educated and included the wives, widows or daughters of the nobility, landowners or military officers, there were also nuns from nursing orders and women from the poorer classes with limited education. The Grand Duchess paid expenses, but the work was unpaid; the volunteers were motivated by a sense of 'patriotism and self-sacrifice'. The volunteers committed themselves to practice charity, kindness and to obey their superiors. They were not permitted to accept payment or gifts from the patients. These precautions were considered necessary because they would be working among thousands of men.

The Mikhailovsky Palace became a collecting point for the materials and medicines to be shipped to the Crimea. It received gifts such as drugs, bandages and linens, and many cash donations for the war effort.[9,14] The Grand Duchess' ladies-in-waiting even took on duties as seamstresses and together with volunteers made uniforms for the nurses.

The availability of charitable funds stimulated the formation of several other nursing communities, including the first secular Societies of Compassionate Widows, Sisters of Mercy and the Community of Compassionate Nuns of the Ascension Convent.[9,14] Their establishment was the most important step in the development of medical education for women in Russia. Although Elena Pavlovna was deeply religious and while she based the objectives of her Community on Christian principles she made it clear from the onset that it should be a secular institution with no direct link to the orthodox Church.[16,20] The name simply reflected the importance of their religion to most Russians. This contrasts with the suggestion by

Elizabeth Murray that the community's founding charter had a clear religious dimension.[23]

When the Grand Duchess announced her plans for the community of nurses there was scepticism and downright opposition from the military authorities, who were concerned that the presence of women in military hospitals would undermine military discipline.[12,20,24] Fortunately, the Tsar's authorization quelled resistance from the military. The Holy Cross Community of Nurses founded by Elena Pavlovna was a unique organization, both in its mandate, by ignoring man-made sectarian difficulties and because from its foundation it worked among others in military hospitals. After the Crimean War it became the starting point for the Russian Red Cross founded with Elena Pavlovna's support in 1867.[12,13,24]
The Grand Duchess demonstrated her organising ability by recruiting personnel, raising money and sending supplies to the war zone. Even the good external relations of Elena Pavlovna also were invaluable. When she learned that many soldiers in the war zone were suffering from malaria and there was a threatening shortage of quinine, the only treatment for malaria, she persuaded her brother, August of Württemberg, to buy at her expense a large quantity of quinine from Britain and have it shipped to Russia, despite the war ongoing between the two countries.[13]

Another collaborator of Nikolay Pirogov and Elena Pavlovna was Ekaterina Bakunina, who had joined the Holy Cross Community of Nurses in December 1854. Ekaterina Bakunina was born in Saint Petersburg, where her father was the governor.[15,25] She decided to become a nurse when she became aware of the tragedies of the Crimea War. Relatives and friends strongly opposed the idea, but she persevered. Grand Duchess Elena Pavlovna supported her and invited her to stay at her Saint Petersburg Palace.
She began her training as a nurse in the Second Landforce Hospital of the Imperial Medico-surgical Academy (now the Military Medical Academy named S.M. Kirov). Under the guidance of Dr. Chartoraev she was taught how to bandage and care for wounds. She carried out day and night duties and during ward rounds assisted with changing patient's bandages. After completing her training, she prepared herself for battlefield conditions by attending surgical operations by Dr. Nemmert, a pupil and successor to Pirogov as Professor of Hospital Surgery and Applied Anatomy at the Medical-Surgical Academy in Saint Petersburg. On one occasion, after a night shift Bakunina was resting in her room when there was a knock on her door. It was Elena Pavlovna; she came in, sat down and with great interest asked how she had spent the night and how the shift had affected her. Until her departure for the Crimea she often talked to the Grand Duchess. Bakunina became entrusted with the detachment

of nurses who went to the Crimea.

The siege of Sevastopol

For most of the year 1854 the city of Sevastopol was under siege by the allied forces with constant bombardment from land and sea, with mounting casualties on both sides.[16,19] By October 1854 there were close to 17 000 wounded in the Crimea, both Russian and other nationalities, most of them in Sevastopol and its surroundings. The grounds around the city became the main battlefield, where the Russian army suffered huge losses. The sick and wounded were treated in a network of dressing stations and field hospitals, which was made difficult by the continuous bombing of the city. When Pirogov arrived in Sevastopol he was confronted with a medical situation of catastrophic proportions. The wounded were kept in the same rooms as patients with typhoid, and those who had undergone surgery were nursed adjacent to patients with gangrene. There was a severe shortage of virtually everything; beds, medical equipment, dressings and medicines. Pirogov wrote that he and his team '*…often would work for 10 days from morning to night operating on those who should have undergone emergency surgery immediately after injury, but did not get the care for 2 - 3 weeks…*'[16]

On 5 November1854 the first group of nurses were invested in the Mikhailovsky Palace chapel.[18] The following day they left for Sevastopol, arriving in the Crimean Peninsula on 30 November. They were followed shortly thereafter by a regular flow of new female staff.[17,26,27] Most were well educated, speaking several languages, and could interpret for the foreign wounded prisoners. The nurses provided aid to the wounded in the immediate vicinity of the combat zone. This contrasted with the nurses under Florence Nightingale, who were stationed in hospitals in Scutari, nowadays Üsküdar, near Constantinople, to which the wounded were ferried by ship, a journey that took about eight days from Balaclava.[28] During quiet times about 7 000 and during intensified battles up to 13 000 casualties could be received at the field hospitals and first aid stations each day. The assistance of the nurses under such extreme situations was invaluable, with each nurse responsible for 100 to 200 casualties.[19]

In December 1854, three other groups totalling 88 nurses from Saint Petersburg and Moscow, among them senior nurse Aleksandra Pavlovna Stachovich, started to work in the hospitals in Simferopol and Sevastopol and supported their colleagues.[16,22,29] On 13 and 17 January1855 another two groups of nurses arrived, one led by Ekaterina Mikhailovna Bakunina. Pirogov trained the new arrivals to assist in operations and to care for the patients after surgery and distributed them among the

various military hospitals. Due to the excessive workload, many of these nurses became exhausted and caught infectious diseases, from which some died. Twelve nurses committed suicide because they were no longer able to perform their work.[4]

On 21 January 1855, Ekaterina Bakunina and her nurses began working in a part of Sevastopol that was under heavy attack. Bakunina was particularly popular with the nurses and the medical staff, to the displeasure of Stachovich, Matron of the Holy Cross Community. She was jealous of Bakunina and accused her of corruption to Elena Pavlovna.[16] This false accusation led to the dismissal of Stachovich. Pirogov called her '…*The worst fishwife produced by the world*…'[16] Ekaterina Khitrovo, formerly head of the Compassionate Widows of Odessa, was appointed by Elena Pavlovna as Matron of the Community of Nurses on 17 October 1855 after the dismissal of Aleksandra Stachovich, but Khitrovo insisted on the condition that it was only for the duration of the Crimean War.[30] Pirogov asked Khitrovo to take charge of monitoring the hospital management, the accounting systems and the stocks. In 1854, while still in Odessa, at the request of Elena Pavlovna, she taught widows in preparation for their move as nurses to the Crimean War. They arrived in the spring of 1855 and were sent to hospitals in Gerson, Nikolaev, Perekop, and Sevastopol. In a letter to his wife Pirogov wrote that:

> *Khitrovo and Bakunina are the pillars of the organisation of women's aid. Bakunina despite her education is prepared to work as a ward orderly during the transports of the sick. Khitrovo as an experienced woman keeps me posted about the internal affairs and activities. Every evening we discuss the daily reports of our work.*[16]

Unfortunately, Ekaterina Aleksandrovna Khitrovo contracted typhus and died early in February 1856 in Simferopol. At her request, she was buried in the Cemetery of the Resurrection Church in Odessa.[31]

Elena Pavlovna and Pirogov considered that Bakunina should take over the leadership of the community since they considered her the only person who could uphold its original mission. In a handwritten note to Bakunina – a mark of special attention - Elena Pavlovna wrote '…*Dear Ekaterina Mikhailovna! Do you want to console me and the community in the enormous loss we have sustained? Will you accept the difficult position of the superior for a year?...*'[18] Bakunina accepted and in February 1856 was appointed Matron of the whole community as successor of Ekaterina Aleksandrovna Khitrovo, a post she held until 1860. After her appointment she visited all the military hospitals in the Crimea and became an example of patience and tireless work for all.[16]

After the war Bakunina and Pirogov remained good friends.[15, 16, 29] In 1859 Bakunina went to Germany and France to study the role of nurses in those countries. On her return she disagreed with Grand Duchess Elena Pavlovna on several issues, including the future of the Sisters of Mercy, and left Saint Petersburg. She also had doubts about her own mission in healthcare, although Pirogov advised her to follow her intuitions and to keep her options open as he wrote '*…you are almost a doctor yourself... not by education but by enormous practise…*'.[15,16] She decided to establish her own nursing community "Kazitsyna" in a hospital in the Tver Province, remaining there until her death in 1894.

Pirogov as the senior medical authority

Because of a constant flow of nurses Pirogov finally had sufficient female staff.[19] In March 1855 Pirogov took upon himself the overall management of all first aid posts and hospitals. Because of the complex work load he decided to form the nursing staff into specialised groups. He divided them into *bandage masters* helping surgeons, *pharmacy assistants* preparing drugs and supervising their distribution and *housekeepers* taking care of clean linen and the sick also supervising the doctors and the administrative staff. Pirogov's confidence in the nurses allowed them to show their full potential. He was unstinting in their praise. He wrote

> *The women bore superhuman strain without a murmur, with the greatest selflessness and resignation. Their conduct towards the surgeons and their assistants was exemplary; their treatment of the patients was of the kindest and all their activities … cannot be qualified other than noble*.[16]

The changes he introduced brought Pirogov into conflict with the hospital management because the housekeepers discovered that the administrative staff abused their position by withdrawing goods, food and money meant for the injured soldiers for their own use.[4,16] Pirogov sent letters via his wife in St. Petersburg to the Grand Duchess and his colleagues describing the sloppiness, fraud and indifference wherever he found them. Pirogov wrote to his wife:

> *Each evening Khitrovo and Karzova come to see me with schemes to catch the hospital thieves… Karzova is simply tireless, spends days and nights in the hospital, cooks for the patients, changes dressings, does everything. Despite all her efforts we failed in finding out why the chicken soup prepared with 90 chickens for 360 patients lacked the proper taste. When the sisters do the cooking their soup tastes much better even though they use fewer fowl. It is a*

pity: the amount assigned is such that one could feed the patient well, yet they get no nourishment at all.[16]

Dr. S.P. Botkin, Pirogov's assistant, wrote about the thieves: '*...They found means even under such supervision of depriving the patients of their portions. They considered it state property to be devoured by anyone who could lay hands on it…*'[32]

Fig.3. Triage scheme for the wounded at the main dressing station by NI Pirogov, 1855.
a) Wounded arriving at the dressing station.
b) The walking wounded with only minor injuries are returned to their unit after treatment
c) Those requiring non-urgent surgery (within 1-2 days) are transferred to the hospital
d) Those whose wounds are so severe that they are unlikely to survive are cared for by nurses and priests
e) The severely wounded needing emergency surgery are operated on by NI Pirogov
Poster, 1950. Image No. 38010, Military Medical Museum of the Ministry of Defence of the Rusian Federation, Saint Petersburg. Reproduced with their permission.

To deal with the massive influx of injured, Pirogov adopted and modified the use of triage earlier used by the French military surgeon Dominique-Jean Larrey in the management of mass casualties.[9,16,19] Pirogov divided the medical facilities into

three sections: dressing stations right at the front, a flying brigade, and emergency field hospitals some distance behind the front.[9,16,19](Fig. 3)

The doctors and nurses were allocated into six groups:

- The first four groups were responsible for carrying out triage and the management of patients according to their allocation by the triage team.
- Pharmacy assistants were responsible for supplying drugs.
- The house keepers served meals to patients able or allowed to eat.

In the spring of 1855, when the fighting intensified, the management changes introduced by Pirogov proved their worth. The personnel knew now how to perform triage with an improved outcome for the patients with fewer severe casualties as a result. They also were less exhausted, with less disease and improved job satisfaction. The escalating violence made it necessary to evacuate the wounded and transfer them to the building of the Noble Assembly in Sevastopol.[19](Fig. 4) This became the main dressing station, where Pirogov now spent most of his time. The ballroom was filled with beds and tables for bandages, and the billiard room was converted into an operating room, whose floor soon became covered in blood. In the

Fig.4. Pirogov at the main dressing station in 1855, oil on canvas, artist M.P. Trufanov, 1960, Image No. 60743, Military Medical Museum of the Ministry of Defence of the Russian Federation, Saint Petersburg. Reproduced with their permission.

dance hall hundreds of amputees were nursed and in the great hall instead of dance music the groans of the wounded were heard. Ten doctors and eight nurses worked vigilantly, alternating day and night, operating and caring for the wounded.
In one period of 36 hours seven surgeons performed 58 major operations, with the assistance of Ekaterina Bakunina. One day a bomb blew a corner of the room away, where Bakunina was assisting in surgery. Fortunately, she and the surgical team stayed unharmed.[15-17] Other nurses assisted in minor surgeries, monitored the medicines, the pharmacy stock and kept an account of the personal belongings and money of the soldiers, given to them for safe keeping.

On 23 May 1855 Pirogov returned to St. Petersburg for 6 weeks. He wanted to '*... contribute something to change the military-medical affairs in Sevastopol for the better...*'[16] He was also exhausted and wanted to satisfy his family about his health. But above all he was deeply upset by the disorder and the most egregious abuses of the administration. Immediately on his return he submitted a note to the Minister of War *About the organization of the care for the wounded*, in which he outlined several organizational changes in the management of the military medical service that he felt were needed to improve the treatment of the wounded and sick. Not waiting for an answer, he and a group of newly recruited doctors, among them Sergey P. Botkin, returned on 28 August 1855 to the war zone.[16,33]

Convoys of the wounded

During his return journey to the Crimea Pirogov saw at first hand the poor conditions of the transport of the wounded.[19] Back in the Crimea he created departments responsible for transportation staffed by nurses, with Ekaterina Bakunina in charge of the convoys for the sick and wounded to hospitals outside the Crimea. Uncomfortable farm carts were used for transport, with each cart carrying three or four soldiers. Together the carts would form a convoy with about 500 injured soldiers. The journeys lasted six or more days, often under the most severe weather conditions; heavy rain and temperatures of -20° C. By the end of 1855 Ekaterina Bakunina had led four such convoys.

Peace negotiations to end the hostilities began in September 1855 and on 18 March 1856 the warring parties signed a peace treaty in Paris.[34] Persistent rain during that winter made it cold and damp in the military hospitals. The nurses wore soldiers' boots to enable them to attend to the sick and wounded. Typhus, malaria, scurvy, dysentery and cholera were prevalent. Every day between 10 and 20 of the wounded died. In the same period 17 of the 202 nurses died from typhus. After the peace 158 nurses received an award, such as the gilded cross and bronze medals.

Sixty-eight were decorated with the medal 'For the Defence of Sevastopol' and awarded pensions.[16,29]

After the Crimean war the nurses received from society the social recognition they deserved, and this resulted in the establishment of still more nursing Communities. They were treated as heroes, praised by the authorities and public alike.[24] Their actions in the Crimea and the subsequent public recognition went a considerable way to establishing public acceptance of nursing and more generally the role of women in Russian society. The members of the Holy Cross Community of Nurses continued their nursing work after the Crimean War.[35] The Holy Cross Community of Nurses are regarded as the model for the Russian Red Cross nursing societies, which were established from 1867 onwards, to provide nurses for times of conflict and emergency.[24,29] In 1867 Tsar Alexandre II signed the Treaty of the Geneva Convention. The Russian Red Cross developed rather fast. Over time all the already exiting communities with it nurses and the newly created communities after the Crimean War joined the Russian Red Cross. In 1877 seven Russian Red Cross Communities existed and together they permanently employed 279 Sisters of Mercy. In 1898 existed 65 Communities and employed more than 2 800 nurses.[24] In peacetime, their expertise was extremely valuable during the famine and the cholera epidemics in 1891-1892. They were almost entirely responsible for the deployment of nurses to civilian and military hospitals, medical centres and other care institutes.[24,29]
After the Crimean War Pirogov resigned from the Imperial Medico-Surgical Academy. Thereafter he devoted his time to advancing the cause of medical education[9] and also put much effort in his work for the Russian and International Red Cross.[36,37]

Conclusion

Significant advances in the participation of Russian women in healthcare took place in the 19th Century as their role became more structured and better organised. The Crimean war was a major stimulus for the further participation of women in healthcare, largely due to the initiatives of the surgeon Nikolay Ivanovich Pirogov and the Grand Duchess Elena Pavlovna. The assistance of nurses under such extreme situations was invaluable. Seventeen Russian nurses died, and those who survived continued their nursing careers and became the foundation for what later became the Russian Red Cross, established in 1867.

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Chapter 7

Nikolay Ivanovich Pirogov forerunner, co-founder and Inspector-General of the Red Cross

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Abstract

Nikolay Ivanovich Pirogov and Grand Duchess Elena Pavlovna Romanova, sister-in-law of Tsar Nicholas I, shared their ideas to organize and train nurses to care for the wounded at the battlefront during the Crimean war. During this war Pirogov pleaded for the establishment of an international treaty that would oversee the provision of international help, including the use of volunteers, to both civilian and military victims of war, regardless of rank or nationality. Pirogov was forerunner of the International Red Cross, co-founder of the Russian Red Cross and acted as Inspector-General. His contribution was recognized by the International Red Cross.

