



Nephrology in Chile

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Area ¹	756,950 km ²
Population ²	17,373,831 (2017)
Capital	Santiago de Chile
Three most populated cities:	1. Santiago 2. Concepción 3. Valparaíso
Official language	Spanish
Gross domestic product (GDP) ^{3,4}	277.08 billion USD (2017)
GDP per capita ^{3,4}	15,346.45 USD (2017)
Human Development Index (HDI) ⁵	0.843 (2018)
Official currency ³	Peso
Total number of nephrologists	242 adult nephrologists 60 pediatric nephrologists
National society of nephrology	Sociedad Chilena de Nefrología www.nefro.cl
Incidence of end-stage renal disease	2018 – 187.4 pmp
Prevalence of end-stage renal disease (on dialysis)	2018 – 1342.2 pmp
Total number of patients on dialysis (all modalities)	2017 – 22,508 patients 2018 – 23,739 patients
Number of patients on hemodialysis	2017 – 21,223 patients (1208 pmp) 2018 – 22,310 patients (1260 pmp)
Number of patients on peritoneal dialysis	2017 – 1285 patients (74 pmp) 2018 – 1429 patients (82.2 pmp)
Number of renal transplantations per year	2017 – 399 (21.7 pmp) 2018 – 312 (16 pmp)

Table References:

1. Geographic Military Institute. (<https://www.igm.cl>)
2. National Institute of Statistics, Census 2017. (<https://www.censo2017.cl>)
3. Central bank of Chile 2018. (<https://www.bcentral.cl>)
4. The World Bank Group. (<https://databank.worldbank.org/home.aspx>)
5. Human Development Indices and Indicators: 2018 Statistical Update. (<http://hdr.undp.org/en/2018-update>)

Introduction

Chile is a country located along the western seaboard of South America, extending over approximately 4329 km within the American continent and including territories in the Antarctica and Oceania. The general information table provides a brief overview of data for the country. Chile is a member of the OECD (Organization for Economic Co-operation and Development) since January 2010.

According to 2017 data from the World Health Organization, life expectancy at birth is 80 years for men and 85 years for women; the birth rate is 13.1 per 1000 inhabitants, and the mortality rate is 6.2 per 1000 inhabitants [1].

Epidemiological indicators obtained in 2010 suggest chronic kidney disease (CKD) prevalence of 2.7%, in presumably healthy people, which increases to 12.1% [2] in

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primary care patients in urban centers. These data have been useful to focus resources in preventive programs in order to delay the progression of renal failure disease as a public policy. The access to diagnosis and therapy of CKD in all its stages is financed and protected by the Explicit Health Guarantees System of universal access (GES) [3].

Prevalence of end-stage renal disease (ESRD) requiring dialysis is 1284 pmp, mainly in hemodialysis (HD), whereas renal transplant rate was 16.6 pmp. Chilean legislation regulates all dialysis centers since 1994. Donation and renal transplant (both living and deceased donors) were legally established in 1996, and efforts are currently being made to establish, by law, a wider policy of presumed donation in people over 18 years of age. Academic nephrologists from the Universidad de Chile, Pontificia Universidad Católica, Universidad de Valparaíso, and Universidad Austral as well as clinical nephrologists from the metropolitan area or regions, and personnel from state institutions, like the Institute of Public Health (ISP), have participated in the drafting of this chapter.

We present a brief history of Chilean nephrology from its beginning, including the different areas where nephrologists are involved, as well as the present conditions of the specialty in the country.

Brief History of Nephrology in Chile

In 1962, a course of nephrology was carried out in the Society of Medicine of Santiago directed at that time by Dr. Renato Gazmuri, the first president of the Chilean Society of Nephrology which started its activities on June 24, 1964.

The first unit of pediatric nephrology was created in 1958 in the Arriaran Hospital in Santiago [4], and the university training of pediatric nephrology began in 1988 at the University of Chile.

The first HD was performed, at the San Borja Hospital, in a woman with septic shock in 1957. Six years later, the national health service (FONASA) was founded to deliver necessary financial coverage establishing as a model of public insurance for high-cost diseases in Latin America.

