History, Current Advances, Problems, and Pitfalls of Nephrology in Russia

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Keywords

Hemodialysis · Kidney diseases · Kidney transplantation · Nephrology

Abstract

Background: The anatomy and physiology of kidneys as well as kidney diseases have been studied in Russia since the 18th century. However, there was a surge in interest in the 1920s, with numerous researchers and clinicians making substantial advances in the understanding of the pathophysiology, pathology, and diagnostics of kidney diseases. The field of nephrology as clinical practice can be traced back to 1957–1958, when the first beds for patients with kidney diseases became available and the first hemodialysis procedure was performed. Nephrology and hemodialysis units were opened soon after, offering kidney biopsy, corticosteroid and immunosuppressive therapies, and dialysis for acute renal failure and end stage of renal disease. In 1965 kidney transplantation commenced. Between 1970 and 1990, the number of centers providing care for patients with kidney diseases increased; however, they were insufficient to meet the demands of native kidney disorders and renal replacement therapy. To address this, several educational institutions established postgraduate programs in nephrology and dialysis, and profes-

sional societies and journals were funded. While economic changes at the end of the 1990s resulted in a rapid increase of dialysis service, kidney transplantation and pathology-based diagnostics of kidney diseases remained underdeveloped. During the last 2 decades cooperation among international professional societies, continuing medical education courses, and the translation and implementation of international guidelines have resulted in substantial improvements in the quality of care provided to patients with kidney diseases. **Summary:** We describe the history and development of clinical nephrology, dialysis, kidney transplantation, education in nephrology and dialysis, professional societies and journals, and registry of patients on renal replacement therapy in Russia during almost 60 years. We also present the most recent registry data analysis, address current problems and difficulties, and stress the role of incorporation into the international nephrology community. **Key Message:** Nephrology in Russia, despite currently experiencing many difficulties, made great advances during the 60 years of its development. General nephrology, nephropathology, and renal replacement therapy are developing fast; implementation of international guidelines, access to modern educational tools, and cooperation with international professional societies are improving the quality of care of renal patients and ensuring further progress.

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Historical Aspects

Russian scientists have been interested in the anatomy and physiology of kidneys as well as kidney diseases since the 18th century. Professor Shumlansky investigated renal anatomy and defended his thesis entitled “De structura renum: Tractatus physiologicoanatomicus” in 1776; the paper was republished in Strasburg in 1788 [1]. In 1853 Professor Polunin [2] described acute renal failure in patients with cholera, and Professor Zakharyin [3] published his paper entitled “Association between protein-containing urine and convulsions in pregnant women,” which was one of the first descriptions of eclampsia. Professor Bogolybov [4] defended his PhD thesis entitled “Renal pathology of parenchymal inflammation (Bright’s disease)” in 1862, and in 1876 Professor Stolnykov [5] designed the quantitative method to detect protein levels in the urine. He also studied hemoglobinuria [6], and he published the association between renal ischemia and left ventricular hypertrophy in 1880 [7]. In 1882, Professor Ivanovsky [8] published his paper entitled “Bacterial inflammation of kidneys as a consequence of erysipelas.”

The first widely recognized historical case of kidney disease in Russia was the illness of Czar Alexander III, who suffered from severe edema, ascites, itching, dyspnea, and hemoptysis. His urinalysis showed the presence of proteins and casts, and he was diagnosed with “chronic interstitial inflammation of kidneys” and died from pulmonary edema on October 20, 1894. Among the attending doctors of Czar Alexander III during his last fatal illness were Professor Ernst Viktor von Leyden from Germany and Professor Grigory Zakharyin [9].

The most important achievement in the field of kidney diseases in 19th century Russia was the first model of nephrotoxic nephritis, developed by Professor Lindemann while working in Professor Mechnikov’s laboratory. Lindemann [10] published his research entitled “Sur le mode d’action de certains poisons renaux” in the *Annals of Institute Pasteur* in 1900, in which he demonstrated the nephrotoxicity of heterologous anti-kidney sera in experimental animals. This model remains the most widely used animal model of crescentic glomerulonephritis.