Introduction

The role of Russia and of the surgeon Nikolay Pirogov[1] in the development of humanitarian aid to the victims of warfare. In this paper we discuss the emergence of neutral organised care to soldiers during times of war. The surgeon Nikolay I. Pirogov (Fig. 1) and the Grand Duchess Elena Pavlovna (Fig. 2), sister-in-law of Tsar Nicholas I and aunt of Tsar Alexander II, contributed largely to this idea. The Crimean War played a pivotal role in this development. This idea of a neutral and well-organized care for the injured and sick during armed conflicts, regardless of rank or nationality, was further developed by medical doctors, individuals with political influence and the Committee of Five. Their efforts would eventually contribute to the establishment in 1863 of the International Red Cross (CIRC) and the national Red Cross societies. We also describe how the early Russian societies for the aid of the wounded were integrated into the Red Cross society in Russia. After the Red Cross formation, as Pirogov was well-advanced in the organization of care for the wounded, acted as an Inspector-General for the Red Cross of deployed care on the battlefield.

Fig. 1. Nikolay Ivanovich Pirogov (1852) In: N.I. Pirogov, Collected work in 8 Volumes. Volume V: Moscow, Gosudarstvennoe Izdatelstvo Meditsinkoy Literatury, 1961, p.10. Military Medical Museum, Defence Ministry of Russian Federation, Saint Petersburg. Reproduced with their permission.

[1] In the text we have used common English transcription. See, for example, Pirogov' for the Russian surname 'Пирогов'. Other transcriptions such as 'Pirogoff' and 'Pirogow' also occur.

Fig. 2. Grand Duchess Elena Pavlovna Romanova, by an anonymous Russian painter. Public domain (according to PD-RusEmpire-www.hillwoodmuseum.org/collection/item/51.117.

From its earliest beginnings the citizens of Russia demonstrated humanity and generosity towards victims of war and armed conflict, whether military or civilian. Ancient literature from the twelfth century onwards describes how women during the period of Kievan Rus', the predecessor of the Russian State, came to the aid of war casualties.[1] During the siege of the Azov fortress (founded by Turks on behalf of the Ottoman Empire, but later recognized Russia's possession) in 1641 women bandaged the injured and brought them food. The noblemen Fyodor Mikhailovich Rtishechev used his money during the Russian-Polish War of 1654 to help the sick and wounded.[2]

The availability of professional healthcare for the majority in Russia increased towards the end of the eighteenth century, thanks to the enlightened views of Tsar Peter I (Peter the Great), his successors and their friends. Peter visited Europe twice and following these visits he introduced several innovations in the healthcare system, especially for war victims, which his successors continued.[3] In 1707 he opened the first Russian medical hospital school in Moscow and along the lines of this hospital he also built hospitals for the army and navy in Saint Petersburg[2].

Peter's motivation was that a healthy soldier was an efficient soldier, hence his focus on medical care for the army and the navy. In 1716 the Tsar himself wrote military regulations in Russian and Dutch, stipulating the number of doctors, surgeons and pharmacists required for the army.[4] Since Peter the Great signed a decree in 1722, each naval hospital had one older woman assisted by other women who were responsible for the hospital linen.[2] Tsarina Elisabeth the Great (1741-1762) ordered already in 1758 that the surviving widows and orphans of doctors, surgeons and pharmacists receive a pension only if they were willing to raise their children for serving the medical care.[3] During the Napoleon War of 1812 the State, private sources and above all the public gave massive aid to the wounded.[2] An example of humanitarianism was the state official, Pavel Pezarovius, who raised 400 000 roubles to help hundreds of war invalids and evacuate 20 000 sick and wounded from Moscow to private homes, where they were cared for. So, Russia had a long tradition of helping war victims. During the second half of the nineteenth century military surgeons, private individuals and humanitarian organizations exerted an increasing influence on governments in Europe. Their efforts contributed to the establishment of the International Red Cross and Red Cross societies in countries world-wide. The surgeon Pirogov played a crucial role in this development.

The surgeon Nikolay Ivanovich Pirogov

Nikolay Ivanovich Pirogov (1810-1881) entered, as a medical student, the University of Moscow in autumn 1824 still 13 years old.[5] After graduating in May 1828 he was sent on a state scholarship to the prestigious postgraduate Balto-German university of Dorpat to specialise in surgery and applied anatomy. From 1833 until May 1835 he continued his education in Germany in Berlin and Göttingen, before returning to Dorpat where he was appointed by his former mentor, Professor Moier and Rector of the Dorpat University, as full professor of theoretical, operational, and clinical surgery and director of the Surgical Clinic.

In March 1841 Pirogov was appointed Professor of Surgery and Applied Anatomy at the Medico-Surgical Academy (since 1881 the Military Medical Academy) and Chief Surgeon of the Second Landforce Hospital with 1000 beds in Saint Petersburg. This appointment came together with the post of director of a factory manufacturing medical equipment and also with the post of Secretary for the Imperial Academy of Sciences. During this time he developed managerial skills that would later prove invaluable during the Caucasian and especially the Crimean Wars.

[2] Saint Petersburg was the capitol of Imperial Russia till 1917.

Network of individual doctors of the military medical services

The establishment of the Committee of the International Red Cross did not happen suddenly. The time had come to make this appeal to the conscience of the peaceful people in countries. Many families had sons under arms.[6,7] In the forties and fifties of the nineteenth century many small and big conflicts arose in Europe. These conflicts in combination with the network of the medical staff, the connections of the nobility in Europe and Russia, and their intertwining led to an environment that favoured the established of first the 'Committee of Five', then renamed to the 'International Committee for the relief to the Wounded'. The Red Cross movement developed rapidly and was in 1876 definitive renamed to the 'Committee of the International Red Cross'. We will discuss five of these conflicts.

Caucasian War 1847

Nikolay Pirogov first became involved in military surgery in 1847 during the Caucasian War, a consequence of a long lasting Russian invasion (1817-1864) of the Caucasus. Tsar Nicholas I sent Pirogov to the warzone to demonstrate the use of the new technique of ether on the battle field.[8] Pirogov had experience of anaesthesia in his practice and considered its use equally or even more necessary during war conditions He felt that those who risk their lives for the homeland, with the chance of losing limbs, should not have to suffer any additional pain. He used anaesthesia '*…to alleviate the fate of those unfortunates who condemned losing one or more members, not so much because of the seriousness of the injury, but because of the various adverse conditions due to the nature of war*.'[9]

He was interested not only in the outcome of surgery in combination with anaesthesia, but also in the hygiene of the troops, the effects of the climate, food and other factors that caused the fevers and epidemics that killed more soldiers than bullets. During this conflict Pirogov and his colleagues treated Russian soldiers, Caucasian rebels and prisoners with equal care. Pirogov put his experiences during the Caucasian War to good advantage during the Crimean War.[10] Because of *'... his pioneering work in military medicine and surgery and his concern for the amelioration of the condition of the wounded and sick in armies in the field*.'[11] Pirogov was named '*…a forerunner in the struggle for humanitarian rules that was to result in the signature of the First Geneva Convention and the founding of a Red Cross Society in Russia*.'[11] This was seven years before the Crimean War, and seventeen years before the Convention of Geneva.[10]

The Sonderbund War

The Sonderbundskrieg was a short Swiss religious civil war. The conservative Catholic mountain cantons of Luzern, Uri, Schwyz, Unterwalden, Zug, Friborg and

Wallis, united in the Sonderbund, reacted to the liberal Protestant cantons, intended to introduce anticlerical legislation under the leadership of Zurich and Bern.[12-14] After a short-lived war from 3 to 29 November 1847, with ninety-three deaths and 510 wounded, the Sonderbund were defeated. The supreme commander of the Swiss army with the highest rank as general in wartime was Guillaume-Henri Dufour. He first served in the French army from 1811 till 1817 to help to defend the French Empire. Where he since 1814 was added to the general staff. In 1859 during the Austria-Sardinia War, during which the battle of Solférino took place, Dufour was appointed again the supreme commander of the Swiss army.

The Crimean War

The Crimean War, which lasted from October 1853 to February 1856, arose from a conflict between Russia and an alliance between the Ottoman Turks, the French, British and the kingdom of Piedmont-Sardinia.[15,16] (Fig. 3) The immediate cause involved the rights of Christian minorities in the Holy Land, which was a part of the Ottoman Empire. The French promoted the rights of Roman Catholics, while Russia

Fig. 3. Historical map of the Crimean War 1854-1855, pen and ink drawing, artist Elena Borzenko, Saint Petersburg, 2016. Private collection, with permission.

promoted those of the Eastern Orthodox Church. The large numbers of casualties and miserable conditions forced for organization of nursing care.[15] Pirogov, remembered that he in 1837 in Paris saw how women were employed in hospitals to take care of patients. This also inspired him to develop a professional aid role for Russian women in the health care system. This came to full fruition during the Crimean War.[17]

The siege of Sevastopol was the final major battle during the Crimean War. The grounds around the city became the main battlefield, where the Russian army suffered huge losses; 225 500 killed and more than half a million wounded. At the beginning of the siege Pirogov requested to be sent there, only to come up against a bureaucratic brick wall. Eventually, Grand Duchess Elena Pavlovna interceded on his behalf with her brother-in-law Nicholas I. Pirogov was appointed by the Tsar as the overall head of the army medical services. This was something completely new in Russian history. He would not only work in his capacity as a surgeon, but perhaps even more importantly as an organizer of medical facilities. He was convinced that successful treatment of mass casualties depended as much or even more on good management as on the skill of the surgeons.[15,17,18] In October 1854 Pirogov arrived in Sevastopol. The medical situations was catastrophic. Typhus patients, gangrene patients and patients, who had underwent surgery, were nursed adjacent to each other in the same rooms. He also noticed a severe shortage of virtually everything; beds, medical equipment, dressings and medication. Because of the large numbers of casualties, the major priority for Pirogov was to start as soon as possible a total management reorganization including among others treatment procedures and the nursing care.[15,17] The latter was something he and Grand Duchess Elena Pavlovna had discussed before Pirogov left for the Crimea. At that meeting the Grand Duchess announced she had a plan for just such a contingency, namely the establishment of sisters of mercy who could be sent as nurses to the war zone.[18]

In the autumn of 1854 Grand Duchess Elena Pavlovna founded, at her own expense, the Exaltation of the Holy Cross Community of nurses and made an appeal to Russian women to train as nurses to care for the wounded and the sick victims of the war. Her Mikhailovsky Palace in St. Petersburg became a military centre and back office. The ladies-in-waiting took on duties as seamstresses, making uniforms for the nurses. They answered also all sorts of questions about the wounded and the sick put to them by family as just the Red Cross is doing nowadays. The staff received contributions for the war effort including drugs, bandages and linens, and many cash donations.[19,20] The establishment of the old and new nursing Societies and

Communities was the most important step in the development of medical education for women in Russia. Pirogov and his team of doctors trained the volunteers in the skills they would need in the Crimea; how to carry out day and night duties, to bandage, to assist to change patient's bandages during ward rounds, to assist in operations, to care for the patients after surgery, and how to distribute them among the various military hospitals. After arrival to the Crimea their training continued. [21-23]

In November 1854, the first group of nurses arrived in the Crimea, followed shortly thereafter by a regular flow of new female staff.[21,24] Most of the nurses were well educated, they spoke several languages, They even interpreted for the wounded foreign prisoners. The field hospitals and first aid stations received about 7 000 up to 13 000 injured depending on the heaviness of the battles. Each nurse cared for 100 to 200 wounded and their assistance under especially extreme situations was invaluable.[15] Some of the nurses died. The workload was excessive, many nurses became exhausted and caught infectious diseases. Twelve nurses committed suicide because they were no longer able to perform their work.

Because of an acute of doctors, the Russian government was forced to recruit doctors from Germany and America.[15,25,26] Pirogov had access to approximately thirty young American doctors, who had learned about this opportunity from advertisements placed Tsar Nicholas I's envoys. Most of them were doing postgraduate studies in Paris. After returning to the United States the American doctors used newly acquired learned skills in their own practices in the hospitals of the American Civil Wars.

By March 1855 Pirogov had enough nurses to allow him to take over the overall management of all first aid posts and hospitals.[15] Pirogov worked mostly in the main dressing station, the building of The Noble Assembly in Sevastopol, but he also regularly visited the first aid posts and hospitals on the Crimea. He divided the voluminous complex work force organization. The female auxiliary staff became bandage masters helping surgeons; pharmacy assistants preparing drugs and supervising their distribution; and housekeepers taking care of clean linen and the sick. The nursing staff supervised the doctors, the administrative military staff and the distribution of drugs, clean linen and food. They also kept an account of the personal belongings and money of the soldiers, given to them for safe keeping. To deal with the massive influx of injured, Pirogov introduced the use of triage developed by the French military surgeon Dominique-Jean Larrey for the management of mass casualties. Because of an acute shortage of hospitals Pirogov

was forced to use farm huts, wooden barracks and military tents. He quickly understood that air flow in the tents and barracks, and sorting patients by diseases was very helpful also from hygiene point of view. In the spring of 1855, the fighting intensified and the management changes introduced by Pirogov now improved their worth.[8,15,17]

When Alexandre II, who in the Spring of 1855 had succeeded his father Nikolay, visited the hospitals on the Crimea he was very moved about what he saw there. In September 1855 he started peace negotiations to end the hostilities and on 18 (30) March 1856 the peace treaty was signed in Paris. After the peace agreement the nurses received awards, such as the gilded cross and bronze medal. They returned home, where they continued their nursing work in military hospitals.[17,23]

During the Crimean War Pirogov made a plea for an international treaty to guarantee the safety of volunteers who provided aid to war victims on the battlefield, regardless of rank or nationality.[2,19] Later, others would make similar pleas. In 1861 the French pharmacist Henry Arnault pleaded for an alliance between sovereign states to inaugurate neutral medical services, that would allow surgeons to treat the wounded and sick on the battle field irrespective their nationality rather than abandoning them.[12] In contrast, the Italian physician and Dr. Ferdinando Palasciano, who fought in the Bourbon army against the Risorgimento riots of 1848, stated that he did not believe that units of voluntary helpers could solve the problem. Like Florence Nightingale he was convinced that the State should only care for their own war-wounded.[12,27]

The French, Sicilians and the British also used women as nurses. The influential British newspaper The Times published news from the Crimean War, including details about the miserable conditions faced by the wounded and sick. Under pressure from the public, the Secretary of War, Sidney Herbert, asked nurse Florence Nightingale (1820-1910) to go to the Crimea to organize humanitarian aid to the wounded.[2,16,28] She arrived on 4 November 1854 in Scutari (now Üsküdar), a suburb of Constantinople on the other side of the Black Sea 625 kilometres from Sevastopol, with the first group of thirty-eight women. More groups arrived later. These included nuns and other women with little or no experience in nursing, but the majority were working-class hospital nurses. Under the British military doctors, Nightingale and her small group of nurses enjoyed little authority. Even worse, the military called her a dangerous spy, because she was considered a friend of the Minister of War. However, despite the difficult conditions under which she had to work and the opposition which she experienced, her strong

character allowed her to accomplish the task she had been given. The British nurses never nursed on the battlefield nor treated the wounded of the enemy.

The quality of the care for the wounded by the Russian aid in the Crimea was recognized by Florence Nightingale. In her *Subsidiary Notes as to the Introduction of Female Nursing into Military Hospitals in Peace and War* published in 1858 she wrote '*...It remains to mention the Russian system, which, as regards the organization of the duties of the "sisters" appeared to me by far the best I have known...*'[29] In the House of Commons two army officers reported that Russian nurses had only insignificant duties in the hospitals on the battlefield. Nightingale corrected them and stated that '*…the Russian system seems to be the only perfectly organized system of female attendants in military hospitals, that was developed in the Crimean War...*'[29] She explained that the nurses were in charge of all that related to the bedside care of the patient. They received orders from the medical officer, attended him in his rounds, conferred with him afterwards and communicated with the feldshers or dressers. Nightingale stated that the Russian organization appeared to be the nearest approach to good organization she had ever encountered.

Battle of Solférino 1859

The battle of Solférino and San Martino, in the northern Italian town of Solférino, was the decisive battle in the Second Italian War of Independence between Austria and an alliance of France, Italy and Piedmont-Sardinia.[30,31] It took place on 23-26 June 1859 and resulted in the victory for the allies. It was the last major battle in world history where all the armies were under the personal command of their monarchs. After the battle, the Austrian Emperor refrained from further direct command of the army. A Swiss surgeon, Louis Appia (1818-1898), took part in the battle. With his brother George, a pastor, he wrote letters to Italian and French doctors to collect necessary materials and to Swiss friends for fund donations. There Louis Appia met with the Swiss army general Guillaume Henri Dufour and with the head of the French military medical service, Hyppolite Larrey (son of Dominique Larrey), but also with Henry Dunant, a Swiss humanist and social activist. Also another Swiss surgeon, Théodore Maunoir a friend of Appia, and the Italian general and nationalist, Giuseppe Garibaldi, participated in this battle for freedom.

