



THAILAND

RENAL REPLACEMENT THERAPY

REGISTRY 2024 ANNUAL DATA REPORT

The Subcommittee of the
Thailand Renal Replacement Therapy (TRT)
Registry 2025 The Nephrology Society of Thailand

Bancha Satirapoj
Editor

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CHAPTER 1

INTRODUCTION

Public interest in chronic kidney disease (CKD) and dialysis has increased steadily over the past two decades and closely mirrors dialysis incidence in the United States, highlighting the potential role of search trend analyses as tools for monitoring public awareness and informing kidney health education and public health strategies.¹ Concurrently, the global burden of kidney failure with renal replacement therapy (RRT) has risen substantially; from 1990 to 2023, the number of individuals receiving dialysis or kidney transplantation increased to 4.59 million worldwide, with pronounced geographic and sex disparities. Type 2 diabetes mellitus and hypertension have emerged as the leading and fastest-growing causes of RRT, underscoring the urgent need to strengthen CKD prevention while expanding dialysis and transplant capacity globally.²

Globally, chronic kidney disease (CKD) affects approximately one in nine adults, with type 2 diabetes mellitus representing the most common underlying cause. Asia bears a disproportionate share of this burden, as the combined populations of India and China alone account for nearly 35% of the world's population, exceeding that of Africa or the combined populations of Europe and the Americas. The Kidney Disease: Improving Global Outcomes (KDIGO) Clinical Practice Guidelines recommend foundational strategies for CKD management, including lifestyle modification, early detection and treatment of hypertension, and the use of evidence-based pharmacologic therapies. However, implementation of these recommendations remains challenging in real-world settings, particularly in Asia, which encompasses countries with diverse income levels, healthcare systems, and policy frameworks.^{3,4} Furthermore, lower baseline kidney function has been independently associated with an increased risk of cardiovascular events and all-cause mortality in Thai populations at high cardiovascular risk, underscoring the clinical and public health importance of early CKD detection and effective management.⁵

End-stage kidney disease (ESKD) has similarly become a major public health challenge in Thailand, where the number of patients requiring RRT has increased continuously over the past decade.⁶ Comparable trends have been observed across Southeast Asia, driven by population aging, improved survival among patients with chronic non-communicable diseases, the rising prevalence of diabetes mellitus and hypertension, and expanded access to RRT in emerging economies.^{7,8} Consequently, the burden of CKD has intensified markedly, with

more than 20,000 new patients initiating dialysis each year in Thailand.⁹ This escalating demand places substantial strain on healthcare systems and highlights the critical need for proactive, data-informed public health responses.

Dialysis care in Asia is largely influenced by strong government stewardship, universal or near-universal health coverage schemes, and patient-centered financing policies designed to expand equitable access to RRT. Several countries, including Thailand, Taiwan, Japan, and South Korea, have implemented national policies that prioritize access to dialysis and kidney transplantation, resulting in substantial improvements in survival and treatment coverage. Nevertheless, marked heterogeneity persists across the region, particularly between high-income economies and low- to middle-income countries, where access to comprehensive renal services remains limited by financial constraints, shortages of trained nephrology personnel, uneven distribution of dialysis facilities, and underdeveloped healthcare infrastructure.¹⁰⁻¹⁴ These disparities contribute to delayed initiation of RRT, suboptimal modality selection, and poorer clinical outcomes in resource-limited settings, underscoring the need for region-specific strategies to address inequities in kidney care.

From a health economics perspective, kidney transplantation is consistently identified as the most cost-effective renal replacement therapy, offering superior survival and quality-adjusted life years (QALYs) at lower long-term costs compared with dialysis modalities. Across multiple economic evaluations in Asia and other regions, both peritoneal dialysis and kidney transplantation demonstrate greater cost-effectiveness than hemodialysis. Hemodialysis is generally associated with higher direct medical costs, greater infrastructure requirements, and lower cost-effectiveness, and is considered dominated by peritoneal dialysis in nearly all comparative analyses, with rare exceptions.¹⁵ These findings have informed national policies in several Asian countries, leading to peritoneal dialysis-favored strategies and increasing emphasis on organ donation systems.¹⁶

Collectively, the evidence supports integrated policy approaches that expand access to kidney transplantation while simultaneously strengthening peritoneal dialysis programs through workforce training, supply chain support, and patient education. Such coordinated strategies are widely regarded as the most effective means of improving access, optimizing resource utilization, and enhancing long-term outcomes for patients with ESKD in Asia.

In Thailand, RRT policy has historically been guided by the Peritoneal Dialysis First (PD-First) strategy under the Universal Coverage Scheme (UCS), which successfully expanded access to home-based dialysis nationwide. However, a key challenge within this framework has been the transition of patients from peritoneal dialysis to hemodialysis, with risks of

modality transfer varying over time.¹⁷ In 2022, Thailand introduced a “free choice” policy, allowing patients with ESKD to select either peritoneal dialysis or hemodialysis as their initial modality based on shared decision-making with healthcare providers. This policy, which remained in effect through 2024, aimed to promote patient autonomy and align national practice with global trends toward personalized healthcare.^{18, 19}

Although the free-choice policy enhanced patient-centered care, it raised concerns about health system sustainability. Following its implementation, hemodialysis utilization—an inherently more resource-intensive and costly modality—increased substantially. Emerging evidence suggested higher early mortality among patients initiating hemodialysis compared with peritoneal dialysis, particularly within the first 90 days. In late 2024, internal discussions within the National Health Security Office (NHSO) highlighted growing budgetary pressures and potential adverse outcomes associated with expanded hemodialysis use, prompting renewed consideration of a more peritoneal dialysis-focused approach in selected patient groups to balance clinical outcomes and financial sustainability.

The rising burden of ESKD in Thailand underscores the need for comprehensive strategies to strengthen RRT capacity and delivery. TRT Registry data (2000–2023), including 152,827 patients, provide important insights into long-term trends and challenges. Of these, 129,113 received hemodialysis and 23,714 peritoneal dialysis, with the UCS as the primary funding source. Cardiovascular disease (34.7%), infections (19.7%), and cerebrovascular disease (7.7%) were the leading causes of mortality.²⁰

In response to the growing burden of ESKD, Thailand has expanded nationwide hemodialysis and peritoneal dialysis services, accompanied by continued growth in dialysis facilities, equipment, and trained personnel.²¹ Despite these advances, substantial challenges remain in ensuring adequate service capacity, timely access, and equitable distribution of care in the face of increasing patient demand. Sustained investment in healthcare infrastructure, workforce development, and updated dialysis policies is therefore essential to maintaining high-quality renal care.

The TRT Registry plays a central role in monitoring national dialysis practices, identifying emerging trends, and highlighting areas for quality improvement. Registry data are critical for informing health policy development and optimizing RRT delivery. This report analyzes TRT Registry data from 2024, with a focus on key trends, system-level challenges, and opportunities for strengthening RRT in Thailand. The findings aim to support clinicians, policymakers, and researchers in developing evidence-based strategies to improve outcomes for patients with ESKD and to enhance the sustainability of the national healthcare system.

Raw TRT data from 2017 to 2025 were consolidated, and exact duplicate records were removed. Patient identity was verified using Department of Provincial Administration (DOPA) records, and only individuals with valid national identification numbers were retained. For each patient, the year of first presentation was determined, and only the earliest record was included to establish an incident cohort. Records with invalid identification numbers underwent extensive data cleaning. When identification numbers could not be resolved, deduplication was performed using name–surname matching. The final analytic dataset comprised 231,664 unique incident patients.

CHAPTER 2

RENAL REPLACEMENT THERAPY (RRT) DURING THE YEAR 2024

Yearly Incidence Trend of Dialysis Patients in 2000–2024

The incidence of RRT, encompassing both hemodialysis and peritoneal dialysis, has demonstrated a consistent upward trend in Thailand from 2000 to 2024 (**Figure 1.1**), reflecting the growing burden of ESKD nationwide. By 2024, registry data indicated a substantial increase in newly initiated RRT cases, with a total of 27,136 patients commencing hemodialysis. This represented a marked acceleration compared with the relatively stable or modest growth observed during the 2020–2023 period (**Figure 1.2**).

Yearly incidence trend of dialysis patients from 2000 to 2024

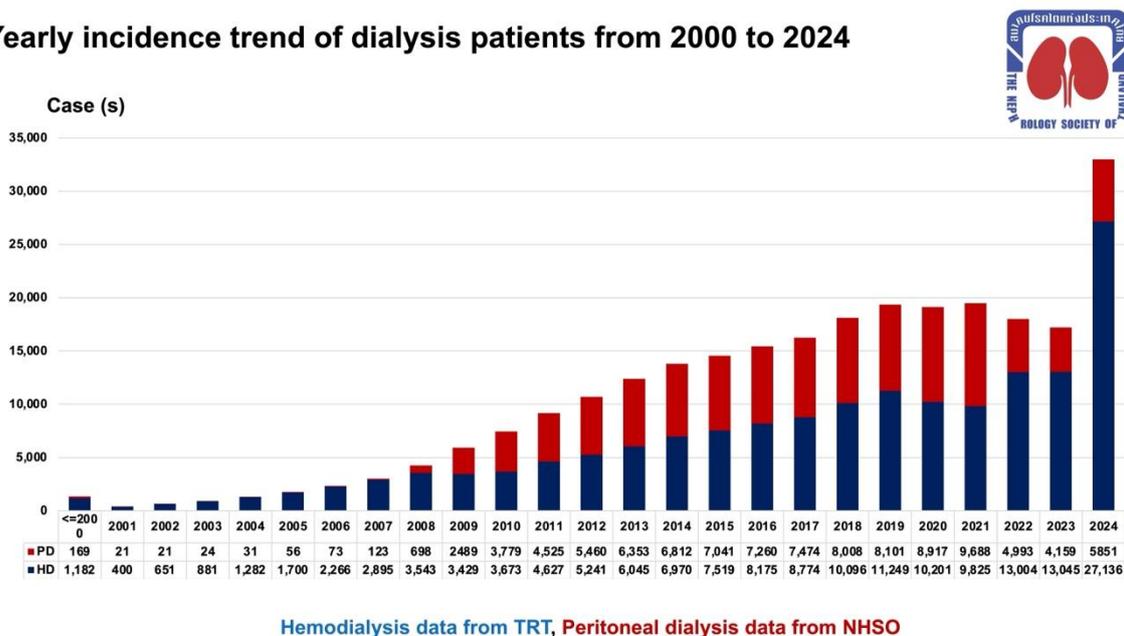


Figure 1.1: Annual incidence trend of dialysis from 2000 to 2024

A key policy milestone during this period was the introduction of the “free choice” dialysis policy in 2022, which allowed patients with ESKD to choose either peritoneal dialysis or hemodialysis as their initial RRT modality through a shared decision-making process with healthcare providers. This policy, which remained in effect through 2024, was designed to enhance patient autonomy, reduce modality-driven disparities, and improve alignment between clinical practice and patient preferences. In addition, the policy reflects a strategic shift in Thailand’s national kidney care framework toward more personalized and patient-centered

care, consistent with global trends in ESKD management. The observed rise in hemodialysis initiation following policy implementation may also suggest increased access to hemodialysis services, evolving patient and physician preferences, and expanded dialysis infrastructure across the country.

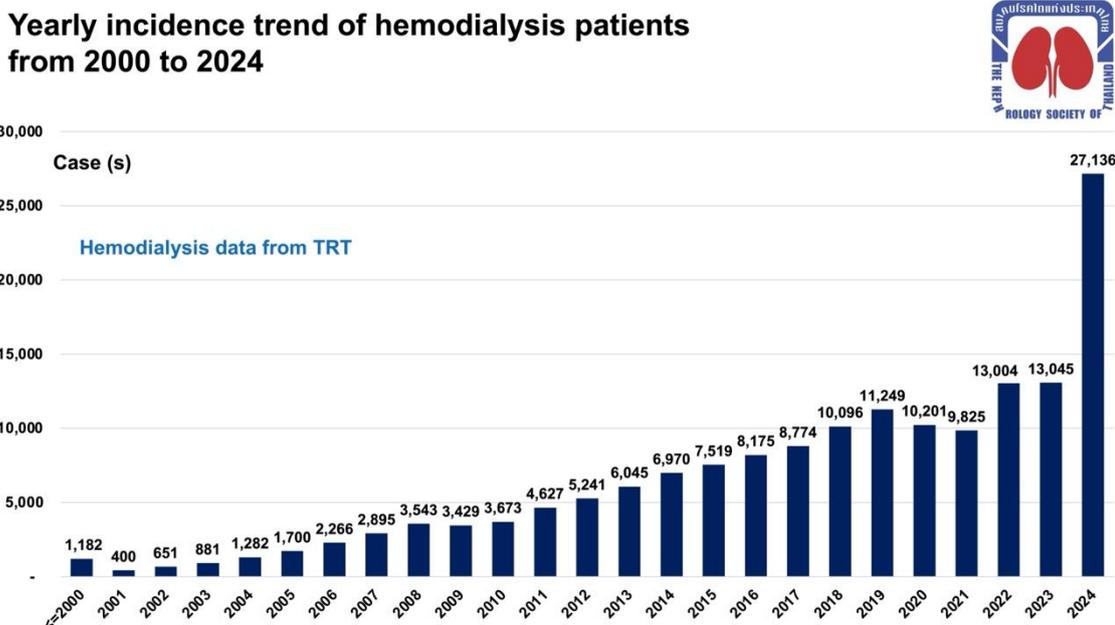


Figure 1.2: Annual incidence trend of hemodialysis from 2000 to 2024

In contrast, initiation of peritoneal dialysis declined markedly over the same period. Data on peritoneal dialysis utilization were obtained from the National Health Security Office (NHSO) of Thailand, which monitors dialysis modality use nationwide. In 2024, only 5,851 patients commenced peritoneal dialysis, representing an approximately twofold reduction compared with the peak levels observed during 2020–2021 (**Figure 1.3**). This substantial decline likely reflects shifting patient and provider preferences following the implementation of the “free choice” policy, expanded availability and accessibility of hemodialysis services, and growing concerns regarding peritoneal dialysis–related complications. In addition, system-level factors, including workforce constraints and limitations in training, follow-up, and logistical support for peritoneal dialysis programs, may have further contributed to the observed reduction in uptake.

Yearly incidence trend of peritoneal dialysis patients from 2000 to 2024

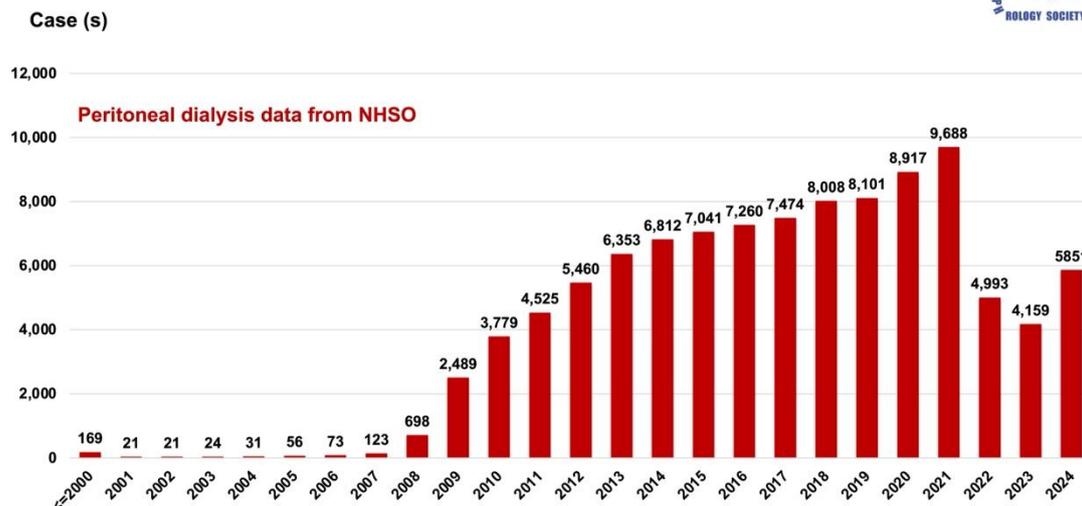


Figure 1.3: Annual incidence trend of peritoneal dialysis from 2000 to 2024

Data on peritoneal dialysis utilization were obtained from the National Health Security Office (NHSO) of Thailand.

Yearly incidence trend of kidney transplantation patients from 2000 to 2024

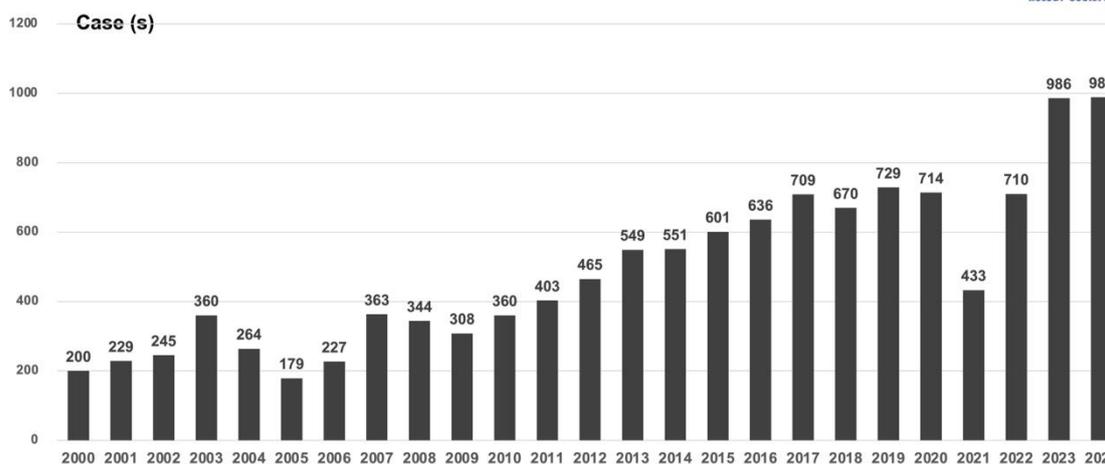


Figure 1.4: Annual incidence trend of kidney transplantation from 2000 to 2024

Data on kidney transplantation were obtained from the Transplantation Society of Thailand (TST).