The first dialysis unit was created in 1965 at Jose Joaquin Aguirre Hospital [5].

Acute peritoneal dialysis (PD) started in 1963 at the Navy Hospital of Valparaíso and in the Del Salvador Hospital of Santiago [6] and continued ambulatory peritoneal dialysis (CAPD) in Indisa Clinic and Universidad Católica de Chile in 1994–1995.

In 1974, the Society for Dialysis and Transplanted patients (ASODI) was created, as a nongovernmental nonprofit institution.

The history of transplantation began in the Jose Joaquin Aguirre Hospital, in 1966 [7]. On June 26, Dr. Jorge Kaplan

performed the first heart transplant in the Navy Hospital, just a few months after the first heart transplant was performed in the world. The first kidney transplant performed in Chile was in January 1968, with a living related donor [8]. The first liver transplant was performed in 1988; combined kidney/pancreas transplants have been done since 1994 [9], and lung and heart transplant began in 1997.

Organ donation and transplantation have been regulated since 1996 by the Law no. 19451, modified in 2010 (Law no. 20413), establishing a presumed donation policy in people over 18 years [10, 11]. In relation to the extraction of organs from living donors for transplant purposes only, the law allows as capable people only those over 18 years, blood relatives up to fourth degree, or the husband, wife, or stable partner of the receptor. Since 2017, the Law no. 20988 regulates cross kidney transplantation in the cases that living donor is present; however, kidney transplantation cannot be performed from relatives due to blood group incompatibility or the presence of high levels of antibodies, whereas a life gift can be shared via cross transplantation method. The requirements needed for the certification of a nephrologist in Chile include a medical school degree (7 years of undergraduate studies) plus 3 years of training in internal medicine and 2 additional years in nephrology. The training can be done in one of the four public or private university centers (University of Chile, University Católica de Chile, University Austral in Valdivia, and University of Concepcion). All of these programs have similar core curriculums and are submitted to periodic accreditation in accordance to national regulations. There are 13 training positions available per year, but only 55% of the capacity is occupied. Internist physicians from Latin America can apply for these training positions if they meet the requirements mentioned above.

Renal Diseases in Chile

Chronic Kidney Disease in Chile

The epidemiology of CKD in Chile has evolved in association with an improvement in the economic conditions, being dominated today by the effects of the epidemic explosion of the classic cardiovascular risk factors such as diabetes mellitus, arterial hypertension, obesity, sedentary lifestyle, and an extension of the life expectancy. In a survey involving people presumably healthy, the prevalence of CKD in Chile reaches 2.7% [2], but in patients users of primary care, it is 12%, being higher in females (14.5%) and adults over 60 years old (23%), mainly in CKD stage 3 [12].

The law, through the GES, assures the detection, prevention, and treatment of CKD, in any of its stages to all citizens of Chile [3, 13].

Acute Kidney Injury and Acute Dialysis in Chile

Acute dialysis in Chile was started in a public hospital in 1957. At that time, septic abortion was a major public health problem, and women suffering septic shock used to die because of acute kidney injury (AKI) or hemolysis.

In the 1980s, acute dialysis expanded to many public and private hospitals, covering the epidemiological changes of AKI due to shock, ischemia, or nephrotoxins, which have been treated with intermittent techniques. The first continuous renal replacement therapy (CRRT) in Chile was performed in a teaching hospital in 1990. Acute dialysis has expanded remarkably in the country and is administered fundamentally by intensive care physicians, except in university hospitals, private clinics, and some public hospitals, where the nephrology teams take charge of the procedures.

A recent survey carried out by the Chilean Society of Nephrology in 29 healthcare centers showed that 31% of them had intermittent renal replacement therapy (RRT) only, while 21% had the chance to use CRRT as well. One out of every three centers reported the intensive care physician as responsible for the indication, and 27% of the centers reported the nephrologist to do so; in the rest both of the specialties were involved in the indication of acute RRT [14].

