THAILAND

RENAL REPLACEMENT THERAPY

Registry 2023 Annual Data Report

The Subcommittee on the Thailand Renal Replacement Therapy (TRT) Registry 2024, The Nephrology Society of Thailand.

Bancha Satirapoj,
Editor

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CHAPTER 1

INTRODUCTION

End-stage kidney disease (ESKD) has become a significant public health concern in Thailand, with a rising number of patients requiring renal replacement therapy (RRT) over the past decade.[1] This trend is also evident across Southeast Asia, driven by factors such as improved survival rates, demographic changes, increased prevalence of risk factors like diabetes and hypertension, and better access to RRT in emerging economies.[2,3] This increase in chronic kidney disease (CKD) prevalence has led to a corresponding rise in the number of patients requiring dialysis, with over 20,000 individuals needing treatment annually.[4] This growing burden on healthcare systems demands a proactive response.

Dialysis care in Asia is defined by government support, patient-centered policies, and a focus on enhancing access to high-quality kidney care services. Despite this progress, disparities persist between affluent nations and lower-income countries in the region, where access to adequate renal care is often constrained by economic limitations and challenges in healthcare infrastructure.[5-9] In Thailand, the major challenge under the PD First policy is the transfer of patients from peritoneal dialysis to hemodialysis, with the risks of transfer changing over time.[10] In Thailand, the landscape of RRT has experienced a significant shift with the introduction of an updated hemodialysis policy under the Universal Coverage Scheme (UCS), effective February 1, 2022. This policy empowers patients with ESKD to choose their preferred treatment modality—either hemodialysis or peritoneal dialysis—thereby fostering a more patient-centered approach to care.[11] This shift mirrors global trends toward personalized healthcare, allowing individuals to make informed choices based on their unique health needs and preferences.[12]

Despite these advancements, there are growing concerns regarding the healthcare system's capacity to accommodate the anticipated surge in demand for RRT services. Experts predict that approximately 15,000 additional patients may opt for hemodialysis within the first year of this policy's implementation, raising questions about the adequacy of existing infrastructure and resources to meet this increased need. The National Health Security Office (NHSO) acknowledges these challenges and emphasizes the necessity for strategic planning and resource allocation to ensure that all patients receive timely and effective care.

A pivotal tool in addressing these challenges is the Thailand Renal Replacement Therapy (TRT) Registry. This comprehensive database plays a crucial role in tracking patient demographics, treatment modalities, and clinical outcomes across various hemodialysis centers throughout the country. By systematically collecting and analyzing this data, the TRT Registry provides valuable insights into current practices, identifies trends over time, and highlights areas requiring improvement. Such information is essential for guiding policy decisions and optimizing RRT delivery nationwide.

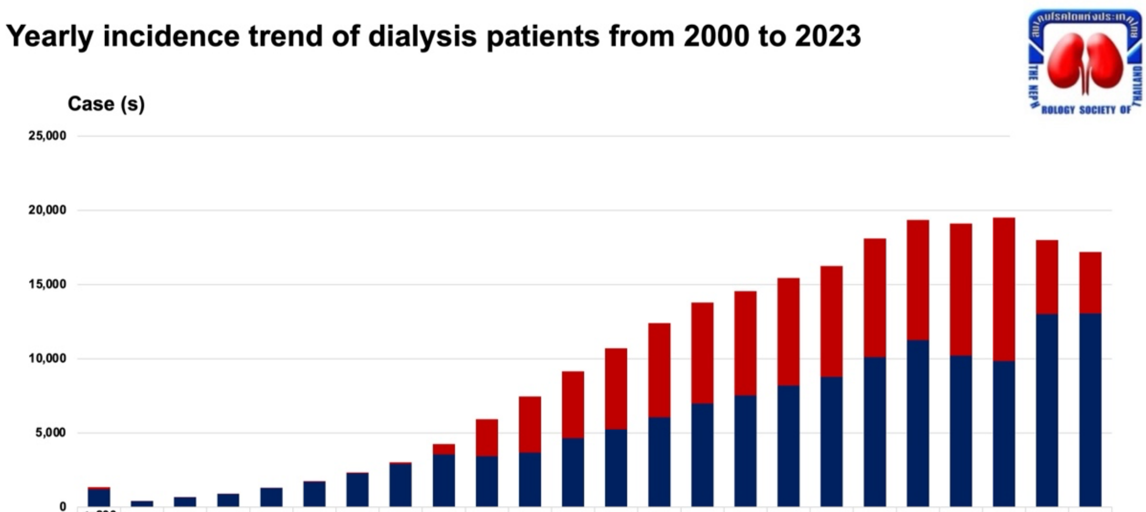
This report aims to present an analysis of the TRT Registry data, highlighting key trends, challenges, and opportunities in the delivery of RRT in Thailand. By exploring the registry's findings, we seek to inform clinicians, policymakers, and researchers, fostering strategies to improve care for ESKD patients and strengthen the healthcare system's capacity to meet their needs.

CHAPTER 2

RENAL REPLACEMENT THERAPY (RRT) DURING THE YEAR 2023

Yearly Incidence Trend of Dialysis Patients in 2000–2023

The incidence of RRT, which includes both hemodialysis and peritoneal dialysis, has shown a steady increase from 2000 to 2023 **(Figure 1.1).** By 2023, data revealed a notable rise in new cases. Specifically, 13,045 new patients began hemodialysis, which represented a rate similar to that of the 2020-2021 period **(Figure 1.2).**



	<=2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PD	169	21	21	24	31	56	73	123	698	2489	3,779	4,525	5,460	6,353	6,812	7,041	7,260	7,474	8,008	8,101	8,917	9,688	4,993	4,159
HD	1,182	400	651	881	1,282	1,700	2,266	2,895	3,543	3,429	3,673	4,627	5,241	6,045	6,970	7,519	8,175	8,774	10,096	11,249	10,201	9,825	13,004	13,045

Figure 1.1: Yearly incidence trend of dialysis patients from 2000 to 2023

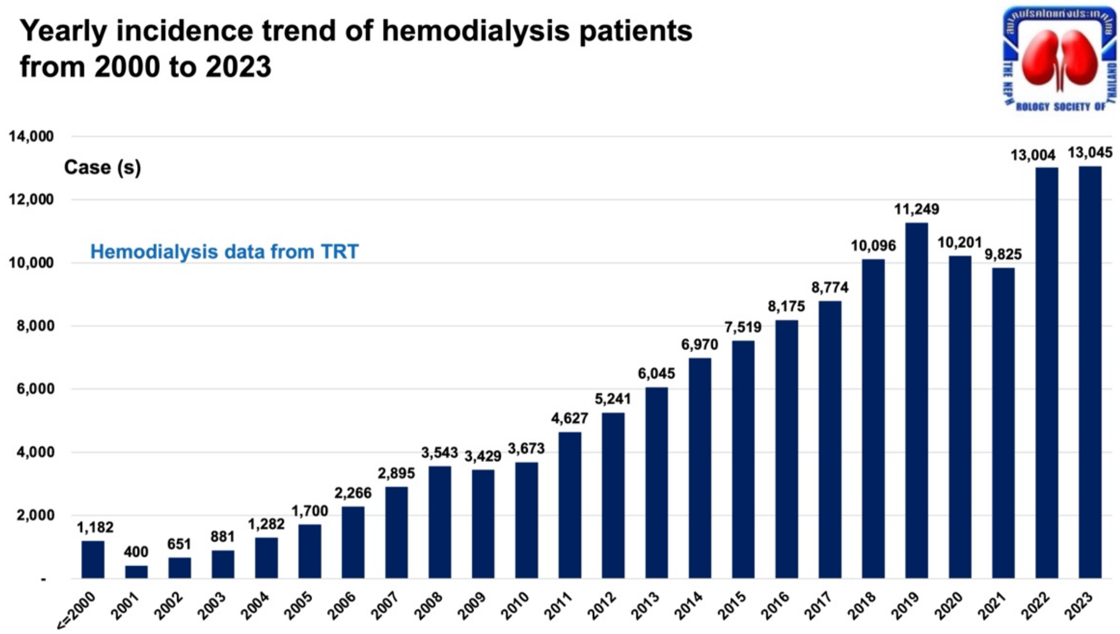


Figure 1.2: Yearly incidence trend of hemodialysis patients from 2000 to 2023

In contrast, 4,159 new patients started peritoneal dialysis, reflecting a dramatic decrease of approximately 2.0 times compared to 2021 **(Figure 1.3).** Meanwhile, 986 patients underwent kidney transplantation as their primary RRT modality, showing a slight increasing trend **(Figure 1.4).**