The next phase of research commenced in the 1920s. In 1921, Professor Zymnitsky [11] implemented a simple kidney function test, based on the relative density of urine, which was known as the modified Volhard test. In 1929, Professor Tareev [12] published his book entitled “Anemia in Bright’s disease.” He later published several monographs, summarizing his clinical experience, and

highlighting the most important issues of pathophysiology, pathology, and clinical presentation of kidney diseases: “Kidneys and the Body” (1932), “Hypoproteinemic syndrome” (1933), “Kidney diseases” (1936), “Nephritis” (1958), “Fundamentals of Nephrology” (1972) [13–17], and many others, all of which became handbooks for several generations of nephrologists. In 1950, Professor Lang [18] published the monograph “Hypertensive disease,” in which he stressed the role of essential hypertension in kidney damage. In 1963, Professor Gynetsynsky [19] published “Physiological mechanisms of water-electrolyte balance,” where he described the details of water reabsorption in the distal nephron.

Development of Nephrology in Russia

General Nephrology

Nephrology as a field of medical practice started its development in Russia (which was then the Soviet Union) in 1957. An initiative of Professor Woffsy, one of the most recognized internists, introduced the first beds for patients with kidney diseases in the internal diseases unit of Moscow City Hospital No. 52 [20]. Professor Ratner, who as a resident studied internal medicine with Professor Lang in the then Leningrad (now known as Saint Petersburg), was invited to manage the patients and played a leading role during the fledgling years of nephrology in Russia. Under her direction the nephrology beds transformed into the first nephrology unit in 1964, and in the same year, the first kidney biopsy in the Soviet Union was performed in the unit. Professor Ratner was also the first to successfully use corticosteroids to treat glomerulonephritis at the end of 1950s. The patient was a child with severe nephrotic syndrome. Immunosuppressants were first used by the initiative of Professor Tareev in 1959, and in 1961, Professors Woffsy and Ratner [21] published a paper entitled “Corticosteroid therapy of glomerulonephritis” in the *Annals of Academy of Medical Science*.

The first pediatric nephrology unit at the National Medical Research Center of Children’s Health (the Research Institute of Pediatrics) was opened in 1965 by the initiative of Professor Studenikin, again headed by Professor Ratner. In 1970, Professor Veltischev started the division of inherited and acquired kidney diseases in the Research Clinical Institute of Pediatrics (which was then the Research Institute of Pediatrics and Children’s Surgery), headed by Professor Ignatova till 2006 [22].

The second nephrology unit opened in Moscow City Hospital No. 52 in 1971, followed soon after with ne-

phrology units opened in Moscow City Hospital No. 24 and the Moscow City Hospital n.a. S.P. Botkin (first headed by Dr. Alexander Lokshin). Other hospitals in Moscow, Saint Petersburg, and most big cities used the Moscow City Hospital No. 52 experience as a model when opening their respective units.

Professor Ratner was active as the leader of the rapidly growing renal service in Moscow until the end of 1980s. Her main interests were glomerulonephritis, transplanted kidney issues, and tubulointerstitial disorders, on which along with Professors Serov and Tomilina, she published a book entitled “Renal dysfunctions” in 1977 [23]. She also established a school of clinical nephrology, which is currently headed by Professor Tomilina.

In 1993 Professor Tomilina initiated the merging of two nephrology units – one for patients with native kidney diseases and the other for recipients of transplanted kidney – with the dialysis and outpatient units to create the Moscow City Nephrology Center, based in Moscow City Hospital No. 52. In 1998, the first intensive care unit for patients with kidney diseases opened in this center. The Moscow City Nephrology Center provides high-quality care for patients with any type of native and transplanted kidney diseases, not only to Moscow citizens, but also to referred patients. Professor Tomilina [24] recently summarized her clinical experience and published a monograph entitled “Selected Chapters in Nephrology.” The nephrology unit of the Moscow City Hospital n.a. S.P. Botkin also became a tertiary referral center at the beginning of 2000. The main priority of both centers is kidney biopsy with high-quality pathology diagnostics for a wide range of renal diseases. The nephropathology unit, which performs kidney biopsy readings for a vast majority of the population in Moscow, the surrounding area, and referred patients from other regions, is actually part of the Moscow City Nephrology Center.