Renal Replacement Therapy in Chile

The proportion of patients in HD in our country has grown exponentially in the last decade, increasing from 12.7 pmp in 1980 to 1260 pmp in 2018 (22,310 patients). PD is used by a minority (Fig. 12.1), with a low increase

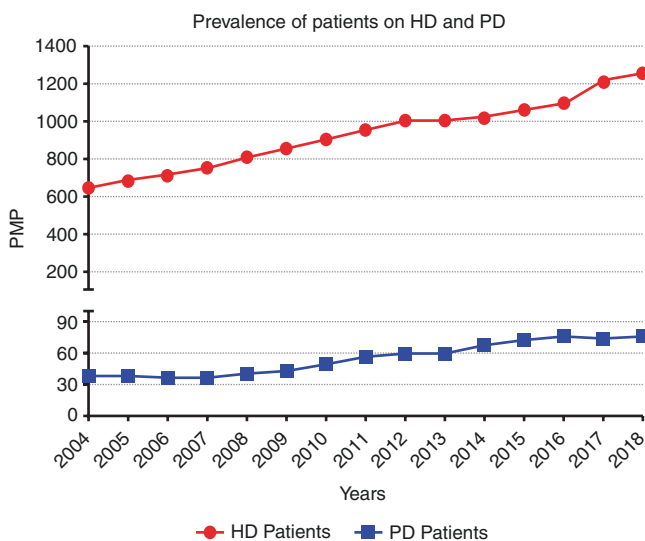


Fig. 12.1 Prevalence of hemodialysis (HD) and peritoneal dialysis (PD) patients, from 2004 to 2018. Pmp, patients per million of population

throughout the years, with an average annual rise of 8.5%, and 3.5% in 2018.

The monthly cost of HD is 1024 USD and for PD 1297 USD. In both therapies the national health service (public) reimburses 100% of the cost of treatment and in the cases of private insurance (private), the reimbursement is 80% of the total cost of the therapy.

Convective therapies as chronic RRT has recently begun in the country in the public and private healthcare centers.

Hemodialysis

HD techniques were established in our country at San Francisco de Borja Hospital, based in Santiago, in 1957. They were initially used for patients with AKI but gradually expanded to patients in CKD stage 5. The first formal dialysis center was created in 1965. Vascular access puncture and Shaldon's catheters in femoral veins were introduced in 1969, following the use of shunts.

The number of patients in chronic HD has increased exponentially. According to the national registry (2018), there are 22,310 patients on chronic HD with a rate of 1264 pmp, treated in 253 centers distributed in 101 cities throughout the country [15].

The most frequent causes of ESRD in dialysis patients are diabetes mellitus (38.9%), nephrosclerosis (10.3%), glomerulopathies (6.3%), and 13% of the cases with unknown causes. The annual mortality rate is 10.7%, and the most frequent causes of death are cardiac (33.4%), infections (16%), stroke (10.4%), and cancer (9.9%) [15].

The prevalence of HD patients with hepatitis B is of 0.11%, hepatitis C 0.64%, and HIV 0.44% (2018).

Vascular access is performed through native arteriovenous fistula in 70.8% of the patients, permanent catheter (24.1%), grafts (2.8%), and temporary dialysis catheters (2.3%) [15].

According to the 2018 national renal data registry report (22,310 patients on HD), 9.9% of these patients have been on HD for 5 years, 8.1% for 10 years, and 0.9% for more than 25 years of treatment [15].

Patients on treatment less than 9 h per week were 2.7%, whereas more than 12 h 15.7%; the ratio of nephrologists to dialysis patients in the country is 1:98.

In HD, each nurse assists a maximum of six adult patients simultaneously and in case of pediatric nurses a total of three patients [16]. These centers reuse blood lines and dialyzers, which is regulated by rules dictated by the Ministry of Health. It is established in Article 25 that the dialyzer residual capacity cannot be less than 80% of its initial volume, and the dialyzer can be reused 26 times, at maximum [16].

HD is financed by the explicit Health Guarantee System that includes treatment and drugs such as erythropoietin, calcitriol, iron, cinacalcet, and phosphate binders. These drugs

are included as a package in their private health insurance and free in the case of public health insurance. The private health insurance system covers 80% of the treatment, whereas the patients pay 20% of the total cost. In the case of patients belonging to the public health insurance, the treatment is free.