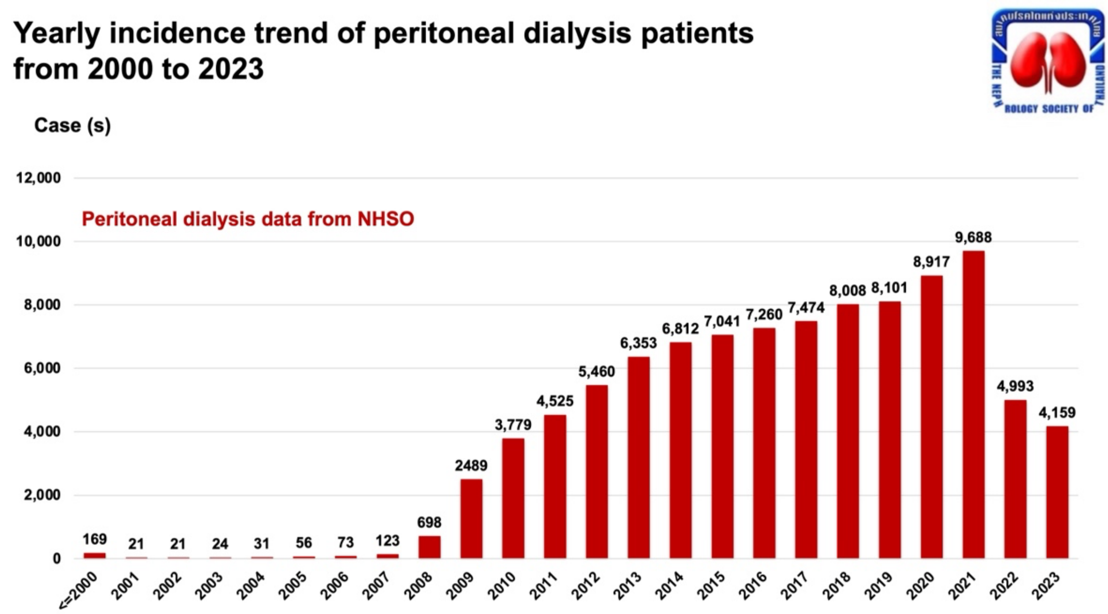


Figure 1.3: Yearly incidence trend of peritoneal dialysis patients from 2000 to 2023

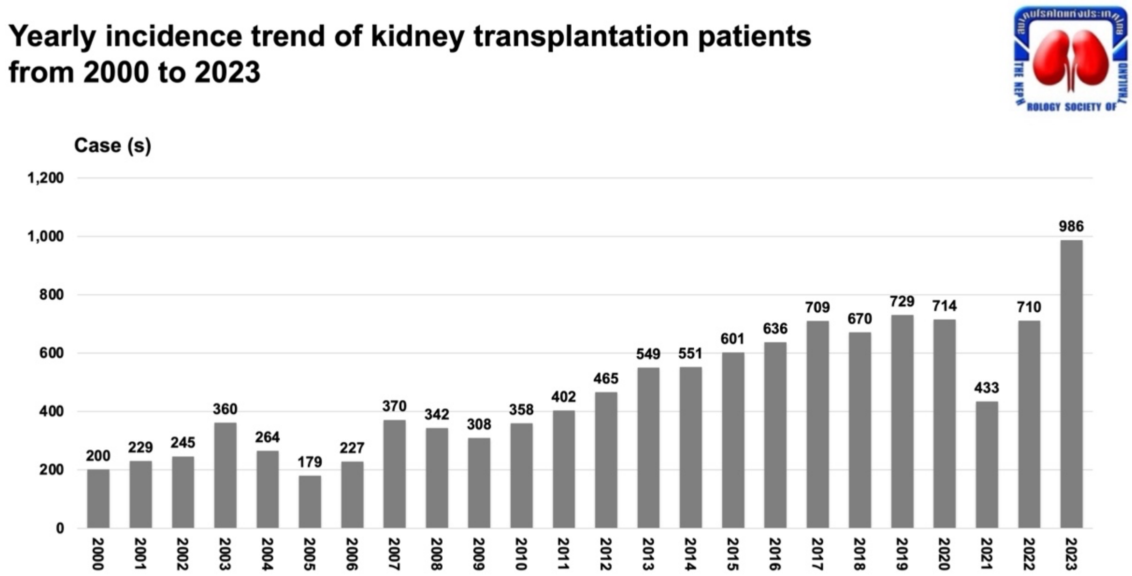
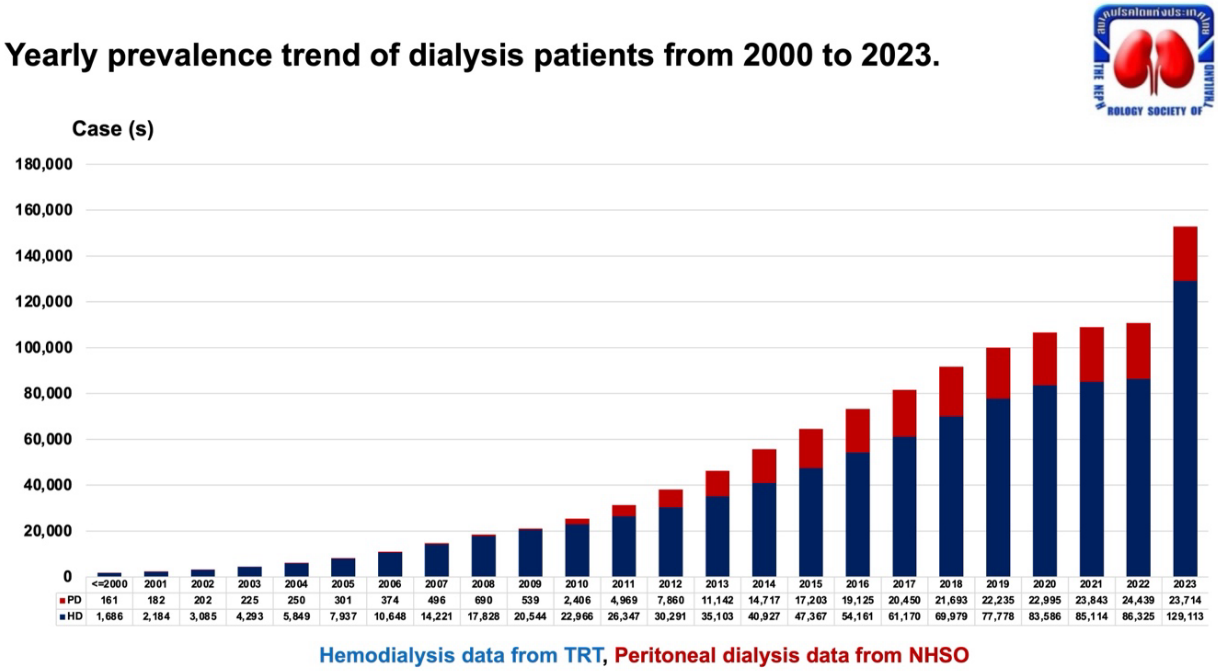


Figure 1.4: Yearly incidence trend of kidney transplantation patients from 2000 to 2023

To ensure data accuracy, all figures presented in this report were meticulously adjusted to eliminate duplicated cases. This was accomplished using the TRT program, version 3, which provides reliable and precise data analysis to support informed decision-making and trend evaluation.