Leading the intense development of clinical and research nephrology in Leningrad were Professor Ryabov, Professor Stavskaya, Dr. Jdanova, and Professor Bagrov – the successor of Professor Gynetsynsky, representing the Novosibirsk physiology school. For almost 50 years Professor Bagrov worked in the field of renal physiology and pathophysiology in close association with clinical practice. His monograph entitled “Water-electrolyte balance in Heart Failure” was published in 1984 [25]. A complex nephrology service, including the first outpatient unit for patients with kidney diseases, was organized in Leningrad in 1977 by Professor Ryabov. In 2003, several outpatient nephrology units in Saint Petersburg were merged under Professor Komandenko, and in 2008, the

Table 1. Spectrum of CKD causes

CKD cause	Cases, %
Chronic glomerulonephritis	34.1
Systemic diseases	14.0
Pyelonephritis and urinary tract infections	8.2
Arterial hypertension	7.4
Congenital anomalies of the kidney and urinary tract	6.7
Nephrolithiasis and nephrocalcinosis	6.6
Diabetes	4.9
Tubulointerstitial nephritis and tubulopathies	3.8
Amyloidosis	3.5
Autosomal dominant polycystic kidney disease	2.8
Chronic urinary tract obstruction	2.3
Multiple myeloma and other hematological diseases	2.1
Vascular diseases	1.2
Kidney and urinary tract neoplasms	0.7
CKD of unknown origin	0.5
Familial glomerular syndromes	0.5
Chronic allograft nephropathy	0.4
Paraneoplastic nephropathies	0.1
Other secondary nephropathies	0.1
Orphan diseases	0.1
Autosomal dominant tubulointerstitial kidney disease	0.07
HIV-nephropathy	0.04

Nephrology unit of Moscow City Hospital n.a. S.P. Botkin, 1994–2017 ($n = 18,368$ cases).

Saint Petersburg City Nephrology Center was opened. Currently, there are many nephrology units in Moscow, Saint Petersburg, and other big cities actively treating patients with glomerulonephritis, systemic diseases, diabetes, amyloidosis, chronic kidney disease (CKD) complications, and even orphan diseases such as atypical hemolytic uremic syndrome, Fabry disease, and cystinosis.

Unfortunately, the exact disease spectrum for CKD is not known, because general statistics, based on the main diagnosis only, does not represent CKD epidemiology. However, the database of the nephrology unit of the Moscow City Hospital n.a. S.P. Botkin provides some information and gives an impression of the disease spectrum. Table 1 represents unpublished data analysis.

The care and management of CKD include (1) CKD diagnostics and stratification; (2) monitoring of proteinuria, eGFR, and blood pressure; (3) treatment of underlying kidney diseases and measures for prevention of CKD progression; and (4) diagnostics, evaluation, and treatment of anemia, metabolic bone disease, cardiovascular complications, etc. Nephroprotection strategies, erythropoiesis-stimulating agents, iron supplementation, and

phosphate binders are widely used. Diagnostic approaches and treatment of glomerulonephritis, including use of corticosteroids, immunosuppressants (cyclophosphamide, calcineurin inhibitors, mycophenolates, rituximab), and plasmapheresis are in agreement with international and national guidelines.

Of note, the International KDIGO Clinical Practice Guidelines for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease – Mineral and Bone Disorder; for Anemia in Chronic Kidney Disease; for Lipid Management in Chronic Kidney Disease; for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease; and for Glomerulonephritis were translated to Russian and widely implemented [26–30]. The translation of KDIGO 2017 Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease – Mineral and Bone Disorder is currently in progress.