Meanwhile, kidney transplantation as the primary RRT modality was undertaken in 989 patients, demonstrating a modest but consistent upward trend over time (**Figure 1.4**). Although transplantation remains the least utilized initial RRT modality, this gradual increase likely reflects improvements in transplant programs, donor availability, perioperative care, and long-term graft outcomes. Collectively, these trends highlight an evolving RRT landscape in Thailand, characterized by declining peritoneal dialysis initiation, expanding use of hemodialysis, and a slow but steady growth in kidney transplantation, underscoring the need for balanced policy planning to optimize modality distribution, resource allocation, and long-term patient outcomes.

Incidence of Renal Replacement Therapy (RRT) in Thailand

Between 2016 and 2024, the incidence of RRT in Thailand demonstrated substantial temporal variation, reflecting evolving epidemiology of ESKD and changes in national health policy (**Table 1.1**). From 2016 to 2019, the total number of newly initiated RRT patients increased steadily from 16,071 to 20,079, corresponding to a rise in incidence from 243.75 to 301.67 per million population (pmp). This increase was driven by parallel growth in both hemodialysis and peritoneal dialysis initiation during this period.

Table 1.1. Incidence of Renal Replacement Therapy (RRT) in Thailand

Year	Hemodialysis	Peritoneal Dialysis	Kidney Transplantation	Total New RRT Patients	Population*	Incidence (per million population)
2016	8,175	7,260	636	16,071	65,931,550	244
2017	8,774	7,474	709	16,957	66,188,503	256
2018	10,096	8,008	670	18,774	66,413,979	283
2019	11,249	8,101	729	20,079	66,558,935	302
2020	10,201	8,917	714	19,832	66,186,727	300
2021	9,825	9,688	433	19,946	66,171,439	301
2022	13,004	4,993	710	18,707	66,090,475	283
2023	13,045	4,159	986	18,190	66,052,615	275
2024	27,136	5,851	989	33,976	65,951,210	515

**Population data are based on mid-year national population estimates. Incidence is expressed as the number of newly treated RRT patients per 1 million population (pmp). Data on peritoneal dialysis utilization were obtained from the National Health Security Office (NHSO) of Thailand. Data on kidney transplantation were obtained from the Transplantation Society of Thailand (TST).*

During 2020 and 2021, the overall incidence of RRT remained relatively stable at approximately 300 pmp, despite fluctuations in dialysis modality. While hemodialysis initiation declined modestly, peritoneal dialysis initiation continued to increase, reaching a peak of 9,688 new patients in 2021. In contrast, the number of patients undergoing kidney transplantation as the initial RRT modality decreased in 2021.

A marked shift in RRT patterns was observed after 2022, temporally associated with the implementation of the national “free choice” dialysis policy. During 2022 and 2023, initiation of hemodialysis increased substantially, exceeding 13,000 new cases annually, whereas peritoneal dialysis initiation declined sharply to fewer than 5,000 new patients per year. As a result, the overall incidence of RRT showed a slight decline during this period, reaching 275 per million population (pmp) in 2023, reflecting changes in modality selection rather than a true reduction in ESKD burden.

In 2024, a dramatic surge in RRT incidence was observed, with 33,976 patients newly initiating RRT, corresponding to an incidence of 515 pmp. This increase was predominantly driven by a sharp rise in hemodialysis initiation, which more than doubled compared with the previous year. Peritoneal dialysis initiation demonstrated partial recovery in 2024 but remained substantially below pre-2022 levels. Kidney transplantation as the initial RRT modality showed a gradual upward trend over time, reaching 989 incident cases in 2024; however, it continued to represent only a small proportion of total incident RRT cases.

Overall, these findings highlight a dynamic evolution of RRT modality distribution in Thailand over the past decade. An initial phase characterized by parallel growth in hemodialysis and peritoneal dialysis was followed by a post-policy era marked by hemodialysis predominance, sustained reductions in peritoneal dialysis initiation, and a gradual increase in kidney transplantation. These shifts carry important implications for healthcare resource allocation, dialysis infrastructure expansion, workforce planning, and long-term strategies aimed at optimizing modality balance and promoting patient-centered ESKD care.

To ensure data accuracy and reliability, all figures presented in this analysis were systematically reviewed and cleaned to eliminate duplicate cases. Data validation was performed using the TRT Registry Program, version 3.3.1, which applies standardized algorithms for patient identification and record reconciliation across reporting centers. This process enhanced data integrity and minimized potential bias arising from duplicate reporting, thereby supporting robust trend analysis and reliable interpretation of national RRT patterns.

Study limitations should be acknowledged. First, this analysis was based on registry data, which may be subject to underreporting or delayed submissions from a small proportion

of centers (10 of 1,206), particularly during periods of policy transition. Second, changes in reimbursement policies and administrative coding practices after 2022 may have influenced modality classification and the timing of RRT initiation, potentially contributing to observed temporal fluctuations. Third, the registry lacks detailed clinical and contextual information, including comorbidity burden, socioeconomic status, patient preferences, and contraindications to specific modalities, which limits causal inference regarding modality selection. Finally, long-term outcomes stratified by dialysis modality and policy era were not evaluated and warrant further investigation.

Despite these limitations, the nationwide coverage of the TRT Registry and the application of standardized data validation procedures provide a comprehensive and reliable overview of RRT trends in Thailand. These findings offer valuable evidence to support policy development, clinical practice, and future health system planning.

Yearly Prevalence Trend of Dialysis Patients, 2000–2024

The prevalence of RRT through hemodialysis and peritoneal dialysis increased steadily from 2000 to 2024, reflecting the growing national burden of ESKD (Figure 1.5). By 2024, a total of 126,505 patients were receiving maintenance hemodialysis, while 23,059 patients were undergoing peritoneal dialysis.

Yearly prevalence trend of dialysis patients from 2000 to 2024

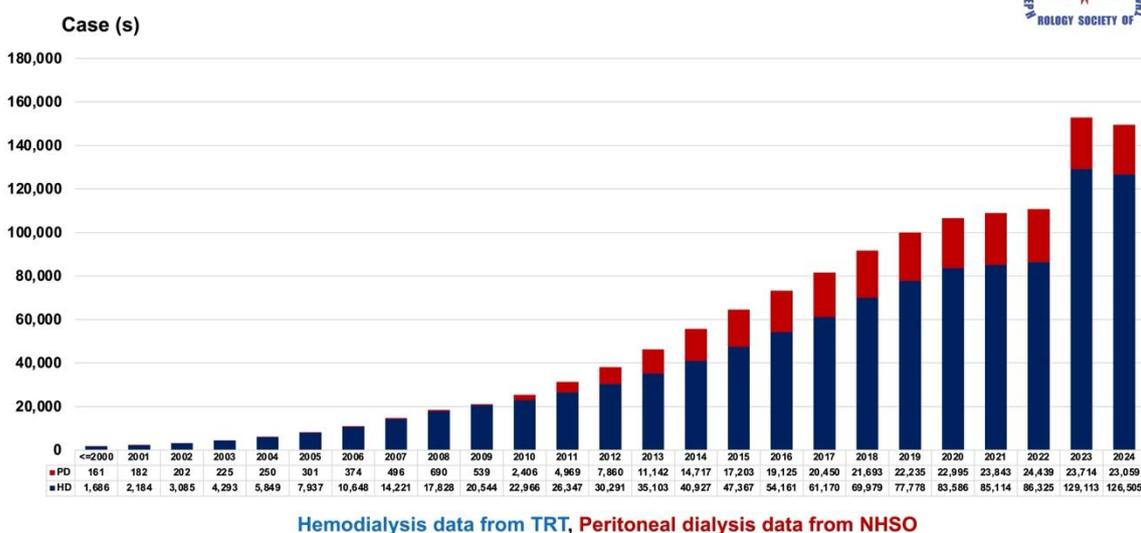


Figure 1.5: Annual prevalence trend of dialysis patients from 2000 to 2024

This sustained rise in RRT prevalence underscores the escalating public health impact of ESKD, driven largely by the increasing prevalence of major risk factors such as diabetes mellitus and hypertension. Data on peritoneal dialysis were obtained from the NHSO of Thailand, which monitors dialysis utilization nationwide.

The expanding number of patients requiring long-term dialysis indicates a growing demand for healthcare infrastructure, trained personnel, and financial resources dedicated to ESKD management. Moreover, this trend highlights the urgent need for strengthened preventive strategies, including improved control of chronic diseases, earlier detection of chronic kidney disease, and comprehensive public health interventions aimed at reducing progression to ESKD. Continued efforts to enhance treatment quality and patient-centered care will be essential to address the long-term challenges posed by the rising dialysis population.

Table 1.2 demonstrates a marked and sustained increase in the prevalence of RRT in Thailand from 2016 to 2024, reflecting the growing burden of ESKD and improved survival among patients receiving long-term RRT. The total number of patients receiving RRT increased from 81,418 in 2016 to 157,070 in 2024, representing nearly a twofold rise. Correspondingly, the prevalence increased steadily from 1,235 per million population (pmp) in 2016 to 2,381 pmp in 2024. This upward trend occurred despite a relatively stable national population size, indicating a genuine increase in treated ESKD rather than a demographic effect alone.

Table 1.2. Prevalence of Renal Replacement Therapy (RRT) in Thailand

Year	Hemodialysis	Peritoneal Dialysis	Kidney Transplantation	Total	Population*	Prevalence (per million population)
2016	54,161	19,125	8,132	81,418	65,931,550	1,235
2017	61,170	20,450	5,360	86,980	66,188,503	1,314
2018	69,979	21,693	5,652	97,324	66,413,979	1,465
2019	77,778	22,235	6,212	106,225	66,558,935	1,596
2020	83,586	22,995	6,926	113,507	66,186,727	1,715
2021	85,114	23,843	6,495	115,452	66,171,439	1,745
2022	86,325	24,439	7,225	117,989	66,090,475	1,785
2023	129,113	23,714	7,555	160,382	66,052,615	2,428
2024	126,505	23,059	7,506	157,070	65,951,210	2,381

**Population data are based on mid-year national population estimates. Prevalence is expressed as the number of patients receiving RRT per million population (pmp). Data on peritoneal dialysis utilization were obtained from the National Health Security Office (NHSO) of Thailand. Data on kidney transplantation were obtained from the Transplantation Society of Thailand (TST).*

Hemodialysis was the primary driver of the rising RRT prevalence. The number of hemodialysis patients increased consistently from 54,161 in 2016 to 86,325 in 2022, followed by a sharp rise to 129,113 in 2023, before stabilizing slightly at 126,505 in 2024. This pronounced increase in recent years likely reflects expanded dialysis capacity, improved registry coverage, policy-related changes, and enhanced access to hemodialysis services nationwide.

Peritoneal dialysis showed a gradual increase from 19,125 patients in 2016 to a peak of 24,439 in 2022, followed by a modest decline to 23,059 in 2024. This pattern suggests a relative shift away from peritoneal dialysis toward hemodialysis, potentially influenced by patient preferences, technique failure, aging of the dialysis population, and healthcare system-related factors.

Kidney transplantation prevalence remained relatively stable throughout the study period, ranging from approximately 5,000 to 8,000 patients. Although transplantation accounted for only a small proportion of overall RRT prevalence, the persistently stable numbers indicate ongoing limitations in donor availability and transplant capacity, despite continued efforts to promote kidney transplantation.

Clinical and Health System Implications

The sustained increase in RRT prevalence reflects a growing long-term care burden on the Thai healthcare system, largely driven by the rapid expansion of hemodialysis services. This trend highlights the urgent need for comprehensive strategic planning, including investments in workforce development, infrastructure expansion, and sustainable budget allocation.

The plateau and recent decline in peritoneal dialysis prevalence raise concerns regarding the long-term sustainability of this modality. These findings underscore the importance of strengthening peritoneal dialysis support systems, improving technique survival, enhancing patient education, and ensuring adequate training of healthcare providers.

Furthermore, the relatively limited contribution of kidney transplantation to overall RRT prevalence emphasizes the need to reinforce organ donation programs, streamline transplant referral pathways, and implement supportive policies to improve access to this cost-effective and survival-enhancing treatment option.

Overall outcome

In summary, national RRT registry data demonstrate a rapidly expanding treated ESKD population in Thailand, characterized by a pronounced shift toward hemodialysis and persistently constrained growth in kidney transplantation. These trends suggest that future renal care strategies should not focus solely on expanding dialysis capacity but should also prioritize effective CKD prevention, optimization of peritoneal dialysis programs, and active promotion of kidney transplantation. Such a balanced and integrated approach will be essential to ensure the long-term sustainability, quality, and equity of renal care services in Thailand.

CHAPTER 3

EPIDEMIOLOGY OF KIDNEY DISEASE IN NEWLY DIAGNOSED DIALYSIS PATIENTS IN 2024

Underlying Causes of End-Stage Kidney Disease (ESKD)

In 2024, the leading underlying causes of ESKD among patients initiating dialysis were diabetic nephropathy and hypertension, which together accounted for more than 80% of all cases. Diabetes mellitus was the most common etiology, responsible for 44.8% of patients, followed by hypertension at 38.7% (**Table 3.1**). Cases with an unknown cause comprised 4.4%, indicating potential gaps in diagnostic evaluation or late presentation. Glomerulonephritis accounted for a smaller proportion, representing 2.6% of cases. Overall, these findings highlight the dominant contribution of chronic non-communicable diseases—particularly diabetes and hypertension—to the current ESKD burden in Thailand and underscore the need for strengthened prevention, early detection, and optimal long-term management of these conditions.

Table 3.1. Underlying Causes of End-Stage Kidney Disease (ESKD)

Etiology	Total (N = 28,737)	Percentage (%)
Diabetic Nephropathy	12,865	44.8
Hypertensive Nephropathy	11,127	38.7
Glomerulonephritis	735	2.6
Obstructive Nephropathy	223	0.8
Polycystic Kidney Disease	223	0.8
Chronic Tubulointerstitial Disease	172	0.6
Others	2,089	7.3
Unknown	1,277	4.4

Biopsy-Proven Glomerulonephritis Resulting in End-Stage Kidney Disease (ESKD)

Among 97 newly initiated dialysis patients in 2024 with biopsy-proven glomerulonephritis, the etiologies leading to ESKD were heterogeneous, as summarized in **Table 3.2**. IgA nephropathy was the most prevalent cause, accounting for 64.9% of cases, underscoring its dominant contribution to progression to ESKD. Mesangial proliferative glomerulonephritis and focal segmental glomerulosclerosis (FSGS) were the second and third most common causes, comprising 11.3% and 8.2% of cases, respectively. These disease entities are well recognized for their association with progressive renal dysfunction and unfavorable long-term kidney outcomes.

Table 3.2. Biopsy-Proven Glomerulonephritis Resulting in End-Stage Kidney Disease (ESKD)

Glomerulonephritis Confirmed by Biopsy	Percentage (%)
IgA nephropathy	64.9
Mesangial proliferative glomerulonephritis	11.3
Focal segmental glomerulosclerosis (FSGS)	8.2
Membranous nephropathy	6.1
Crescentic glomerulonephritis	4.1
Membranoproliferative glomerulonephritis (MPGN)	1.0
Others	4.1

Age, Gender and Education of Dialysis Patients

Overall, the study population was predominantly male (53.2%), with a mean age of 60.7 ± 14.5 years. Age distribution was comparable between dialysis modalities, with the largest proportion of patients aged 45–64 years (44.3%), followed by those aged 65–74 years (25.9%). Patients receiving peritoneal dialysis had a higher proportion of individuals younger than 19 years compared with those receiving hemodialysis (3.0% vs. 0.5%). More than half of the cohort had a primary school education or lower (52.6%), a pattern more pronounced among peritoneal dialysis patients (59.2%). In contrast, patients undergoing hemodialysis were more likely to have attained a bachelor's degree or higher than those on peritoneal dialysis (11.7% vs. 6.8%). The demographic and educational characteristics of both groups are summarized in **Table 3.3**.