Yearly Prevalence Trend of Dialysis Patients in 2000-2023

The prevalence of RRT through peritoneal dialysis and hemodialysis has steadily increased from 2000 to 2023, reflecting the growing burden of ESKD during this period **(Figure 1.5).** By 2023, the data indicated that a total of 129,113 patients were receiving ongoing hemodialysis treatment, while 23,714 patients were undergoing peritoneal dialysis. This increase in the number of patients undergoing RRT highlights the escalating public health challenge posed by ESKD, driven in part by the rising incidence of underlying conditions such as hypertension and diabetes. Notably, the data on peritoneal dialysis specifically came from the National Health Security Office (NHSO) of Thailand, which tracks the utilization of dialysis modalities nationwide. These figures also suggest a growing demand for healthcare infrastructure and resources dedicated to the management of ESKD, as well as the need for continued advancements in treatment options and patient care. Furthermore, the trend points to an urgent need for preventive measures, including improved management of risk factors, early detection of kidney disease, and public health initiatives aimed at reducing the incidence of conditions leading to ESKD.



	<=2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PD	161	182	202	225	250	301	374	496	690	539	2,406	4,969
HD	1,686	2,184	3,085	4,293	5,849	7,937	10,648	14,221	17,828	20,544	22,966	26,347

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PD	7,860	11,142	14,717	17,203	19,125	20,450	21,693	22,235	22,995	23,843	24,439	23,714
HD	30,291	35,103	40,927	47,367	54,161	61,170	69,979	77,778	83,586	85,114	86,325	129,113

Figure 1.5: Yearly prevalence trend of dialysis patients from 2000 to 2023

CHAPTER 3

EPIDEMIOLOGY OF KIDNEY DISEASE IN NEWLY DIAGNOSED DIALYSIS PATIENTS IN 2023

Underlying Causes of End-Stage Kidney Disease (ESKD)

In 2023, the underlying causes of ESKD among new dialysis patients were primarily attributed to diabetic nephropathy and hypertension, which together accounted for over 80% of cases. Diabetes was the most common cause, responsible for 41.8% of cases, followed closely by hypertension at 39.1%, as detailed in **Table 2.1.** Cases with an unknown etiology represented 10.8%, suggesting the need for further investigation into these origins. Glomerulonephritis, although less common, accounted for 3.0% of the total cases. These findings underscore the critical role of chronic conditions, particularly hypertension and diabetes, in driving the increasing prevalence of ESKD. Moreover, they emphasize the importance of targeted preventive strategies, early diagnosis, and effective management of these conditions to mitigate the burden of ESKD in the population.

Table 2.1. Underlying Causes of End-Stage Kidney Disease (ESKD)

Etiology	Total (N = 13,844)	Percentage (%)
Diabetic Nephropathy	5,787	41.8
Hypertensive Nephropathy	5,422	39.1
Unknown	1,492	10.8
Glomerulonephritis	421	3.0
Others	396	2.9
Obstructive Nephropathy	135	1.0
Polycystic Kidney Disease	105	0.8
Chronic Tubulointerstitial Disease	71	0.5

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

The causes of glomerulonephritis leading to ESKD in 56 new dialysis patients in 2023, as confirmed by kidney biopsy, were diverse, as shown in **Table 2.2.** The most common cause was IgA nephropathy, which accounted for 32.3% of the cases, highlighting its significant role in the progression to ESKD. The second and third most common causes were focal segmental glomerulosclerosis (FSGS) and crescentic glomerulonephritis, making up 6.1% and 4.6% of the cases, respectively. These conditions are known for their aggressive nature and poor renal outcomes. Additionally, the cause of kidney damage was unknown in 35.4% of the cases, indicating the need for further investigation into this group.

Table 2.2. Biopsy-Proven Glomerulonephritis Resulting in End-Stage Kidney Disease (ESKD)

Glomerulonephritis Confirmed by Biopsy	Percentage (%)
IgA nephropathy	32.3
Focal segmental glomerulosclerosis (FSGS)	6.1
Crescentic glomerulonephritis	4.6
Membranous nephropathy	3.0
Mesangial proliferative glomerulonephritis	1.5
Membranoproliferative glomerulonephritis (MPGN)	1.5
Unknown	35.4
Others	15.4

Age, Gender and Education of Dialysis Patients

The dialysis population had a mean age of 60.9±13.9 years, with a sex distribution of 53.3% male and 46.7% female. When this population was divided into two groups based on the type of dialysis—hemodialysis and peritoneal dialysis—the age and sex distribution remained similar across both groups. Specifically, the mean age in both the hemodialysis and peritoneal dialysis cohorts was comparable, reflecting a balanced representation of both sexes in each treatment modality. This consistency suggests that age and sex were not significant differentiators between the two groups in the study population, as shown in **Table 2.3.**

The majority of dialysis patients had an education level of primary school or lower, comprising 53.7% (7,436 individuals). The group receiving peritoneal dialysis had a higher percentage of individuals with this educational background (66.6%) compared to hemodialysis (53.0%). In contrast, hemodialysis patients had a higher percentage of individuals with a bachelor's degree or higher (11.0%) compared to peritoneal dialysis (8.3%), as shown in **Table 2.3.**

Table 2.3. Characteristics of Dialysis Patients: Age, Gender, and Education Level

Category	Hemodialysis (N= 13,045)	Peritoneal Dialysis (N= 743)	Total (N= 13,844)
Gender (Male/Female %)	53.5 / 46.5	50.3 / 49.7	53.3 / 46.7
Age (years)	60.8 ± 13.9	61.3 ± 14.6	60.9 ± 13.9
Age Groups (N, %)			
<18 years	26 (0.2)	12 (1.6)	38 (0.3)
18–40 years	1,213 (9.4)	47 (6.4)	1,263 (9.2)
41–60 years	4,335 (33.5)	229 (31.1)	4,584 (33.3)
>60 years	7,387 (56.9)	449 (60.9)	7,870 (57.2)
Education Levels (N, %)			
Primary school or lower	6,918 (53.0)	495 (66.6)	7,436 (53.7)
Secondary school	1,312 (10.1)	69 (9.3)	1,387 (10.0)
High school	1,596 (12.2)	47 (6.3)	1,646 (11.9)
Vocational/High vocational certificate	822 (6.3)	34 (4.6)	863 (6.2)
Bachelor's degree or higher	1,434 (11.0)	62 (8.3)	1,505 (10.9)
Unknown	963 (7.4)	36 (4.9)	1,008 (7.3)

Kidney Transplantation Waiting List Among Dialysis Patients

The data showing that only 2.8% of hemodialysis patients and 2.9% of peritoneal dialysis patients are registered on the kidney transplant waiting list highlight significant challenges related to accessibility and awareness of kidney transplantation. This low registration rate is particularly concerning among younger patients, with only 5.2% of individuals under 60 and 4.2% of those under 65 included on the list, as shown in **Table 2.4.**

Table 2.4. Kidney Transplantation Waiting List Among Dialysis Patients

Category	Hemodialysis (N= 13,045)	Peritoneal Dialysis (N= 743)	Total (N=13,844)
Waiting lists for kidney transplantation	359 (2.8 %)	22 (2.9 %)	383 (2.8%)
Age (years)			
<60 years	294 (5.2%)	18 (6.1%)	312 (5.2%)
<65 years	318 (4.2%)	20 (4.8%)	338 (4.2%)
<70 years	332 (3.5%)	22 (4.1%)	355 (3.5%)
<75 years	341 (3.0%)	22 (3.4%)	364 (3.1%)

Distribution of New Dialysis Patients Across Reimbursement Schemes

In 2023, 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 2.5.** The UCS covered the majority of new dialysis patients at 65.5%, followed by the SSS at 13.2% and the CSMBS at 12.3%.

The UCS's broad coverage plays a key role in managing the growing ESKD burden. While all schemes predominantly favored hemodialysis, the UCS showed a higher proportion of patients receiving peritoneal dialysis compared to the other schemes. This variation may be due to differences in dialysis availability, patient preferences, and healthcare provider recommendations.