Dialysis

Hemodialysis (HD) techniques, invented and developed in western countries, immediately raised great interest in the Soviet Union. The first paper presenting an international experience of “artificial kidney” use was published by Dr. Parin [31] in 1955. The first Soviet “Artificial Kidney Apparatus” (AKA-60) was invented in 1957 by Yuri Kozlov and his colleagues in the Research Institute of Experimental Surgical Technologies; production of the AKA-60 commenced in the Factory of Medical Equipment in Kazan [32].

In 1958, the first HD procedure using the Moeller dialysis machine was performed by Professors Pytel, Lopatkin, and Djavadzade at the University Clinic of Russian National Research Medical University n.a. N.I. Pyrogov (then the 2nd Moscow Medical Institute), based in Moscow City Hospital No. 1. Professor Pytel, a recognized urologist, was specifically interested in nephrology and had already studied crush syndrome and hepatorenal syndrome. In 1961, he published a monograph entitled “Artificial kidney and its clinical usage”, which was the first Russian monograph in the field [33].

Between 1958 and 1960 four “Experimental renal laboratories” for the treatment of patients with acute renal failure (ARF) opened: one in the Hematology Research Center (then the Research Institute of Blood Transfusion), one in Moscow Hospital No. 1, one in the Moscow City Hospital n.a. S.P. Botkin, and one in the 1st Moscow Medical University n.a. I.M. Sechenov (then the 1st Moscow Medical Institute). In 1960, the department of HD for patients with ARF, working in cooperation with the

“Laboratory of Artificial Kidney” headed by Professor Gert Kulakov, was opened in the Moscow City Hospital n.a. S.P. Botkin. It was headed by Dr. Melikyan, who was one of the pioneers of HD in Russia and worked actively for 4 decades.

The year 1962 saw the first ever procedure not using donor blood with AKA-60 [34]. In 1964, the modified AKA-140 was invented, with production starting in Leningrad in 1969. HD was primarily used for the treatment of ARF in the setting of obstetric and surgical complications, poisoning, Hanta virus hemorrhagic fever, and crush syndrome. By 1971 more than 50 HD centers, equipped with AKA machines were successfully implemented throughout the Soviet Union. This allowed the expansion of indications for HD to chronic renal failure. The first dialysis unit for patients with end-stage renal disease (ESRD) was started in Moscow City Hospital No. 24 in 1967.

In 1963, the first pediatric patient, a 3-year-old child, was treated with HD. The first pediatric HD unit for the treatment of children with ARF was established in 1976 in the St. Vladimir Children’s Hospital (then the Children’s Hospital n.a. I.V. Rusakov), headed by Dr. Zverev. It was the only such unit in the country for many years, and later became the first center for children with hemolytic uremic syndrome; in 1991 peritoneal dialysis (PD) was successfully performed for the first time in Russia at this center.

Between 1971 and 1973 Hemodialysis System 6 (SHD-6) was invented by Professor Kulakov and engineer Balabanov. The new model of HD machine enabled HD procedures to be performed on 6 patients simultaneously [32]. The first two machines were introduced in 1974 in the “Laboratory of Artificial Kidney” in the Moscow City Hospital n.a. S.P. Botkin. Later, the SHD-8 replaced the SHD-6 and was introduced to clinical practice in many cities. In 1976, the first arteriovenous fistula was placed by Dr. Timokhov and Dr. Melikyan at the Moscow City Hospital n.a. S.P. Botkin, with arteriovenous fistula swiftly replacing shunts as the standard dialysis access technique in most HD units for ESRD patients soon after. The nephrology service in Leningrad first included HD units, working in cooperation with clinical nephrology and outpatient units; Professor Shostka coordinated this work.

During the next 2 decades, the number of HD units increased; however, they were insufficient to meet the demands of dialysis care for the ESRD patients. The biggest challenge for the dialysis service was the Spitak (Armenia) earthquake in 1988. At least 400 earthquake victims de-

veloped crush syndrome, and many of them with ARF were treated with HD. Most victims were evacuated from Armenia to Moscow and other major cities.