Jean Henri (Henry) Dunant, a Swiss businessman, writer and social activist, arrived in Solferino on the evening of 24 June 1859, hoping to meet Napoleon Bonaparte to discuss a business problem he had in Algeria. However his arrival coincided with the final stages of the battle allowing to its awful aftermath, where in a single day,

about 40 000 soldiers on both sides died or were left wounded on the battlefield. He was horrified and greatly moved by the terrible suffering of the wounded soldiers left on the battlefield, and the near-total lack of medical attention and basic care. For several days he helped to treat and provide assistance for the wounded, organizing aid and providing money to buy provisions and other necessities. It was three years after the battle before he could bring himself to write about his experiences and observations. In 1862 he published in French his book *Un souvenir de Solférino*.[32] As he described in his book '*...The stillness of the night was broken by groans, by stifled sighs of anguish and suffering. Heart-rending voices kept calling for help. Who could ever describe the agonies of that fearful night...*'[32] Even then some of the scenes he witnessed were of '*…horrors yet more ghastly than those here described, and which the pen absolutely declines to set down...*'[32] But he also wrote of the many great acts of kindness shown to the wounded, irrespective of nationality, by the inhabitants of the surrounding villages and towns. Finally he called for international treaties to guarantee the neutrality and protection of those involved in armed conflicts, whether military of civilian and including medical and nursing personnel. He put this as a question to his readers: '*...Would it not be possible, in times of peace and quiet, to form relief societies for the purpose of having care given to the wounded in wartime by zealous, devoted and thoroughly qualified volunteers...*'[32]

But this is indeed what Pirogov and Grand Duchess Elena Pavlovna had achieved several years earlier during the Crimean War. In his book Dunant did acknowledge the work of Elena Pavlovna and Florence Nightingale during the Crimean War but made no mention of the enormous contribution made by Pirogov. About the Russian nurses who worked at the Crimean battlefront Dunant wrote '*…où elles furent bénies par des milliers de soldats russes…*' ['*…where they earned the blessing of thousands of Russian soldiers…*'] [30,32]Together with the medical staff the nurses worked directly under shellfire on the peninsula in hospital and private houses.[17]

Expedition against Rome, the Battle of Aspromonte

On 29 August 1862, during the battle of Aspromonte, part of the Italian War of Independence the Italian general, politician and nationalist Giuseppe Garibaldi was shot in his foot. The doctors Di Negro, Palasciano and Bertani took care of Garibaldi, who was worldwide well-known and recognized. For two months these experienced surgeons could not decide whether or not the bullet had settled in the bone. They could not agree on his treatment, and asked Nikolay Pirogov for his help. He had experience with gunshot-wounds and was highly respected by his colleagues.[8,15] He arrived together with the English surgeon Dr Partridge in the

city of La Spezia at the end of October. Pirogov quickly diagnosed that a bullet was located at the lower part of the tibia and fibula and prescribed the appropriate treatment in a protocol. After another six weeks, the diagnosis of Pirogov proved to be the right. The patient had made a full recovery and Pirogov received a warm letter of thanks from Garibaldi.

In 1863, seven years after the end of the Crimean War, Pirogov wrote his [*Broad guidelines for general war surgery, according to reminiscences from the wars in the Crimea and the Caucasus and from the hospital practice*].[15] He waited so long with this publication as a result of his traumatic experiences in the war. Because war sentiments waved around in Europe, he felt compelled to write a book as a manual on war medicine and surgery as he had noticed '*…that not only Russian doctors but also foreign doctors (German and American) did not know the ABC of surgery. And other publications did not justify to the facts…*'[15,17] His book became the standard reference for the next ninety years and was widely considered to have made a major contribution to the organization of citizens who volunteered to provide assistance to the casualties of war.

People with political influence, who took up the plea for an international treaty

Henry Dunant's heart-rending account of the terrible aftermath of the battle of Solférino, so vividly described in his book *Un Souvenir de Solférino,* which was translated soon after its publication into many different languages.[6] It touched the imagination of the common reader and resulted in worldwide cries of indignation from around the world.

It was sent to leading political, military figures and other influential individuals in Europe, including Elena Pavlovna. He also visited many of them to make them aware of the purpose of his proposed institution.[6] Henry Dunant had lunch on 14 September 1862 in Potsdam with De Semonov, counsellor to the Russian Court. De Semonov informed him about the interest of Grand Duchess Elena Pavlovna in his book and after having read it had sent aid to Poland during the revolt. The Grand Duchess invited Henry Durant for a meeting, which took place in August 1863 at Ouchy and Bocage on the shores of Lake Geneva (Lake Leman), Switzerland.[31] She promised him to interest her nephew, Tsar Alexander II, in the idea of national institutions that would provide assistance on the battlefields during wartime. Another Russian Grand Duchess the later Queen of Württemberg, Olga Nikolaeva Romanova, daughter of Tsar Nicholas I and sister-in-law of Elena Pavlovna met twice with Dunant.[31,33] Grand Duchess Olga was the first among all the princesses and queens, who turned the not yet realized idea of Dunant already in

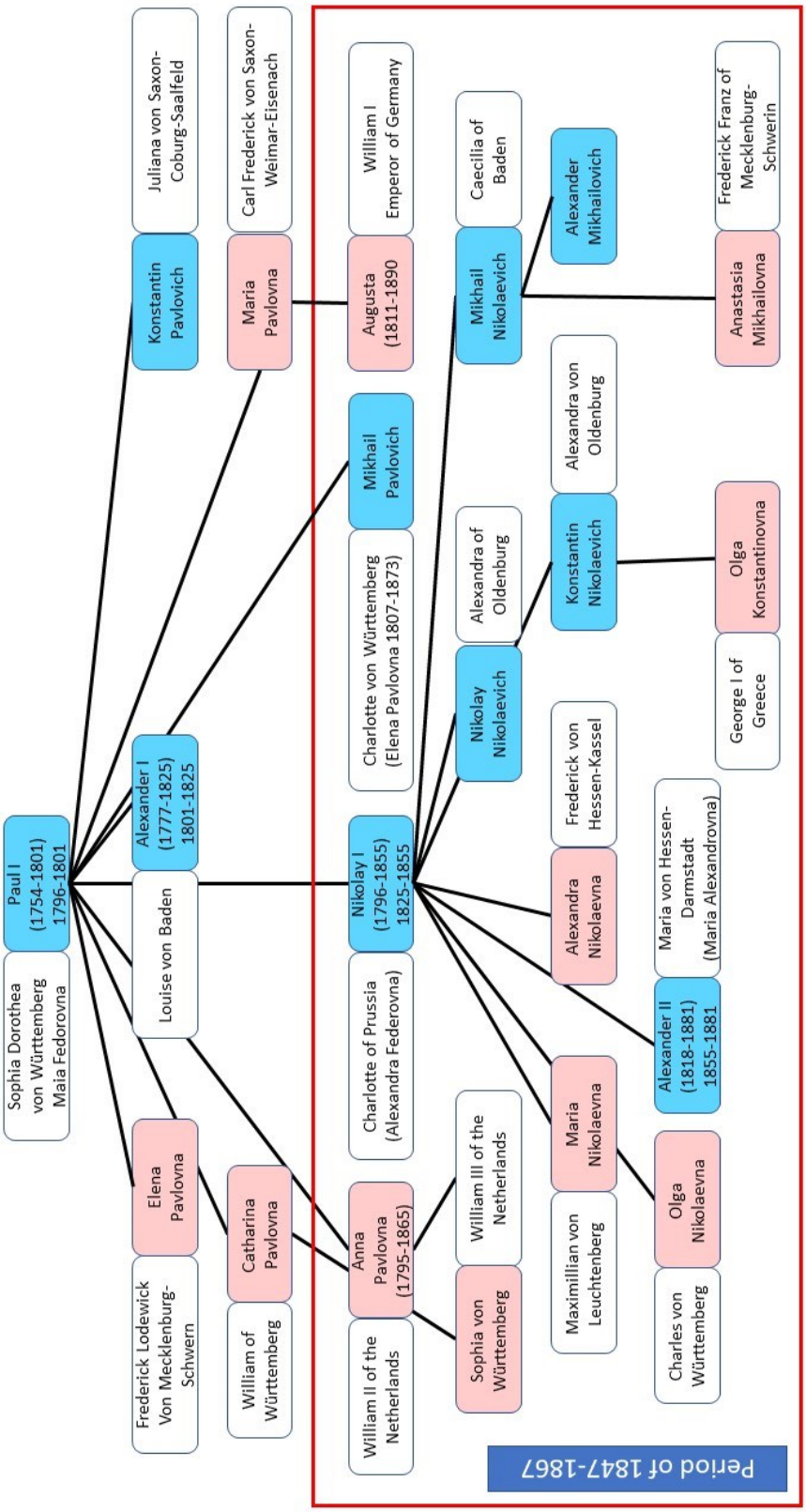

Fig. 4. Family tree of the House of Romanov during the period 1847-1867. First author is owner of this figure.

1862 into an established foundation for human aid named 'Society for men and women'.[31] Both Grand Duchesses of the house of Romanov were in first or second line related to Duchies and Kingdoms in Europe. Their commitments in late 1862 and beginning 1863 influenced their relatives in Europe and accelerated the process. Their examples soon were followed by the Kingdom of the Netherlands, the House of Hessen, the House of Prussia, the Kingdom of Saxony, the House of Baden, the House of Mecklenburg-Schwerin, the House of Saxony-Weimar, the House of Oldenburg, those of Ostgoland, the kingdom of Sweden, the Kingdom of Belgian, the Duchy of Brabant, and the County of Flanders.(Fig. 4)

Committee of Five later renamed to the International Committee of the Red Cross

The publication of Dunant's book is considered to have been a decisive factor leading to the foundation of the International Red Cross (ICRC). The lawyer Gustave Moynier made the book and Dunant's proposals the main item on the agenda of meeting of the Geneva Society for Public Welfare on 9 February 1863, of which he was the President. A five-person Committee chaired by Moynier and with Dunant one of the key members was formed to investigate the possibility of their implementation. It became appropriately called the "Committee of Five". The other members were the Swiss army general Guillaume-Henri Dufour and the Swiss surgeons Louis Amédée Appia and Théodore Maunoir.[7] Their first meeting on 17 February 1863 is now considered the founding date of the International Committee of the Red Cross although the committee did not adopt that name until 1876. However, within eight days of their first meeting it was decided to rename the committee "International Committee for the relieve to the Wounded". The main purpose of the committee was '*…to provide immunity to the medical staff to accomplish their duty without interruption or interference, irrespective of the changing fortunes of war...*' Surprisingly, in the minutes of the committee there is no mention of Nikolay Pirogov since the shared ideas of Pirogov and Elena Pavlovna were an important factor in developing Red Cross societies internationally and in Russia.[19,24]

In October 1863 the Committee of Five organized an international conference in Geneva (the first Geneva Convention) which effectively marked the launch of the Red Cross movement. It was attended by delegates from eighteen national governments plus representatives from four philanthropic societies [the German Johanniter Orden and three Swiss social institutions].[12] Russia was among the first countries to support the objectives of this conference. The Russian delegation included Captain Aleksander Kireyev, adjutant of Grand Duke Konstatin. Grand

Duchess Elena Pavlovna sent her librarian, Essakov, as an observer to the conference.[31] During the conference committee member Dr. Appia chaired a meeting with the seventeen physicians present at the conference. He outlined the importance of the medical service as a counterbalance to the military. As Pierre Boissier put it: '*...The blood let by the one was staunched by the other...*'[31]
During the conference two letters were read.[12] The letter of Prince Demidov, state counsellor and chamberlain of the Russian Tsar, drew attention, to the fate of prisoners of war. He recommended that they be provided with assistance and allowed to receive messages from their families in order to keep up their morale. In the other letter from General Count Dmitry Alekseevich Milyutin, Russian Minister of War, the General regretted that there was insufficient time to send an official representative of his government, the more so because Russia wanted to introduce an army medical service active in times of peace as well as during war. The count expressed his personal sympathy for the project from a charitable point of view but wanted to avoid completely anything affecting international law as that should be left to the initiative and the competence of government bodies.

On 29 October the proposals of the committee, based on the suggestions of Henry Dunant, were approved. The final resolutions of the conference contained the following articles:

- The establishment of national relief societies for wounded soldiers;
- Neutrality and protection for wounded soldiers;
- The utilization of volunteer forces for relief assistance on the battlefield;
- The organization of additional conferences to enact these concepts in legally binding international treaties.

Soon after this conference many national Red Cross Societies were formed. During the conference the delegates recognized that the volunteers could be in danger of their lives in battle zones unless they could be readily identified as non-combatants. Accordingly they decided that volunteers should wear an armband with a distinctive identifying emblem. The emblem chosen was a red cross on a white background, the reverse of the Swiss national emblem of a white cross on a red background, so chosen as it honored the Swiss, upon whose soil the conference was held. Later, in Muslim countries, the Red Cross would become the Red Crescent.

The development of the Russian Red Cross

In Russia the idea of a voluntary committee along the lines suggested by the Conference of Geneva in October 1863 gained momentum. The first meeting of the Russian Red Cross was organized on 14 December 1866 by F.Ya. Karel, court physician and privy councilor to the Tsar, and the baronesses M.P. Frederiks and

M.S. Sabinin, ladies-in-waiting to the Tsarina.[34] The main office was in Saint Petersburg. On 15 December Tsarina Maria Aleksandrovna accepted the patronage of the Society. On 17 February 1867 Nikolay Pirogov was appointed as Privy Councillor to the Russian Red Cross and the Tsarina and is mentioned in the minutes as one of the original founders of the Society.[34] On 30 April 1867 the statute was finally approved by the members, who's number steadily increased to 218. The Russian Red Cross also got the blessing of the High Metropolitan of Moscow, Filaret and Tsar Aleksander II approved the final statute on 3 May 1867.[34] In the same year Alexander II also signed the Geneva Convention. On Russia's initiative, an International Conference was convened in St. Petersburg in October 1868, during which a declaration, known as the Declaration of St Petersburg, was accepted prohibiting the use of expanding bullets during armed conflicts.[34] This ban was extended by The Hague Convention of 1899, initiated by the Russian Tsar Nicholas II and his foreign minister Count Mikhail Nikolayevich Muravyov. It was the first multilateral treaty to address the conduct of warfare, including specifying the treatment of the wounded and prisoners of war.

The Berlin Conference of the Committee of the International Red Cross (CIRC)

The Berlin Conference took place from 10-14 (22-26) April 1869. The president of the Russian Red Cross, General Adjutant Aleksander Karlovich Baumgarten, was appointed secretary for the main committee. The second day of the conference began with a presentation reports from the various national societies affiliated to the CIRC. The first presentation was by General Adjutant Baumgarten, who described how nurses of the nursing Communities established by Grand Duchess Elena Pavlovna were obliged to keep a diary detailing all the requirements of the injured or sick soldiers. The heads of these Communities passed that information on to the Grand Duchess, enabling her to form a complete picture of the state of the care for the victims of the war. He also said that within three to four months of the establishment of the Russian society local committees had been formed throughout whole Russia including ones in Siberia and the Caucasus.[34]

Pirogov as Inspector-General for the Russian and International Red Cross

Following on from the Berlin Conference the Russian Red Cross decided to send an authorized representative to the Franco-German War in Alsace and Lorraine.[34] At a meeting of the Society on 11 September 1870, Nikolay Pirogov was appointed as their representative. During the meeting he noted that one of the most important but difficult tasks was the organization of aid posts for the victims in a warzone. He recommended the establishment of as many ambulatory mobile hospitals as possible

and to take the initiative to design and erect hospital barracks. He had in mind the Asian yurt (a portable, round tent covered with skins used as dwelling by nomads in Central Asia) as it can be erected quickly. As an example, he gave the commissioning of hospital barracks close to Sevastopol during the Crimean War. Such a system was unknown by the French and British forces at the beginning of the war, but they later adapted the Russian system of barracks and mobile military hospital tents. Pirogov also mentioned that the Americans had introduced this barrack system on a large scale during the American civil War.