Table 2.5. Distribution of New Dialysis Patients Across Reimbursement Schemes

Category	Hemodialysis (N= 13,045)	Peritoneal Dialysis (N= 743)	Total (N=13,844)
Universal Coverage Scheme (UCS)	8,482 (65.0%)	554 (74.6%)	9,067 (65.5%)
Social Security Scheme (SSS)	1,720 (13.2%)	94 (12.7%)	1,824 (13.2%)
Civil Servant Medical Benefit Scheme (CSMBS)	1,640 (12.6%)	44 (5.9%)	1,694 (12.3%)
Self-payment	325 (2.5%)	7 (0.9%)	335 (2.4%)
Others	878 (6.7%)	44 (5.9%)	925 (6.7%)

Type of Vascular Access in Initial Hemodialysis Patients

` The primary types of vascular access used in initial hemodialysis patients were as follows: arteriovenous fistula (AVF), which accounted for 35.9%; double lumen catheter, which represented 34.4% and permanent catheter, used in 22.3% of patients, as shown in **Table 2.6.** The data revealed a notably high prevalence of patients relying on double lumen catheters for chronic hemodialysis, highlighting their significant role in long-term dialysis treatment. This finding may suggest challenges in achieving optimal vascular access, as the double lumen catheter is often considered a less ideal choice compared to the AVF due to its association with higher risks of complications.

Table 2.6. Types of Vascular Access in Initial Hemodialysis Patients

Type of Vascular Access	Total (N=13,045)	Percentage (%)
Arteriovenous Fistula (AVF)	4,850	35.9
Double Lumen Catheter (DLC)	4,657	34.4
Permanent Catheter	3,014	22.3
Arteriovenous Graft (AVG)	302	2.2

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

The frequency of hemodialysis treatments varies based on patient needs, healthcare access, and specific medical guidelines. Among patients with ESKD, the most common dialysis regimens are twice-weekly dialysis (48.1%) and thrice-weekly dialysis (51.3%).

Table 2.7. Hemodialysis Adequacy in Patients on Hemodialysis

Hemodialysis Adequacy	Percentage (%)	
Dialysis Frequency		
Two times a week hemodialysis	48.1%	
Three times a week hemodialysis	51.3%	
Four times a week hemodialysis	0.2%	
Two times a week hemodialysis	**Mean ± SD**	**Median (IQR)**
spKt/V	1.67±0.37	1.65 (1.42, 1.88)
spKt/V < 1.8 (N, %)	2,889	65.8%
Urea Reduction Ratio (URR) (%)	73.7± 8.3	74.9 (69.2, 79.4)
URR < 65 (N, %)	582	13.0%
Normalized Protein Catabolic Rate (nPCR)	1.16±0.27	1.14 (0. 96, 1.33)
nPCR < 1 (N, %)	1,314	30.1%
Three times a week hemodialysis		
spKt/V	1.60±0.34	1.58 (1.37¸1.82)
spKt/V < 1.2 (N, %)	578	11.0%
Urea Reduction Ratio (URR) (%)	72.4± 8.0	73.2 (67.8, 77.9)
URR < 65 (N, %)	854	16.1%
Normalized Protein Catabolic Rate (nPCR)	1.06±0.25	1.04 (0.89, 1.21)
nPCR < 1 (N, %)	2,230	42.7%

The adequacy of these treatment regimens is often evaluated using spKt/V and the Urea Reduction Ratio (URR), which quantify dialysis efficiency by measuring urea clearance—a marker of waste removal during dialysis, as shown in **Table 2.7.** For twice-weekly hemodialysis, the mean spKt/V was 1.67±0.37, and the mean URR was 73.7± 8.3%. For thrice-weekly hemodialysis, the mean spKt/V was 1.60±0.34, and the mean URR was 72.4± 8.0%. Among patients undergoing twice-weekly dialysis, 65.8% face challenges in achieving the optimal spKt/V value of 1.8 with this schedule, whereas only 11.0% of patients on thrice-weekly dialysis fail to reach the optimal spKt/V value of 1.2 with this schedule.[11]

Achieving an adequate Normalized Protein Catabolic Rate (nPCR) is essential to ensure that patients receive sufficient protein to prevent malnutrition and maintain muscle mass. For twice-weekly hemodialysis, the mean nPCR was 1.16±0.27 g/kg/day, while for thrice-weekly hemodialysis, the mean nPCR was 1.06±0.25 g/kg/day. Moreover, approximately 30-40% of patients in both groups had an nPCR of less than 1 g/kg/day. This range is considered suboptimal for maintaining muscle mass and overall protein balance, which is particularly important for dialysis patients. According to KDOQI guidelines, a dietary protein intake of 1.0–1.2 g/kg/day is recommended to maintain stable nutritional status.[12]

Metabolic and Electrolyte Profiles of New Dialysis Patients

A comprehensive assessment of the metabolic and electrolyte profiles of new dialysis patients has become increasingly important, particularly as these factors significantly impact patient outcomes. This analysis focuses on key electrolytes and metabolic parameters that are crucial for managing patients undergoing dialysis, as shown in **Table 2.8.**

Table 2.8. Metabolic and Electrolytes Profiles of Newly Diagnosed Dialysis Patients

Parameters	Mean ± SD	Median (IQR)	N (%)
Fasting Plasma Glucose (mg/dL)	136.7 ± 72.2	114 (94, 153)	
Hemoglobin A1C (%)	6.9 ± 1.7	6.33 (5.6, 7.7)	
Total Cholesterol (mg/dL)	166.5 ± 48.7	160 (134, 191)	
HDL-Cholesterol (mg/dL)	46.6 ± 16.3	44 (36, 55)	
LDL-Cholesterol (mg/dL)	96.1 ± 39.0	90 (68, 117)	
Triglycerides (mg/dL)	136.7 ± 84.5	116 (83, 166)	
Serum Uric Acid (mg/dL)	7.1 ± 2.2	7 (5.6, 8.4)	
Serum Uric Acid by Range			
3.5 - 7.2			2,898 (51.3%)
<3.5			182 (3.2%)
>7.2			2,567 (45.5%)
Serum Sodium (mEq/L)	136.2 ± 3.8	137 (134, 139)	
Serum Sodium by Range			
135 - 145			8,239 (68.9%)
<135			3,681 (30.8%)
>145			42 (0.4%)
Serum Potassium (mEq/L)	4.2± 0.6	4.23 (3.9, 4.7)	
Serum Potassium by Range			
3.5 - 5.5			10,448 (87.2%)
<3.5			1,184 (9.9%)
>5.5			351 (2.9%)
Serum Chloride (mEq/L)	99.0± 4.6	99 (97, 102)	
Serum Chloride by Range			
96 - 106			8,862 (74.8%)
<96			2,439 (20.6%)
>106			548 (4.6%)
Serum Bicarbonate (mEq/L)	23.4 ± 3.7	24 (22, 26)	
Serum Bicarbonate by Range			
22 - 26			6,185 (52.0%)
<22			3,497 (29.4%)
>26			2,212 (18.6%)

The data was analyzed using the average laboratory results for each patient and then classified into each category group.

The mean hemoglobin A1C (HbA1c) was 6.9±1.7%, achieving the recommended target for diabetes management, indicating that many patients have optimal glucose control, which may improve long-term cardiovascular outcomes. The mean total cholesterol level was 166.5 ± 48.7 mg/dL, falling within the typical range for dialysis patients; however, this relatively low level may also suggest malnutrition, a common concern in this population. Additionally, the mean LDL-cholesterol (LDL-C) level was 96.1±39.0 mg/dL, showing considerable variability among patients and suggesting that some individuals may be at increased cardiovascular risk due to elevated LDL levels.