Table 3.3. Demographic and Educational Characteristics of Dialysis Patients

Category	Hemodialysis (N = 27,136)	Peritoneal Dialysis (N = 1,601)	Total (N = 28,737)
Gender (Male/Female, %)	53.4 / 46.6	50.3 / 49.7	53.2 / 46.8
Age (years), mean \pm SD	60.8 ± 14.4	59.3 ± 15.9	60.7 ± 14.5
Age Groups, N (%)			
< 19 years	124 (0.5)	46 (3.0)	170 (0.6)
20–44 years	3,688 (14.0)	204 (13.1)	3,892 (14.0)
45–64 years	11,641 (44.3)	707 (45.4)	12,348 (44.3)
65–74 years	6,828 (26.0)	391 (25.1)	7,219 (25.9)
≥ 75 years	4,006 (15.2)	211 (13.5)	4,217 (15.1)
Education Levels, N (%)			
Primary school or lower	14,171 (52.2)	948 (59.2)	15,119 (52.6)
Secondary school	2,875 (10.6)	183 (11.4)	3,058 (10.6)
High school	3,250 (12.0)	189 (11.8)	3,439 (12.0)
Vocational / High vocational certificate	1,812 (6.7)	72 (4.5)	1,884 (6.6)
Bachelor's degree or higher	3,160 (11.7)	108 (6.8)	3,268 (11.4)
Unknown	1,868 (6.9)	101 (6.3)	1,969 (6.9)

Note: Values are presented as mean \pm SD or number (%), as appropriate.

Table 3.4 summarizes the demographic and educational characteristics of patients with diabetic ESKD receiving RRT by dialysis modality. The cohort showed a slight male predominance, with a mean age of approximately 62.9 ± 12.2 years, which was comparable between hemodialysis and peritoneal dialysis groups. Most patients were aged 45–64 years, followed by those aged 65–74 years, while patients younger than 19 years comprised a very small proportion. Peritoneal dialysis patients were slightly younger overall, whereas a higher proportion of patients aged ≥ 75 years was observed in the hemodialysis group. More than half of the patients had a primary school education or lower, particularly among peritoneal dialysis patients. In contrast, attainment of a bachelor's degree or higher was more common among hemodialysis patients, while the proportion of patients with unknown educational status was similar between groups.

Table 3.4. Demographic and Educational Characteristics of Diabetic Dialysis Patients

Category	Hemodialysis (N = 12,146)	Peritoneal Dialysis (N = 719)	Total (N = 12,865)
Gender (Male/Female, %)	50.2 / 49.8	47.4 / 52.6	50.1 / 49.9
Age (years), mean \pm SD	62.9 ± 12.2	61.8 ± 12.1	62.9 ± 12.2
Age Groups, N (%)			
< 19 years	31 (0.3)	1 (0.1)	32 (0.3)
20–44 years	864 (7.4)	60 (8.6)	924 (7.4)
45–64 years	5,687 (48.4)	364 (52.0)	6,051 (48.6)
65–74 years	3,391 (28.9)	194 (27.7)	3,585 (28.8)
≥ 75 years	1,767 (15.1)	81 (11.6)	1,848 (14.9)
Education Levels, N (%)			
Primary school or lower	7,037 (57.9)	434 (60.4)	7,471 (58.1)
Secondary school	1,193 (9.8)	87 (12.1)	1,280 (10.0)
High school	1,273 (10.5)	87 (12.1)	1,360 (10.6)
Vocational / High vocational certificate	708 (5.8)	29 (4.0)	737 (5.7)
Bachelor's degree or higher	1,261 (10.4)	42 (5.8)	1,303 (10.1)
Unknown	674 (5.6)	40 (5.6)	714 (5.6)

Note: Values are presented as mean \pm SD or number (%), as appropriate.

Kidney Transplantation Waiting List Among Dialysis Patients

The data show that only 7.8% of hemodialysis patients and 3.8% of peritoneal dialysis patients are registered on the kidney transplant waiting list, highlighting significant challenges related to accessibility and awareness of kidney transplantation. This low registration rate is particularly concerning among younger patients, with only 4.8% of individuals under 60 years of age and 5.6% of those under 65 years included on the waiting list, as shown in **Table 3.5**.

Table 3.5. Kidney Transplantation Waiting List Among Dialysis Patients

Category	Hemodialysis (N = 27,136)	Peritoneal Dialysis (N = 1,601)	Total (N = 28,737)
Patients on kidney transplantation waiting list, N (%)	2,108 (7.8)	60 (3.8)	2,168 (7.5)
Age eligibility thresholds, N (% of total patients)			
< 60 years	1,334 (4.9)	40 (2.5)	1,374 (4.8)
< 65 years	1,558 (5.7)	46 (2.9)	1,604 (5.6)
< 70 years	1,766 (6.5)	49 (3.1)	1,815 (6.3)
< 75 years	1,920 (7.1)	50 (3.1)	1,970 (6.9)

Distribution of New Dialysis Patients Across Reimbursement Schemes

In 2024, the distribution of new dialysis patients in Thailand across various reimbursement schemes reflects the country's commitment to providing access to RRT for individuals with ESKD, as shown in **Table 3.6**. The UCS covered the majority of new dialysis patients (66.9%), followed by the CSMBS at 13.4% and the SSS at 12.1%.

The broad coverage provided by the UCS plays a key role in managing the growing burden of ESKD. Although hemodialysis was the predominant modality across all reimbursement schemes, the UCS demonstrated a higher proportion of patients receiving peritoneal dialysis compared with the other schemes. This variation may reflect differences in dialysis availability, patient preferences, and healthcare provider recommendations.

Table 3.6. Distribution of New Dialysis Patients Across Reimbursement Schemes

Category, N (%)	Hemodialysis (N = 27,136)	Peritoneal Dialysis (N = 1,601)	Total (N = 28,737)
Universal Coverage Scheme (UCS)	17,989 (66.3)	1,222 (76.3)	19,211 (66.9)
Social Security Scheme (SSS)	3,373 (12.4)	94 (5.9)	3,467 (12.1)
Civil Servant Medical Benefit Scheme (CSMBS)	3,667 (13.5)	179 (11.2)	3,846 (13.4)
Self-payment	607 (2.2)	17 (1.1)	624 (2.2)
Others	1,500 (5.5)	89 (5.6)	1,589 (5.5)

Type of Vascular Access in Initial Hemodialysis Patients

The primary types of vascular access used in patients initiating hemodialysis were arteriovenous fistula (AVF), accounting for 56.1% of cases; permanent catheters, used in 22.8% of patients; and double lumen catheters, representing 13.6%, as shown in **Table 3.7**.

The data reveal a notably high proportion of patients relying on permanent and double lumen catheters for hemodialysis, highlighting their substantial role in long-term dialysis treatment. This finding may indicate challenges in achieving optimal vascular access, as double lumen catheters are generally considered less desirable than AVFs because of their association with higher risks of infection, thrombosis, and other complications.

Table 3.7. Types of Vascular Access in Initial Hemodialysis Patients

Type of Vascular Access	Total (N)	Percentage (%)
Arteriovenous Fistula (AVF)	13,067	56.1
Permanent Catheter	5,322	22.8
Double Lumen Catheter (DLC)	3,165	13.6
Arteriovenous Graft (AVG)	721	3.1

Hemodialysis Adequacy in Two- and Three-Times-Per-Week Hemodialysis Patients

Among patients with ESKD, twice-weekly and thrice-weekly hemodialysis schedules were almost equally utilized, reflecting both clinical considerations and system-level factors influencing dialysis delivery. As shown in **Table 3.8**, 46.8% of patients underwent twice-weekly hemodialysis, while 52.9% received thrice-weekly treatment.

Dialysis adequacy, evaluated using single-pool Kt/V (spKt/V) and the urea reduction ratio (URR), demonstrated modest differences between the two treatment schedules. Patients receiving twice-weekly hemodialysis had a higher mean spKt/V (1.67 ± 0.37) and URR ($74.09 \pm 8.34\%$) compared with those on thrice-weekly hemodialysis (spKt/V 1.60 ± 0.34 ; URR $72.37 \pm 8.08\%$). Despite these comparable mean adequacy indices, a large proportion of patients receiving twice-weekly hemodialysis failed to achieve the recommended spKt/V target of 1.8, with 64.0% falling below this threshold. In contrast, only 10.6% of patients undergoing thrice-weekly hemodialysis did not meet the target spKt/V of 1.2. These findings suggest that, although average adequacy measures may appear acceptable, twice-weekly hemodialysis is associated with a substantially higher risk of underdialysis when guideline-recommended targets are applied.²²

Nutritional status, assessed by the normalized protein catabolic rate (nPCR), also differed between treatment groups. Mean nPCR values were slightly higher in patients receiving twice-weekly hemodialysis (1.16 ± 0.27 g/kg/day) than in those on thrice-weekly regimens (1.06 ± 0.25 g/kg/day). However, a considerable proportion of patients in both groups exhibited suboptimal protein intake, with nPCR values below 1.0 g/kg/day observed in 28.8% of patients receiving twice-weekly hemodialysis and 42.3% of those receiving thrice-weekly

hemodialysis. This finding highlights a substantial burden of potential protein-energy wasting, particularly among patients undergoing more frequent dialysis, and underscores the need for integrated nutritional assessment and intervention alongside dialysis adequacy monitoring.

Table 3.8. Hemodialysis Adequacy in Patients on Hemodialysis

Hemodialysis Adequacy	Mean \pm SD	Median (IQR)	N (%)
Dialysis Frequency			
-Two times per week			46.8%
-Three times per week			52.9%
- Four times per week			0.3%
Two-Times-per-Week Hemodialysis			
-spKt/V	1.67 \pm 0.37	1.66 (1.42–1.91)	
-spKt/V < 1.8			5,984 (64.0%)
-Urea Reduction Ratio (URR, %)	74.09 \pm 8.34	75.12 (69.56–79.90)	
-URR < 65%			1,232 (13.0%)
-Normalized Protein Catabolic Rate (nPCR)	1.16 \pm 0.27	1.14 (0.96–1.35)	
nPCR < 1.0			2,673 (28.8%)
Three-Times-per-Week Hemodialysis			
-spKt/V	1.60 \pm 0.34	1.58 (1.36–1.82)	
-spKt/V < 1.2			1,246 (10.6%)
-Urea Reduction Ratio (URR, %)	72.37 \pm 8.08	73.07 (67.73–77.97)	
-URR < 65%			1,931 (16.2%)
-Normalized Protein Catabolic Rate (nPCR)	1.06 \pm 0.25	1.04 (0.89–1.21)	
-nPCR < 1.0			4,974 (42.3%)

Metabolic and Electrolyte Profiles of New Dialysis Patients

A comprehensive evaluation of the metabolic and electrolyte profiles of patients newly initiated on dialysis is essential, as these parameters have important implications for clinical management and patient outcomes. The present analysis summarizes key metabolic and electrolyte abnormalities observed at dialysis initiation, as detailed in **Table 3.9**.

Glycemic control, assessed by hemoglobin A1c (HbA1c), showed a mean value of 6.9 \pm 1.7%, suggesting that, on average, glycemic control was within recommended targets for patients with diabetes at the time of dialysis initiation. Lipid profiles revealed a mean total cholesterol level of 162.8 \pm 46.4 mg/dL and a mean LDL-cholesterol level of 93.3 \pm 37.3 mg/dL, with wide interindividual variability. While these levels are generally within acceptable ranges, relatively low cholesterol values in a substantial proportion of patients may reflect underlying protein-energy wasting or malnutrition, a recognized concern in the dialysis population.

Table 3.9. Metabolic and Electrolyte Profiles of Newly Diagnosed Dialysis Patients

Parameters	Mean \pm SD	Median (IQR)	N (%)
Fasting Plasma Glucose (mg/dL)	137.5 \pm 71.4	114 (94–155)	
Hemoglobin A1c (%)	6.9 \pm 1.7	6.40 (5.6–7.7)	
Total Cholesterol (mg/dL)	162.8 \pm 46.4	157 (131–188)	
HDL-Cholesterol (mg/dL)	46.8 \pm 15.9	44 (36–55)	
LDL-Cholesterol (mg/dL)	93.3 \pm 37.3	88 (67–114)	
Triglycerides (mg/dL)	135.4 \pm 88.9	115 (81–164)	
Serum Uric Acid (mg/dL)	6.9 \pm 2.2	7.0 (5.5–8.2)	
Serum Uric Acid by Range (mg/dL)			
3.5–7.2			6,493 (54.5%)
< 3.5			423 (3.6%)
> 7.2			4,995 (41.9%)
Serum Sodium (mEq/L)	136.3 \pm 3.6	137 (135–139)	
Serum Sodium by Range (mEq/L)			
135–145			18,044 (71.7%)
< 135			7,085 (28.1%)
> 145			50 (0.2%)
Serum Potassium (mEq/L)	4.2 \pm 0.6	4.2 (3.8–4.6)	
Serum Potassium by Range (mEq/L)			
3.5–5.5			22,317 (88.3%)
< 3.5			2,287 (9.1%)
> 5.5			672 (2.7%)
Serum Chloride (mEq/L)	99.0 \pm 4.3	99 (97–102)	
Serum Chloride by Range (mEq/L)			
96–106			19,011 (76.2%)
< 96			4,954 (19.8%)
> 106			999 (4.0%)
Serum Bicarbonate (mEq/L)	23.6 \pm 3.3	24 (22–26)	
Serum Bicarbonate by Range (mEq/L)			
22–26			13,483 (53.6%)
< 22			6,691 (26.6%)
> 26			4,984 (19.8%)

Note: Laboratory data were analyzed using the average laboratory values for each patient and subsequently categorized according to predefined reference ranges.

The mean serum uric acid level was 6.9 ± 2.2 mg/dL, with more than 40% of patients exhibiting hyperuricemia (>7.2 mg/dL). Electrolyte profiles demonstrated that mean and median serum sodium, potassium, chloride, and bicarbonate levels were largely within normal reference ranges; however, clinically significant abnormalities were common. Hyponatremia (serum sodium <135 mEq/L) was observed in 28.1% of patients, whereas hypernatremia was rare (0.2%). With respect to potassium balance, 9.1% of patients had hypokalemia and 2.7% had hyperkalemia. Chloride abnormalities were also prevalent, with 19.8% of patients having hypochloremia and 4.0% exhibiting hyperchloremia.

Acid–base disturbances were frequent at dialysis initiation. Metabolic acidosis, defined as serum bicarbonate levels <22 mEq/L, was present in 26.6% of patients, while 19.8% had metabolic alkalosis (serum bicarbonate >26 mEq/L). Collectively, these findings highlight a substantial burden of metabolic and electrolyte derangements among new dialysis patients, underscoring the importance of early biochemical assessment, close monitoring, and individualized correction strategies to optimize clinical outcomes.

Mineral and Bone Parameters Including Albumin Status

Table 3.10 summarizes mineral, bone, and serum albumin parameters among patients newly initiated on dialysis. The mean serum calcium and phosphate levels were 8.9 ± 1.3 mg/dL and 4.5 ± 1.6 mg/dL, respectively, while the median intact parathyroid hormone (iPTH) level was 268.7 pg/mL (IQR 143–452). Although average mineral and bone parameters were generally within acceptable ranges, a substantial proportion of patients exhibited clinically relevant abnormalities.

Hypercalcemia (serum calcium >10.3 mg/dL) was observed in 3.6% of patients, whereas hypocalcemia (<8.6 mg/dL) was present in 35.5%. Phosphate disturbances were common, with hyperphosphatemia (>4.5 mg/dL) affecting 45.5% of patients and hypophosphatemia (<2.7 mg/dL) observed in 9.1%. These findings indicate a high burden of disordered mineral metabolism at the time of dialysis initiation.

With respect to parathyroid hormone levels, 61.8% of patients had iPTH concentrations within the recommended target range of 135–585 pg/mL. However, 23.3% had suppressed iPTH levels (<135 pg/mL), suggesting potential low bone turnover, while 14.9% exhibited markedly elevated iPTH levels (>585 pg/mL), consistent with advanced secondary hyperparathyroidism.

Nutritional status, assessed by serum albumin, showed a mean level of 3.8 ± 0.5 g/dL. Notably, 25.0% of patients had hypoalbuminemia (serum albumin <3.5 g/dL), reflecting a considerable burden of protein-energy wasting and/or inflammation in this population. Collectively, these findings highlight the complexity of CKD-mineral and bone disorder (CKD-MBD) and nutritional abnormalities in patients at dialysis initiation, underscoring the need for early and integrated management strategies.

Table 3.10. Mineral and Bone Parameters in Newly Diagnosed Dialysis Patients

Parameters	Mean ± SD	Median (IQR)	N (%)
Serum Calcium (mg/dL)	8.9 ± 1.3	8.9 (8.4–9.3)	
Serum Calcium by Range (mg/dL)			
8.6–10.3			14,744 (60.9%)
< 8.6			8,587 (35.5%)
> 10.3			873 (3.6%)
Serum Phosphate (mg/dL)	4.5 ± 1.6	4.4 (3.5–5.4)	
Serum Phosphate by Range (mg/dL)			
2.7–4.5			10,963 (45.5%)
< 2.7			2,187 (9.1%)
> 4.5			10,962 (45.5%)
Serum Intact PTH (pg/mL)	353.4 ± 352.7	268.7 (143–452)	
Serum Intact PTH by Range (pg/mL)			
135–585			10,550 (61.8%)
< 135			3,973 (23.3%)
> 585			2,539 (14.9%)
Serum Albumin (g/dL)	3.8 ± 0.5	3.8 (3.49–4.10)	
Serum Albumin by Range (g/dL)			
≥ 3.5			17,318 (75.0%)
< 3.5			5,778 (25.0%)

Note: Laboratory data were analyzed using the average laboratory values for each patient and subsequently categorized according to predefined reference ranges.