On 13 September 1870, Nikolay Pirogov as official Inspector-General of the Russian Red Cross, of the Russian Ministry of Internal Affairs, and also on behalf of the Association for the Care of Sick and Wounded Soldiers left with Dr. Bertenson, one of his former pupils, for the war zone in Alsace and Lorraine. Before he left he visited Tsarina Maria Aleksandrovna.[35] She asked him to report also to her as she wished to be kept informed about the impact of private support for military health care facilities. The Tsarina and Grand Duchess Elena Pavlovna provided Pirogov and his companion with the necessary documents, letters and certificates of legitimacy, which would allow foreigners access to facilities at the battlefield.[35]

The Russian Red Cross provided Pirogov and Bertenson also with a letter of authorization headed with the Red Cross symbol, so they could prove the purpose of their journey to the chairman of the International Committee in Berlin, Mr. Von Sydow, and to the other foreign authorities. After their arrival in Berlin and having showed their credentials to Mr. Von Sydow, they learned from him that they also needed the permission of the Prussian Ministry of War to visit the field hospitals and the war zone. Its medical department told them, that only the King could give this permission to foreigners. Von Sydow had at the request of Pirogov, arranged an audience with Queen Augusta of Prussia, the niece of Elena Pavlovna. This request was granted within twenty four hours and Pirogov presented their credentials to the Queen. She mediated on their behalf with the King, who provided the required permission. To avoid any further delay in Pirogov's departure they were also provided by Duke Ujest (Ujazd) of the Order of St. John with their legitimation and even more important with cards with the Red Cross, - green ones - for a free journey, and yellow ones (which were not used) - for free provisions. Finally he was also given a white bandage identified with the Red Cross symbol, to be worn on the left arm. [35]

Pirogov's task during this conflict was to report on five main areas:

- To what extent was the application of the international philanthropy, of which the 'Red Cross Society' is an expression, actually implemented?
- What were the relations between private international assistance and the military administration, and what impact did private assistance have had on the fate of the sick and wounded during the course of the war?
- With the current methods of warfare, how much had the situation of the wounded improved on the battlefield and immediately thereafter?
- Prior to the Crimean War the standard surgical procedure was immediate amputation of injured limbs. Pirogov had introduced a wait-and-see treatment which had avoided the need for amputation in many cases. He was interested in how far this approach was successful during this conflict.
- How can the lessons learned from this war be applied by the Russian military medical service and by those providing private assistance to the wounded and sick?[35]

In a period of five weeks, Pirogov visited up to seventy military hospitals in France and Germany and met many foreign physicians. He was particularly pleased that old friends, as well as young doctors from Germany, France, Great Britain and America, showed him everything that in their opinion needed attention. They were interested in his experiences during previous conflicts. In Strasbourg the Elsassian surgeon Gergot showed Pirogov an infirmary and pointed in the dressing ward to the damage to the ceiling and floor caused by a bomb. He complained about the barbarism of the besiegers, who had attacked the hospital, ignoring the Red Cross flags. Pirogov smiled as he recalled how French bombs had damaged the Russian dressing station in Sevastopol during the Crimean War.[19]

He recorded his findings and conclusions in a Russian report to the Russian Red Cross [*Report on the visit to the military - sanitary facilities in Germany, Lorraine and Elsa in 1870*][35] In his report he made the case for the formation of organized assistance for the wounded in the theatre of war, drawing parallels between the results of the treatment of the wounded in the hospitals of the Germans and the French and the more effective results of the Russian doctors during the Caucasian conflict and the defence of Sevastopol during the Crimean War.[36] Pirogov had collected a lot of information about the hospitals, he had visited in Germany and France, to which he had looked at in his usual scientific and impartial manner. In his report it becomes obvious that the Red Cross movement was in its infancy. He emphasized that particular attention should be paid to regulations and its compliance, well-to-do management whit attention to where, how, who and with

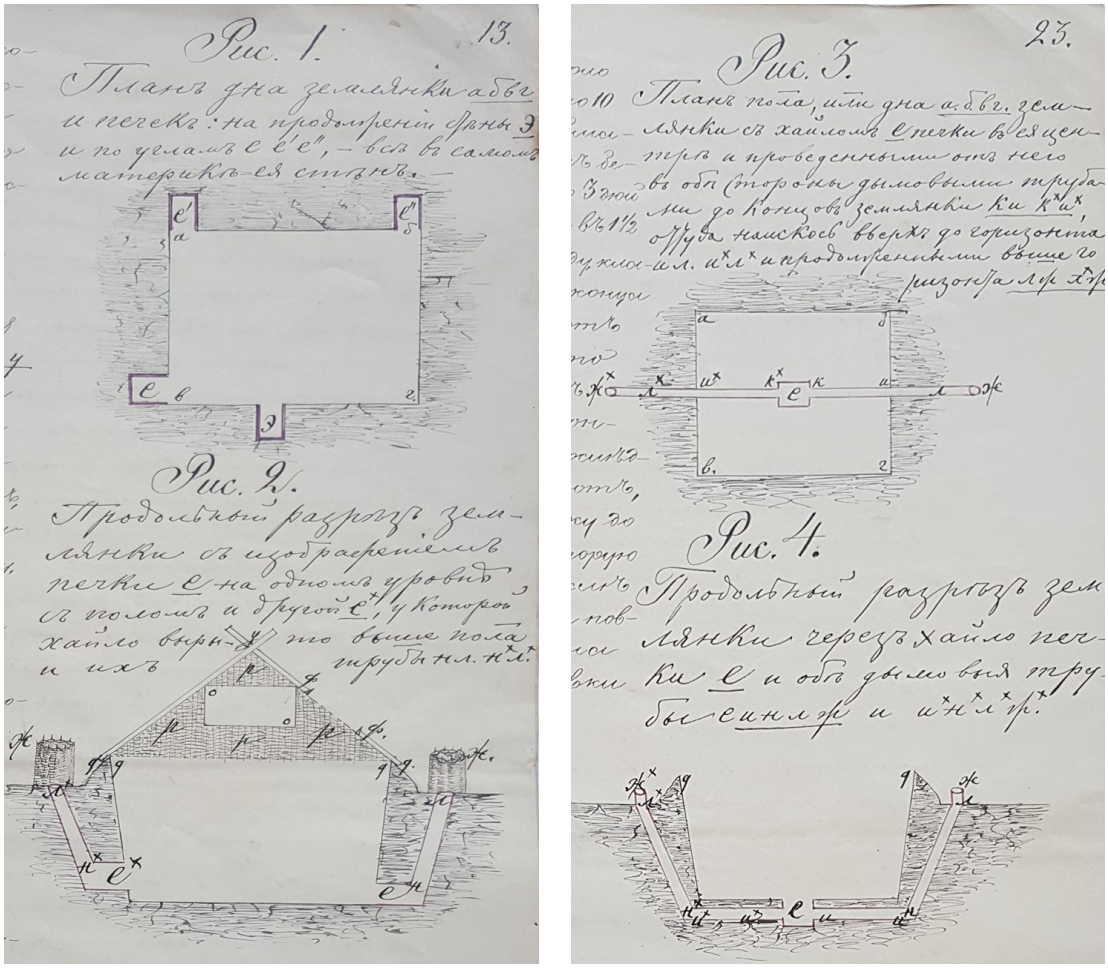

Fig. 5a and 5b. Pit holes in the ground as living spaces for a fast moving army, designed and drawn by Nikolay I. Pirogov in 1877-1878. FR III-23, pp. 44 and 48, in the Fundamental Library of the Military Medical Academy named S.M. Kirov. Public Domain.

what material participants should be deployed. He also gave advice and directions for nursing associations and for humanitarian activities. Pirogov was much respected as a surgeon internationally and he was asked to give permission for the report to be translated and published in German to enable to reach a wider audience. [35] At the annual meeting of the Committee of the Russian Red Cross on 5 December 1870, it was unanimously approved to award Nikolay Pirogov with honorary membership as a token of their deep gratitude for his work on behalf of the Committee.[34]

The Russian Red Cross was active both in Russia and abroad.[37] In 1871 the nurses of the Red Cross for the first time took part in war expeditions to Kuldza (Latvia) and Urga (Mongolia). In 1876 two communities of the Red Cross worked in Cernogoria (Ukraine).

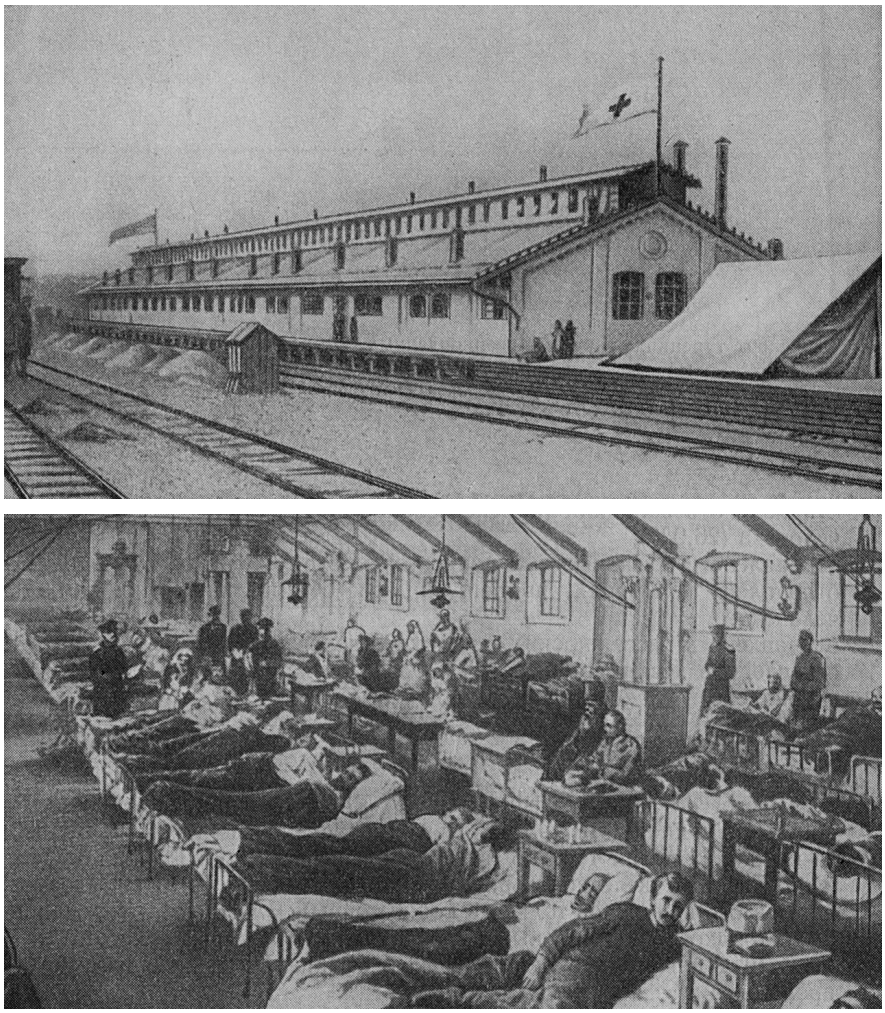

Fig. 6a and 6b. 1 Evacuation point in Yassy. 2 Interior of the evacuation point in Yassy, in N. Abaz, (*The Red Cross in the rear of the operating army in 1877-1878, Vol.1 – 2, p. 567*), St. Petersburg 1880 - 1882, p. 566. Military Medical Museum of Defence Ministry of Russian Federation, Saint Petersburg. Reproduced with their permission.

During the Russo-Turkish War also known as the Balkan War 1877-1878, a conflict between the Ottoman Empire and a coalition of Russia, Bulgaria, Serbia and Montenegro, another Red Cross community travelled to Serbia to provide nursing care for the wounded and sick.[37-39] On 22 September 1877, the Russian Red Cross asked Nikolay Pirogov, now 67-year-old, to report on the Balkan War. He visited dressing stations and hospitals in Romania and Bulgaria, investigating their procedures for organizing care for the wounded, for evacuating patients and for staff circumstances. He also took time to instruct doctors how best to manage patients with burns. He observed the work of nurses, noting how they went about caring for

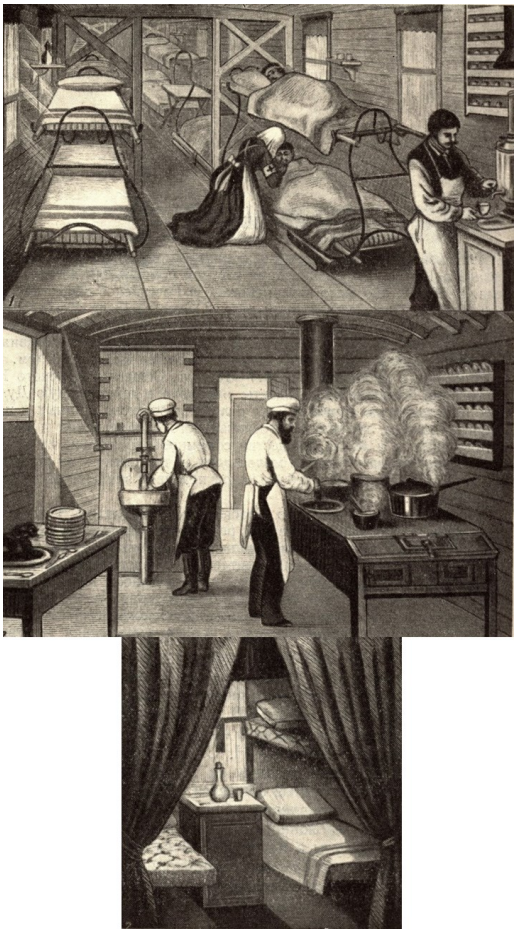

Fig. 7. Interior of the hospital train railway infirmary of the Russian Red Cross.
1 Interior of a railway carriage for the wounded soldiers.
2 Kitchen in the hospital train.
3 Interior of the officer's carriage, in N. Abaz, (*The Red Cross in the rear of the operating army in 1877-1878, Vol.1 – 2, p. 567*), St. Petersburg 1880 - 1882, p. 567. Military Medical Museum of Defence Ministry of Russian Federation, Saint Petersburg. Reproduced with their permission.

patients. Finally, he drew serious attention to any shortcomings in the organization of the care for injured military personnel and civilian casualties of the war.

In one of the dressing stations visited by Pirogov several of the doctors had been students of his. He noted with satisfaction that the organization and the treatment of wounded soldiers reflected what he had taught them. He could not fail to see, however, that the general conditions in the dressing station fell below the standards he expected.[36] During this war Pirogov designed pit holes in the ground as living spaces for a rapidly moving army.(Fig. 5a and 5b) Pirogov's report to the Red Cross on the Balkan War was published in Russian within eight months after being

delivered to the Red Cross and in German in 1882 [*The warfare, the sanitation service, and the private aid on the battlefields in Bulgaria and in the back of the operating Army 1877 – 1878*].[40]

During the Balkan War the nurses of the Communities of the Exaltation of the Cross, the Holy Trinity and Pokrovskaya operated independently of the Russian Red Cross in the barracks in Yassa (Romania).(Fig. 6a and 6b) They cared for the wounded in first aid stations and in trains that were not specially equipped for this purpose, often in areas where epidemics such as typhoid, dysentery and malaria were prevalent.(Fig. 7) The typhus epidemic infected almost all the nurses, and although it is difficult to imagine, they continued to care for their patients.[37] In Adrianopol (a European part of Turkey) there were only eight nurses to care for 4 000 patients. Despite suffering from typhus the nurses at the evacuation point and ambulance transport continued to perform under an extremely heavy workload. One nurse, sister Lebedeva, saved a wounded soldier by allowing the surgeons to transplant skin from both her upper arms. She continued to work despite suffering from malaria and with eighteen sutures in her arms.[39]

The integration of old and new nursing Communities into the Russian Red Cross

After the Crimean War the Merciful Sisters and the Compassionate Widows received from society the social recognition they deserved, and this resulted in the establishment of still more nursing Communities. From 1859 more communities, an orphanage, a psychiatric ward and a general hospital were founded in St. Petersburg, Moscow, Kiev and in the Pskov Province. Nikolay Pirogov and his colleagues were directly involved in the training programs, teaching the nurses at the Medico-Surgical Academy and at various external locations. The main task was the training of highly qualified nurses and nursing assistants.

The organization of nursing care was no longer the responsibility of one person, but of a central management with a network of local societies, which in wartime were subordinate to the military medical service and the military command.[17,34]

The Russo-Turkish (Balkan) war accelerated the development of the Russian Red Cross. In 1877 seven Russian Red Cross Communities existed and together they permanently employed 279 Merciful Sisters and further 250-300 nurses not belonging to one of the Red Cross Communities but were available to the Red Cross to send to the war zone. The Russian Red Cross was almost entirely responsible for the deployment of nurses to civilian and military hospitals, medical centres and other care institutes. Nurses who volunteered to work at the front were divided into groups of sixteen under the leadership of a senior nurse before they went to the

front. About 750 nurses were employed during the Balkan conflict, of whom around hundred became reservists after the peace agreement.

Within six months of its formation the number of Russian Red Cross personnel had grown and there was an increase in medical supplies. It also maintained its own military hospitals and barracks, transit stations, first aid stations and a flying medical brigade to the rear of the army. In addition, the Red Cross used six private medical trains to evacuate the wounded.

In the summer of 1877 the Russian Red Cross began with new education programmes. In the last decade of the nineteenth century more than twenty Communities were registered with the Russian Red Cross. The work of these Communities during the famine and cholera epidemic in 1891-1892 highlighted the valuable contributions they could also make in peacetime. By 1898 there were sixty five such Communities in Russia, employing 2 812 nurses and by 1913 they were to be found in all regions of the country.[39,41] By then the total number of Societies had risen to 109, with a total of 3 442 nurses and other staff. The general recognition of the Sisters of Mercy was thus confirmed.[39] The verdict of Pirogov was clear '*Every doctor who works with Merciful Sisters must bow to their activity. The Merciful Sister is an indispensable aid to the doctor, especially to the surgeon. A doctor who knows and loves his job, will find in the Merciful Sister his tireless assistant*.'[15,17]

Regulations and training Programs

The regulations of the Red Cross formed part of the statutes of the various nursing Communities.[39] They described the requirements for admission (age, personal and social status, level of education and training achieved), the guidelines of the organization, educational programs and the rights and obligations of the nurses and the Communities. One of the main functions of the Red Cross Societies was the training of nurses. Training lasted one and a half to two years and consisting of the following components: theoretical education, which included anatomy, physiology, pathology, knowledge of epidemiology, pharmacy, prescriptions and selected topics about women, children, skin, nervous and mental diseases. Practical education laid emphasis on internal medicine, general surgery, outlines of bandage knowledge, minor surgery and vaccination.

The teaching was conducted in the building of the Red Cross, in independent medical institutes, in military hospitals and in city and village hospitals and private clinics. Under the supervision of qualified nurses, the students first worked in

Fig. 8. A honorary diploma of the Belgian Red Cross Society presented to Pirogov in 1880, in: M.M. Gran, Z.G. Frenkelya, A.I. Shingareva, (*1810-1920 Nikolay Ivanovich Pirogov and his legacy the Pirogov congresses. Jubilee edition)*, Co-partnership R. Golike and A. Bilroth, Saint Petersburg, page 98, 1911. Public Domain.

wards, in operating rooms, in outpatient clinics assisting the doctors and in pharmacies where they were taught about the preparation of medicines. After passing an examination followed by a two-year work experience in the Communities, which paid for their education, they worked in that institution as a registered nurse. Students who did not belong to a Community and who paid themselves for their education received a certificate. They were assigned to the reserve sections of the Red Cross and the Executive Committee of the Red Cross could call on them during emergencies. This obligation to be always available when the need arose proved to be invaluable in the fight against cholera, typhoid and diphtheria during the epidemic of 1891-1892. The Russian Society of the Red Cross and the Red Crescent Societies nowadays play an important role in the development of national health care and in the activities of the International Red Cross.