The economic changes following the collapse of the Soviet Union resulted in the substantial growth of dialysis care services. Unfortunately, this growth was not accompanied by the development of dialysis machine production, and now only imported equipment is used in the Russian Federation. While many intensive care units were equipped with dialysis machines that performed HD and continuous hemodiafiltration, the PD program for adult patients was started in 1995 to improve dialysis services; the first three units were opened in the Moscow City Clinical Hospital No. 52, Moscow City Hospital n.a. S.P. Botkin, and Moscow City Clinical Hospital No. 7, followed by Mariinskaya City Hospital, Saint Petersburg, and later in the other big cities. The PD unit of Moscow City Clinical Hospital No. 52 is actually the biggest in the Russian Federation.

In 2002, the Ministry of Health issued an order regarding “Excellence of Organization of Dialysis Care,” whereby public-private partnership implementation resulted in a rapid increase in the HD outpatient units. The International KDIGO and ERBP Guidelines concerning CKD and acute kidney injury were translated to Russian and widely implemented [30, 35, 36].

Evaluation of the disease spectrum of ESRD is based on the data from the Registry of patients on renal replacement therapy (RRT), started by the Russian Dialysis Society in 1998. The available individual data analysis is shown in Table 2 [37].

The evaluation and management of patients receiving RRT include monitoring of dialysis dose and key quality indicators, blood pressure, body mass index, serum albumin, hemoglobin, total cholesterol, total calcium, serum phosphates, and parathyroid hormone. Comorbidities, treatment patterns, mortality, and survival are also evaluated on a regular basis. Patients on RRT receive antihypertensive medications, iron supplementation, erythropoiesis-stimulating agents, phosphate binders, and calcimimetics.

Transplantation

The first kidney transplantation from a deceased donor was performed by Dr. Voronoy in 1933 in Kherson (now a territory of Ukraine). While the procedure was not successful, the first ever attempt, published in 1936, enabled further developments [38]. The first successful kidney transplantation from a living donor, in this case a relative, was performed by Professor Petrovsky at the

Table 2. Causes of ESRD in patients on hemodialysis and peritoneal dialysis

ESRD cause	Patients, %
Chronic glomerulonephritis	36.2
Interstitial nephritis, including pyelonephritis	15.6
Diabetes	14.2
Polycystic kidney disease	12.0
Arterial hypertension	6.9
Other congenital conditions	5.5
Systemic diseases	3.5
Other	2.9
Unknown	2.5
Amyloidosis	0.9

Russian Dialysis Society Registry, 2011–2013 ($n = 15,880$ patients).

Russian Research Center of Surgery in 1965. In 1967, the National Medical Research Center of Transplantology and Artificial Organs n.a. V.I. Shumakov (then the Research Institute of Organ and Tissue Transplantation, first headed by Professor Solovyov) was created by Professor Petrovsky. Professor Petrovsky, along with Professor Solovyov and his group, published a book entitled “Kidney transplantation” in 1969 [39], when the program of kidney transplantation from deceased donors was initiated and widely implemented by Professor Shumakov, who headed the Research Institute of Organ and Tissue Transplantation for more than 30 years since 1974. The number of centers performing kidney transplantation exclusively from deceased donors increased over the next 2 decades. Professor Phylipstsev played a leading role in the implementation of kidney transplantation for almost 3 decades. In 1990, the first center for pediatric kidney transplantation was opened in the Russian Children’s Clinical Hospital.

In 1992, the federal legislation regarding “transplantation of organs and/or tissues” was introduced, whereby only direct relatives are allowed to donate kidneys for transplantation. Several regulatory documents have been released since the order addressing “reglement of brain death diagnostics” (2014). The program of kidney transplantation from living donors commenced in 1999 in the National Medical Research Center of Transplantology and Artificial Organs, headed by Professor Moysuk, who summarized the experience of the first 2 years in the article “Kidney transplantation from living relative donor” [40].