Anemia Status and Use of Erythropoiesis-Stimulating Agents in Newly Diagnosed Dialysis Patients

Table 3.11 summarizes anemia status and erythropoiesis-stimulating agent (ESA) use among patients newly initiated on dialysis in 2024. Overall, anemia was highly prevalent at dialysis initiation. The mean hemoglobin level was 9.4 ± 1.5 g/dL, with a median of 9.4 g/dL (IQR 8.4–10.4). Only 27.4% of patients achieved the recommended hemoglobin target range of 10.0–11.5 g/dL. In contrast, 65.1% had hemoglobin levels below 10.0 g/dL, indicating a substantial burden of moderate-to-severe anemia, while 7.5% had hemoglobin levels above 11.5 g/dL.

Marked differences in anemia control were observed across reimbursement schemes. Patients covered by the CSMBS had the highest proportion achieving target hemoglobin levels (39.7%), followed by the self-payment group (33.6%) and the SSS (30.5%). In comparison, only 23.9% of patients under the UCS reached the target range, and more than 70% of UCS patients had hemoglobin levels below 10.0 g/dL. These findings suggest that disparities in reimbursement schemes may influence access to, or intensity of, anemia management prior to or at dialysis initiation.

Iron status assessment revealed additional challenges in anemia management. The median transferrin saturation (TSAT) was 25.2% (IQR 18.6–34.1%), and the median ferritin level was 359 ng/mL (IQR 178–653). Evidence of iron deficiency was common: 29.9% of patients had TSAT levels below 20%, and an additional 34.1% had TSAT values between 20% and 29%, indicating borderline iron availability. Furthermore, 28.4% of patients had ferritin levels below 200 ng/mL, consistent with depleted iron stores. Conversely, markers suggestive of iron overload were also observed, with 16.4% of patients having TSAT levels above 40% and 35.8% exhibiting ferritin levels greater than 500 ng/mL. This wide variability highlights the heterogeneity of iron status at dialysis initiation and underscores the complexity of iron management in this population.

ESA therapy was widely utilized, with the majority of administrations given via the intravenous route (84.4%), reflecting standard practice in dialysis units. Recombinant human erythropoietin (epoetin alfa) was the predominant ESA used (87.9%), whereas epoetin beta (1.7%), darbepoetin alfa (0.3%), and methoxy polyethylene glycol–epoetin beta (0.2%) were used infrequently. Overall, these findings indicate that despite widespread ESA use, anemia remains suboptimally controlled in a large proportion of new dialysis patients, emphasizing the need for earlier detection, optimized iron management, and equitable access to anemia therapies across reimbursement schemes.

Table 3.11. Anemia Status and Use of Erythropoiesis-Stimulating Agents

Parameters	Mean ± SD	Median (IQR)	N (%)
Hemoglobin (g/dL)	9.4 ± 1.5	9.4 (8.4–10.4)	
Hemoglobin by Range (g/dL)			
10.0–11.5			7,016 (27.4%)
< 10.0			16,638 (65.1%)
11.5–13.0			1,675 (6.6%)
> 13.0			240 (0.9%)
Hemoglobin in Universal Coverage Scheme (UCS)			
Hemoglobin (g/dL)	9.2 ± 1.5	9.2 (8.2–10.2)	
10.0–11.5			4,079 (23.9%)
< 10.0			12,048 (70.7%)
11.5–13.0			801 (4.7%)
> 13.0			122 (0.7%)
Hemoglobin in Social Security Scheme (SSS)			
Hemoglobin (g/dL)	9.6 ± 1.6	9.6 (8.5–10.7)	
10.0–11.5			955 (30.5%)
< 10.0			1,843 (58.9%)
11.5–13.0			294 (9.4%)

> 13.0			35 (1.1%)
Hemoglobin in Civil Servant Medical Benefit Scheme (CSMBS)			
Hemoglobin (g/dL)	10.0 ± 1.4	10.1 (9.1–11.0)	
10.0–11.5			1,385 (39.7%)
< 10.0			1,619 (46.4%)
11.5–13.0			431 (12.4%)
> 13.0			55 (1.6%)
Hemoglobin in Self-Payment Group			
Hemoglobin (g/dL)	9.6 ± 1.6	9.8 (8.6–10.7)	
10.0–11.5			184 (33.6%)
< 10.0			308 (56.3%)
11.5–13.0			46 (8.4%)
> 13.0			9 (1.7%)
Transferrin Saturation (%)	28.2 ± 14.6	25.2 (18.6–34.1)	
Transferrin Saturation by Range (%)			
30–40			1,441 (19.6%)
< 20			2,196 (29.9%)
20–29			2,502 (34.1%)
> 40			1,206 (16.4%)
Ferritin (ng/mL)	506.5 ± 515.4	359 (178–653)	
Ferritin by Range (ng/mL)			
200–500			6,550 (35.8%)
< 200			5,194 (28.4%)
> 500			6,551 (35.8%)
Erythropoiesis-Stimulating Agent (ESA) Use			
Intravenous route			24,505 (84.4%)
Subcutaneous route			2,493 (8.6%)
Missing			2,046 (7.0%)
ESA Type			
Epoetin alfa			25,537 (87.9%)
Epoetin beta			492 (1.7%)
Darbepoetin alfa			90 (0.3%)
Methoxy polyethylene glycol-epoetin beta			53 (0.2%)

Note: Laboratory data were analyzed using the average laboratory values for each patient and subsequently categorized according to predefined reference ranges.

Hepatitis and HIV Serology and Vaccination in Newly Diagnosed Dialysis Patients

Data on viral hepatitis and HIV serology were incompletely reported, with missing information ranging from approximately 24% to 31% across serologic tests. Among patients with available data, hepatitis B surface antigen positivity was observed in 3.4% of patients, anti-HCV antibody positivity in 2.3%, and HIV seropositivity in 0.7% (**Table 3.12**).

Vaccination coverage among newly diagnosed dialysis patients remained suboptimal. Only 16.0% had received the COVID-19 vaccine, while 43.1% and 38.7% were vaccinated against influenza and hepatitis B, respectively. Pneumococcal vaccination was particularly

uncommon, with a coverage rate of only 1.7%, highlighting a substantial gap in preventive care for this high-risk population.

Table 3.12. Hepatitis and HIV Serology Status, and Vaccination Coverage Among Newly Diagnosed Dialysis Patients

Serology / Vaccination Status	Result (N, %)	Missing (N, %)
Serology		
Positive HBs Antigen	996 (3.4%)	7,089 (24.4%)
Positive Anti-HBs Antibody	8,886 (30.6%)	8,565 (29.5%)
Positive Anti-HCV Antibody	682 (2.3%)	7,573 (26.1%)
Positive HIV Status	215 (0.7%)	9,124 (31.4%)
Vaccination Status (N = 9,052)		
COVID-19 Vaccine	1,445 (16.0%)	-
Hepatitis B Vaccine	3,506 (38.7%)	-
Influenza Vaccine	3,897 (43.1%)	-
Pneumococcal Vaccine	152 (1.7%)	-
Other Vaccines	52 (0.6%)	-

Clinical Outcomes in Dialysis Patients

Previous national data from Thailand (2018–2023) reported mortality rates among dialysis patients ranging from approximately 6% to 10%. In contrast, the mortality rate among newly initiated dialysis patients in 2024 was lower, at 5.1%, indicating an improvement in early dialysis outcomes (Table 3.13).

Table 3.13. Causes of Death Among Newly Diagnosed Dialysis Patients

Cause of Death	N (%)
Cardiac disease	441 (30.4%)
Infectious disease	287 (19.8%)
Cerebrovascular disease	118 (8.1%)
Malignancy	60 (4.1%)
Liver disease	21 (1.5%)
Kidney disease	35 (2.4%)
Accident	23 (1.6%)
Suicide	3 (0.2%)
Uncertain cause	166 (11.4%)
Other causes	297 (20.5%)
Overall mortality rate	1,451 / 28,737 (5.1%)

Analysis of causes of death revealed that cardiac disease was the leading cause, accounting for 30.4% of all deaths, followed by infectious diseases (19.8%). Together,

cardiovascular and infectious causes comprised more than half of all deaths, underscoring their dominant contribution to mortality in this population. Cerebrovascular disease represented 8.1%, while malignancy accounted for 4.1% of deaths. Notably, deaths attributed to infection exceeded those from cerebrovascular disease, highlighting the ongoing burden of infection-related complications in dialysis patients.

A substantial proportion of deaths were classified as other (20.5%) or uncertain causes (11.4%), reflecting limitations in cause-of-death ascertainment and suggesting the need for improved mortality reporting systems. Overall, these findings emphasize that further reductions in mortality among dialysis patients are likely to depend on optimized cardiovascular risk management, stringent infection prevention and control measures, and improved surveillance and documentation of clinical outcomes.

CHAPTER 4

EPIDEMIOLOGY OF KIDNEY DISEASE IN ALL DIALYSIS PATIENTS

Underlying Causes of End-Stage Kidney Disease (ESKD)

The underlying causes of ESKD among dialysis patients were predominantly diabetic nephropathy and hypertension, which together accounted for more than 65% of cases. Diabetes was the leading cause, responsible for 32.7% of cases, followed closely by hypertension at 32.2%, as shown in **Table 4.1**. Glomerulonephritis accounted for 3.2% of cases, with lupus nephritis (N = 965) being the most common subtype. Chronic tubulointerstitial diseases represented 2.6% of cases, including chronic urate nephropathy (N = 306), analgesic nephropathy (N = 203), and dysplastic kidney disease (N = 206).

These findings underscore the dominant role of chronic metabolic and vascular disorders—particularly diabetes and hypertension—in driving the burden of ESKD. They highlight the urgent need for targeted prevention, early detection, and optimal management of these conditions to reduce disease progression and the associated healthcare burden. Notably, 5.6% of ESKD cases had no identifiable etiology due to unavailable diagnostic information, and 12.4% of cases had missing data.

Table 4.1. Underlying Causes of End-Stage Kidney Disease (ESKD)

Etiology	Total (N = 140,031)	Percentage (%)
Diabetic Nephropathy	45,785	32.7
Hypertensive Nephropathy	45,029	32.2
Glomerulonephritis	4,453	3.2
Chronic Tubulointerstitial Disease	3,596	2.6
Obstructive Nephropathy	1,549	1.1
Polycystic Kidney Disease	1,690	1.2
Others	12,883	9.2
Unknown	7,898	5.6
Missing Data	17,395	12.4

Biopsy-Proven Glomerulonephritis Resulting in End-Stage Kidney Disease (ESKD)

Among 751 dialysis patients with biopsy-confirmed glomerulonephritis up to 2024, the etiologies leading to ESKD were heterogeneous (**Table 4.2**). IgA nephropathy was the most frequent cause, accounting for 217 cases (28.9%), highlighting its dominant contribution to

progressive kidney failure in this cohort. This finding is consistent with its known high prevalence and long-term risk of renal deterioration.

Membranous nephropathy was the second most common etiology, identified in 42 patients (5.6%), followed closely by focal segmental glomerulosclerosis (FSGS) in 38 patients (5.1%) and membranoproliferative glomerulonephritis (MPGN) in 30 patients (3.9%). These primary glomerular diseases are well recognized for their variable treatment response and tendency toward progressive renal decline, thereby substantially contributing to the development of ESKD.

Less common causes included crescentic glomerulonephritis (16 cases, 2.1%), mesangial proliferative glomerulonephritis (9 cases, 1.2%), chronic allograft nephropathy (8 cases, 0.8%), and amyloidosis (2 cases, 0.3%). Although individually infrequent, these conditions are often associated with rapid disease progression or systemic involvement, leading to poor renal outcomes. A considerable proportion of patients (292 cases, 38.9%) were classified as having an unknown etiology, reflecting the limitations of diagnostic evaluation, late presentation, or incomplete biopsy data. In addition, 95 patients (12.7%) were categorized under other causes, representing a diverse group of less common or mixed pathological diagnoses.

Overall, these findings demonstrate that IgA nephropathy remains the leading biopsy-proven cause of ESKD in this population, while a substantial burden of disease is attributable to unidentified or heterogeneous etiologies. This underscores the importance of early kidney biopsy, comprehensive diagnostic workup, and timely intervention to improve long-term renal outcomes and reduce progression to ESKD.

Table 4.2. Biopsy-Proven Glomerulonephritis Resulting in End-Stage Kidney Disease (ESKD)

Etiology	Total (N = 751)	Percentage (%)
IgA Nephropathy	217	28.9
Membranous Nephropathy	42	5.6
Focal Segmental Glomerulosclerosis (FSGS)	38	5.1
Membranoproliferative Glomerulonephritis (MPGN)	30	3.9
Crescentic Glomerulonephritis	16	2.1
Mesangial Proliferative Glomerulonephritis	9	1.2
Chronic Allograft Nephropathy	8	0.8
Amyloidosis	2	0.3
Others	95	12.7
Unknown	292	38.9

Age, Gender and Education of Dialysis Patients

The dialysis population had a mean age of 62.6 ± 16.7 years, with a sex distribution of 52.5% male and 47.5% female. When stratified by dialysis modality, patients receiving hemodialysis were slightly older than those on peritoneal dialysis (62.8 ± 16.7 vs. 61.0 ± 15.9 years), while the sex distribution remained comparable between the two groups (52.7% vs. 50.6% male, respectively). Overall, both treatment modalities demonstrated a relatively balanced representation of age and gender, indicating that these demographic factors were not major determinants of dialysis modality selection (**Table 4.3**). The broad distribution across age groups further reflects the utilization of both hemodialysis and peritoneal dialysis among diverse demographic populations.

Regarding educational attainment, the majority of dialysis patients had completed primary school or lower, accounting for 39.0% (54,570 individuals) of the total cohort. This proportion was notably higher among patients receiving peritoneal dialysis (55.0%) compared with those undergoing hemodialysis (37.3%). In contrast, a substantially greater proportion of hemodialysis patients had attained a bachelor's degree or higher (14.5%) than peritoneal dialysis patients (5.6%). Intermediate education levels, including secondary and high school, were similarly distributed between the two groups.

Table 4.3. Demographic and Educational Characteristics of Dialysis Patients

Category	Hemodialysis (N = 126,505)	Peritoneal Dialysis (N = 13,526)	Total (N = 140,031)
Gender (Male/Female, %)	52.7 / 47.3	50.6 / 49.4	52.5 / 47.5
Age (years, mean \pm SD)	62.8 ± 16.7	61.0 ± 15.9	62.6 ± 16.7
Age Groups (N, %)			
< 19 years	2,774 (2.3)	280 (2.2)	3,054 (2.3)
20–44 years	14,838 (12.3)	1,673 (12.9)	16,511 (12.3)
45–64 years	46,335 (38.3)	5,362 (41.5)	51,697 (38.6)
65–74 years	28,999 (24.0)	3,463 (26.8)	32,462 (24.3)
> 75 years	27,967 (23.1)	2,159 (16.7)	30,126 (22.5)
Education Levels (N, %)			
Primary school or lower	47,132 (37.3)	7,438 (55.0)	54,570 (39.0)
Secondary school	23,058 (18.2)	2,617 (19.4)	25,675 (18.3)
High school	13,720 (10.9)	1,205 (8.9)	14,925 (10.7)
Vocational/High vocational certificate	10,208 (8.1)	695 (5.1)	10,903 (7.8)
Bachelor's degree or higher	18,313 (14.5)	758 (5.6)	19,071 (13.6)
Unknown	14,074 (11.1)	813 (6.0)	14,887 (10.6)

Note: Values are presented as mean \pm SD or number (%), as appropriate.

These findings highlight a clear disparity in educational background between dialysis modalities. The higher proportion of lower educational attainment among peritoneal dialysis

patients suggests potential socio-economic, health literacy, or accessibility barriers that may influence treatment selection and long-term outcomes. Such differences warrant consideration in patient education strategies, shared decision-making, and policy development to ensure equitable access to dialysis care.

Table 4.4 summarizes the demographic and educational characteristics of patients with diabetic ESKD receiving RRT by dialysis modality. Among diabetic dialysis patients, the mean age was 65.4 ± 12.9 years, with similar values in the hemodialysis and peritoneal dialysis groups (65.4 ± 13.0 vs. 65.1 ± 12.5 years). Most patients were aged 45–64 years (41.9%) and 65–74 years (30.1%), while those younger than 45 years comprised a small proportion of the cohort. The overall sex distribution was balanced, with 49.7% male and 50.3% female patients. A similar pattern was observed across dialysis modalities, although a slight female predominance was noted in the peritoneal dialysis group (52.5%). Regarding educational attainment, more than half of the patients had completed primary school or lower (51.8%), with a higher proportion in the peritoneal dialysis group than in the hemodialysis group (65.0% vs. 50.3%). In contrast, a bachelor's degree or higher was more common among hemodialysis patients (13.4% vs. 4.5%). Secondary and high school education levels were similarly distributed between groups.

Overall, diabetic dialysis patients in this cohort were predominantly elderly, had a balanced gender distribution, and generally low educational attainment, with notable differences in educational background between dialysis modalities.