Recognition of the role of Nikolay Pirogov

We have made a plea for the role of Nikolay I. Pirogov in the development of the

International Red Cross. After the Crimean War Pirogov's heritage was valued by others. His contribution to improving the plight of the causalities of war was recognized by the Belgian Red Cross (Fig. 8), by the International Red Cross, but also by his colleagues physicians. In August 1897 during the International Medical Congress its Committee awarded Henry Dunant with the current Congress Prize of the city Moscow for his services to suffering humanity. Nikolay Pirogov was awarded with a Memorial with the permission of Tsar Nikolas II. On the eve of the same Congress, on 3 August 1897, the monument placed in front of the entrance to the clinic of the medical faculty of the University of Moscow was unveiled in the presence of thousands of his medical colleagues from across the world.[42]

In 1898 Frédéric A. Ferrière (1848-1924), deputy to the Grand Council and vice-president of the International Committee of the Red Cross and cousin of Louis Appia, wrote in the *Bulletin International des Sociétés de la Croix-Rouge* [43], that '*…in 1854 the Grand Duchess Helene Pavlovna sent a detachment of Sisters of Mercy to the Crimean War, led by the famous surgeon Pirogov for the many wounded of all nationalities, who had fallen under the walls of Sevastopol...*' He also stated in the same journal '*…that the idea of the Red Cross society has its cradle in Russia. That's where it was realized for the first time...*' We have made plausible that the emergence of the International Red Cross was the result of the interaction between medical doctors and influential and private individuals. In our opinion the influence of Russia in particular Nikolay Pirogov on this development was highlighted in this article.

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Chapter 8

The Dutchman Herman Boerhaave and the Russian Nikolay Ivanovich Pirogov are brilliant medical scientists, whose remembrance will be eternal

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Abstract

The Dutchman Herman Boerhaave (1668–1738) and the Russian Nikolay Ivanovich Pirogov (1810–1881) were brilliant physicians who made significant contributions to the practice of medicine. Herman Boerhaave graduated as a doctor in 1693 and eventually became professor of medicine, botany and chemistry at the University of the city Leiden. He is perhaps best known as a teacher and for introducing bedside teaching to the medical curriculum. Nikolay Ivanovich Pirogov qualified as a physician in 1828 at the Moscow University, was awarded with his PhD at the German-Baltic University of Dorpat in 1832. In 1836 he was appointed as a professor in Dorpat and in 1841 as professor of surgery and applied anatomy at the Imperial Medico-Surgical Academy in St. Petersburg. Scientific achievements of N. I. Pirogov in medicine are multifaceted: he is the originator of unique technologies for studying the structure of a human being and developed anatomical atlases on these technologies. He was a virtuoso surgeon, an early adopter of ether anaesthesia, and innovator of medical triage and evacuation of the wounded. Why in one article a comparison the scientific achievements of these two briljant personalities, who have entered the world history of medicine, are investigated, becomes clear from the words of N.I. Pirogov, who greatly appreciated Herman Boerhaave. Pirogov wrote that "…he did not consider himself an equal to Herman Boerhaave…" Was Pirogov right or were it modest words, this is up to the reader to decide. The influence of Anglo-Saxon literature and scientific schools, the role of Herman Boerhaave in the professional development of N.I. Pirogov, and the innovations created by them in medicine were analysed on basis of archival documents.

Introduction

In the 16th century the most influential medical schools in Europe were those of Padua in Italy, and Montpellier and Paris in France.[1] The Netherlands during the 16th and 17th centuries suffered under eighty years of brutal Spanish occupation which ended in 1574 under the leadership of William Prince of Orange, also known as William the Silent, when the months-long siege of the city of Leiden by the Spanish was broken with the help of the citizens of Leiden and the Spanish eventually expelled. In gratitude Prince William granted the city of Leiden its own university (Fig.1), the first in the country, with a medical faculty.

Because of a Papal edict that excluded all non-Catholics from Italian Universities, the centre of medical studies moved from Italy to northern Europe, and especially to the protestant University of Leiden.[2-4] The university was open to all students irrespective of race, nationality or religion and this is reflected in the motto of the university "*Preasidium Libertatis*", in English "*A bastion of liberty".* There were two opposing concepts of medical education among medical schools in Europe; one accepted and introduced the new method of independent scientific research to study the structure and functions of the human body, the other choose to keep to the older, classical ideas.[5] Leiden embraced the new, scientific, approach to medicine based on undogmatic research.

In 1589 at the request of Pieter Pauw (1564 -1617) an anatomical theatre was established in Leiden, where Pauw regularly gave anatomical demonstrations using the Vesalius methods and recommended his textbooks to the students. Then in 1636

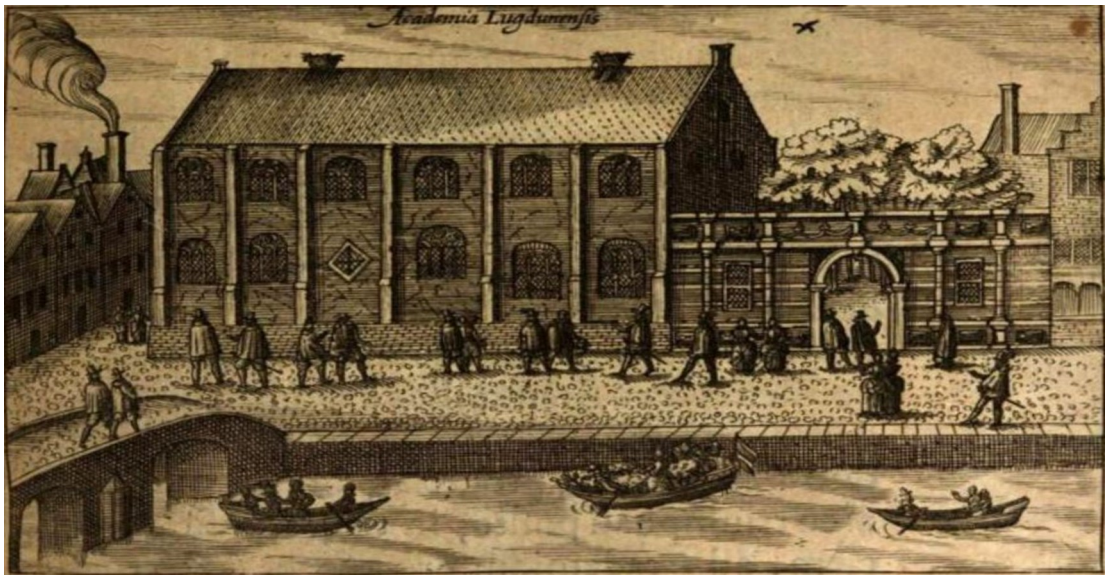

Fig. 1. The Academy building of Leiden University in 1614, a pen-and-ink drawing by Jacob Marci and Justum à Colster, 1 January 1614, Academia Leidensis. In: Marci,J., à Colster J., Illustrium Hollandiae Westfrisiae ordinum alma academia Leidensis, Lugduni Batavorum (Leiden), 1614. In public domain.

Leiden University introduced clinical bedside teaching in the Caecilia hospital in the city, based on the system used by Padua University. The Leiden medical faculty was to play an important role in educating medical students from around the world, as it still does to this day.

In Russia for much of its history the majority of the population had little or no access to qualified healthcare, but relied on folk healers and traditional folk remedies, although monks in the monasteries provided a basic health care. In contrast, from the beginning of the 17th century the ruling classes had access to qualified foreign physicians, including graduates of Leiden University.

Tsar Peter the Great instigated several radical changes to Russian society, including to healthcare and medicine, based on his observations during his first tour of Europe (commonly known as the Grand Embassy) in 1696-97.[6-8] Together with his Dutch court physician Nicolaas Bidloo he built the first hospital and medical school in Moscow, which was officially opened by the Tsar in 1707. The most talented Russian-born medical students were sent abroad after graduation on state scholarships to medical centres of excellence in Europe including Leiden. During the 18th century these Leiden trained physicians and other foreign medical graduates made significant contributions to Moscow University, established by the daughter of Peter the Great, Elisabeth Petrovna, in 1755. Despite these changes, Russia still lagged considerably behind the Netherlands and the rest of Europe in the field of Medicine.

Herman Boerhaave, professor of Medicine, Botany and Chemistry

Herman Boerhaave (1668-1738) was born in Voorhout on 31 December 1668, the son of the minister of the local Dutch Reformed church.[1,9] (Fig. 2) He was educated at home by his father who taught him the classic languages as preparation of him entering grammar school. In 1684 he finished grammar school and entered Leiden University to study philosophy and theology with the intention of following in his father's footsteps as a minister of religion.[10,11] He graduated in 1690 in philosophy but continued his study of theology, and also started to study mathematics and medicine.

From 1690 until 1693 Boerhaave studied anatomy and clinical medicine under Carolus Drelincourt; clinical medicine under Lucas Schacht; anatomical demonstrations under Govert Bidloo, Jan Rau and Antonius Nuck. However his attendance at lectures was fragmentary and he taught himself by studying the works of Hippocrates, Vesalius and Tomas Sydenham, at that time considered the entire body of classical medicine. When he felt that he had sufficient knowledge of medicine, he defended his thesis *De Utilitate explorandorum in aegris excrementorum ut signorum* [*About the importance of investigation into excretions and signals in a patient*] not in Leiden but in Harderwijk on 14 July 1693.[1,10,12] He then returned to Leiden and opened a medical practice at home.[5] He also began to study chemistry and carried out experiments in his home, which he continued even after he had been appointed a lecturer at the faculty of Medicine.

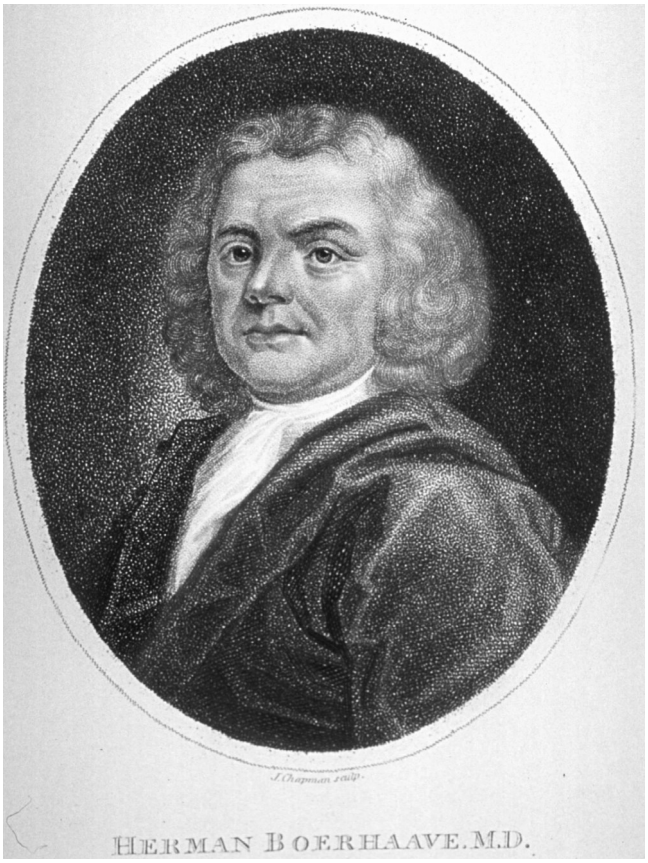

Fig. 2. Portrait of Herman Boerhaave, Dutch physician, botanist and chemist. Painted by J. Chapman, 8 December 1798, Image http://resource.nlm.nih.gov/101408907. In public domain.

In 1701 Boerhaave was appointed as lecturer in theoretical medicine at Leiden University to replace Carolus Drelincourt, who died in 1697.[13,14] He also had to cover for Govert Bidloo, professor of anatomy and medicine, during his absence as personal physician to King-Stadtholder William III.[5]

Boerhaave gave his first lecture in clinical medicine on 23 June 1701. He chose as the title of his lectures *Institutiones Medicae* [*Lessons of Medicine*]*;* they were divided over five themes: physiology, pathology, semeiotica, hygiene and therapeutics.[12] He also gave clinical lessons at the bedside of the patients in the Caecilia hospital in the centre of Leiden.[5] The hospital had twelve beds reserved for teaching purpose. He published two textbooks covering his theoretical and clinical lectures; the first *Institutiones Medicae* published about 1708 and the second *Aphorismi* in 1709.

Herman Boerhaave was more of an educator than a scientist. He was a follower of Hippocrates and Sydenham, and he used the history of medicine as an instrument of learning.[5] He introduced the pocket lens and the thermometer into clinical medicine as tools that aided the diagnosis of diseases.

In 1709 Boerhaave was appointed professor of Medicine and Botany and in 1714 appointed as professor of Clinical Medicine. Although the introduction of bedside teaching has often been attributed to Boerhaave, it had been introduced much earlier by Johannes van Heurnius (1543-1601) [15], and Franciscus de le Boe Sylvius (1614-1672) [16] but it was Boerhaave who re-introduced it.[5] Indeed it appears that Boerhaave did not put much emphasis on bedside teaching.[11] Between 1697 and 1710 only 40 patients per year were used for this purpose, from 1710 to 1720 per year 20 patients, from 1720 to 1730 per year 3 patients, between 1732 and 1736 no patients and from 1737 to 1742 only 20 patients each year.

Boerhaave was not only interested in theology, philosophy and medicine but also in botany, chemistry and physics. He made every effort to keep abreast of progress in these fields.[5,11] He wanted to apply these natural sciences in clinical medicine because, as he wrote:

> *the human body is a machine, some of whose intrinsic parts consist of vessels suited to contain, transport, reconstitute, divide, collect, and secrete the fluids; others consist of mechanical instruments, which by reason of their shape, their hardness, and the firmness of their connection are able both to serve as supports for other parts and to execute certain movements.*[5]

Boerhaave introduced a new three-part curriculum for medical students, a preparatory study consisting of lectures on the natural sciences, followed by an advanced study of anatomy and physiology. In the third part students were taught at the bedside, with emphasis on the importance of careful observation of the patient, and the principles of treatment. Autopsies were conducted at the Caecilia Hospital. In 1715 Boerhaave was appointed Rector Magnificus of the Leiden University and again in 1731.[17]

Rudolf Virchow (1821-1902) wrote that physiology and pathology were still not separated and that the *Institutiones Medicae* was made in one piece.[18] According to Rudolf Virchow (1821-1902) Boerhaave's lectures would have confused his students by using the terms physiology and pathology since during the time of Boerhaave the two were not considered as separate disciplines. It was a pupil of Boerhaave's, Hieronymus D. Gaubius (1705-1780), who made known his master's definition of physiology: The illness that develops in a human body, and which the human body itself cannot heal itself using the rules of nature, is called disease. [18]

Herman Boerhaave had been giving private chemistry lessons to foreign students since 1702. Then a year after his appointment as lecturer in clinical medicine he was given permission from the university to teach chemistry. He was subsequently appointed as professor of chemistry in 1718 after the death of the previous incumbent of the chair, Professor Jacobus le Mort (1650-1718).[12,13]

Peter the Great, Tsar of all Russia, twice visited the Netherlands with his Great Embassy in 1696-97 and in 1717. In October 1697 he visited the university in Leiden, where he was received by the Rector Magnificus (President), Govert

Bidloo, and his fellow professors.[19] They showed him around the university and the anatomical theatre, which he examined with great interest. Govert Bidloo then presented the Tsar with a document in Latin describing the institution and the laws of the university.[6,20] On 28 April 1698, on his way back from Britain to Amsterdam, Peter the Great first visited Delft to view to the crypt of Prince William of Orange, the founding father of the University. Afterward he again visited Leiden university, viewing the anatomical theatre and the botanical garden.[6,21] During his second Great Embassy tour Peter the Great visited Leiden University for the third time in March 1717 and met with Herman Boerhaave in his capacity of Rector Magnificus.[22]

But was Boerhaave really as important for medicine as is often assumed? As Lindeboom, in the introduction to his first volume of *Boerhaave's Correspondence* wrote: '…*What is done in Holland to keep alive and illuminate the figure of Boerhaave*…'[13] Even in the city of Leiden, where he spent all of his working life, it was not until 1870, 122 years after his death, that a statue of Boerhaave was erected in his honour. In Great Britain in 1739 two accounts of the life of Herman Boerhaave were published the year after his death, one by Samuel Johnson [23], the other by William Burton [24]. Burton's book was republished in 1746 and since than no book on Boerhaave has been published in Great Britain.[10,17] As Sassen wrote in his paper for the International Symposium in commemoration of the three hundredth birthday of Boerhaave, held in Leiden in November 1968, '...*In Great Britain Herman Boerhaave is now familiar only to students of the history of medicine and science*…'[10]

Nikolay Ivanovich Pirogov, an innovator who transformed surgery from a craft to science.