The mean serum uric acid level in the dialysis population was 7.1±2.2 mg/dL. The mean and median values, along with the IQR for electrolyte profiles, indicated that sodium, potassium, chloride, and bicarbonate levels were generally within the normal range. However, a significant portion of the population exhibited abnormalities in these parameters. Specifically, 30.8% had hyponatremia, defined as serum sodium levels <135 mEq/L. Regarding potassium levels, 2.9% of patients had hyperkalemia and 9.9% of patients had hypokalemia. Additionally, 29.4% of the population had metabolic acidosis, indicated by serum bicarbonate levels <22 mEq/L, while 18.6% had metabolic alkalosis, with serum bicarbonate levels >26 mEq/L. These findings underscore the prevalence of electrolyte disturbances and acid-base imbalances in dialysis patients, highlighting the need for close monitoring and appropriate management to prevent complications.

Mineral and Bone Parameters including Albuminuric Status

Table 2.9. Mineral and Bone Parameters in Newly Diagnosed Dialysis Patients

Parameter (n, %)	Mean ± SD	Median (IQR)	N (%)
Serum Calcium (mg/dL)	8.8 ± 1.3	8.8 (8.3, 9.3)	
8.6–10.3			6,600 (58.7%)
<8.6			4,192 (37.3%)
>10.3			444 (3.9%)
Serum Phosphate (mg/dL)	4.6 ± 1.6	4.4 (3.5, 5.4)	
2.7–4.5			5,009 (44.7%)
<2.7			1,026 (9.2%)
>4.5			5,169 (46.1%)
Serum Intact-PTH (pg/mL)	357.6 ± 412.9	254.6 (133.5, 443.6)	
135–585			4,281 (59.2%)
<135			1,839 (25.4%)
>585			1,114 (15.4%)
Serum Albumin (g/dL)	3.7 ± 0.5	3.75 (3.5, 4.1)	
≥3.5			7,419 (69.4%)
<3.5			3,267 (30.6%)

The data was analyzed using the average laboratory results for each patient and then classified into each category group.

Table 2.9 presents the mineral, bone, and serum albumin levels in the 2023 dialysis population. The mean serum calcium and phosphate levels were 8.8 ± 1.3 mg/dL and 4.6 ± 1.6 mg/dL, respectively, with a median intact parathyroid hormone (iPTH) level of 254.6 (IQR

133.5 to 443.6) pg/mL. While most mineral and bone parameters were within normal ranges, significant abnormalities were observed: 3.9% of patients had hypercalcemia, 46.1% had hyperphosphatemia, and 9.2% had hypophosphatemia.

Regarding, iPTH, 59.2% of patients had levels within the target range (135–585 pg/mL), but 25.4% had levels below 135 pg/mL, and 15.4% had levels above 585 pg/mL. The mean serum albumin level was 3.7 ± 0.5 g/dL, with 30.6% of patients exhibiting hypoalbuminemia, indicating widespread protein malnutrition or inflammation, which can negatively impact health and treatment outcomes.

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

Table 2.10 presents data on anemia status and the use of erythropoiesis-stimulating agents (ESAs) in new dialysis patients in 2023. The mean hemoglobin level was 9.2 ± 1.5 g/dL, with 25.4% of patients reaching the recommended target range of 10–11.5 g/dL. A significant proportion, 68.5%, had hemoglobin levels below 10.0 g/dL, while 6.1% exceeded the target.

Anemia management varied by reimbursement scheme: 35.5% of CSMBS patients and 33.1% of self-paying patients reached the target range, compared to 28.3% under the SSS and 22.1% under the UCS. This suggests that reimbursement schemes may impact anemia management.

The median transferrin saturation was 25.6% (IQR 18.6 to 34.8%), and the median ferritin level was 373 ng/mL (IQR 188 to 690 ng/mL). Iron depletion was common, with 29.9% of patients having transferrin saturation <20%, and 34.1% having levels between 20% and 29%. Additionally, 26.7% had ferritin <200 ng/mL. On the other hand, 16.4% had transferrin saturation >40%, indicating possible iron overload, while 37.3% had ferritin >500 ng/mL, suggesting iron overload.

Most ESAs were administered intravenously (88.9%), with recombinant human erythropoietin (Epoetin Alfa) being the most commonly used (97.5%), while Epoetin Beta accounted for only 1.8%.

Table 2.10. Anemia Status and Use of Erythropoiesis-Stimulating Agents

Parameters	Mean ± SD	Median (IQR)	N (%)
Hemoglobin (g/dL)	9.2± 1.5	9.24 (8.2, 10.3)	
Hemoglobin (g/dL) by Range			
10–11.5			3,089 (25.4%)
<10			8,314 (68.5%)
>11.5–13			626 (5.2%)
>13			112 (0.9%)
Hemoglobin (g/dL) in Universal Coverage Scheme (UCS)	9.0 ± 1.5	9.06 (8.1, 10.0)	
10–11.5			1,764 (22.1%)
<10			5,885 (73.9%)
>11.5–13			264 (3.3%)
>13			53 (0.7%)
Hemoglobin (g/dL) in Social Security Scheme (SSS)	9.5 ± 1.6	9.48 (8.3, 10.6)	
10–11.5			426 (28.3%)
<10			924 (61.4%)
>11.5–13			134 (8.9%)
>13			21 (1.4%)
Hemoglobin (g/dL) in Civil Servant Medical Benefit Scheme (CSMBS)	9.8 ± 1.5	9.82 (8.8, 10.8)	
10–11.5			582 (35.5%)
<10			870 (53.1%)
>11.5–13			159 (9.7%)
>13			29 (1.8%)
Hemoglobin (g/dL) in Self-Payment Group	9.5 ± 1.5	9.63 (8.7, 10.6)	
10–11.5			96 (33.1%)
<10			170 (58.6%)
>11.5–13			21 (7.3%)
>13			3 (1.0%)
Transferrin Saturation (%)	28.7 ± 15.0	25.56 (18.6, 34.8)	
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)	539.4 ± 558.5	373 (188, 690)	
200–500			2,878 (35.9%)
<200			2,137 (26.7%)
>500			2,986 (37.3%)
Erythropoietin Stimulating Agents (ESA) Use			
Intravenous route			10,208 (88.9)
Subcutaneous route			1,263 (11.0)
Missing			2,373 (0.1)
Recombinant Human Erythropoietin (Epoetin Alfa)			11,001 (97.5)
Recombinant Human Erythropoietin (Epoetin Beta)			197 (1.8)
Darbepoetin Alfa			51 (0.5)
Methoxy Polyethylene Glycol-Epoetin Beta			32 (0.3)

The data was analyzed using the average laboratory results for each patient and then classified into each category group.

Hepatitis & HIV Serology and Vaccination in Newly Diagnosed Dialysis Patients

Data on viral hepatitis and HIV serology were significantly missing (55%–60%). Among the available data, only 1.9% of dialysis patients tested positive for hepatitis B antigen, 1.3% for anti-HCV antibodies, and 0.4% for HIV antibodies **(Table 2.11).**

Vaccination rates were low: 6.9% of patients received the COVID-19 vaccine, 26.8% received the influenza vaccine, and 65.5% were vaccinated for hepatitis B. Alarmingly, only 0.9% had received the pneumococcal vaccine, highlighting a significant gap in vaccination coverage for this vulnerable population.

Table 2.11. Hepatitis and HIV Serology Status, as well as Vaccination Rates and Coverage, Among Newly Diagnosed Dialysis Patients

Serology/Vaccination	Result (N, %)	Missing (N, %)
Positive HBs Antigen	474 (1.9%)	3,028 (55.1%)
Positive Anti-HBs Antibody	3,936 (16.3%)	3,258 (55.1%)
Positive Anti-HCV Antibody	312 (1.3%)	4,347 (60.2%)
Positive HIV Status	87 (0.4%)	4,580 (61.2%)
Vaccination (N = 9,094)		
COVID-19 Vaccine	275 (6.9%)	
Hepatitis-B Vaccine	2,572 (65.0%)	
Influenza Vaccine	1,058 (26.8%)	
Pneumococcal Vaccine	34 (0.9%)	

Clinical Outcomes in Dialysis Patients

Previous data from Thailand (2018 to 2022) indicated a mortality rate ranging from approximately 6% to 10%. In 2023, the mortality rate among newly initiated dialysis patients was 3.6%. Analyzing the causes of death within this population, the major contributors were cardiac disease (32.1%) and infectious diseases (20.6%), as shown in **Table 2.12.** This suggests that improving patient outcomes should focus on better management of cardiovascular health and infection prevention, which are two of the most significant risks for dialysis patients. Enhanced clinical care, regular monitoring, and the implementation of preventive measures for these conditions could potentially reduce mortality rates in the future.