Table 4.4. Demographic and Educational Characteristics of Diabetic Dialysis Patients

Category	Hemodialysis (N = 40,886)	Peritoneal Dialysis (N = 4,873)	Total (N = 45,759)
Gender (Male/Female, %)	50.0 / 50.0	47.5 / 52.5	49.7 / 50.3
Age (years, mean \pm SD)	65.4 ± 13.0	65.1 ± 12.5	65.4 ± 12.9
Age Groups (N, %)			
< 19 years	160 (0.4)	36 (0.8)	196 (0.4)
20–44 years	2,269 (5.8)	218 (4.7)	2,487 (5.6)
45–64 years	16,507 (41.9)	1,982 (42.5)	18,489 (41.9)
65–74 years	11,718 (29.7)	1,549 (33.2)	13,267 (30.1)
> 75 years	8,775 (22.3)	879 (18.9)	9,654 (21.9)
Education Levels (N, %)			
Primary school or lower	20,564 (50.3)	3,168 (65.0)	23,732 (51.8)
Secondary school	5,617 (13.7)	773 (15.9)	6,390 (14.0)
High school	4,205 (10.3)	346 (7.1)	4,551 (9.9)
Vocational/High vocational certificate	2,836 (6.9)	173 (3.6)	3,009 (6.6)
Bachelor's degree or higher	5,487 (13.4)	220 (4.5)	5,707 (12.5)
Unknown	2,199 (5.4)	197 (4.0)	2,396 (5.2)

Note: Values are presented as mean \pm SD or number (%), as appropriate.

Kidney Transplantation Waiting List Among Dialysis Patients

Overall, a relatively small proportion of dialysis patients were registered on the kidney transplant waiting list, accounting for 14.0% of the total cohort. Registration rates were slightly higher among hemodialysis patients than peritoneal dialysis patients (14.2% vs. 12.3%). These findings indicate limited access to, or utilization of, kidney transplantation services among patients receiving maintenance dialysis.

Among age-eligible patients, registration rates remained low across all thresholds. Only 7.4% of patients younger than 60 years and 8.8% of those younger than 65 years were listed for transplantation. Even among patients younger than 75 years, the proportion registered on the waiting list was only 11.0%. As shown in **Table 4.5**, these results suggest that a substantial number of potentially eligible patients were not referred for, or enrolled in, transplant programs.

Overall, the low waiting list enrollment, particularly among younger and potentially suitable candidates, highlights important barriers related to referral practices, patient awareness, socio-economic factors, and healthcare system accessibility. Addressing these gaps may help improve equitable access to kidney transplantation and optimize long-term outcomes in this population.

Table 4.5. Kidney Transplantation Waiting List Among Dialysis Patients

Category	Hemodialysis (N = 126,505)	Peritoneal Dialysis (N = 13,526)	Total (N = 140,031)
Patients on kidney transplantation waiting list, N (%)	17,990 (14.2)	1,660 (12.3)	19,650 (14.0)
Age Eligibility Thresholds, N (% of total patients)			
< 60 years	9,522 (7.5)	909 (6.7)	10,431 (7.4)
< 65 years	11,200 (8.9)	1,056 (7.8)	12,256 (8.8)
< 70 years	12,737 (10.1)	1,195 (8.8)	13,932 (9.9)
< 75 years	14,053 (11.1)	1,320 (9.8)	15,373 (11.0)

Distribution of Dialysis Patients Across Reimbursement Schemes

The distribution of dialysis patients across different reimbursement schemes reflects the structure of renal replacement therapy coverage in Thailand (**Table 4.6**). The UCS accounted for the largest proportion of patients, covering 48.3% of the total cohort, followed by the CSMBS at 18.9% and the SSS at 16.0%.

Notably, the UCS covered a substantially higher proportion of peritoneal dialysis patients compared with hemodialysis patients (82.2% vs. 44.7%), indicating its central role in

supporting home-based dialysis therapy. In contrast, patients receiving hemodialysis were more evenly distributed across reimbursement schemes, with considerable representation under CSMBS (20.2%) and SSS (17.3%). Self-payment accounted for a relatively small proportion of patients in both modalities.

Overall, these findings highlight the pivotal role of the UCS in ensuring equitable access to dialysis services, particularly peritoneal dialysis. Differences in coverage patterns across schemes may reflect policy-driven modality preferences, variations in service availability, and socio-economic factors that influence treatment selection.

Table 4.6. Distribution of Dialysis Patients Across Reimbursement Schemes

Category, N (%)	Hemodialysis (N = 126,505)	Peritoneal Dialysis (N = 13,526)	Total (N = 140,031)
Universal Coverage Scheme (UCS)	56,535 (44.7)	11,116 (82.2)	67,651 (48.3)
Social Security Scheme (SSS)	21,908 (17.3)	512 (3.8)	22,420 (16.0)
Civil Servant Medical Benefit Scheme (CSMBS)	25,513 (20.2)	937 (6.9)	26,450 (18.9)
Self-payment	11,509 (9.1)	145 (1.1)	11,654 (8.3)
Others	11,040 (8.7)	816 (6.0)	11,856 (8.5)

Type of Vascular Access in Hemodialysis Patients

Among hemodialysis patients, AVF was the most commonly used vascular access, accounting for 61.3% of cases (Table 4.7). This was followed by permanent catheters (22.7%), double lumen catheters (10.7%), and arteriovenous grafts (5.3%).

Although AVF was the predominant access type, more than one-third of patients relied on catheter-based access, including permanent and double lumen catheters. This relatively high dependence on catheters suggests potential barriers to timely AVF or graft creation, such as delayed referral, limited surgical capacity, or patient-related factors. Given the higher risks of infection, thrombosis, and hospitalization associated with catheter use, these findings highlight the need for strategies to promote earlier access planning and increased utilization of permanent vascular access.

Table 4.7. Types of Vascular Access in Hemodialysis Patients

Type of Vascular Access	Total (N = 84,972)	Percentage (%)
Arteriovenous Fistula (AVF)	52,121	61.3
Permanent Catheter	19,281	22.7
Double Lumen Catheter (DLC)	9,057	10.7
Arteriovenous Graft (AVG)	4,513	5.3

Hemodialysis Adequacy in Two- and Three-Times-per-Week Hemodialysis Patients

Among patients receiving maintenance hemodialysis, thrice-weekly treatment was the most common regimen, accounting for 67.5% of cases, followed by twice-weekly dialysis in 30.8% and four-times-weekly dialysis in 1.7% (**Table 4.8**). Treatment frequency was determined by clinical status, dialysis adequacy, and healthcare accessibility.

Dialysis adequacy was assessed using spKt/V and the URR. In patients undergoing twice-weekly hemodialysis, the mean spKt/V was 1.73 ± 0.35 and the mean URR was $75.03 \pm 7.33\%$. However, 59.6% of these patients had an spKt/V below 1.8, indicating suboptimal dialysis adequacy. In contrast, patients receiving thrice-weekly hemodialysis had a mean spKt/V of 1.68 ± 0.33 and a mean URR of $74.09 \pm 6.87\%$, with only 5.2% failing to achieve the target spKt/V of 1.2. Similarly, the proportion of patients with URR < 65% was low in both groups (8.8% in twice-weekly and 9.3% in thrice-weekly dialysis).

Nutritional status, assessed by normalized protein catabolic rate (nPCR), showed mean values of 1.20 ± 0.25 g/kg/day in twice-weekly and 1.11 ± 0.21 g/kg/day in thrice-weekly hemodialysis patients. Despite these acceptable average values, a substantial proportion of patients had nPCR < 1.0 g/kg/day, particularly in the thrice-weekly group (31.0% vs. 21.5%), suggesting inadequate protein intake in a considerable number of patients (**Table 4.8**).

Table 4.8. Hemodialysis Adequacy in Patients on Hemodialysis

Hemodialysis Adequacy	Mean \pm SD	Median (IQR)	N (%)
Dialysis Frequency			
Two times per week	—	—	32,806 (30.8)
Three times per week	—	—	71,993 (67.5)
Four times per week	—	—	1,816 (1.7)
Two-Times-per-Week Hemodialysis			
spKt/V	1.73 ± 0.35	1.71 (1.49, 1.94)	—
spKt/V < 1.8	—	—	17,202 (59.6)
Urea Reduction Ratio (URR, %)	75.03 ± 7.33	75.81 (70.89, 80.11)	—
URR < 65%	—	—	2,576 (8.8)
Normalized Protein Catabolic Rate (nPCR)	1.20 ± 0.25	1.18 (1.02, 1.36)	—
nPCR < 1.0	—	—	6,189 (21.5)
Three-Times-per-Week Hemodialysis			
spKt/V	1.68 ± 0.33	1.66 (1.46, 1.89)	—
spKt/V < 1.2	—	—	3,523 (5.2)
Urea Reduction Ratio (URR, %)	74.09 ± 6.87	74.62 (70.02, 78.93)	—
URR < 65%	—	—	6,336 (9.3)
Normalized Protein Catabolic Rate (nPCR)	1.11 ± 0.21	1.10 (0.96, 1.25)	—
nPCR < 1.0	—	—	21,004 (31.0)

Note: Data were analyzed using the average laboratory values for each patient and subsequently classified into the corresponding categories.

Overall, while thrice-weekly hemodialysis was associated with better achievement of adequacy targets, a significant proportion of patients—especially those receiving twice-weekly dialysis—did not meet recommended spKt/V thresholds. In addition, the high prevalence of low nPCR highlights the need for improved nutritional assessment and intervention. These findings emphasize the importance of individualized dialysis prescriptions and integrated nutritional support to optimize clinical outcomes.

According to KDOQI guidelines, a dietary protein intake of 1.0–1.2 g/kg/day is recommended for dialysis patients to ensure stable nutritional status and support muscle preservation. The fact that a significant proportion of patients in both groups fall below this threshold suggests a potential area of concern for improving the nutritional care of dialysis patients.²³

Metabolic and Electrolyte Profiles of Dialysis Patients

A comprehensive assessment of metabolic and electrolyte profiles is essential for optimizing the management of dialysis patients, as these parameters are closely associated with clinical outcomes. The key findings are summarized in **Table 4.9**.

Glycemic control, assessed by hemoglobin A1c (HbA1c), showed a mean value of 6.8 ± 1.6%, suggesting that overall glucose control in this cohort was generally acceptable. Similarly, fasting plasma glucose levels demonstrated moderate variability, indicating ongoing challenges in maintaining stable glycemic status in some patients.

Regarding lipid profiles, the mean total cholesterol level was 163.4 ± 42.3 mg/dL, while the mean LDL-cholesterol level was 92.9 ± 33.5 mg/dL. These values were generally within recommended ranges; however, the wide variability suggests heterogeneous cardiovascular risk. In addition, relatively low cholesterol levels in some patients may reflect underlying malnutrition or inflammation, which are common in the dialysis population.

The mean serum uric acid level was 6.8 ± 1.9 mg/dL, with 38.6% of patients having levels above 7.2 mg/dL, indicating a substantial burden of hyperuricemia.

Electrolyte analysis showed that mean serum sodium, potassium, chloride, and bicarbonate levels were largely within normal ranges. Nevertheless, clinically significant abnormalities were common. Hyponatremia (serum sodium <135 mEq/L) was observed in 23.3% of patients, reflecting potential disturbances in fluid balance and solute regulation.

Potassium disorders were present in a notable proportion of patients, with hypokalemia (<3.5 mEq/L) in 6.2% and hyperkalemia (>5.5 mEq/L) in 1.6%. Given the critical role of potassium in cardiac function, these abnormalities represent important clinical concerns.

Most patients had serum chloride levels within the reference range; however, 18.8% had hypochloremia and 2.0% had hyperchloremia, suggesting possible alterations in volume status and acid–base balance.

Acid–base disturbances were also common. Metabolic acidosis, defined as serum bicarbonate <22 mEq/L, was present in 21.3% of patients, while metabolic alkalosis (bicarbonate >26 mEq/L) was observed in 18.8%. These findings highlight the persistent challenges in maintaining acid–base homeostasis in patients receiving dialysis.

Table 3.9. Metabolic and Electrolyte Profiles of Newly Diagnosed Dialysis Patients

Parameters	Mean ± SD	Median (IQR)	N (%)
Fasting Plasma Glucose (mg/dL)	131.7 ± 58.8	113.3 (93.5, 150.3)	
Hemoglobin A1c (%)	6.8 ± 1.6	6.3 (5.5, 7.6)	
Total Cholesterol (mg/dL)	163.4 ± 42.3	158.3 (135.0, 186.0)	
HDL-Cholesterol (mg/dL)	47.3 ± 15.0	45.0 (36.9, 55.1)	
LDL-Cholesterol (mg/dL)	92.9 ± 33.5	88.8 (69.4, 111.3)	
Triglycerides (mg/dL)	134.1 ± 81.5	115.0 (84.0, 160.0)	
Serum Uric Acid (mg/dL)	6.8 ± 1.9	6.7 (5.6, 7.9)	
Serum Uric Acid by Range (mg/dL)			
3.5–7.2			30,326 (59.0)
< 3.5			1,237 (2.4)
> 7.2			19,840 (38.6)
Serum Sodium (mEq/L)	136.7 ± 3.1	137.0 (135.0, 138.7)	—
Serum Sodium by Range (mEq/L)			
135–145			61,525 (76.6)
< 135			18,730 (23.3)
> 145			104 (0.1)
Serum Potassium (mEq/L)	4.3 ± 0.5	4.3 (3.9, 4.6)	
Serum Potassium by Range (mEq/L)			
3.5–5.5			74,362 (92.3)
< 3.5			4,995 (6.2)
> 5.5			1,252 (1.6)
Serum Chloride (mEq/L)	98.7 ± 3.6	98.8 (96.6, 100.9)	
Serum Chloride by Range (mEq/L)			
96–106			63,280 (79.2)
< 96			15,028 (18.8)
> 106			1,574 (2.0)
Serum Bicarbonate (mEq/L)	23.9 ± 2.8	23.9 (22.3, 25.5)	
Serum Bicarbonate by Range (mEq/L)			
22–26			48,207 (60.0)
< 22			17,117 (21.3)
> 26			15,080 (18.8)

Note: Laboratory data were analyzed using the average values for each patient and categorized according to predefined reference ranges.

Overall, these results demonstrate a high prevalence of metabolic and electrolyte abnormalities among dialysis patients. Regular monitoring, individualized treatment strategies, and integrated nutritional and medical support are essential to correct these disturbances, reduce complications, and improve long-term outcomes.

Mineral and Bone Parameters, Including Albumin Status

Table 4.10 presents a comprehensive overview of mineral, bone, and serum albumin parameters in the dialysis population. Key indicators, including serum calcium, phosphate, iPTH, and albumin, were evaluated, as they play a crucial role in the management of CKD-MBD and in assessing overall patient health.

The mean serum calcium level in this cohort was 9.0 ± 1.1 mg/dL, with the majority of patients (65.7%) falling within the normal reference range of 8.6–10.3 mg/dL. Nevertheless, calcium disturbances were common, with 30.5% of patients exhibiting hypocalcemia (serum calcium <8.6 mg/dL) and 3.8% presenting with hypercalcemia (serum calcium >10.3 mg/dL). These imbalances are clinically relevant, as abnormal calcium levels contribute to bone fragility and vascular calcification, thereby increasing cardiovascular risk in dialysis patients.

The mean serum phosphate level was 4.6 ± 1.4 mg/dL. Nearly half of the patients (47.0%) had hyperphosphatemia (serum phosphate >4.5 mg/dL), while 6.0% had hypophosphatemia (serum phosphate <2.7 mg/dL). Phosphate dysregulation remains a major concern in this population, as persistent hyperphosphatemia is strongly associated with secondary hyperparathyroidism, vascular calcification, and increased mortality.

With regard to iPTH, the mean level was 391.9 ± 356.3 pg/mL, with a median of 301.8 pg/mL (IQR: 168.6–499.4 pg/mL). Approximately 63.1% of patients had iPTH levels within the recommended target range of 135–585 pg/mL. However, 18.4% had suppressed iPTH levels (<135 pg/mL), suggesting low bone turnover, while 18.6% had elevated levels (>585 pg/mL), consistent with secondary hyperparathyroidism. These findings indicate that a substantial proportion of patients remained outside optimal targets for bone metabolism control.

The mean serum albumin level was 3.8 ± 0.5 g/dL, with a median of 3.9 g/dL (IQR: 3.6–4.1 g/dL). Although most patients (79.7%) had albumin levels ≥ 3.5 g/dL, a considerable proportion (20.3%) exhibited hypoalbuminemia. Low serum albumin is a well-established marker of malnutrition, inflammation, and adverse clinical outcomes. Its high prevalence in this cohort highlights the ongoing burden of nutritional and inflammatory disorders in dialysis

patients and underscores the importance of regular nutritional assessment and targeted interventions.

Overall, these findings demonstrate a high prevalence of mineral metabolism abnormalities and nutritional impairment in the dialysis population. Continuous monitoring and individualized management strategies are essential to optimize CKD-MBD control, improve nutritional status, and reduce long-term complications.