Nikolay Pirogov was born 13 (25) November 1810 in Moscow.[25,26] (Fig. 3) Until the age of 9 years he was taught at home initially by his mother and sisters, then by private tutors who taught him Latin and French.

The family had friends from diverse backgrounds who influenced the young Pirogov, including the retired A.M. Klaus, who's profession was vaccinating. He showed the young Nikolay how to use a microscope. But the one who had the greatest influence was the surgeon, anatomist and physiologist, Efrem Osipovich Mukhin, Professor and Dean of the Medical Faculty of Moscow University. It was Mukhin who successfully treated Nikolay's older brother, when he was bedridden with rheumatic fever, after several other physicians had failed. This made a great impression on Pirogov and fostered in him an interest in medicine.

In 1821 Pirogov entered a private boarding school, but within two years financial difficulties befell the family and he had to leave the school. Efrem Mukhin arranged for him to be admitted as a student in the Medical Faculty of Moscow University even though he was then only thirteen years old. He graduated as a physician in 1828 [25] after which he won a scholarship to the German-Baltic University of Dorpat (now Tartu in Estonia), where he studied anatomy and surgery. After graduating he remained for a further two years in Dorpat to carry out a research

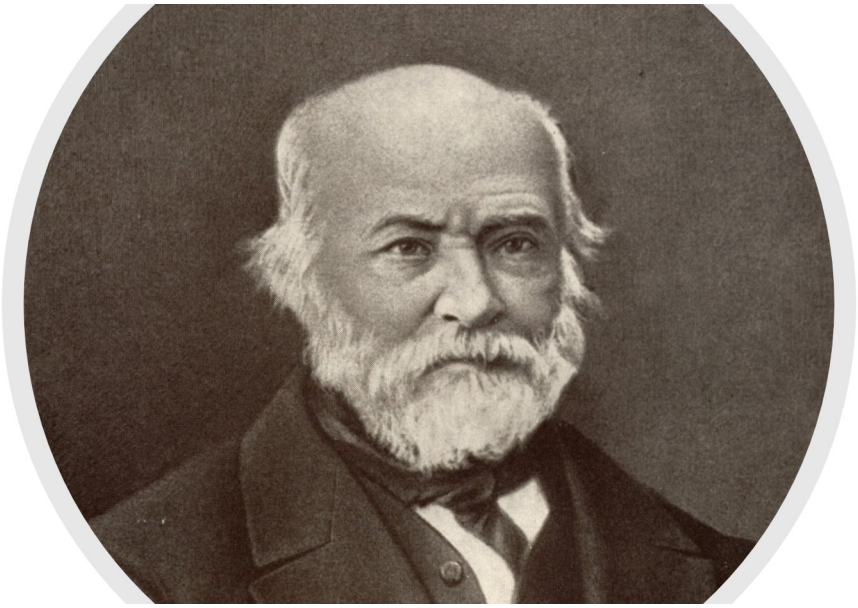

Fig. 3. Photograph N.I. Pirogov in the 1870's. In: N.I. Pirogov, Collected work in 8 Volumes. Volume VII: Moscow, Gosudarstvennoe Izdatelstvo Meditsinskoy Literatury, 1960, p. 7. Military Medical Museum of Defence Ministry of Russian Federation, Saint Petersburg. Reproduced with their permission.

project for his doctorate. He successfully defended his thesis '*Is ligation of the abdominal aorta with an aneurysm of the groin a readily feasible and safe intervention?'* in August 1832.[27] Pirogov then spent two years at the Charité Hospital in Berlin and during summer holidays also studied in Göttingen before returning to Dorpat in 1835. In February 1836 he was appointed professor of theoretical, operative and clinical surgery at Dorpat University. Between 1837 and 1846 Pirogov travelled to Paris on paid nine months leave and in the same period he published three manuscripts: *Surgical anatomy of arterial system and fasciae, 1837* in Latin and German [28], *Clinical records in two volumes, 1839* in German [29], and *The cutting of the Achilles tendon as an operative orthopaedic remedy, 1840* in German.[30]

In 1841 he was appointed professor of hospital surgery and applied anatomy at the Imperial Medico-Surgical Academy (now the Military Medical Academy named S.M. Kirov) (Fig. 4) in St. Petersburg and Chief Surgeon of the Second Military Land Force Hospital.[31]He also worked as a consultant-surgeon in three other hospitals and had a private practise at home. Pirogov instituted the teaching of microscopy and histology to the medical curriculum. His objective was: "*To assist in raising the medical skills in Russia to a level equal of that of the advanced countries of Europe*".[25,32] He became the secretary of the Academy of Science and one of the four members of the Medical Council of the Ministry for Internal Affairs.[25,32]

In 1846 he established the Institute for Applied Anatomy within the academy, where in addition to teaching medical students future teachers of anatomy in Russia were

trained. Pirogov published extensively on anatomy, including several anatomical atlases, the most notable his three-dimensional atlas of topographical anatomy published in four volumes between 1852 and 1859. The topographical atlas was Pirogov's last work on medicine before he took part in the Crimean War during 1854-1856. It laid a firm foundation for the field of topographical anatomy, with great practical significance for surgery and enhanced his reputation as a distinguished surgeon and anatomist. Several anatomical structures are named after him, including the Pirogov angle (the junction of the internal jugular and subclavian veins), the Pirogov aponeurosis and the Pirogov triangle, an area located between the mylohyoid muscle, the intermediate tendon of the digastric muscle and the hypoglossal nerve. He also invented a number of surgical operations, the best known, the osteoplastic foot amputation, is named after him. Pirogov was a dedicated teacher who encouraged students to excel clinically, guided them in scientific endeavours and equipped doctors with scientifically based techniques of surgical intervention. From his work during the Caucasian and Crimean wars he can be considered the founder of military field surgery.

Nikolay Pirogov was a key figure in the development of anaesthesia in Russia.[33] He experimented with alternative techniques for administering ether and investigated the use of chloroform in animals and humans. He was the first to perform systematic research into anaesthesia-related morbidity and mortality. Pirogov was one of the first to administer ether anaesthesia during surgery on the battlefield. His textbook on the principles of military medicine remained virtually unchanged until the outbreak of the Second World War. He was that rare combination of a scientist, a skilled surgeon and an excellent teacher.

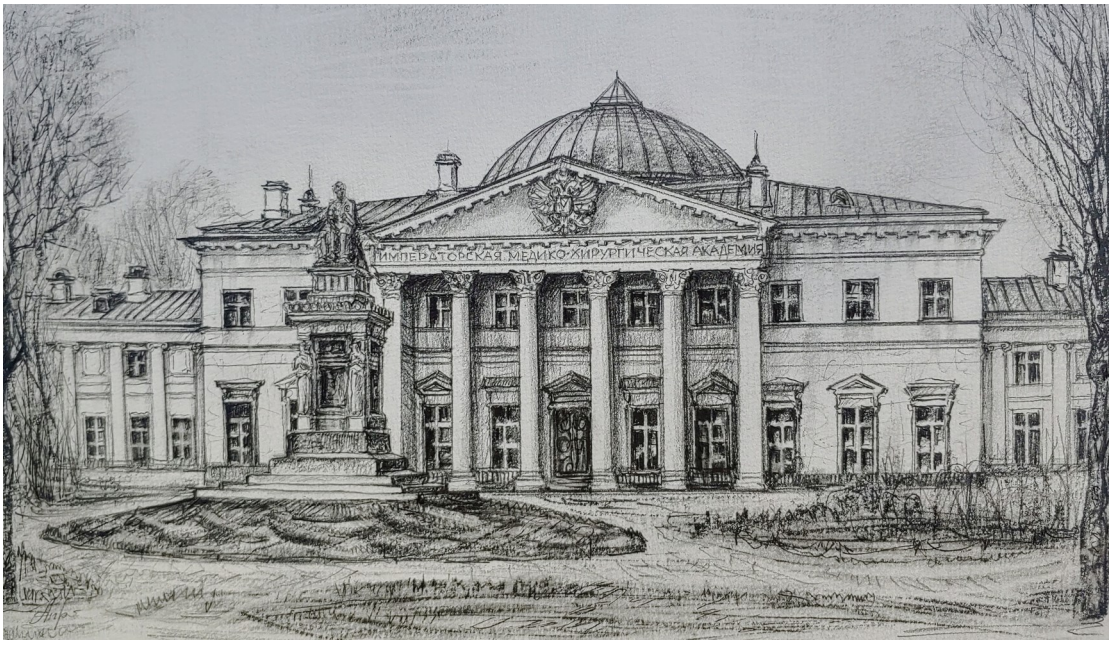

Image 4. The main building of the Imperial Medico-Surgical Academy around 1800, pen-and-ink drawing, artist Margarita V. Apraksina, St. Petersburg, 2019. Private collection, with permission.

The 19th century Crimean war was a major stimulus for the participation of women in healthcare in Russia, largely due to the initiatives of Nikolay Ivanovich Pirogov and the Grand Duchess Elena Pavlovna, sister-in-law of Tsar Nicholas I. Together they organized and trained nurses to care for the wounded on the battlefront during the war. Indeed Russia was the first country to send well-trained female nurses to the battlefront, and their work under such extreme situations was invaluable. Seventeen Russian nurses died, and those who survived continued their nursing careers and became the foundation for what later became the Russian Red Cross, established in 1867. After the Crimean War Nikolay Pirogov resigned his position at the Imperial Medico-Surgical Academy and focused more on education and supervising students during their foreign internship in Germany.

Pirogov was a forerunner of the International Red Cross, co-founder of the Russian Red Cross and acted as its Inspector-General. During the Crimean war he had pleaded for the establishment of an international treaty that would oversee the provision of international help, including the use of volunteers, to both civilian and military victims of war, regardless of rank or nationality. On 17 February 1867 he was appointed as Privy Councillor to the Russian Red Cross.[34] His managerial skills, which proved invaluable during the Caucasian and Crimean wars, were also of great value for his work for the International Red Cross. In April 1869 the Russian Red Cross sent Nikolay Pirogov as its authorized representative to the Franco-German War in Alsace and Lorraine.[34] In a period of five weeks he visited up to seventy military hospitals in France and Germany and met many foreign physicians. He recorded his findings and conclusions in a Russian report to the Russian Red Cross.[35] After his return from the war zone the Committee of the Russian Red Cross unanimously awarded him honorary membership of the Russian Red Cross as a token of their deep gratitude for his work on behalf of the Committee.[34]

During the Russo-Turkish War of 1877-1878, also known as the Balkan War, a conflict between the Ottoman Empire and a coalition of Russia, Bulgaria, Serbia and Montenegro Nikolay Pirogov, now 67-years-old, was again asked to report on this armed conflict by the International Red Cross.[36-38] He visited dressing stations and hospitals in Romania and Bulgaria, investigating their procedures for organizing care for the wounded and for evacuating patients. Pirogov's report to the Red Cross on the Balkan War was published in Russian and in German.[39]

Nikolay Ivanovich Pirogov died on 5th December 1881 in the village of Vishnya (now Vinnytsia, Ukraine). His body is preserved using embalming techniques he himself developed shortly before his death and rests in the village church in Vishnya.

The international network

Herman Boerhaave

Herman Boerhaave never studied abroad nor accepted a position abroad. Indeed he seldom travelled further than between his home in Leiden and later Oegtsgeest, a distance of about five kilometres. He did receive several offers, including an

invitation to become a court physician of Tsarina Anna Ivanovna[40] and to become a member of the Imperial Russian Academy of Science, both of which he declined. He was, however, elected as a member of the French Academy of Sciences in 1728, and two years later of the Royal Society of London. He did, however, maintain an extensive correspondence with colleagues worldwide.[13] The personal archives of Herman Boerhaave have been kept since 1798 in the fundamental library of the Military Medical Academy named S.M. Kirov in Saint Petersburg. Two authors (IFH and FB) searched the catalogue of the library for entries about Herman Boerhaave, including his (international) correspondence.[41] The volume of this correspondence they found was considerably less than suggested by Lindeboom. [13]

Nikolay I. Pirogov

In 1837 Pirogov visited several hospitals in Paris, where he met a number of senior surgeons, among them Alfred-Armand-Louis-Marie Velpeau, renowned for his knowledge of surgical anatomy, and Astley Cooper, a surgeon and anatomist, who was professor of comparative anatomy at the Royal College of Surgeons in London. [25] In 1844 Pirogov travelled on a grant to visit anatomical departments in Italy, France, Switzerland and Austria.

Pirogov's heritage was valued by others, but the posthumous recognition by his colleagues for his contribution to medicine would have been the most gratifying to him. On the eve of the meeting of the XII International Congress of Medicine held in Moscow 16 years after his death in August 1897, a memorial statue of Pirogov was unveiled in front of the entrance to the medical faculty of the University of Moscow in the presence of thousands of his medical colleagues from across the world.[42] During this Congress several speeches were delivered by fellow colleagues illustrating not only Pirogov's enormous contribution to medicine and in particular to surgery and medical education. Some compared him to past illustrious physicians such as Harvey, Jenner, Helmholtz, Pasteur, Virchow and Lister. One speech in particular is worth recording:

> *For a long time two main directions existed in surgery: empiricism and theory. For centuries the practice of our art was in the hands of artisans, who in the barber shop climbed from apprentice to companion. There was no more theory here than with other crafts. The predominantly technical nature of surgery could not derive general concepts and scientific guidelines from its operations. This only took shape when lessons were learned from science, which so far had no connection with surgery, and this science organically learned to connect with. The first scientific principle that appeared in surgery after the development of the medical sciences was anatomy. Ambroise Pare, "the first barber of kings", as he called himself, who had also worked as a dissector on the anatomical floor, symbolizes the merger of barber-surgeon with anatomy. Jean Louis Petit, Desault and Bichat are then the other formidable landmarks in the scientific development of surgery. When we go outside to the Djevichje field here in Moscow, we are vividly reminded of this combination of surgery and anatomy. We can see from the beautiful and historical true monument of Pirogov that,*

among his many other accomplishments, he also had the great merit of contributing to the introduction of anatomy into surgery.[43]

Their scientific heritage

Method of the Bibliographic search

We undertook a bibliographic search for Nikolay Pirogov and Herman Boerhaave using for books the online NLM catalogue, IndexCat and Worldcat, and for journal articles Pubmed, Medline, Embase, Web of Science and PubMed Central from their first published material up to and including any articles referring to them up to 2018. We included any publications by themselves, manuscripts, books and journal articles, also re-publications of their published works. For comparison we added a bibliographic search for Rudolph Virchow (1821-1902), who lived approximately in the same time period as Pirogov and who was internationally well-known as the founder of cellular pathology.

The terms for our search were Pirogov, Boerhaave or Virchow in the title or keywords. Articles that contained the terms "Boerhaave syndrome" or "Boerhaave's syndrome" were excluded as they did not refer to Boerhaave as a person. Similarly we excluded articles that did not refer to Virchow as a person, such as Virchow-Robin space or Salmonella Virchow. All publications were individually checked by one of the authors (FB) for eligibility to be included in the dataset.

All references were sorted according to title, author, language of the publication, type of publication (book or journal article) and publication year and added to separate files for Pirogov, Boerhaave and Virchow; these were then combined in one master file. The name variations in English or Russian as a result of the difference in transcriptions were homogenised. Duplicate publications were removed. The resulting files were used for further analysis using Microsoft Excel.

Our search in the online sources yielded 678 unique publications about Pirogov and 630 for Boerhaave. The earliest publication in the Pirogov set was his thesis published in 1832.[44] The earliest publication in the collection of Boerhaave was a book published by him in 1687 (*Disputatio de cohaesione corporum*) [Disputation on the cohesion of bodies] when he was studying theology and philosophy.

What we can learn from the search

Pirogov published on medical themes or themes related to medicine. In contrast, Boerhaave published on a variety of themes not always related to medicine. Publication by or about Pirogov are largely in his native language, Russian (82%) but also some in German, while Boerhaave is mentioned only in a minority of articles written in Dutch (25%) or in the scientific language of the time, Latin (15%). While publications about Boerhaave are largely in other (modern) languages (60%), the number of non-Russian articles on Pirogov (18%) are significantly less (Chi-square test; $p<0.001$)). In comparison, Virchow is closer to Pirogov than to Boerhaave in terms of the percentage of publications in a non-native language. We can therefore conclude that Pirogov is much less well-known outside Russia while Boerhaave was better recognised outside the Netherlands.

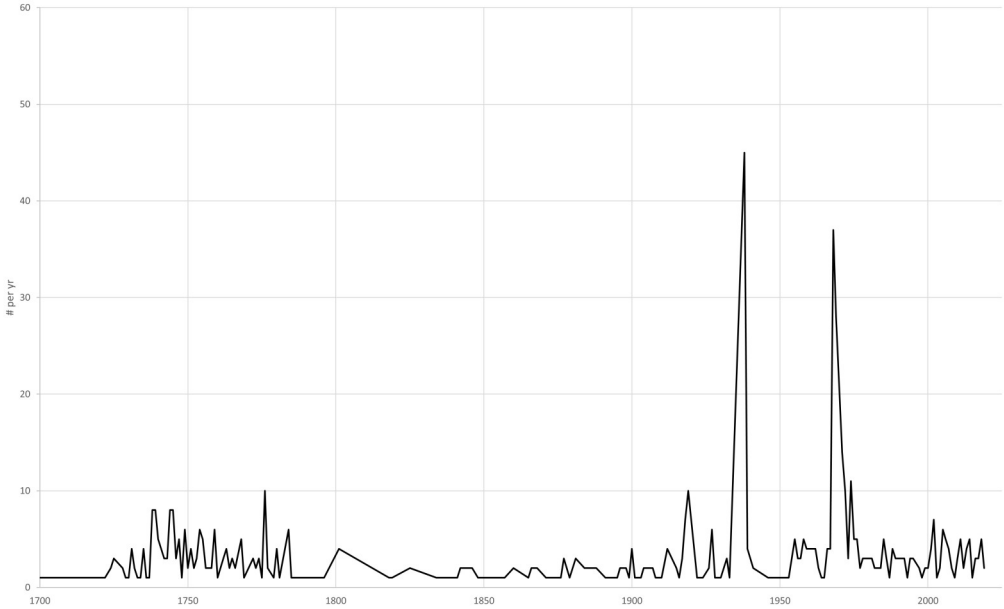

Fig. 5. Number of annual publications for Herman Boerhaave.