Peritoneal Dialysis

Acute PD is rarely performed in our country. Continuous ambulatory peritoneal dialysis (CAPD), automated peritoneal dialysis (APD), continuous cycling peritoneal dialysis (CCPD), and nocturnal intermittent peritoneal dialysis (NIPD) have been used since 1994 as an alternative treatment to HD, and the prevalence throughout the years of patients in PD is shown in Fig. 12.1. Nowadays, there are 1308 adult patients (75.3 pmp), 53% male, average age 49.8 years. Out of the 40 PD centers, 23 are private, 15 are in public hospitals, and 2 are in university clinics [17].

In 2018, most of the adult patients (93%) are in APD and only 3% in CAPD with a peritonitis rate of 0.13 episodes/patient/year and a gross mortality rate of 9.2% per year [17].

PD is financed by the explicit Health Guarantee System including treatment and drugs, such as erythropoietin, calcitriol, iron IV, cinacalcet, and phosphate binders. These drugs are included as a package in their private health insurance and free in the case of public health insurance. The private health insurance system covers 80% of the treatment, whereas the patients pay 20% of the total cost. In the case of patients belonging to the public health insurance, the treatment is free.

In PD, each nurse takes care of 30 adult patients, at maximum, simultaneously and in case of pediatric nurses a total of 15 patients [16].

Renal Transplantation

The history of transplant in Chile began in 1968. In our days, there are 20 renal transplant centers (18 adult and 2 pediatrics) and 2 histocompatibility laboratories in network. A high proportion (72%) of renal transplants are financed by the state through FONASA (national health fund), 28% by private health institutions (ISAPRES), and 1% by the Armed Forces insurance, all of them under the benefit of GES.

The National Procurement and Transplant Coordination (CNPT) was created by the Ministry of Health in 2010, establishing a sanitary model to assure research and the procurement of encephalic death donors throughout the country. Its activity has been reflected in an increase of the percentage of multi-organ donors in relation to the renal only and promoting the use of expanded cadaver donor (ECD). Indeed, in

2018, 27% of the transplants were performed from ECD donors [18].

The transplant waiting list for cadaver donors is a legal responsibility of the public health institute, with a unique national waiting list for each organ, with priority criteria in accordance to the current legislation and in agreement with the transplant centers. The prioritization of kidney receptors is based mainly on histocompatibility criteria, the waiting time, and PRA percentage.

From 2013 onward, the law for organ allocation considering pediatric patients is a priority in cases of donors less than 45 years. In Chile, by the end of December 2018, a total of 8,646 renal transplants have been performed (32% living and 68% deceased donors) being 9% to pediatric patients. In the last 2 years, 45 pancreas-kidney, 45 liver-kidney, and 2 heart-kidney transplants have been performed [19].

Renal transplant rate in 2017 reached 21.7 pmp and, in 2018, 16.6 pmp (including living and deceased donors). At the end of 2018, the kidney transplant waiting list for cadaver donors included 2057 patients, which represents less than 10% of the patients on dialysis. The number of potential recipients on the waiting list with the highest immunological risk (patients with PRA \geq 80%, re-transplant, or those <18 years) has increased, representing 23% of the waiting list.

The average waiting time for receiving a renal transplant in the last 2 years has been 28 months, but only 9 months for patients <18 years, showing the priority assigned to younger patients [18, 19].

The results show a graft survival of 92% and 85% for living and deceased donors, at 1 year, respectively. At 5 years, 86% for living donors and 75% for deceased and at 10 years 71% and 60% for living and deceased donors, respectively [18].

Pediatric Nephrology in Chile

Pediatric nephrology was established in 1958, when nephrology units were created in different hospitals. The first specialists were trained under the mentoring of renowned adult nephrologists, including fellowship abroad. Postgraduate university programs started in 1990 [20].

Today, there are 63 active pediatric nephrologists (17 pmp < 15 years), and one-third of them are working in regions away from the capital, Santiago.