Table 3.10. Mineral and Bone Parameters Including Albuminuric Status in All Dialysis Patients

Parameters	Mean \pm SD	Median (IQR)	N (%)
Serum Calcium (mg/dL)	9.0 \pm 1.1	8.9 (8.5, 9.4)	
Serum Calcium by Range (mg/dL)			
8.6–10.3			51,961 (65.7)
< 8.6			24,127 (30.5)
> 10.3			3,002 (3.8)
Serum Phosphate (mg/dL)	4.6 \pm 1.4	4.4 (3.6, 5.3)	
Serum Phosphate by Range (mg/dL)			
2.7–4.5			37,067 (46.9)
< 2.7			4,752 (6.0)
> 4.5			37,142 (47.0)
Serum Intact PTH (pg/mL)	391.9 \pm 356.3	301.8 (168.6, 499.4)	
Serum Intact PTH by Range (pg/mL)			
135–585			42,293 (63.1)
< 135			12,321 (18.4)
> 585			12,453 (18.6)
Serum Albumin (g/dL)	3.8 \pm 0.5	3.9 (3.6, 4.1)	
Serum Albumin by Range (g/dL)			
\geq 3.5			61,815 (79.7)
< 3.5			15,749 (20.3)

Note: Laboratory data were analyzed using the average laboratory values for each patient and subsequently categorized according to predefined reference ranges.

Anemia Status and Use of Erythropoiesis-Stimulating Agents in Dialysis Patients

Table 4.11 summarizes anemia status and the use of ESAs among dialysis patients. The mean hemoglobin level was 9.7 \pm 1.4 g/dL, indicating that anemia remained highly prevalent in this population. Only 36.1% of patients achieved the recommended target range of 10.0–11.5 g/dL, while more than half (56.0%) had hemoglobin levels below 10.0 g/dL. A smaller proportion of patients (7.9%) had hemoglobin levels above 11.5 g/dL.

Table 4.11. Anemia Status and Use of Erythropoiesis-Stimulating Agents

Parameters	Mean \pm SD	Median (IQR)	N (%)
Overall Hemoglobin (g/dL)	9.7 \pm 1.4	9.8 (8.8, 10.6)	
Hemoglobin by Range (g/dL)			
10.0–11.5			29,071 (36.1)
< 10.0			45,101 (56.0)
11.5–13.0			5,720 (7.1)
> 13.0			638 (0.8)
Universal Coverage Scheme (UCS)			
Hemoglobin (g/dL)	9.4 \pm 1.4	9.5 (8.5, 10.3)	
10.0–11.5			12,530 (28.6)
< 10.0			28,807 (65.8)
11.5–13.0			2,119 (4.8)
> 13.0			321 (0.7)
Social Security Scheme (SSS)			
Hemoglobin (g/dL)	9.9 \pm 1.4	10.0 (9.0, 10.9)	
10.0–11.5			5,049 (38.9)
< 10.0			6,471 (49.9)
11.5–13.0			1,332 (10.3)
> 13.0			130 (1.0)
Civil Servant Medical Benefit Scheme (CSMBS)			
Hemoglobin (g/dL)	10.3 \pm 1.2	10.4 (9.7, 11.0)	
10.0–11.5			7,822 (54.3)
< 10.0			4,866 (33.8)
11.5–13.0			1,611 (11.2)
> 13.0			120 (0.8)
Self-Payment Group			
Hemoglobin (g/dL)	9.7 \pm 1.3	9.9 (8.9, 10.7)	
10.0–11.5			1,947 (39.2)
< 10.0			2,688 (54.2)
11.5–13.0			306 (6.2)
> 13.0			21 (0.4)
Transferrin Saturation (%)	29.2 \pm 12.5	27.1 (21.1, 34.5)	
Transferrin Saturation by Range (%)			
30–40			15,964 (24.5)
< 20			13,704 (21.0)
20–29			26,074 (40.0)
> 40			9,437 (14.5)
Ferritin (ng/mL)	517.0 \pm 471.6	398.9 (216.0, 658.5)	
Ferritin by Range (ng/mL)			
200–500			26,687 (38.7)
< 200			15,679 (22.7)
> 500			26,568 (38.5)
ESA Use			
Intravenous			85,546 (61.1)
Subcutaneous			16,693 (11.9)
Missing			37,792 (27.0)
ESA Type			
Epoetin alfa			97,386 (92.9)
Epoetin beta			3,046 (2.9)

Darbepoetin alfa			415 (0.4)
Methoxy polyethylene glycol–epoetin beta			289 (0.3)

Note: Laboratory data were analyzed using the average laboratory values for each patient and subsequently categorized according to predefined reference ranges.

Marked differences in anemia control were observed across reimbursement schemes. Patients covered by the CSMBS demonstrated the best anemia management, with 54.3% achieving the target hemoglobin range. This was followed by patients under the SSS (38.9%) and the self-payment group (39.2%). In contrast, only 28.6% of patients under the UCS reached the target range, suggesting disparities in access to anemia management resources and supportive care.

Assessment of iron status showed a median transferrin saturation of 27.1% (IQR 21.1–34.5%) and a median ferritin level of 398.9 ng/mL (IQR 216.0–658.5 ng/mL). Iron deficiency remained common, with 21.0% of patients exhibiting transferrin saturation below 20% and 40.0% having levels between 20% and 29%. In addition, 22.7% of patients had ferritin levels below 200 ng/mL, indicating depleted iron stores. Conversely, 14.5% had transferrin saturation above 40%, and 38.5% had ferritin levels exceeding 500 ng/mL, suggesting potential iron overload in a substantial subset of patients.

Regarding ESA utilization, most patients received ESAs via the intravenous route (61.1%), while 11.9% were treated subcutaneously. Information on administration route was unavailable for 27.0% of patients. Epoetin alfa was the predominant ESA, accounting for 92.9% of prescriptions, whereas other agents, including epoetin beta, darbepoetin alfa, and methoxy polyethylene glycol–epoetin beta, were used infrequently.

Overall, these findings indicate that anemia remains inadequately controlled in a large proportion of dialysis patients, with significant variability across reimbursement schemes. Suboptimal iron status and differential access to ESA therapy may contribute to these disparities, underscoring the need for more standardized and equitable anemia management strategies.

Hepatitis and HIV Serology and Vaccination Status in Dialysis Patients

Table 4.12 summarizes the serological status for viral hepatitis and HIV, as well as vaccination coverage among dialysis patients. A substantial proportion of serological data was missing, ranging from approximately 15.0% to 18.0%, indicating incomplete routine screening in this population.

Among patients with available results, 6.7% tested positive for hepatitis B surface antigen, 5.0% for anti-HCV antibodies, and 2.0% for HIV. In contrast, 62.3% had positive anti-HBs antibodies, suggesting prior hepatitis B vaccination or resolved infection in a majority of patients.

Vaccination coverage remained suboptimal across all vaccine types. Only 25.2% of patients had received the COVID-19 vaccine, while 40.3% were vaccinated against influenza and 22.6% against hepatitis B. Coverage for pneumococcal vaccination was particularly low, at only 1.3%.

Overall, these findings highlight important gaps in both infectious disease screening and preventive care among dialysis patients. The relatively high prevalence of hepatitis B, hepatitis C, and HIV, combined with low vaccination uptake, underscores the need for strengthened surveillance systems and more comprehensive immunization programs to reduce infection-related morbidity and mortality in this high-risk population.

Table 4.12. Hepatitis and HIV Serology Status, and Vaccination Coverage Among Dialysis Patients

Serology / Vaccination Status	Result (N, %)	Missing (N, %)
Serology		
Positive HBs Antigen	7,975 (6.7)	20,572 (14.7)
Positive Anti-HBs Antibody	71,541 (62.3)	25,132 (18.0)
Positive Anti-HCV Antibody	5,863 (5.0)	21,517 (15.4)
Positive HIV Status	2,261 (2.0)	25,091 (17.9)
Vaccination Status		
COVID-19 Vaccine	26,245 (25.2)	–
Hepatitis B Vaccine	23,551 (22.6)	–
Influenza Vaccine	41,948 (40.3)	–
Pneumococcal Vaccine	1,386 (1.3)	–

CHAPTER 5

CAUSES OF DEATH IN DIALYSIS PATIENTS AND PATIENT SURVIVAL

Causes of Death in Dialysis Patients

From 2017 to 2024, a total of 83,344 deaths were recorded among 212,612 registered dialysis patients, corresponding to a cumulative mortality proportion of 39.2%. Mortality was higher among patients receiving peritoneal dialysis than among those undergoing hemodialysis (54.2% vs. 37.3%, respectively) (**Table 5.1**). In terms of incidence, the overall mortality rate was 9.5 deaths per 100 patient-years, with higher mortality observed among peritoneal dialysis patients (13.3 per 100 patient-years) compared with hemodialysis patients (8.8 per 100 patient-years).

Cardiac disease was the leading cause of death, accounting for 20.1% of all deaths, followed by infectious diseases (12.7%) and cerebrovascular disease (4.6%). Other recognized causes included malignancy (2.2%), kidney disease (1.4%), accidents (0.8%), and liver disease (0.7%). In addition, 7.0% of deaths were classified as having an uncertain cause.

Table 5.1. Causes of Death in Dialysis Patients

Cause of Death	Total (N = 83,344) N (%)	Hemodialysis (N = 70,331) N (%)	Peritoneal Dialysis (N = 13,013) N (%)
Cardiac Disease	16,734 (20.1)	15,190 (21.6)	1,544 (11.9)
Infectious Disease	10,578 (12.7)	8,534 (12.1)	2,044 (15.7)
Uncertain	5,816 (7.0)	4,688 (6.7)	1,128 (8.7)
Cerebrovascular Disease	3,870 (4.6)	3,268 (4.7)	602 (4.6)
Malignancy	1,805 (2.2)	1,701 (2.4)	104 (0.8)
Kidney Disease	1,127 (1.4)	1,022 (1.5)	105 (0.8)
Accident	663 (0.8)	621 (0.9)	42 (0.3)
Liver Disease	603 (0.7)	568 (0.8)	35 (0.3)
Suicide	121 (0.1)	94 (0.1)	27 (0.2)
Other	8,276 (9.9)	8,255 (11.7)	8,138 (62.5)
Missing	33,751 (40.5)	28,790 (40.9)	4,961 (38.1)
Cumulative Mortality Proportion	83,344 / 212,612 (39.2)	70,331 / 188,618 (37.3)	13,013 / 23,994 (54.2)
Overall Mortality Rate	9.5/100/year	8.8/100/year	13.3/100/year

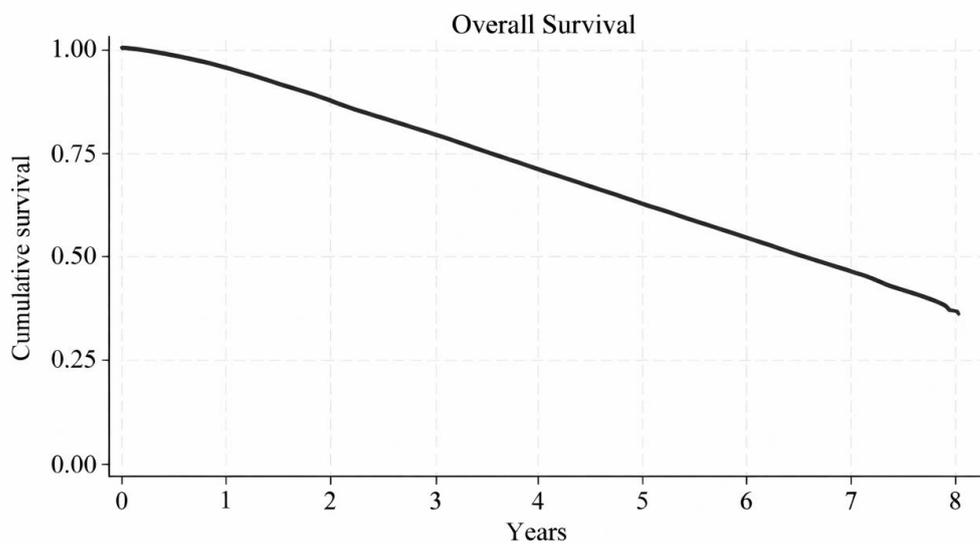
Notable differences in cause-specific mortality were observed between dialysis modalities. Deaths due to cardiac disease were more frequent among hemodialysis patients

than among peritoneal dialysis patients (21.6% vs. 11.9%), indicating a greater burden of cardiovascular mortality in the hemodialysis population. In contrast, infectious diseases accounted for a higher proportion of deaths among peritoneal dialysis patients compared with hemodialysis patients (15.7% vs. 12.1%), suggesting increased vulnerability to infection-related complications, possibly related to long-term catheter use and peritoneal access.

A substantial proportion of deaths had missing cause-of-death information (40.5%), which may limit the precision of cause-specific mortality analyses and highlights the need for improved data completeness and reporting systems. Overall, these findings emphasize the continued predominance of cardiovascular and infectious causes of death in dialysis patients and underscore the importance of targeted preventive and monitoring strategies tailored to dialysis modality.

Patient Survival

Over a median follow-up of 2.48 years (interquartile range [IQR], 1.31-4.30), survival analysis of patients receiving RRT in Thailand in 2024 demonstrated favorable short-term outcomes. The 1-year survival rate was 95.4% (95% CI, 95.2–95.5), declining to 78.9% (95% CI, 78.5–79.2) at 3 years and 61.9% (95% CI, 61.5–62.4) at 5 years (**Figure 5.1**).



Time After Initiation	Survival Rate (%)	95% Confidence Interval
1 Year	95.4	95.2–95.5
3 Years	78.9	78.5–79.2
5 Years	61.9	61.5–62.4

Figure 5.1. Overall Survival of Patients Receiving RRT in Thailand (2024)

These findings indicate that while early survival following dialysis initiation remains high, there is a substantial decline in long-term survival, reflecting the cumulative impact of comorbidities, dialysis-related complications, and progressive cardiovascular and infectious risks. The relatively narrow confidence intervals suggest robust and precise survival estimates derived from the national registry.

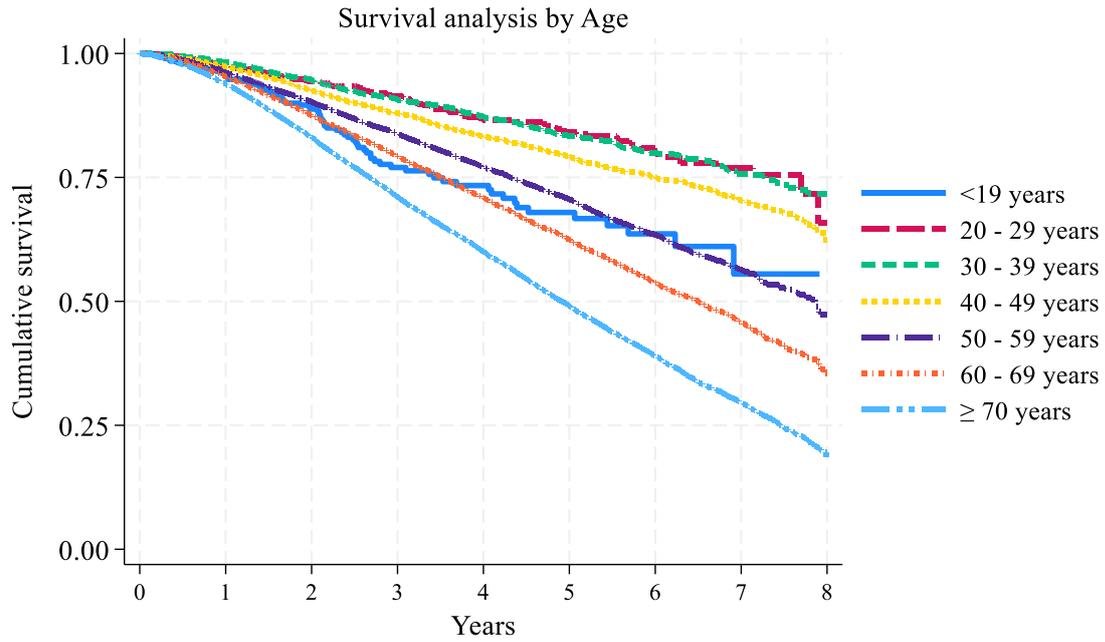
Overall, the observed survival pattern is consistent with international registry reports, in which mortality increases steadily with dialysis duration. The decline in survival beyond three years underscores the importance of sustained multidisciplinary care, optimization of cardiovascular risk management, infection prevention, and timely evaluation for kidney transplantation to improve long-term outcomes among patients receiving RRT in Thailand.

Survival Outcomes by Age Group

Figure 5.2 illustrates the five-year survival of patients receiving RRT in Thailand stratified by age group. A significant association between age and survival was observed (log-rank $p < 0.001$). Five-year survival was highest among young adults aged 20–29 years (84.06%; 95% CI, 80.90–86.75) and 30–39 years (83.43%; 95% CI, 81.86–84.88). Survival remained relatively favorable in patients aged 40–49 years (79.22%; 95% CI, 78.02–80.36), but declined progressively thereafter.

Among patients aged 50–59 years, five-year survival decreased to 70.57% (95% CI, 69.53–71.59), and further declined to 62.50% (95% CI, 61.57–63.40) in those aged 60–69 years. The lowest survival was observed in patients aged ≥ 70 years, with only 49.06% (95% CI, 48.27–49.83) surviving at five years.

Overall, these findings demonstrate a clear inverse relationship between age and long-term survival in Thai hemodialysis patients, with a marked decline in survival observed after the age of 50 years.