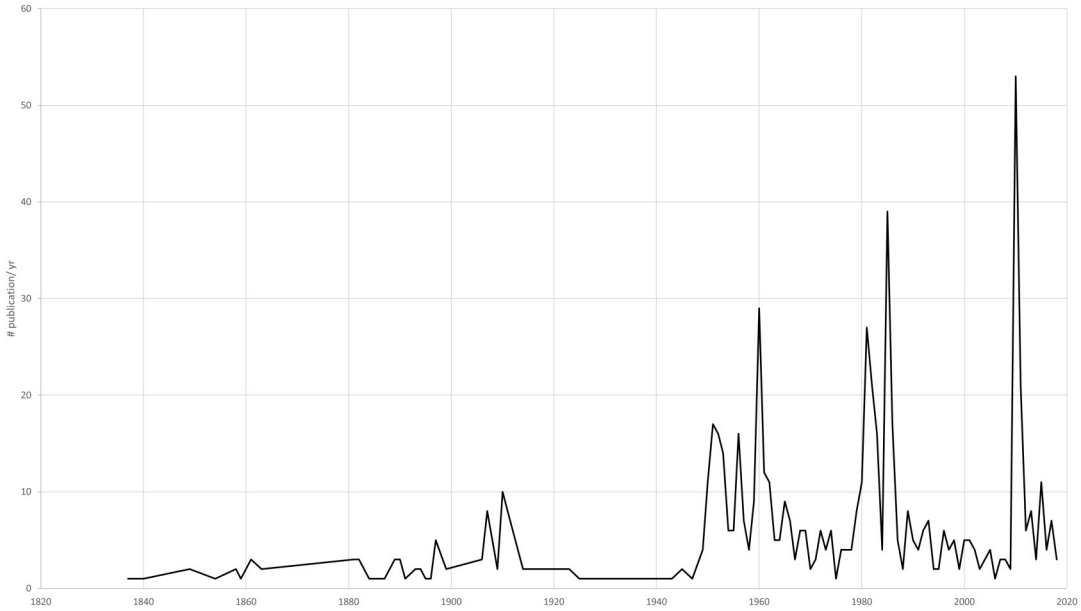

Fig. 6. Number of annual publications for Nikolay Pirogov.

The number of publications each year for Pirogov, Boerhaave and Virchow are shown in the figures 5 to 7. All the three graphics show a non-homogeneous pattern over time for the three authors. For Pirogov the number of publications peak around 1910 (100 years after his birth), and again around 1960 and 1981 (100 years after his death), but there were also larger peaks in 1985 and in 2010.(Fig. 6.) During his life and shortly after the death of Boerhaave there was an increase in publications largely attributable to re-publication of his works and to publications of the notes of

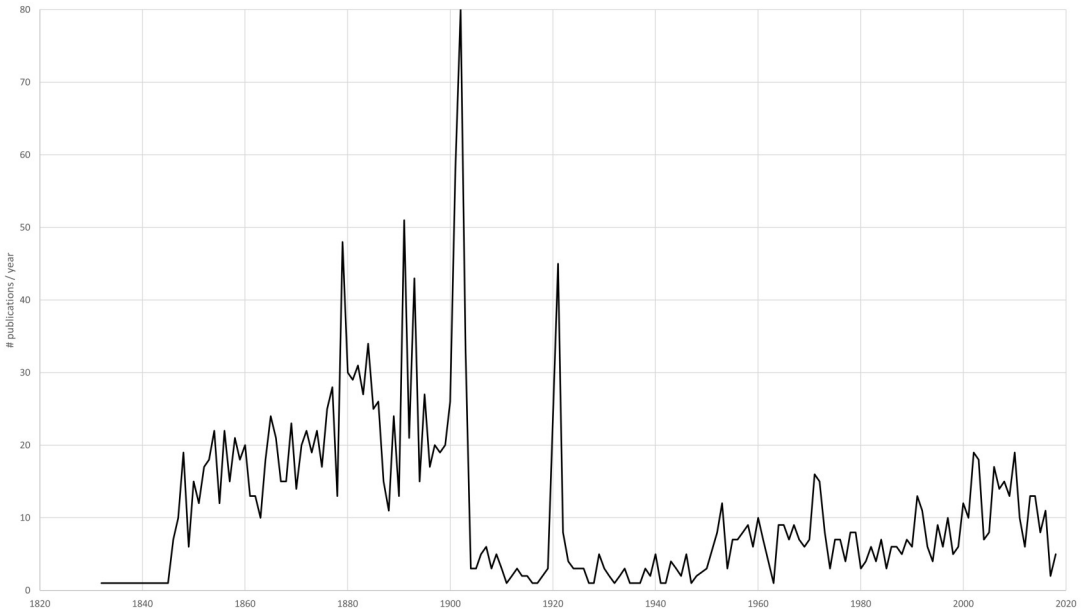

Fig. 7. Number of annual publications for Rudolf Virchow.

his students.(Fig. 5.) For a long period thereafter only 1-2 publication appeared annually. A first peak of 10 publications occurs in 1919 and a second peak in 1938, 200 years after his death. A third peak occurs in 1968, followed by a somewhat increased baseline publication activity. The data for Virchow is somewhat different, as he was a very prolific author and during his life the number of publications (840) was significantly higher than in the years after his death in 1902.(Fig. 7) After his death there is a gradual increase of publications about him, but his graphic does not show the marked spikes seen with Pirogov and Boerhaave.

Table 1 shows details of all the authors of books and articles on both scientists. For Boerhaave there were 334 authors, many of whom only published one article. Table 2 shows authors who produced at least six publications. Apart from Boerhaave himself, the most prolific authors about him were Lindeboom, van Swieten and Swammerdam. For Pirogov there were 351 authors. The most prolific author about him is Geselevich. For both Boerhaave and Pirogov their work was reprinted in later years and were counted as separate publication. Especially for Boerhaave there is a small group of prolific authors had a significant number of publications. Lindeboom, for example, attracted at least 300 citations, from his publications on Boerhaave. Twenty of his 39 publications were in English, enabling a broader scientific public to become aware of Boerhaave. For Pirogov only Geselevich can be considered a prolific author and he published only in Russian.

Our search for publications about Pirogov and Boerhaave has some limitations. The catalogues we used were predominantly in digital format, and the accuracy of this conversion is very dependent on the extent to which especially older literature has been entered into the catalogues we used. Many of our original sources, both in Leiden and Saint Petersburg, were handwritten and, in some cases, very difficult to

Table 1: Number of publications including their own publications. Produced by the authors

	Pirogov	Boerhaave	Virchow
Total items in biography	678	625	2013
Language			
Russian	552	1	22
Dutch	1	159	14
German	18	53	1521
Latin	4	93	2
Other languages	98	318	445
n.a.	5	1	9
Publication form			
Book	175	334	809
Journal	502	291	1221

Table 2: Authors of the books and articles on both scientists

Publication for Boerhaave		Publications for Pirogov		Publications for Virchow	
Author	number	Author	number	Author	number
Boerhaave (Own publications (6) and posthumous reprints)	39	Pirogov (Own publications)	51	Virchow (Own publications)	866
Lindeboom	41	Geselevich	22	Andree	70
van Swieten	32	Makovoz	8	Diepgen	9
Swammerdam	13	Mirskii	8	Orth	9
Alpinus	8	Budko	7	Pagel	9
Belloni	8	Bukin	7	Schmidt	8
van Leersum	8	Zabludovskii	7	Ackerknecht	7
Schoute	7	Lubotskii	6	Aschoff	7
Kaiser	6	Oborin	6	Beneke	7
Luyendijk-Elshout	6	Rudenko	6		
Schultens	6	Shabunin	6		
		Sorokina	6		

decipher. It is therefore possible that this, together with transcription errors arising during the conversion to digital format, could have resulted in a less than 100 % success rate. We limited our search to Boerhaave or Pirogov in the title or the keywords. Our method could not detect references to them in general articles dealing with, for example, the development of medicine in a particular period or on

the history of a particular medical treatment. Thus, our dataset is much smaller than if we had broadened the scope of our search.

Supervision of Doctorate students
Between his appointment as professor of medicine in 1709 and his death in 1738 Herman Boerhaave supervised 178 doctorate students, of whom 102 were foreigners. They included 48 from German-speaking areas and 43 from English-speaking areas.[45] However, not all of the 178 students would have been studying medical subjects since Boerhaave also held the chairs of botany and chemistry. Nikolay Pirogov supervised 12 doctorate students during his time as professor in Dorpat and a further 38 students after his appointment to Saint Petersburg in 1841. [46]

Conclusion
Herman Boerhaave and Nikolay Pirogov shared a common interest in furthering the practice of medicine and in medical education, despite their different backgrounds. They both excelled in their scientific and practical work during their life and were highly appreciated by their contemporaries. Both had an extensive international network around them. Pirogov travelled widely in Europe making many connections with colleague physicians. In contrast Herman Boerhaave is thought never to have travelled further than from Leiden and his home.

The main difference between Boerhaave and Pirogv is that Boerhaave held more chairs than just medicine, such as botany and chemistry, and was interested in physics.

Boerhaave was more theoretical than a practical physician, and can’t be considered a medical scientist. Nowadays you can describe Boerhaave as a specialist in internal medicine.

Pirogov was not at all satisfied with his basic medical education which was rather theoretical along the way of the Dutch Leiden medical school. He promised himself if possible to change this form of education. Pirogov, therefore, did not hesitate to criticise his colleagues through substantiated scientific research, which he published internationally and by giving demonstrations not only in his own country but also abroad. He wanted medicine to become not a handcraft but a science to the benefit of his colleagues and the patient. Even in wartime, he taught "hostile colleagues" and treated "hostile patients" because he was primarily a physician and not a military physician. Because the injured and sick were high in his standard, his humane side also drifted upwards. After the Crimean War various negative publications appeared concerning Russian medical treatment. He responded by publishing his findings of war management, not only in the Crimean War but also in the Caucasian war. This publication became the guide in times of epidemic and war situations worldwide. This led to Pirogov being considered the forerunner and co-founder of the Red Cross and shows that he lifted medicine beyond political conflicts.

After their death both scientists were gradually forgotten as the number of publications diminished, but both periodically attracted attention from other authors. Publications about Boerhaave were often in languages other than Dutch, particularly in English, whereas those about Pirogov were largely restricted to Russian. Despite that Boerhaave comes from a very small language area (Dutch) he is more often mentioned in international literature. His most important biographer wrote the majority of his publications in English, and we assume this aided to a larger stream of international publications. However, in the past decade many of the publications about Pirogov have been in languages other than Russian (25%), which could help to make him better known internationally.

Pirogov's oblivion both in Russia and abroad has several causes. He was married to a noble lady, and the family had close and warm connections with the Imperial family. In 1917, the revolution took place in Imperial Russia. Especially for the nobility and faithful to the Imperial family it was a hard and disastrous period.[47] During communism, Pirogov's archives were put under lock and key and Pirogov was banned in Russia.[26] It was only during the Second World War that he was "rediscovered" and in particular his work on war management was studied. And in the fifties and sixties of the 20th century during the de-Stalinization led by Khrushchev, extensive research was started into the archives and works of Nikolay Pirogov.[26,47] This has led to a Russian instruction manual, in which can be found information on his scientific career, and in which all his publications, textbooks, etc are mapped.[46] In the same period all his works were republished in Russian in 8 volumes.
Because many of Pirogov's original works have been published in Russian, Latin, and German, many researchers encounter barriers.
We conclude that not only internal but also external environmental factors have led to Pirogov's unfamiliarity. Even though the Netherlands is a very open country, researchers encounter a similar language barrier for Herman Boerhaave. But a second barrier is that since the 1740's the archives of Boerhaave are located in the Military Medical Academy named SM Kirov in Saint Petersburg, Russian Federation. Access to these files has been very limited during the last 300 years. Still, both scientists are not forgotten and publications in a common scientific language (first Latin, later English) keep the memory of the achievements Boerhaave and Pirogov alive.

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Chapter 9

Summary and concluding remarks

During my training at the University of Leiden to obtain a master degree in Slavic Languages and Literature, I was pointed to the physician N.I. Pirogov during a summer course in Odesa in Ukraine. The University of Odessa was named after this doctor and scientist. Therefore, I was surprised that almost nothing was known about this scholar outside the Russian-speaking area, because it appeared that Pirogov had built up a great name in the nineteenth century. The Dutch physician and Leiden scholar Herman Boerhaave, who lived in the eighteenth century, on the other hand, has acquired a reputation and world fame.

The central question of this thesis is therefore: how can it be explained that the fame of scholars in medicine can differ so much, while both have made great contributions to the improvement of the Western and Russian medical school.

The medical worlds of Russia and the Netherlands seem quite different, but the opposite appears true. The second chapter describes a brief history of Medicine and medical education in Russia. An in-depth investigation shows that from the sixteenth-seventeenth century onwards, Dutch and in particular doctors with a doctorate from Leiden university had a strong influence on the development of the medical curriculum and the organisation of Medicine in Russia. This influence lasted until the end of the eighteenth century. Empress Catherine the Great (reign:1762-1796) was able to reap her predecessors' benefits during her reign. We have seen that the first Russian medical professors (some trained at Leiden University) were direct or indirect Nikolay Ivanovich Pirogov's teachers. Continuing this tradition, he wrote that he considered himself not equal to Boerhaave, nor Sydenham or Paré. Great renown men of world medicine who preceded him in medical history. Was he right, or was he failing himself with this?

In chapters three, four and five, we explore Pirogov's role as an anatomist, surgeon and anaesthesiologist. Characteristic of his approach to the development of Medicine is research based on literature and observations (empirical research). He conducted animal experiments and sometimes also applied experiments on himself and volunteers (students and colleagues). He analysed and described his findings very carefully before using his results and techniques to patients on a large scale.
Under his leadership, the profession of surgeon changed from craftsmanship to science.
In anatomy, the development of applied anatomy by Pirogov has always been instrumental in increasing the surgeon's knowledge. He developed several atlases including a four-part three-dimensional atlas with black and white plates, but others with colour plates, which he provided with meticulous descriptions.
He devised several surgical procedures, of which the eponymous osteoplastic foot amputation is the best known. Several anatomical structures are named after him,

including the Pirogov angle, the junction of the internal jugular veins and the subclavian veins, the Pirogov aponeurosis, and the Pirogov triangle, an area between the mylohyoid muscle the intermediate tendon of the digastric muscle and the hypoglossal nerve.
He was also one of the first to experiment with the use of ether. He applied his acquired knowledge of anaesthesia in normal circumstances and on a large scale in war situations, for example, during the Caucasian (1847) and Crimean War (18536-1856).

In chapters 6 and 7, Nikolay I. Pirogov is described as a doctor and medical researcher and as a manager/organiser in times of crisis. He played an essential role during the Crimean War by acting as head of the medical forces and applying the triage system to provide as much help as possible to victims and the sick. He had access to Russian and foreign doctors and a large group of well-trained female nurses. Supported by Grand Duchess Elena Pavlovna Romanova, sister-in-law of Tsar Nicholas, Pirogov trained (civil) female volunteers for deployment to the Crimea front. His fellow doctors continued the training in civilian and military hospitals when he was already present in Crimea, where he continued to train them.
It should be noted that the medical care concerned not only the Russian victims but also the wounded of the counterparties. After the Crimean War, these trained nurses found a place in civil and military hospitals. Also many nursing organisations and training courses for nurses were created.
Nikolay Pirogov has described his vision on the organisation of war surgery in a renowned book, *Kriegschirurgie*. His vision and this book have led to Pirogov being known worldwide only as a war surgeon. His experiences during the Caucasus and Crimean War and the constant opposition he received as an innovator eventually caused him to resign from his post as professor and chief surgeon of the Imperial Medico-Surgical Academy in St. Petersburg in 1860.

Pirogov's vision and efforts, along with his domestic and foreign staff and including the Russian female nurse's work, have not gone unnoticed. Henri Dunant, journalist and philanthropist, had a traumatic experience at the Battle of Solferino. Dunant also wrote a book, but to make the world aware of the atrocities of war. He wanted to set up a citizens' initiative of volunteers. Dunant met with Grand Duchess Elena Pavlovna Romanova on several occasions and eventually led to the International Red Cross's founding.
Because of his knowledge of the organisation of medical assistance during military conflicts, Pirogov was asked at an old age by the (International) Red Cross to make reports and recommendations as Inspector General not only on the battlefields of Alsace-Lorraine but also on other hearths of war. He died in 1881 on his estate in Vishnya, now Ukraine.