Education

The first Department of Nephrology came from the Department of Internal and Occupational Diseases of the 1st Moscow Medical University n.a. I.M. Sechenov (formerly known as the Faculty of Medicine of Emperor's Moscow University, created in 1755), which started in 1930 and was headed by Professor Tareev from 1950. Under his leadership, nephrology became one of the main priorities, and in 1966 the Clinic of Nephrology, Internal and Occupational Diseases opened, merging the Department of Nephrology, the Department of Internal and Occupational Diseases, and the Nephrology and HD units. Between 1986 and 2017, the head of the Clinic of Nephrology was Professor Mukhin. In 1972, Professor Tareev initiated the Laboratory of Nephrology Problems, which was headed by his daughter, Professor Tareeva, from 1975 [41].

An educational course on hemodialysis at the Russian Medical Academy of Continuous Postgraduate Education (formerly the Central Institute of Medical Qualification, created in 1930) was initiated by Professor Kulakov in 1965, based at the "Laboratory of Artificial Kidney". In 1982, this educational course developed into the first Department of Nephrology and Hemodialysis, headed by Professor Kulakov [32]. The Department was, and still is, based in the Moscow City Hospital n.a. S.P. Botkin; the close relationships between academia and clinical practice ensured the development of the field. Currently the Department is headed by Professor Ermolenko, one of the opinion leaders in the field, whose monograph entitled "Chronic Hemodialysis" was published in 1982 [42].

In 1996, the Research Institute of Nephrology was created at the 1st Saint Petersburg Medical University n.a. I.P. Pavlov (formerly the Women's Medical Institute, and later the 1st Leningrad Medical Institute), with Professor Ryabov as the first director. The Institute of Nephrology merged the Course of Nephrology and Dialysis (later the Department of Nephrology and Dialysis, headed by Professor Eacayan), the Department of Internal Medicine (formerly the Department of Internal Diseases, created in 1914 and headed by Professor Lang from 1919 to 1921), and several laboratories with the clinical nephrology unit.

A course of "efferent therapy" was started in 1994 at the Saint Petersburg Medical Academy of Postgraduate Education (formerly the Emperor's Clinical Institute, created in 1896). The course was later changed to the Department of Nephrology and Efferent Therapy and existed until 2011, when the Saint Petersburg Medical Academy of Postgraduate Education merged with the Saint Petersburg Medical Academy n.a. I.M. Mechnikov (for-

merly the Institute of Psychoneurology, created in 1907) under the name North-Western State Medical University n.a. I.M. Mechnikov.

In 2004, the Department of Nephrology, headed by Professor Tomilina, opened in the Moscow State University of Medicine and Dentistry (formerly the Moscow Institute of Medicine and Dentistry, created from the Moscow State Institute of Dentistry in 1949). This is a unique institution, providing postgraduate education in the fields of clinical nephrology, nephropathology, dialysis, and transplantation.

All of the abovementioned institutions provide professional education for residents and PhD students as well as certification courses and short-term continuing medical education (CME) courses.

Societies

The Society of Nephrology and Immunopathology, as part of the Moscow Scientific Society of Therapeutics created in 1895, started its work in 1958 and is currently active, conducts monthly meetings, and is devoted to selected issues of clinical nephrology, immunonephrology, and nephropathology.

The Scientific Society of Nephrology (SSN) was founded in 1969 by Professor Tareev, who was the President of the Society for almost 15 years. The congresses of the SSN have been conducted every 6 years since 1974, and during the intervening years Nephrology Summer Schools, initiated by Professor Natochin, the successor of Professor Gynetsynsky, were the most important events.

First contacts with ISN leadership were established by Professor Tomilina in 1994, when she invited Professor Brenner and Professor Dirks to attend the SSN meeting in Moscow. In 1995, the first CME course under the aegis of the ISN, ERA-EDTA, and IPNA was conducted in Moscow. The formal organizer was the SSN, but Professor Tomilina was the driving force. Among the invited international speakers were Professor Cameron and Professor Lameire. Unfortunately, due to formal official regulations the SSN was unable to continue its work for several years. The Scientific Society of Russian Nephrologists, the successor of the SSN, was started in 2005, conducting congresses and plenary assemblies and creating national guidelines and protocols.