Table 2.12: Causes of Death Among Newly Diagnosed Dialysis Patients

Cause of Death	Total (N = 504)	Percentage (%)
Cardiac Disease	162	32.1
Infectious Disease	104	20.6
Cerebrovascular Disease	37	7.3
Malignancy	20	3.9
Liver Disease	10	2.0
Kidney Disease	7	1.4
Accident	6	1.2
Suicide	3	0.6
Uncertain	61	12.1
Overall Mortality Rate	**504/13,844**	**3.6**

CHAPTER 4

EPIDEMIOLOGY OF KIDNEY DISEASE IN ALL DIALYSIS PATIENTS

Underlying Causes of End-Stage Kidney Disease (ESKD)

The underlying causes of ESKD among all dialysis patients were primarily attributed to diabetic nephropathy and hypertension, which together accounted for over 60% of cases. Diabetes was the most common cause, responsible for 34% of cases, followed closely by hypertension at 27.9%, as detailed in **Table 3.1.** Chronic tubulointerstitial diseases accounted for 5.4% of cases, with specific causes including chronic urate nephropathy (N=474), analgesic nephropathy (N=233), and chronic pyelonephritis (N=62). Glomerulonephritis, though less common, represented 2.9% of the total cases, with lupus nephritis (N=1,091) being the most frequent subtype. These findings underscore the critical role of chronic conditions, particularly diabetes and hypertension, in driving the increasing prevalence of ESKD. They also highlight the importance of targeted preventive strategies, early diagnosis, and effective management of these conditions to alleviate the burden of ESKD. Finally, it is important to note that 19.5% of ESKD cases had no available data indicating the cause of the disease.

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

Etiology	Total (N = 142,938)	Percentage (%)
Diabetic Nephropathy	48,659	34.0
Hypertensive Nephropathy	39,914	27.9
Chronic Tubulointerstitial Disease	7,758	5.4
Glomerulonephritis	4,261	2.9
Others	3,495	2.4
Obstructive Nephropathy	2,340	1.6
Polycystic Kidney Disease	1,694	1.2
Unknown	6,931	4.8
Missing Data	27,816	19.5

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

The causes of glomerulonephritis leading to ESKD in 836 dialysis patients, as confirmed by kidney biopsy up until 2023, were varied, as detailed in **Table 3.2.** The most prevalent cause was IgA nephropathy, which accounted for 29.3% of cases, emphasizing its significant role in the progression to ESKD. The second, third, and fourth most common causes were membranoproliferative glomerulonephritis (MPGN), membranous nephropathy, and focal segmental glomerulosclerosis (FSGS), comprising 26.1%, 10.2%, and 9.6% of cases, respectively. These conditions are characterized by their aggressive course and poor renal prognosis, contributing substantially to the burden of ESKD. Additionally, in 10.2% of cases, the cause of kidney damage remained unidentified, underscoring the need for further diagnostic exploration in this cohort.

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

Etiology	Total (N = 836)	Percentage (%)
IgA Nephropathy	245	29.3
Membranoproliferative Glomerulonephritis (MPGN)	218	26.1
Membranous Nephropathy	86	10.2
Focal Segmental Glomerulosclerosis (FSGS)	80	9.6
Chronic Allograft Nephropathy	19	2.3
Mesangial Proliferative Glomerulonephritis	16	1.5
Crescentic Glomerulonephritis	12	1.9
Amyloidosis	7	0.8
Unknown	86	10.2
Others	67	8.0

Age, Gender and Education of Dialysis Patients

The dialysis population had a mean age of 61.9 ± 16.7 years, with a sex distribution of 52.1% male and 46.3% female. When divided into two groups based on the type of dialysis—hemodialysis and peritoneal dialysis—the age and sex distribution remained similar across both groups. Specifically, the mean age was nearly identical in both the hemodialysis and peritoneal dialysis cohorts, and both groups exhibited a relatively balanced representation of males and females. This consistency suggests that age and sex were not significant differentiators between the two treatment modalities, as shown in **Table 3.3.** The age and sex distribution across dialysis modalities indicate that both hemodialysis and peritoneal dialysis are utilized across a broad demographic, with no significant bias toward either gender or age group.

In terms of educational background, the majority of dialysis patients had a primary school education or lower, accounting for 32.9% (47,321 individuals) of the total population. Among these, peritoneal dialysis patients had a significantly higher percentage with this educational level (55.5%) compared to hemodialysis patients (30.3%). Conversely, a higher proportion of hemodialysis patients had attained a bachelor's degree or higher, comprising 13.8% of this group, compared to just 5.1% among those on peritoneal dialysis, as detailed in **Table 3.3.** The educational disparity between the two dialysis groups suggests that patients on peritoneal dialysis may face more socio-economic or accessibility challenges, which could be an important factor in treatment choices and health outcomes.

Table 3.3. Characteristics of Dialysis Patients: Age, Gender, and Education Level

Category	Hemodialysis (N = 129,113)	Peritoneal Dialysis (N = 14,779)	Total (N = 143,892)
Gender (Male/Female %)	52.3 / 46.1	50.8 / 48.2	52.1 / 46.3
Age (years)	62.3 ± 17.05	59.9 ± 15.4	61.9 ± 16.7
Age Groups (N, %)			
<18 years	2,998 (2.5%)	240 (1.7%)	3,238 (2.4%)
18–40 years	10,326 (8.5%)	1,369 (9.6%)	11,695 (8.6%)
41–60 years	35,808 (29.4%)	4,696 (33.0%)	40,504 (29.8%)
>60 years	72,584 (59.6%)	7,928 (55.7%)	80,512 (59.2%)
Education Levels (N, %)			
Primary school or lower	39,116 (30.3%)	8,205 (55.5%)	47,321 (32.9%)
Secondary school	28,870 (22.4%)	2,844 (19.2%)	31,714 (22.0%)
High school	12,769 (9.9%)	1,190 (8.1%)	13,959 (9.7%)
Vocational/High vocational certificate	10,402 (8.1%)	740 (5.0%)	11,142 (7.7%)
Bachelor's degree or higher	17,816 (13.8%)	760 (5.1%)	18,576 (12.9%)
Unknown	20,140 (15.6%)	1,040 (7.0%)	21,180 (14.7%)

Kidney Transplantation Waiting List Among Dialysis Patients

The data reveal that only 33.9% of hemodialysis patients and 10.9% of peritoneal dialysis patients are currently registered on the kidney transplant waiting list. These low registration rates highlight significant barriers related to both accessibility and awareness of kidney transplantation. Of particular concern is the low representation of younger patients, with only 26.1% of individuals under 60 and 25.3% of those under 65 years of age being included on the list, as shown in **Table 3.4.**

Table 3.4. Kidney Transplantation Waiting List Among Dialysis Patients

Category	Hemodialysis (N = 129,113)	Peritoneal Dialysis (N = 14,779)	Total (N = 143,892)
Waiting Lists for Kidney Transplantation (N, %)	43,596 (33.9%)	1,594 (10.9%)	45,190 (31.6%)
Age (years)			
<60 years	13,725 (27.6%)	865 (13.8%)	14,590 (26.1%)
<65 years	17,464 (27.0%)	1,006 (11.9%)	18,470 (25.3%)
<70 years	21,970 (27.2%)	1,172 (11.0%)	23,142 (25.3%)
<75 years	26,222 (27.6%)	1,305 (10.6%)	27,527 (25.7%)

Distribution of Dialysis Patients Across Reimbursement Schemes

The distribution of dialysis patients in Thailand across different reimbursement schemes highlights the country's efforts to ensure access to RRT for individuals with ESKD, as shown in **Table 3.5.** The UCS accounted for the largest proportion of dialysis patients, covering 46.2%, followed by the CSMBS at 21.2% and the SSS at 16.3%.