After examining Nikolay Pirogov's scientific contribution to Medicine, it became possible in Chapter 8 to answer whether Pirogov and Boerhaave were comparable in their contribution to science. We were also able to investigate whether and how their fame was maintained after death. Using publication series, it was possible to show that both were remembered in a considerable number of publications. In contrast to many English and Latin publications by and about Boerhaave, the publications by and about Pirogov are mainly in Russian, reaching a smaller international audience. Biographers and other researchers who publish in an international scientific language (then Latin, now English) have a decisive influence on this or any other scholar's fame.

Pirogov enjoyed great fame and respect from his worldwide colleagues towards the end of his life. Minutes of the Fifth International Medical World Congress in 1897, held in Moscow and St. Petersburg, show that Pirogov was honoured for his contributions to various disciplines. During the same Congress, on August 3, 1897, a statue in his memory was unveiled in front of the main building of Moscow University. Not only had thousands of colleagues from around the world contributed financially to this, but they were also present at the unveiling.
Nikolay Ivanovich Pirogov deserves a place in world medical history in the line of renown names such as Boerhaave, Sydenham and Paré because of his many scientific and organisational contributions.

Chapter 10

Nederlandse samenvatting

Nikolay Ivanovich Pirogov en zijn bijdrage aan de geneeskunde in het 19de-eeuws keizerlijk Rusland

Tijdens mijn opleiding aan de Universiteit Leiden als studente Slavische Taal- en Letterkunde ben ik gedurende een zomercursus in Odessa in Oekraïne gewezen op de medicus N.I. Pirogov. De universiteit van Odessa was vernoemd naar deze arts en wetenschapper. Het verbaasde mij dan ook, dat er buiten het Russischtalige gebied bijna niets bekend is over deze geleerde, want het blijkt dat deze arts in de negentiende eeuw toch een grote naam had opgebouwd. De Nederlandse arts en Leidse geleerde Herman Boerhaave, die in de achttiende eeuw heeft geleefd, daarentegen heeft wel naam en wereldfaam verworven.

De centrale vraag van dit proefschrift luidt dan ook: hoe is het te verklaren dat faam van geleerden in de geneeskunde zo kan verschillen, terwijl beiden grote bijdragen hebben geleverd aan de verbetering van de westerse en Russische medische school.

Ogenschijnlijk lopen de medische werelden van Rusland en Nederland behoorlijk uiteen, echter het tegendeel blijkt waar. In het tweede hoofdstuk wordt een beknopte geschiedenis van de geneeskunde en het medisch onderwijs in Rusland beschreven. Tijdens een diepgaand onderzoek blijkt dat vanaf de zestiende-zeventiende eeuw Nederlandse en in het bijzonder gepromoveerde geneeskundigen uit Leiden een sterke invloed hebben gehad op de ontwikkeling van het medisch curriculum en de organisatie van de geneeskunde in Rusland. Die invloed hield aan tot eind achttiende eeuw. Het was Tsarina Catharina de Grote, die tijdens haar regeringsperiode de vruchten kon plukken van haar voorgangers. We hebben vast kunnen stellen dat de eerste Russische medische hoogleraren (sommigen opgeleid aan de universiteit in Leiden) de leermeesters waren van Nikolay Ivanovich Pirogov. Hij ging voort in deze traditie en schreef, dat hij zichzelf niet beschouwde als een gelijke aan Boerhaave, Sydenham of Paré. Grote mannen van wereldfaam die hem voorgingen in de medische geschiedenis. Had hij gelijk of deed hij zichzelf hiermee te kort?

In de hoofdstukken drie, vier en vijf hebben we de rol van Pirogov onderzocht als anatoom, chirurg en anesthesioloog. Kenmerkend voor zijn aanpak van de ontwikkeling van de geneeskunde is onderzoek op basis van literatuur en waarnemingen (empirisch onderzoek). Hij voerde dierenexperimenteel onderzoek uit en soms paste hij ook experimenten toe op zichzelf en op vrijwilligers (studenten en/of collega's). Hij analyseerde en beschreef zeer zorgvuldig zijn bevinden, voordat hij op grootte schaal zijn bevindingen en technieken op patiënten toepaste.
Onder zijn leiding veranderde het beroep van chirurg van vakmanschap in wetenschap.

In de anatomie was de ontwikkeling van de toegepaste anatomie steeds instrumenteel om de kennis van de chirurg te vergroten. Hij ontwikkelde meerdere atlassen waaronder een vierdelig driedimensionaal atlas met zwart-wit platen maar anderen ook met kleurenplaten, voorzien van zeer zorgvuldige beschrijvingen
Hij bedacht een aantal chirurgische ingrepen, waarvan de gelijknamige osteoplastische voetamputatie de bekendste is. Ook zijn er verschillende anatomische structuren naar hem vernoemd, inclusief de Pirogov-hoek, de kruising van de interne halsaderen en de subclavia-aders, de Pirogov-aponeurose en de Pirogov-driehoek, een gebied tussen de mylohyoïde spier, de tussenpees van de digastrische spier en de hypoglossale zenuw.
Hij was ook een van de eersten die experimenteerde met het gebruik van ether. Hij paste zijn opgedane kennis van anesthesie toe onder normale omstandigheden en op grote schaal in oorlogssituaties, bijvoorbeeld tijdens de Kaukasische (1847) en Krimoorlog (18536-1856).

In hoofdstuk 6 en 7 treffen we Nikolay I. Pirogov aan, niet alleen als arts en medisch onderzoeker, maar ook als manager/organisator in tijden van crisis. Hij speelde een belangrijke rol tijdens de Krimoorlog door op te treden als hoofd van de medische troepen en door het toepassen van het triage systeem om zoveel mogelijk hulp te kunnen bieden aan slachtoffers en zieken. Hij had daarbij niet alleen de beschikking over Russische en buitenlandse artsen maar ook over een grote groep goedopgeleide vrouwelijke verpleegkundigen. Met behulp van Grootvorstin Elena Pavlovna Romanova, schoonzuster van Tsaar Nikolaas I, werden vrouwelijke vrijwilligers voor uitzending naar het front op de Krim opgeleid door Pirogov. Dit werd voortgezet door zijn collega artsen in civiele en militaire ziekenhuizen toen hij zelf al op de Krim aanwezig was, waar hijzelf ook onverlet doorging met hen verder op te leiden. Opgemerkt moet worden dat de Medische zorg niet alleen de Russische slachtoffers betrof maar ook de gewonden van de tegenpartijen. Na de Krimoorlog vonden deze verpleegkundigen een plaats in de civiele en militaire ziekenhuizen. Zo ontstonden er vele verpleegkundige organisaties en opleidingen tot verpleegkundigen.
Nikolay Pirogov heeft zijn visie op de organisatie van oorlogschirurgie beschreven in een vermaard boek, *die Kriegchirurgie*. Deze visie en dit boek heeft ertoe geleid dat Pirogov wereldwijd alleen bekend is als oorlogschirurg. Zijn ervaringen tijdens de Kaukasische en Krim oorlog en de voortdurende tegenwerking als innovator hebben er uiteindelijk voor gezorgd dat hij zijn post als hoogleraar en hoofdchirurg van de Keizerlijke Medisch-chirurgische academie in Sint-Petersburg opgaf in 1860.

De visie en inspanningen van Pirogov samen met zijn binnen- en buitenlandse staf en inclusief de werkzaamheden van de Russische vrouwelijke verpleegkundige zijn niet onopgemerkt gebleven. Henri Dunant, journalist en filantroop, had een

traumatische ervaring opgedaan bij de slag om Solferino. Ook Dunant schreef een boek maar met als doel de wereld te wijzen op de gruwelijkheden van het voeren van oorlog. Hij wilde een burgerinitiatief van vrijwilligers opzetten. Dunant heeft een aantal malen ontmoetingen gehad met Grootvorstin Elena Pavlovna Romanova en uiteindelijk leidde dit alles tot de oprichting van het Internationale Rode Kruis.
Pirogov is vanwege zijn goede kennis van organisatie van medische hulp tijdens militaire conflicten door het (Internationale) Rode Kruis tot op hoge leeftijd gevraagd om als Inspecteur-Generaal niet alleen verslag en aanbevelingen te doen van de slachtvelden van de Elzas-Lotharingen, maar ook van andere oorlogshaarden. Hij is in 1881 overleden op zijn landgoed in Vishnya, nu Oekraïne.

Nadat we de wetenschappelijke bijdrage van Nikolay Pirogov aan de Geneeskunde hebben onderzocht, werd het mogelijk om in hoofdstuk 8 de vraag te beantwoorden of Pirogov en Boerhaave vergelijkbaar waren in hun bijdrage aan de wetenschap. Ook konden we onderzoeken of en hoe hun bekendheid na overlijden in stand bleef. Aan de hand van publicatiereeksen was het mogelijk om te tonen dat beiden in een aanzienlijk aantal publicaties werden herinnerd. In tegenstelling tot vele Engelstalige en Latijnse publicaties van en over Boerhaave, zijn de publicaties van en over Pirogov vooral in het Russisch, waardoor een kleiner internationaal publiek werd bereikt. Biografen en/of andere onderzoekers die in een internationale wetenschappelijk taal publiceren (destijds Latijn, heden Engels) is een bepalende invloed op de bekendheid van deze of enig andere geleerde.

Pirogov genoot aan het einde van zijn leven grote bekendheid en respect van zijn wereldwijde collega's. Uit notulen van het vijfde Internationale Medische Wereld Congres in 1897, dat gehouden werd in Moskou en Sint-Petersburg, blijkt dat Pirogov in verschillende disciplines werd geëerd om zijn bijdragen. Tijdens ditzelfde Congres werd op 3 augustus 1897 een standbeeld ter nagedachtenis van hem onthuld voor het hoofdgebouw van de Universiteit van Moskou. Hieraan hadden niet alleen duizenden collega's van over de hele wereld aan bijgedragen, maar zij waren ook aanwezig bij de onthulling.
Nikolay Ivanovich Pirogov verdient een plaats in de medische wereldgeschiedenis in de rij van bekende namen als Boerhaave, Sydenham en Paré vanwege zijn vele wetenschappelijke en organisatorische bijdragen.

Chapter 11

Резюме на русском языке

Николай Иванович Пирогов и его вклад в медицину в Императорской России XIX века

Во время обучения в Лейденском университете в рамках программы подготовки магистра славянских языков и литературы я проходила летние курсы на Украине, в Одессе. Здесь мне рассказали о враче Н.И. Пирогове. В честь него был назван Одесский университет. Поэтому я была удивлена, что об этом ученом почти ничего не было известно за пределами русскоязычной области, так как казалось, что Пирогов был известной личностью в девятнадцатом веке. С другой стороны, голландский врач и лейденский ученый Герман Бургаве, живший в восемнадцатом веке, имел мировую известность.

Исходя из этого, центральным вопросом моего выступления является выяснение того, как можно объяснить, что слава ученых в медицине может так сильно разниться.

Медицинские миры России и Нидерландов кажутся совершенно разными, но на самом деле все наоборот. Во второй главе описана краткая история медицины и медицинского образования в России. Углубленное исследование показывает, что начиная с XVI-XVII веков голландцы и особенно доктора с докторской степенью в Лейденском университете оказали сильное влияние на разработку медицинских учебных программ и организацию медицины в России. Это влияние длилось до конца восемнадцатого века. Императрица Екатерина Великая (период правления: 1762-1796 гг.) смогла воспользоваться благами своих предшественников во время своего правления. Мы выяснили, что первые русские профессора медицины (некоторые обучались в Лейденском университете) были прямыми или косвенными учителями Николая Ивановича Пирогова. Продолжая эту традицию, он писал, что не считает себя равным Бургаве, Сиденхему или Парэ. Известные деятели мировой медицины, предшествовавшие ему в истории медицины. Был ли он прав, или ошибался?

В главах 3, 4 и 5 мы исследуем роль Н.И.Пирогова как анатома, хирурга и анестезиолога. Характерной чертой его подхода к развитию медицины являются исследования, основанные на литературе и наблюдениях (эмпирические исследования). Он проводил эксперименты на животных, а иногда также проводил эксперименты над собой и добровольцами (студентами и коллегами). Он очень тщательно проанализировал и описал свои открытия, прежде чем использовать свои результаты и методы на пациентах в больших масштабах.

Под его руководством профессия хирурга превратилась из ремесленника в науку.

В анатомии развитие прикладной анатомии Пироговым всегда способствовало повышению знаний хирурга. Он разработал несколько

атласов, включая трехмерный атлас из четырех частей с черными и белыми пластинами, а также другие с цветными пластинами, которые он снабдил подробными описаниями.

Он разработал несколько хирургических процедур, из которых наиболее известна одноименная костно-пластическая ампутация стопы. В его честь названы несколько анатомических структур, в том числе угол Пирогова, соединение внутренних яремных вен и подключичных вен, «апоневроз Пирогова» и «треугольник Пирогова», область между подъязычной мышцей, промежуточным сухожилием двубрюшной мышцы и подъязычным нервом.

Он также был одним из первых, кто экспериментировал с использованием эфира. Полученные знания в области анестезии он применял в обычных обстоятельствах и широко в военных ситуациях, например, во время Кавказской (1847 г.) и Крымской войн (1853-1856 гг.).

В главах 6 и 7 Николай Иванович Пирогов описывается как врач и медицинский исследователь, а также как менеджер или организатор в период чрезвычайных ситуаций. Он сыграл важную роль во время Крымской войны, действуя в качестве главы медицинских сил и применяя систему сортировки для оказания максимально возможной помощи раненым и больным. Он был хорошо знаком с российскими и иностранными врачами и с большой группой хорошо обученных медсестер. При поддержке великой княгини Елены Павловны, невестки царя Николая I, Пирогов готовил сестер милосердия для отправки в Крым. Следует отметить, что медицинская помощь касалась не только российских пострадавших, но и раненых со стороны противника.

Его коллеги-врачи продолжили обучение в гражданских и военных госпиталях, когда он уже находился в Крыму, где он продолжил их обучать. После Крымской войны эти обученные медсестры нашли себе место в гражданских и военных госпиталях. Также было создано множество сестринских организаций и учебных курсов для медсестер.

Николай Пирогов описал свое видение организации военной хирургии в известном труде *Kriegschirurgie* «Начала общей военно-полевой хирургии». Его опыт и эта книга привели к тому, что Пирогов стал известен во всем мире исключительно как военный хирург. Его опыт во время Кавказской и Крымской войны и постоянное сопротивление, которое он получал как новатор, в конечном итоге заставили его уйти в отставку с должности профессора и главного хирурга Императорской Медико-хирургической академии в Санкт-Петербурге в 1860 году.

Взгляды и усилия Пирогова, а также его отечественный и зарубежный персонал, включая работу сестер милосердия, не остались незамеченными. Анри Дюнан, журналист и филантроп, получил трагический опыт в битве при Сольферино. Дюнан также написал книгу, чтобы рассказать миру о зверствах войны. Он хотел создать гражданскую волонтерскую инициативу. Дюнан

несколько раз встречался с великой княгиней Еленой Павловной что в конечном итоге привело к созданию Международного Красного Креста.

Благодаря познаниям в организации медицинской помощи во время военных конфликтов, Пирогов в преклонном возрасте попросил (Международный) Красный Крест отправиться на театр военных действий в Эльзасе-Лотарингии и на других полях сражений и делать отчеты и рекомендации в качестве Генерального инспектора, не только на полях сражений. Он умер в 1881 году в своем имении в Вишне, ныне Украина.

Изучив научный вклад Николая Пирогова в медицину, в главе 8 появилась возможность ответить, были ли Пирогов и Бургаве сопоставимыми по своему вкладу в науку своего времени. Мы также смогли выяснить, сохранилась ли их слава после смерти и каким образом она сформировалась. Используя серию публикаций, можно было показать, что оба они были упомянуты в значительном количестве публикаций. В отличие от многих английских и латинских публикаций Бургаве и о нем, публикации Пирогова и о Пирогове в основном написаны на русском языке и охватывают меньшую международную аудиторию. Биографы и другие исследователи, которые публикуются на международном научном языке (ранее на латыни, теперь на английском), имеют решающее влияние на известность того или иного ученого. К концу своей жизни Пирогов пользовался большой известностью и уважением со стороны своих коллег по всему миру. Протоколы Пятого Международного Медицинского Всемирного Конгресса 1897 года, проходившего в Москве и Санкт-Петербурге, показывают, что Пирогов был отмечен за свой вклад в различные направления медицины. На том же съезде, 3 августа 1897 г., перед главным корпусом Московского университета был открыт памятник в его честь. Мало того, что тысячи коллег со всего мира внесли финансовый вклад в это, они также присутствовали на церемонии открытия.

Николай Иванович Пирогов заслуживает занять место в мировой истории медицины в ряду таких известных имен, как Бургаве, Сиденхем и Парэ, благодаря своим многочисленным работам в области науки и организации медицины.

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Curriculum vitae

Ingrid Fokkiena Hendriks was born on 29 April, 1955, in Deventer, The Netherlands. In 1973, she passed the final exam of the HAVO at the Alexander Hegius Scholengemeenschap in Deventer. In 1983 she passed the exams for Technical Ophthalmic Assistant at the Leidse Onderwijsinstellingen in Leiderdorp. In 1987 she passed the exam for Latin for Pre-university education at the Day- and Evening Scholengemeenschap “Boerhaave” in Leiden. In 1992 she passed the Colloquium Doctum at Leiden University . In the same year she started her study on Slavic Language and Literature at the University of Leiden. She graduated in 2001. In 2013 she started as an external PhD-researcher at the Leiden University Medical Center work on the subject: "Nikolay Ivanovich Pirogov and his contribution to Medicine in 19th Century Imperial Russia."