In 1997, the Union of Pediatric Nephrologists was funded by an initiative of Professor Papayan [22]. In 1998, the Russian Dialysis Society (RDS) was established, with Professor Tomilina as the first president. This society is currently the most active professional society of nephrologists in Russia. It is affiliated with the ISN, ERA-

EDTA, and EKHA, and cooperates with KDIGO, ERBP, and WKD leadership. The RDS is specifically dedicated to the education of nephrologists throughout the Russian Federation, and conducts up to five CME conferences each year in Moscow, Saint Petersburg, and the big cities in Siberia, Volga, Far East, North West, North, and South Regions. Numerous international leaders of nephrology deliver talks at these meetings as invited speakers, as well as conducting ISN Educational Ambassadors Courses. The RDS also supports the registry and the journal *Nephrology and Dialysis* (see below). Translations of most KDIGO and ERBP Guidelines and World Kidney Day Editorials were undertaken and published by RDS initiatives [26–30, 35, 36, 43, 44].

Journals

The first journal to publish papers with nephrology articles in Russian was *Urology and Nephrology*, which was started in 1968 on the basis of the *Urology* journal, issued since 1965. The journal *Nephrology* was started by Professor Smirnov in Saint Petersburg in 1997 and was the first journal to publish a wide range of articles in the field.

In 1998, the journal *Nephrology and Dialysis* (an official journal of the RDS) was initiated by Professor Tomilina. This journal is the most influential nephrology journal in Russia with one of the highest impact factors among all medical journals in Russia. The journal *Clinical Nephrology* was started in 2009, and was edited by Professor Mukhin till 2017.

Registry

In 1998, Professor Tomilina initiated the registry of patients on RRT. The registry data is published every other year in the journal *Nephrology and Dialysis*, providing detailed information about many aspects of RRT in Russia. These include information not only about the number of centers and patients, but also on issues of anemia, hypertension, CKD-MBD management, viral hepatitis diagnostics and treatment, and many other aspects. The registry is affiliated with the ERA-EDTA Registry, providing data for international publications.

The most recent analysis, which includes published data till the end of 2015 [45] and unpublished data up to the end of 2016, shows that the total number of centers providing RRT is 506 (including 466 providing HD, 111 for PD, and 37 for kidney transplantation), with many centers providing two or three modalities. Of note, only centers providing care to both adult and pediatric patients with ESRD were included, while centers providing

care specifically to patients with acute kidney injury were not registered. The number of patients with ESRD on HD + PD by the end of 2016 was 44,771 (33,876 on HD, 8,537 on PD, and 2,358 living with transplanted kidney); the mean ratio was 305 per million inhabitants. Furthermore, the number of patients on HD in 2016 was 78% greater than that in 2010, mainly due to the development of public-private partnership.

Current Problems

- Absence of nephrology courses for students in Medical schools
- Relatively short-term professional postgraduate education (2-year residency, absence of fellowship programs)
- Lack of certified nephrologists
- Under-recognition of CKD burden by health authorities and policy makers
- Under-diagnostics of CKD in the adult population
- Lack of cooperation among nephrologists and general practitioners, endocrinologists, cardiologists, and other specialists
- Under-diagnostics of CKD and ESRD in the pediatric population
- Lack of nephrology units, disproportionate to the number of dialysis units, especially outside big industrial areas
- Lack of renal pathologists and unavailability of kidney biopsy in many regions
- Under-development of PD
- Uneven distribution of dialysis service throughout the territory of the country, with several remote regions still poorly covered by RRT
- Lack of transplantation and insufficient organ harvesting
- Insufficient funds for research

Conclusions

Nephrology in Russia, despite currently experiencing many difficulties, made great advances during the 60 years of its development. General nephrology, nephropathology, and RRT are developing fast. Implementation of international guidelines, access to modern educational tools, and cooperation with international professional societies are improving the quality of care of renal patients and ensuring further progress.

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Statement of Ethics

No ethic approval is required for this type of study.

Disclosure Statement

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