In 1980, PD was introduced as a RRT [21]. In 1994, CAPD was included into the services financed by the state [22]. There are ten centers with PD (eight in the public system and two in the private area) and four pediatric HD centers, all of them in the public health system.

According to the national registry, until 2015, the prevalence and incidence of stage 2 and 5 CKD were 50.7 and 10.4 pmp < 15 years, respectively. Eighty-three patients were

on PD and 29 in HD. The age of initiation on PD has dropped from 7.8 years to 5.5 years old, being 25% of the children under 6 months.

The average age for initiating HD has been constantly maintained (9 years old). Fifty-three percent of the causes of ESRD are structural abnormalities as reflux, obstruction, and hypoplasia-dysplasia, 15% glomerular, and 10% hereditary.

In addition to the dialytic treatment, children with stages 4 and 5 have access to erythropoietin, calcitriol, iron IV, and growth hormones as they are included in the patients' health insurance.

Pediatric renal transplant started in the 1970s in the Catholic University Clinical Hospital, for patients from the public system, under the support of adult patient transplant teams [8]. Between 1989 and 2012, three public centers [9], corresponding to 95% of the transplanted pediatric patients, performed 462 transplants in children of 10.2 ± 4.2 years old (20% < 6 years of age), 68% of them with deceased donors. Seventy percent of them came from PD, and 9% were transplanted preemptively.

Immunosuppressant therapy considers induction in all patients (20% antithymocyte globulin and 80% receptor inhibitor IL2), tacrolimus, and mycophenolate mofetil, with steroid-free regimen. The results of this program are similar to those described in the international literature. Graft survival rates at 1, 3, and 5 years are 92%, 86%, and 83% for living donors and 87%, 80%, and 71% for deceased donors. The patient survival rate is 99%, 97%, and 96% for living donors and 97%, 97%, and 95% for deceased donors at 1, 3 and 5 years of follow-up, respectively [22].

National statistics show that we have reached up to 575 transplanted patients until 2017 [22].

For that reason, the organ allocation law considers now pediatric patients as a priority, in order to reduce their waiting times. Before prioritization between 2011 and 2012, there were 17 transplants in patients under 18 years of age, while after the prioritization in 2017 and 2018, a total of 35 patients were transplanted.

Nephrology Practice in Chile

Chile has the unique feature of being a very long country with a few cities concentrating most of the population, social, and medical development. Most of the nephrologists live and work in those cities, leaving smaller cities with few specialists to cope with the nephrology needs.

There are not enough trained nephrologists for the country's demand. Many regions depend on "travelling doctors" going there once a month and working in collaboration with internal medicine or even general practitioner doctors. That is why an enthusiastic effort is being done to create telemedicine programs to solve the problem.

The health system in Chile includes public insurance (Fondo Nacional de Salud, FONASA) which covers most of the population and assures universal access to kidney replacement programs (dialysis and transplantation) all over the country. There is also private health insurance which is responsible for a wealthier population, almost one-third of Chilean inhabitants. The huge prevalence of kidney disease requires a great number of qualified professionals to take care of them.

Most medical doctors work both in public hospitals and private clinics. Some work at dialysis clinics, while some visit hospitalized patients at medical clinics but not being full-time employees of these clinics.

Critical care nephrology needs a lot of development outside of the university or public critical care units, especially because of trained personal shortage (nephrologists, nurses). This is a well-paid work but depends on the number of medical visits made.

According to the time committed to the in public hospitals and private clinics shifts, doctors can get roughly between USD 3000 and 6000 as employees, leaving room for more income from liberal exercise of the profession at their own offices or dialysis clinics as medical director or as attending nephrologists. These extra-hospital jobs can probably double their monthly income.

In case of the nurses of public hospitals and private hospitals, monthly salary is USD 1900–2300; this income can vary depending on the calling shifts.

There is plenty of room for trained nephrologists to work, especially in smaller cities. Foreign professionals, migrating to the country due to different causes, must be certified through passing proficiency tests to perform clinical work in Chile.

Currently, there are 17.4 nephrologists per million populations in Chile.