The broad reach of the UCS is a key factor in addressing the increasing burden of ESKD in Thailand. Although all schemes predominantly support hemodialysis, the UCS had a notably higher proportion of patients receiving peritoneal dialysis compared to the other schemes. This difference may be attributed to variations in the availability of dialysis options, patient preferences, and the recommendations of healthcare providers.

Table 3.5. Distribution of Dialysis Patients Across Reimbursement Schemes

Category	Hemodialysis (N = 129,113)	Peritoneal Dialysis (N = 14,779)	Total (N = 143,892)
Universal Coverage Scheme (UCS)	50,115 (41.8%)	12,018 (82.5%)	62,133 (46.2%)
Civil Servant Medical Benefit Scheme (CSMBS)	27,517 (22.9%)	941 (6.5%)	28,458 (21.2%)
Social Security Scheme (SSS)	21,396 (17.9%)	535 (3.7%)	21,931 (16.3%)
Self-payment	13,217 (11.0%)	137 (0.9%)	13,354 (9.9%)
Others	7,648 (6.4%)	930 (6.4%)	8,578 (6.4%)

Type of Vascular Access in Hemodialysis Patients

The primary types of vascular access used in hemodialysis patients were as follows: arteriovenous fistula (AVF), which accounted for 38.9%; double lumen catheter (DLC), which represented 22.8%; and permanent catheter, used by 18.8% of patients, as shown in Table 3.6. The data reveal a notably high reliance on double lumen catheters for long-term hemodialysis, underscoring their significant role in chronic dialysis management. This finding suggests potential challenges in achieving optimal vascular access, as the double lumen catheter is generally considered a suboptimal choice compared to the AVF due to its association with higher complication rates.

Table 3.6. Types of Vascular Access in Hemodialysis Patients

Type of Vascular Access	Total (N = 129,113)	Percentage (%)
Arteriovenous Fistula (AVF)	55,759	38.9
Double Lumen Catheter (DLC)	32,710	22.8
Permanent Catheter	26,898	18.8
Arteriovenous Graft (AVG)	8,665	6.1

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

The frequency of hemodialysis treatments is determined by several factors, including the patient's clinical condition, healthcare accessibility, and established medical guidelines. Among patients with ESKD, thrice-weekly dialysis is the most common regimen, accounting for 65.0% of cases, while twice-weekly dialysis is used by 34.3% of patients. These frequencies are typically chosen based on the patient's ability to tolerate treatment, the efficiency of dialysis sessions, and the medical team's assessment of the patient's needs.

Table 3.7. Hemodialysis Adequacy in Patients on Hemodialysis

Hemodialysis Adequacy	**Total (N = 129,113)**	**Percentage (%)**
Dialysis Frequency		
Two times a week hemodialysis	35,372	34.3
Three times a week hemodialysis	67,034	65.0
Four times a week hemodialysis	493	0.5
Two times a week hemodialysis	**Mean ± SD**	**Median (IQR)**
spKt/V	1.71 ± 0.34	1.69 (1.47, 1.93)
spKt/V < 1.8 (N, %)	20,586	62.1
Urea Reduction Ratio (URR) (%)	74.8 ± 7.3	75.6 (70.5, 79.9)
URR < 65 (N, %)	3,096	9.3
Normalized Protein Catabolic Rate (nPCR)	1.20 ± 0.25	1.18 (1.01, 1.36)
nPCR < 1 (N, %)	7,644	23.0
Three times a week hemodialysis		
spKt/V	1.64 ± 0.33	1.61 (1.41, 1.84)
spKt/V < 1.2 (N, %)	4,889	7.6
Urea Reduction Ratio (URR) (%)	73.1 ± 7.3	73.61 (68.7, 78.2)
URR < 65 (N, %)	8,245	12.7
Normalized Protein Catabolic Rate (nPCR)	1.09 ± 0.23	1.07 (0.93, 1.23)
nPCR < 1 (N, %)	24,236	37.7

The adequacy of dialysis treatment is commonly evaluated using parameters such as spKt/V and the Urea Reduction Ratio (URR), which assess the efficiency of dialysis by quantifying urea clearance, a key indicator of waste removal during the procedure, as shown in **Table 3.7.**

For patients on twice-weekly hemodialysis, the mean spKt/V was 1.71 ± 0.34, and the mean URR was 74.8 ± 7.3%. On the other hand, patients on thrice-weekly hemodialysis had a mean spKt/V of 1.64 ± 0.33 and a mean URR of 73.1 ± 7.3%. Notably, 62.1% of patients receiving twice-weekly dialysis had an spKt/V < 1.8, which is considered below the optimal target for adequate dialysis, whereas only 7.6% of patients on thrice-weekly dialysis failed to meet the target spKt/V of 1.2.[11] These findings highlight the challenges associated with achieving adequate dialysis with less frequent hemodialysis schedules, as the more frequent dialysis sessions (thrice-weekly) tend to result in better urea clearance and more efficient waste removal.

In terms of Normalized Protein Catabolic Rate (nPCR), which is crucial for ensuring adequate protein intake to prevent malnutrition and preserve muscle mass, the mean nPCR for twice-weekly hemodialysis patients was 1.20 ± 0.25 g/kg/day. For patients on thrice-weekly hemodialysis, the mean nPCR was slightly lower at 1.09 ± 0.23 g/kg/day. These results suggest a trend towards lower protein intake in the thrice-weekly cohort. Moreover, a concerning proportion of patients across both groups had nPCR values below 1.0 g/kg/day, with 23.0% of patients on twice-weekly hemodialysis and 37.7% of those on thrice-weekly hemodialysis failing to meet the recommended threshold for protein intake. This suboptimal nPCR range (< 1.0 g/kg/day) is known to be inadequate for maintaining muscle mass and overall protein balance, which is particularly critical for dialysis patients.

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.[12]

Metabolic and Electrolyte Profiles of Dialysis Patients

A comprehensive evaluation of the metabolic and electrolyte profiles of dialysis patients is crucial, as these parameters are closely linked to patient outcomes and overall health management. The following analysis highlights key electrolytes and metabolic markers that play a pivotal role in the care of dialysis patients, as presented in **Table 3.8.**

Hemoglobin A1C (HbA1c): The mean HbA1c level was 6.7 ± 1.6%, aligning with the recommended target for effective diabetes management. This suggests that a significant proportion of patients have achieved optimal glucose control, which is critical for preventing diabetes-related complications and improving long-term cardiovascular outcomes. Nonetheless, continued monitoring of glucose control remains important, particularly in light of the challenges dialysis patients face in maintaining stable metabolic profiles.

Total Cholesterol: The mean total cholesterol level was 164.1 ± 42.4 mg/dL, which falls within the typical range observed in dialysis populations. While this level is generally considered acceptable, it may also reflect malnutrition, a common concern in dialysis patients due to limited dietary intake and altered metabolism. Low cholesterol levels can be an indirect marker of poor nutritional status, which can exacerbate other comorbidities, including cardiovascular disease and muscle wasting.

LDL-Cholesterol (LDL-C): The mean LDL-C level was 93.4 ± 33.5 mg/dL, showing significant variability among patients. Although this level is generally considered acceptable according to current guidelines, the variability suggests that some patients may be at increased cardiovascular risk due to elevated LDL levels. Managing lipid levels, particularly LDL-C, is crucial in this population to reduce the risk of atherosclerosis and other cardiovascular complications that are prevalent in dialysis patients.