Age Groups (N, %)	5-Year Survival (%)	95% Confidence Interval
<19 years	67.93	60.41, 74.34
20–29 years	84.06	80.90, 86.75
30–39 years	83.43	81.86, 84.88
40–49 years	79.22	78.02, 80.36
50–59 years	70.57	69.53, 71.59
60–69 years	62.50	61.57, 63.40
≥ 70 years	49.06	48.27, 49.83

Figure 5.2. Five-Year Survival of Hemodialysis Patients by Age in Thailand (2024)

Note: Survival estimates were calculated using the Kaplan–Meier method. Group differences were assessed using the log-rank test ($p < 0.001$).

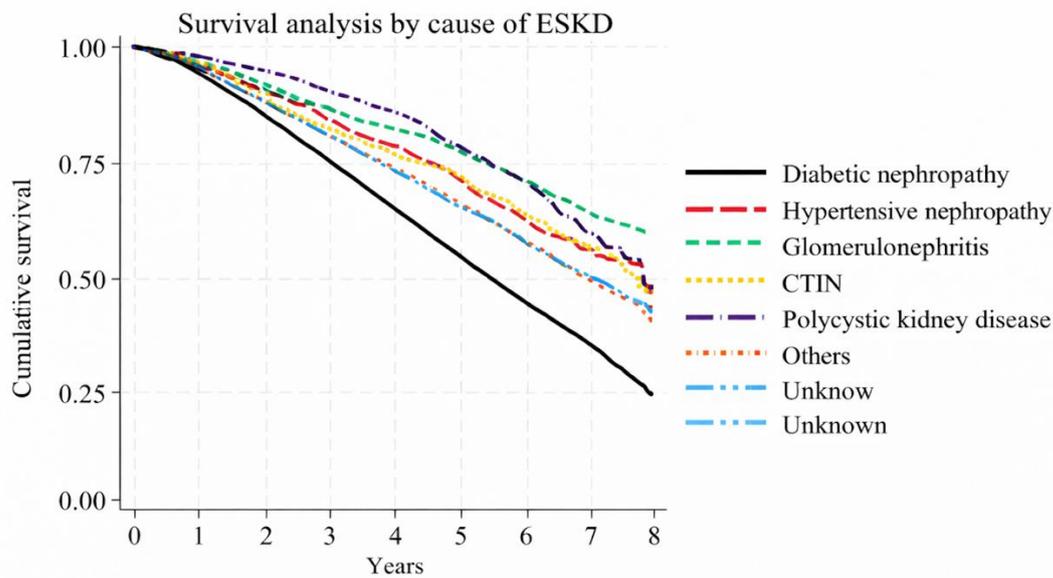
Survival Outcomes by Cause of ESKD

Five-year survival among hemodialysis patients differed significantly according to the underlying cause of ESKD (log-rank test, $p < 0.001$) (**Figure 5.3**). Patients with polycystic kidney disease demonstrated the most favorable prognosis, with a five-year survival rate of 79.2%, followed by those with glomerulonephritis (77.7%) and hypertensive nephropathy (72.0%).

In contrast, patients with diabetic nephropathy had the poorest long-term outcomes, with a five-year survival rate of 54.6%, reflecting a high burden of cardiovascular disease, metabolic complications, and multi-organ involvement. Intermediate survival was observed

among patients with chronic tubulointerstitial nephritis (72.7%) and those with other or unknown causes (67.1% and 66.2%, respectively).

These findings highlight substantial heterogeneity in survival outcomes according to ESKD etiology. The markedly lower survival among patients with diabetic nephropathy underscores the need for intensified cardiovascular risk reduction, metabolic control, and multidisciplinary care. Conversely, more favorable outcomes among patients with inherited and inflammatory renal diseases may reflect earlier referral, younger age at dialysis initiation, and fewer comorbidities.



Cause of ESKD	5-Year Survival (%)	95% Confidence Interval
Diabetic nephropathy	54.6	53.9–55.4
Hypertensive nephropathy	72.0	68.8–74.9
Glomerulonephritis	77.7	75.4–79.8
Chronic tubulointerstitial nephritis (CTIN)	72.7	69.2–75.9
Polycystic kidney disease	79.2	76.1–81.9
Others	67.1	65.6–68.5
Unknown	66.2	64.5–67.9

Figure 5.3. Five-Year Survival of Hemodialysis Patients by Cause of ESKD in Thailand (2024)

Note: Survival estimates were calculated using the Kaplan–Meier method. Group differences were assessed using the log-rank test ($p < 0.001$).

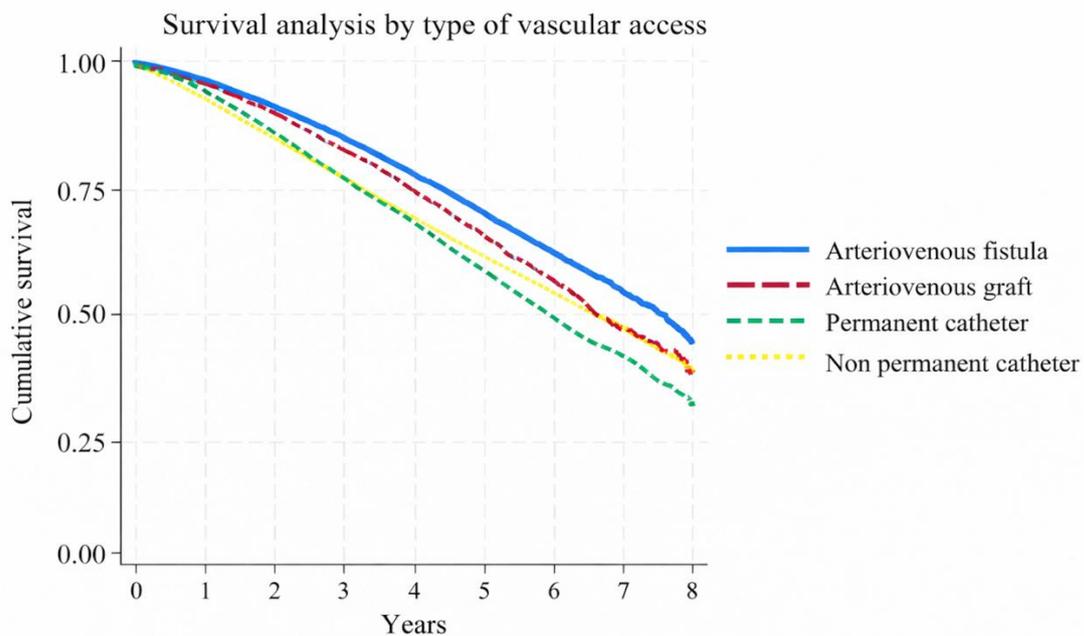
Survival Outcomes by Vascular Access Type

Five-year survival among hemodialysis patients varied significantly according to vascular access type (log-rank test, $p < 0.001$) (Figure 5.4). Patients with arteriovenous fistulas

demonstrated the most favorable outcomes, with a five-year survival rate of 70.2%, followed by those with arteriovenous grafts (66.1%). In contrast, patients using permanent and non-permanent catheters experienced substantially lower survival rates of 58.4% and 61.8%, respectively.

The superior survival associated with arteriovenous fistulas likely reflects lower rates of access-related infections, thrombosis, and hospitalization, as well as better dialysis adequacy and long-term vascular stability. Conversely, catheter-based access was associated with poorer survival, consistent with increased risks of bloodstream infections, central venous stenosis, and chronic inflammation.

These findings emphasize the importance of timely vascular access planning and early arteriovenous fistula creation. Strengthening predialysis care, improving referral pathways for vascular access surgery, and minimizing long-term catheter use should remain key priorities within Thailand’s RRT program.



Type of Vascular Access	5-Year Survival (%)	95% Confidence Interval
Arteriovenous fistula (AVF)	70.2	69.4–71.0
Arteriovenous graft (AVG)	66.1	63.6–68.5
Permanent catheter	58.4	57.3–59.5
Non-permanent catheter	61.8	60.9–62.6

Figure 5.4. Five-Year Survival of Hemodialysis Patients by Type of Vascular Access in Thailand (2024)

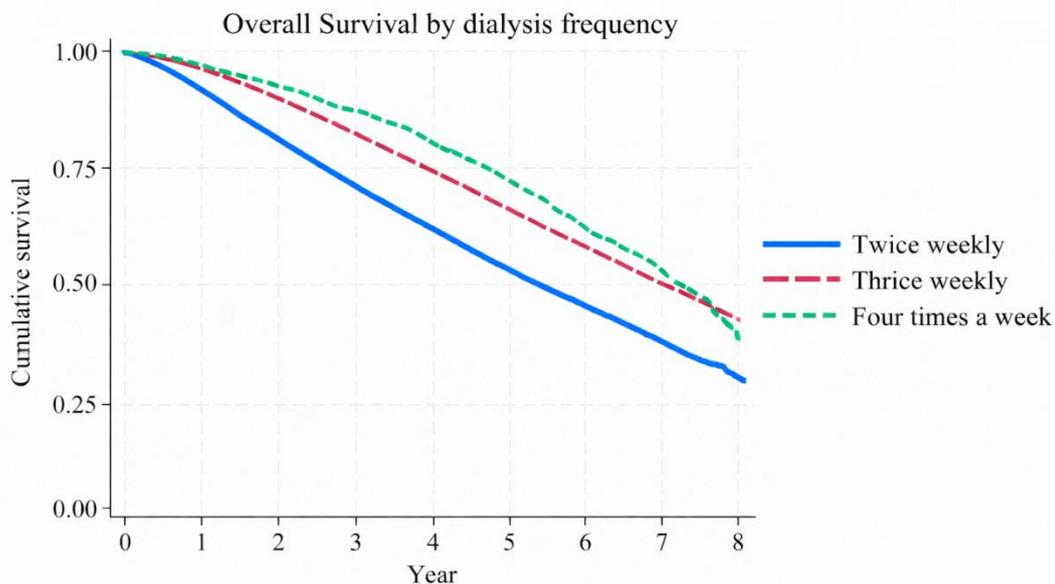
Note: Survival was estimated using the Kaplan–Meier method. Differences between groups were assessed using the log-rank test ($p < 0.001$).

Survival Outcomes by Dialysis Frequency

Five-year survival differed significantly according to dialysis frequency (log-rank test, $p < 0.001$) (**Figure 5.5**). Patients receiving twice-weekly hemodialysis had the lowest survival, at 52.7%, whereas those treated with thrice-weekly and four-times-weekly schedules demonstrated higher survival rates of 67.0% and 71.7%, respectively.

The progressive improvement in survival with increasing dialysis frequency likely reflects better volume control, enhanced solute clearance, and improved metabolic stability. In contrast, lower survival among patients undergoing twice-weekly dialysis may be related to inadequate dialysis dose, greater fluctuations in fluid and electrolyte balance, and delayed transition to standard-frequency therapy.

While twice-weekly hemodialysis may be appropriate for selected patients with substantial residual kidney function, careful patient selection, close monitoring, and timely escalation of treatment intensity are essential to optimize long-term outcomes.



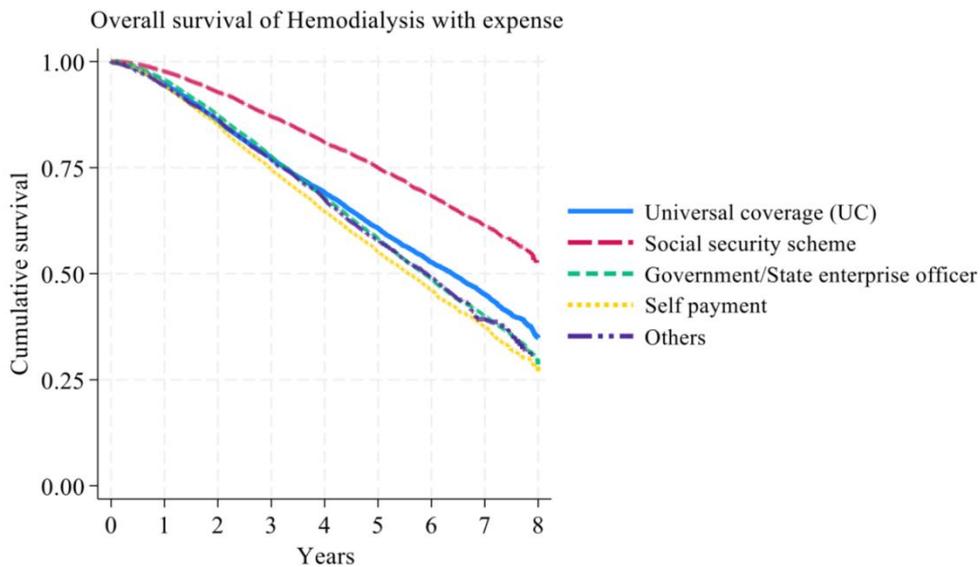
Dialysis Frequency	5-Year Survival (%)	95% Confidence Interval
Twice-weekly hemodialysis	52.7	51.9–53.6
Thrice-weekly hemodialysis	67.0	66.5–67.6
Four times weekly hemodialysis	71.7	68.5–74.7

Figure 5.5. Five-Year Survival of Hemodialysis Patients by Dialysis Frequency in Thailand (2024)

Note: Survival estimates were calculated using the Kaplan–Meier method. Group differences were assessed using the log-rank test ($p < 0.001$).

Survival Outcomes by Health Insurance Scheme

Five-year survival among hemodialysis patients differed significantly according to health insurance scheme (log-rank test, $p < 0.001$) (**Figure 5.6**). Patients covered under the SSS demonstrated the most favorable long-term outcomes, with a five-year survival rate of 74.4%.



Health Insurance Scheme	5-Year Survival (%)	95% Confidence Interval
Universal Coverage (UC)	56.5	55.8–57.2
Social Security Scheme (SSS)	74.4	73.5–75.3
Civil Servant Medical Benefit Scheme (CSMBS) /Government–State Enterprise Officer	57.6	56.7–58.5
Self-Payment	55.3	54.1–56.6
Others	56.1	54.3–57.9

Figure 5.6. Five-Year Survival of Hemodialysis Patients by Health Insurance Scheme in Thailand (2024)

Note: Survival estimates were derived using the Kaplan–Meier method. Differences between groups were assessed using the log-rank test ($p < 0.001$).

In contrast, patients enrolled in the UCS, CSMBS, and those who were self-paying exhibited similar and comparatively lower survival rates, ranging from 55.3% to 57.6%. Patients classified under other insurance categories also showed modest survival outcomes (56.1%).

The superior survival observed among SSS beneficiaries may reflect differences in age distribution, employment status, comorbidity burden, and access to coordinated healthcare

services. Conversely, lower survival in other groups may be influenced by older age at dialysis initiation, higher disease complexity, socioeconomic constraints, and disparities in access to multidisciplinary care.

These findings highlight important socioeconomic gradients in long-term outcomes among hemodialysis patients. Strengthening equitable access to high-quality dialysis care, standardizing clinical practices across insurance schemes, and enhancing support for vulnerable populations should remain central priorities within Thailand's national RRT program.

CHAPTER 6

DIALYSIS CENTER PROVIDERS IN THAILAND

Number of Hemodialysis Centers in Thailand

The number of hemodialysis centers in Thailand has increased steadily from 2007 to 2024, in parallel with the growing burden of ESKD, as illustrated in **Figure 6.1**. By 2024, a total of 1,206 hemodialysis centers were operating nationwide. This expansion reflects both the rising prevalence of chronic kidney disease and ESKD and the healthcare system's efforts to improve access to dialysis services and renal care across the country.

Number of Hemodialysis Centers in Thailand from 2000 to 2024

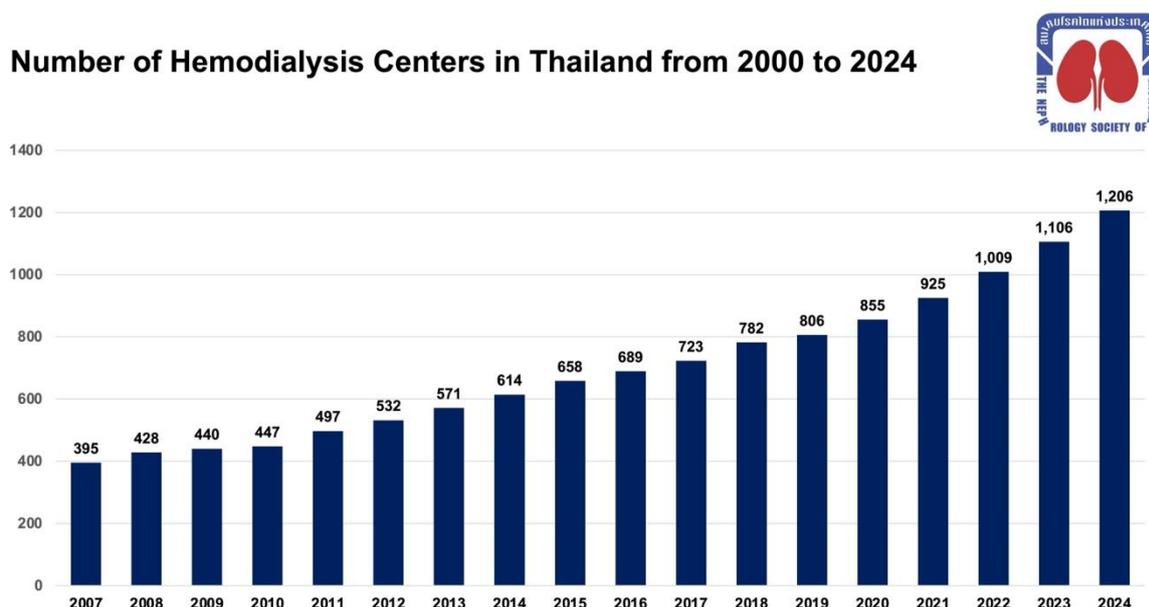


Figure 6.1. Increase in the Number of Hemodialysis Centers in Thailand

Number of Peritoneal Dialysis Centers in Thailand

The number of peritoneal dialysis centers in Thailand increased gradually from 2007 to 2024, as shown in **Figure 6.2**. A marked expansion occurred between 2017 and 2018, when the number of centers rose from 145 to 193, indicating a substantial increase in service availability during this period. In contrast, growth stabilized thereafter, with only a modest increase from 193 to 209 centers between 2018 and 2024. This trend suggests that although peritoneal dialysis services have continued to expand, the pace of new center establishment has slowed in recent years, possibly reflecting capacity constraints, regional service saturation, and evolving renal care strategies.