Highlight of Nephrology in Chile

Earthquakes and Nephrology in Chile

Earthquakes have been a constant threat in our country throughout all of its history. Located in the ring of fire of the Pacific, Chile is one of the most seismic regions of the planet. The fearsome and most destructive earthquake occurred in 1960 at 3:11 p.m. in the City of Valdivia situated in the south of Chile. It registered 9.6 on the Richter scale, and more than 2000 people died; this earthquake was followed by a tsunami that washed away the cities along the coast. More than two million people were affected by the disaster.

Saturday, February 27, 2010, local time 3:34 h (6:34 h GMT), the city of Maule was awakened by an earthquake 8.8 on the Richter scale with epicenter at 115 km northeast

of the city of Concepcion, one of the largest cities of the country. It was the second most destructive earthquake registered in the country killing a total of 507 people. Most fatalities were attributed to drowning caused by the tsunami and suffocation after the collapse of adobe houses. Many victims were never found, presumably swept by the sea. Although crush injuries were rare, we were aware of two AKI patients requiring dialysis support, who recovered kidney function later. The low prevalence of crush injuries may be largely attributable to the high standards of seismic construction in Chile.

The major problems faced in this hazard were the interruption of communication that were reestablished 3 days post-earthquake only. The local agent for the RDRTF/ISN intervened as a central link between nephrologists and the Chilean Health Ministry. In the affected area, there were more than 2000 chronic dialysis patients, and several dialysis units were immediately out of use due to inadequate water availability.

After 1 week, all chronic patients regained access to dialysis, without increase in the expected mortality for the period. Local and international adequate training may be lifesaving if renal problems occur in earthquake circumstances [23].

Six patients on chronic HD were reported dead immediately post catastrophe, which represents 0.36% of total deaths. In three of these cases, the cause of death was clearly not associated to lack of dialysis treatment but to other medical causes.

The patients with APD, due to lack of electricity in their homes, began doing CAPD; some were transferred to close locations that were supplied with electricity. There were no reports of peritonitis or dead patients [24].

Future Perspectives of Nephrology in Chile

The following aspects deserve to be included in the planning of strategies oriented to enhance the quality of the nephrology in our country:

1. An increase in the number of specialists: This includes the design of effective strategies to stimulate the interest of young physicians for the specialty.
2. A serious effort in nephroprotection:
 - (a) A national network in teleconsultation has to be implemented in primary care facilities in coordination with nephrologists.
 - (b) A hard multidisciplinary work needs to be established in order to reduce the epidemic expansion of cardiovascular risk factors in our population and their effects in renal health.
3. Renal replacement therapy (RRT):

- (a) Hemodialysis (HD): An increase in the water quality used in hemodialysis in public and private centers, in order to reach an ultrapure water standard.
 - (b) Peritoneal dialysis (PD): The introduction of new dialysis solutions and the use of telemedicine to make an easier and better-assisted therapy.
 - (c) Kidney transplant: To improve the strategies to increase the donation of deceased donors, focusing on education and enhancing the confidence in the public transplant network. To start soon with a crossed donation program.
4. Academics, teaching, and research:
- (a) A big effort has to be done to keep and recruit new academic nephrologist into the university teams in order to maintain and increase the capability of human resources training.
 - (b) National and private funds need to be raised to improve the research capacities in areas of nephrological clinical impact.

Conclusive Remarks

Nephrology in Chile has developed rapidly in all its aspects: academics and basic and clinical research with support from universities and scientific societies.

RRT is within reach for all its inhabitants, and the prevention of ESRD progression and renal replacement therapies, HD, PD, and transplantation are protected by law, which guarantees universal access in the private and public health service.

Chile has a high rate of patients undergoing HD treatment (1260 pmp) in 204 HD centers and 49 hospitals that have a HD center.

The increase in the number of renal transplants is limited due to the low number of kidney donations. The number of transplants has not increased despite having the alleged presumed donation policy in people over 18 years of age and multiple advertising campaigns aimed at the general population.

There are a small number of nephrologists to cover the increasing demand and a low interest among young doctors to embrace the specialty.

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