Number of Peritoneal Dialysis Centers in Thailand from 2000 to 2024

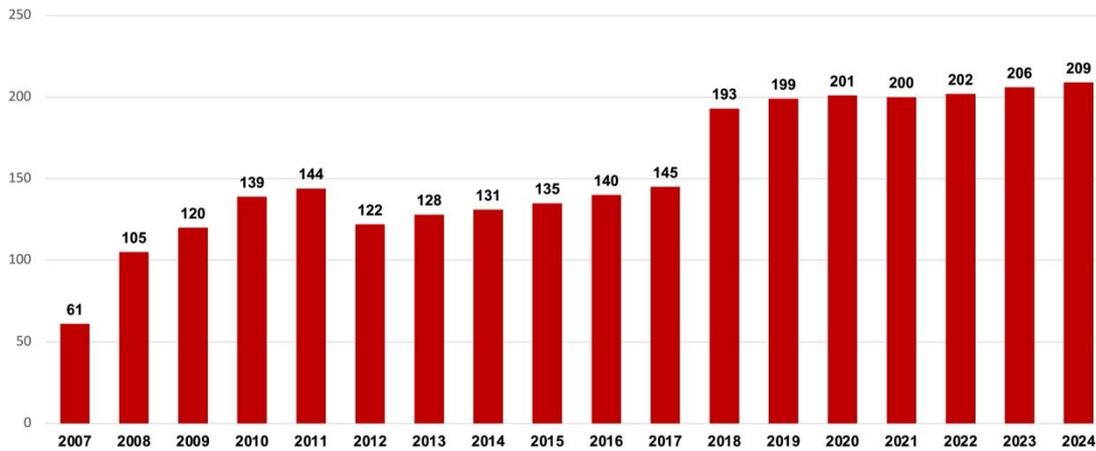


Figure 6.2. Increase in the Number of Peritoneal Dialysis Centers in Thailand

Distribution of Hemodialysis Centers Across Regions in Thailand

The regional distribution of hemodialysis centers in Thailand has remained relatively stable over time, as shown in **Table 6.1**.

Table 6.1. Distribution of Hemodialysis Centers Across Regions

Region	2018	2019	2020	2021	2022	2023	2024
Bangkok and Vicinity	256 (32.7%)	270 (33.5%)	288 (33.7%)	314 (34.0%)	324 (32.1%)	344 (31.1%)	359 (29.8%)
Central Part	88 (11.3%)	83 (10.3%)	86 (10.1%)	93 (10.0%)	110 (10.9%)	110 (9.9%)	120 (10.0%)
Western Part	35 (4.5%)	37 (4.6%)	36 (4.2%)	37 (4.0%)	44 (4.4%)	45 (4.1%)	50 (4.1%)
Eastern Part	62 (7.9%)	64 (7.9%)	70 (8.2%)	76 (8.2%)	85 (8.4%)	96 (8.7%)	94 (7.8%)
Northeastern Part	199 (25.4%)	199 (24.7%)	214 (25.0%)	235 (25.2%)	258 (25.6%)	302 (27.3%)	355 (29.4%)
Northern Part	67 (8.6%)	80 (9.9%)	81 (9.4%)	81 (8.8%)	94 (9.3%)	105 (9.5%)	115 (9.5%)
Southern Part	75 (9.6%)	73 (9.1%)	80 (9.5%)	89 (9.6%)	94 (9.3%)	104 (9.4%)	113 (9.4%)
Total	782 (100%)	806 (100%)	855 (100%)	925 (100%)	1,009 (100%)	1,106 (100%)	1,206 (100%)

In 2024, the largest proportions of hemodialysis centers were located in Bangkok and its vicinity (29.8%) and the Northeastern region (29.4%). This pattern reflects the concentration of

healthcare infrastructure in urban and metropolitan areas, particularly Bangkok, while the Northeastern region also represents a major hub for dialysis service provision. The remaining centers were distributed across the Central, Northern, Southern, Eastern, and Western regions, supporting broad nationwide access to hemodialysis services.

Distribution of Peritoneal Dialysis Centers Across Regions in Thailand

The regional distribution of peritoneal dialysis centers in Thailand has remained relatively stable over time, as shown in **Table 6.2**. In 2024, the Northeastern region accounted for the largest share of peritoneal dialysis centers (30.1%), underscoring its substantial demand for renal replacement therapy services. Bangkok and its vicinity represented the second-largest proportion (17.2%), reflecting the continued concentration of healthcare infrastructure in the capital and surrounding metropolitan areas. The remaining peritoneal dialysis centers were distributed across the Central, Northern, Southern, Eastern, and Western regions, supporting broader nationwide access to peritoneal dialysis care.

Table 6.2. Distribution of Peritoneal Dialysis Centers Across Regions

Region	2018	2019	2020	2021	2022	2023	2024
Bangkok and Vicinity	39 (20.2%)	39 (19.6%)	38 (18.9%)	37 (18.5%)	37 (18.3%)	37 (18.0%)	36 (17.2%)
Central Part	29 (15.0%)	29 (14.6%)	29 (14.4%)	29 (14.5%)	28 (13.9%)	28 (13.6%)	31 (14.8%)
Western Part	9 (4.7%)	10 (5.0%)	10 (5.0%)	10 (5.0%)	10 (5.0%)	11 (5.3%)	12 (5.7%)
Eastern Part	13 (6.7%)	16 (8.0%)	17 (8.5%)	18 (9.0%)	18 (8.9%)	20 (9.7%)	18 (8.6%)
Northeastern Part	58 (30.1%)	59 (29.6%)	60 (29.9%)	60 (30.0%)	62 (30.7%)	63 (30.6%)	63 (30.1%)
Northern Part	20 (10.4%)	22 (11.1%)	22 (10.9%)	21 (10.5%)	22 (10.9%)	22 (10.7%)	23 (11.0%)
Southern Part	25 (13.0%)	24 (12.1%)	25 (12.4%)	25 (12.5%)	25 (12.4%)	25 (12.1%)	26 (12.4%)
Total	193 (100%)	199 (100%)	201 (100%)	200 (100%)	202 (100%)	206 (100%)	209 (100%)

Number of Hemodialysis Machines

The number of hemodialysis machines in Thailand increased substantially from 2012 to 2024, reflecting the rising burden of ESKD and the growing demand for dialysis services (**Table 6.3**). Growth was generally steady over the study period, with a marked acceleration after 2019, particularly between 2023 and 2024. By 2024, a total of 16,652 hemodialysis machines were in operation nationwide, indicating significant expansion of dialysis capacity. This trend underscores

ongoing efforts to strengthen renal care infrastructure in response to the increasing need for renal replacement therapy.

Table 6.3. Growth in the Number of Hemodialysis Machines in Thailand (2012–2024)

Year	Number of Hemodialysis Machines
2012	5,271
2013	5,598
2014	5,359
2015	6,638
2016	7,423
2017	7,830
2018	8,196
2019	8,804
2020	10,512
2021	11,045
2022	11,613
2023	12,353
2024	16,652

Human Resources in Dialysis Centers

The number of full-time qualified physicians, dialysis nurse specialists, and nurses trained through 4–6-month short-course programs in hemodialysis and peritoneal dialysis increased overall between 2018 and 2024, as shown in **Table 6.4**. This growth reflects the rising burden of ESKD and the increasing demand for specialized renal care services.

By 2024, the dialysis workforce comprised 1,021 full-time qualified physicians, 2,520 dialysis nurse specialists, 2,142 nurses trained in hemodialysis, and 172 nurses trained in peritoneal dialysis through short-course programs. The expansion of this specialized workforce underscores sustained efforts to strengthen human resource capacity in dialysis centers and highlights the critical role of structured training programs in supporting the delivery of high-quality dialysis care nationwide.

Table 6.4. Human Resources in Dialysis Centers Across Thailand

Category	2018	2019	2020	2021	2022	2023	2024
Full-time qualified physicians	482	782	716	722	799	931	1,021
Full-time dialysis nurse specialists	918	1,464	1,479	1,393	1,541	2,048	2,520
Nurses trained in 4–6-month short-course hemodialysis programs	1,089	1,767	1,724	1,930	1,913	1,932	2,142
Nurses trained in 4–6-month short-course peritoneal dialysis programs	132	229	181	157	165	282	172

Distribution of Dialysis Centers by Provider

The establishment of hemodialysis centers in Thailand has been driven primarily by the private and government sectors, with a steady increase in the number of centers from 2019 to 2024, as shown in **Table 6.5**. By 2024, the private sector operated the largest number of hemodialysis centers (692 centers), followed by government providers (498 centers), while non-governmental organizations (NGOs) contributed a small but stable number of centers. This trend reflects the expanding role of the private sector in meeting the growing demand for hemodialysis services, alongside the continued importance of government facilities in ensuring access to care, particularly for patients in rural and underserved areas.

In contrast, peritoneal dialysis centers were predominantly established within government hospitals throughout the study period, increasing gradually from 197 centers in 2019 to 207 centers in 2024. Only a limited number of peritoneal dialysis centers were operated by NGOs, and none were reported in the private sector. The relatively slower expansion of peritoneal dialysis centers compared with hemodialysis centers may reflect differences in service delivery models, infrastructure requirements, patient preferences, and the need for specialized training and programmatic support for peritoneal dialysis.

Table 6.5. Growth in the Number of Dialysis Centers by Provider

Year	Government (HD)	Government (PD)	Private (HD)	Private (PD)	Non-Governmental Organizations (HD)	Non-Governmental Organizations (PD)
2019	378	197	416	–	12	2
2020	389	198	449	–	17	3
2021	413	197	494	–	18	3
2022	440	199	553	–	16	3
2023	467	203	623	–	16	3
2024	498	207	692	–	16	2

HD = hemodialysis; PD = peritoneal dialysis.

Status of Dialysis Centers

Hemodialysis centers in Thailand have traditionally been concentrated within hospital-based facilities; however, a substantial expansion of out-of-hospital hemodialysis centers has occurred between 2019 and 2024, as shown in **Table 6.6**. By 2024, a total of 810 hemodialysis centers were operating within hospitals, while 396 centers were located in out-of-hospital settings nationwide. This shift reflects a growing emphasis on outpatient dialysis delivery, likely driven by increasing service demand, improved accessibility, and the expansion of community-based dialysis models.

In contrast, peritoneal dialysis centers have remained exclusively hospital-based throughout the study period, with a gradual increase in the number of in-hospital centers from 199 in 2019 to 209 in 2024. This pattern underscores the continued reliance on hospital infrastructure for peritoneal dialysis services, which require structured patient training, close clinical monitoring, and coordinated multidisciplinary support. The absence of out-of-hospital peritoneal dialysis centers highlights the distinct organizational and care delivery requirements of this modality.

Table 6.6. Growth in the Number of Dialysis Centers by Type

Year	In-Hospital Dialysis Centers (HD)	In-Hospital Dialysis Centers (PD)	Out-of-Hospital Dialysis Centers (HD)	Out-of-Hospital Dialysis Centers (PD)
2019	640	199	166	–
2020	674	201	181	–
2021	718	200	207	–
2022	738	202	271	–
2023	780	206	326	–
2024	810	209	396	–

HD = hemodialysis; PD = peritoneal dialysis.

Operation Type of Dialysis Centers

Hemodialysis services in Thailand have traditionally been delivered through in-house dialysis facilities; however, a marked shift in operational models has occurred between 2019 and 2024, as shown in **Table 6.7**. While in-house centers continued to account for a substantial proportion of services, there was a notable expansion of outsourced dialysis services and private standalone clinics over the study period.

Table 6.7. Growth in the Number of Hemodialysis Centers by Service Type

Year	In-house Government Hospital Centers	Outsourced Government Hospital Centers	In-house Private Hospital Centers	Outsourced Private Hospital Centers	Private Standalone Clinics	In-house Non- Governmental Organizations
2019	318	60	208	52	156	12
2020	321	68	215	62	172	17
2021	326	87	221	70	203	18
2022	328	112	228	74	251	16
2023	338	129	233	79	311	16
2024	342	156	231	78	383	16

By 2024, a total of 589 hemodialysis centers were operated as in-house facilities, comprising government hospitals, private hospitals, and non-governmental organizations. In parallel, outsourced dialysis services increased substantially, with 234 centers operating under

outsourced models within government and private hospitals. The most pronounced growth was observed in private standalone clinics, which increased steadily to 383 centers nationwide by 2024.

This shift toward outsourced services and standalone clinics reflects strategic efforts to expand dialysis capacity and improve access to care, particularly in settings where establishing in-house facilities may be limited by infrastructure, workforce, or financial constraints. The diversification of service delivery models has become an important approach to meeting the rapidly growing demand for dialysis care among patients with end-stage kidney disease, enhancing service availability in both urban and non-urban areas.

CHAPTER 7

SUMMARY DIALYSIS STATUS IN THAILAND

Over the past two decades, Thailand has experienced a rapid and sustained expansion of renal replacement therapy, reflecting a growing national burden of end-stage kidney disease. Registry data from 2000 to 2024 demonstrate a continuous rise in RRT incidence and prevalence, with the incidence reaching a historic high of 515 per million population in 2024. This growth has been driven primarily by the expansion of hemodialysis, particularly following the implementation of the national “free choice” dialysis policy in 2022, which promoted patient-centered modality selection.

Hemodialysis has become the dominant initial and maintenance modality, supported by expanded infrastructure, workforce capacity, and reimbursement mechanisms. In contrast, peritoneal dialysis utilization declined substantially after 2022 and has not returned to pre-policy levels, reflecting challenges related to technique failure, training systems, and changing provider and patient preferences. Kidney transplantation has increased modestly but continues to represent a small proportion of RRT initiation because of persistent limitations in donor availability and transplant capacity.

The prevalence of RRT more than doubled between 2016 and 2024, reaching over 2,600 per million population, reflecting both rising ESKD incidence and improved patient survival. Service capacity expanded in parallel, with more than 1,200 hemodialysis centers operating nationwide by 2024. The private sector has become the main provider of hemodialysis services, while public hospitals remain essential for ensuring access in rural and underserved regions.

The epidemiology of ESKD in Thailand is dominated by non-communicable diseases, particularly diabetes mellitus and hypertension, which together account for more than two-thirds of cases. A substantial proportion of patients still have unidentified causes of kidney disease, highlighting gaps in early diagnosis and diagnostic infrastructure. The dialysis population is predominantly older adults, with relatively low educational attainment, indicating the important influence of socioeconomic and health literacy factors on treatment outcomes.

Access to kidney transplantation remains limited, with only a small proportion of patients registered on waiting lists. The UCS plays a central role in financing RRT, particularly for peritoneal dialysis, while hemodialysis patients are distributed across multiple reimbursement systems. Differences in coverage are associated with disparities in access, quality of care, and survival outcomes.

Important gaps in dialysis practices persist. A high proportion of patients initiate hemodialysis using central venous catheters, indicating delayed vascular access planning. Twice-weekly dialysis remains common and is associated with suboptimal adequacy. Nutritional impairment, metabolic disturbances, mineral bone disorders, and anemia are highly prevalent, reflecting ongoing challenges in comprehensive patient management.

Preventive care remains suboptimal, with incomplete screening for viral infections and low vaccination coverage, particularly for pneumococcal disease. These gaps increase vulnerability to preventable morbidity and mortality in an already high-risk population.

Between 2017 and 2024, cumulative mortality reached 39.2%, with higher mortality observed among peritoneal dialysis patients. Cardiovascular disease and infections were the leading causes of death. Short-term survival remained favorable, exceeding 95% at one year, but declined to approximately 62% at five years. Survival varied significantly by ESKD etiology, vascular access type, dialysis frequency, and health insurance scheme. Patients with diabetic nephropathy, catheter-based access, low dialysis frequency, and disadvantaged insurance coverage experienced poorer outcomes.

Overall, these findings highlight substantial progress in expanding access to RRT in Thailand under universal health coverage, alongside persistent structural, clinical, and socioeconomic challenges. Improving long-term outcomes will require strengthened CKD prevention and early detection, enhanced pre-dialysis care, timely vascular access creation, optimization of dialysis adequacy, revitalization of peritoneal dialysis programs, expansion of transplantation capacity, and improved preventive care systems. Continued investment in high-quality registry data and integrated policy planning will be essential to ensure sustainable, equitable, and patient-centered renal care in Thailand.

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