Table 3.8. Metabolic and Electrolyte Profiles of All Dialysis Patients

Parameters	Mean ± SD	Median (IQR)	N (%)
Fasting Plasma Glucose (mg/dL)	127.3 ± 56.4	109 (91.8, 144.2)	
Hemoglobin A1C (%)	6.7 ± 1.6	6.2 (5.5, 7.5)	
Total Cholesterol (mg/dL)	164.1 ± 42.4	159 (135.5, 186.8)	
HDL-Cholesterol (mg/dL)	47.5 ± 15.2	45 (37, 55.6)	
LDL-Cholesterol (mg/dL)	93.4 ± 33.5	89.2 (70.1, 112)	
Triglycerides (mg/dL)	132.7 ± 81.3	113 (82.7,158.3)	
Serum Uric Acid (mg/dL)	6.8 ± 1.8	6.7 (5.6, 7.9)	
Serum Uric Acid by Range			
3.5 - 7.2			34,701 (59.5%)
<3.5			1,212 (2.1%)
>7.2			22,399 (38.4%)
Serum Sodium (mEq/L)	136.9 ± 3.1	137.3 (135.3, 139)	
Serum Sodium by Range			
135 - 145			70,466 (78.6%)
<135			19,068 (21.3%)
>145			154 (0.2%)
Serum Potassium (mEq/L)	4.3 ± 0.6	4.3 (3.9, 4.7)	
Serum Potassium by Range			
3.5 - 5.5			82,140 (91.2%)
<3.5			5,881 (6.5%)
>5.5			2,022 (2.3%)
Serum Chloride (mEq/L)	98.5 ± 3.6	98.5 (96.4, 100.7)	
Serum Chloride by Range			
96 - 106			68,984 (77.6%)
<96			18,458 (20.7%)
>106			1,502 (1.7%)
Serum Bicarbonate (mEq/L)	24.0 ± 2.9	24 (22.3, 25.7)	
Serum Bicarbonate by Range			
22 - 26			52,751 (58.8%)
<22			18,318 (20.4%)
>26			18,709 (20.8%)

The data was analyzed using the average laboratory results for each patient and then classified into each category group.

The mean serum uric acid level in the dialysis population was 6.8 ± 1.8 mg/dL, which is slightly elevated compared to the typical reference range. In terms of electrolyte balance, the mean and median values, along with the IQR, indicated that the levels of serum sodium, potassium, chloride, and bicarbonate were generally within the normal range. However, significant portions of the population exhibited abnormalities in these key metabolic parameters.

Sodium: A substantial 21.3% of patients had hyponatremia, defined as serum sodium levels of <135 mEq/L, which is a notable deviation from the normal range (135–145 mEq/L). This may indicate issues with fluid balance, kidney function, or other underlying conditions.

Potassium: Potassium disturbances were observed in the population, with 2.3% of patients exhibiting hyperkalemia (serum potassium >5.5 mEq/L) and 6.5% presenting with hypokalemia (serum potassium <3.5 mEq/L). Given potassium's critical role in cardiac and muscular function, these imbalances are of particular concern.

Chloride: The majority of patients had serum chloride levels within the normal range (96-106 mEq/L). However, 20.75% exhibited hypochloremia (serum chloride <96 mEq/L), while a small proportion (1.69%) had hyperchloremia (serum chloride >106 mEq/L). These abnormalities could be indicative of disturbances in acid-base balance or fluid status.

Bicarbonate: The serum bicarbonate levels revealed significant metabolic disturbances. 20.4% of the patients had metabolic acidosis, as indicated by serum bicarbonate levels <22 mEq/L, which is a common finding in dialysis patients due to impaired kidney function in excreting acid. In contrast, 20.8% had metabolic alkalosis, with serum bicarbonate levels >26 mEq/L. Both conditions reflect the acid-base imbalances commonly observed in this patient population, requiring careful management to prevent complications.

These findings emphasize the high prevalence of electrolyte imbalances and acid-base disturbances in dialysis patients, which can significantly impact overall health. Close monitoring and timely interventions are essential to manage these abnormalities effectively, minimize complications, and optimize patient outcomes.

Mineral and Bone Parameters, Including Albuminuric Status

Table 3.9 provides a comprehensive overview of the mineral, bone, and serum albumin levels in the dialysis population. The analysis highlights key parameters such as serum calcium, phosphate, intact parathyroid hormone (iPTH), and albumin, which are critical in managing dialysis patients and assessing their overall health.

The mean serum calcium level in this cohort was 9.0 ± 1.2 mg/dL, with most patients (65.7%) falling within the normal range of 8.6–10.3 mg/dL. However, there was a notable prevalence of calcium imbalances, as 29.2% of patients exhibited hypocalcemia (serum calcium <8.6 mg/dL), and 5.1% had hypercalcemia (serum calcium >10.3 mg/dL). These abnormalities are important as calcium imbalances can increase the risk of bone disease and cardiovascular complications, which are common in dialysis patients.

The mean serum phosphate level was 4.6 ± 1.4 mg/dL, with a significant proportion of patients showing hyperphosphatemia (48.4%), where serum phosphate levels exceed 4.5 mg/dL, and hypophosphatemia (6.4%), where levels fall below 2.7 mg/dL. Phosphate imbalance is particularly concerning in dialysis patients, as elevated phosphate levels are associated with increased mortality due to cardiovascular calcification and bone mineral disorders.

Table 3.9. Mineral and Bone Parameters, Including Albuminuric Status, in All Dialysis Patients

Parameter (n, %)	**Mean ± SD**	**Median (IQR)**	**N (%)**
Serum Calcium (mg/dL)	9.0 ± 1.2	9 (8.5, 9.5)	
8.6–10.3			58,007 (65.7%)
<8.6			25,772 (29.2%)
>10.3			4,477 (5.1%)
Serum Phosphate (mg/dL)	4.6 ± 1.4	4.5 (3.6, 5.4)	
2.7–4.5			39,940 (45.3%)
<2.7			5,600 (6.4%)
>4.5			42,715 (48.4%)
Serum Intact-PTH (pg/mL)	427.1 ± 415.7	315.6 (169, 542.3)	
135–585			43,173 (59.1%)
<135			13,753 (18.8%)
>585			16,136 (22.1%)
Serum Albumin (g/dL)	3.8 ± 0.5	3.87 (3.6, 4.1)	
≥3.5			68,342 (79.1%)
<3.5			18,058 (21.0%)

The data was analyzed using the average laboratory results for each patient and then classified into each category group.

Regarding serum iPTH, the mean level was 427.1 ± 415.7 pg/mL, with a median of 315.6 pg/mL (IQR: 169, 542.3 pg/mL). The iPTH levels serve as a marker for bone metabolism, and while 59.1% of patients had iPTH levels within the recommended target range of 135–585 pg/mL, a substantial proportion had out-of-target iPTH levels: 18.8% had levels below 135 pg/mL, indicating potential hypoparathyroidism or low bone turnover, and 22.1%

had levels above 585 pg/mL, which may indicate secondary hyperparathyroidism, a common issue in CKD.

Finally, the mean serum albumin level was 3.8 ± 0.5 g/dL, with the IQR ranging from 3.6 to 4.1 g/dL. Low serum albumin levels are often associated with malnutrition, inflammation, and poor health outcomes. A worrisome 21.0% of patients had hypoalbuminemia (serum albumin <3.5 g/dL), a strong indicator of nutritional deficits and inflammatory states, both of which are prevalent in dialysis patients. Hypoalbuminemia is a well-known risk factor for increased morbidity, mortality, and poor dialysis outcomes, making it a critical parameter to monitor.

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

Table 3.10 presents data on anemia status and the use of erythropoiesis-stimulating agents (ESAs) in dialysis patients. The mean hemoglobin level was 9.8 ± 1.5 g/dL, with 37.9% of patients achieving the recommended target range of 10–11.5 g/dL. A significant proportion (51.8%) had hemoglobin levels below 10.0 g/dL, while 10.4% exceeded the target range.

Anemia management varied across reimbursement schemes: 55.1% of CSMBS patients, 38.8% of SSS patients, and 36.9% of self-paying patients reached the target range, compared to just 29.7% of patients under the UCS. This suggests that reimbursement schemes may influence the effectiveness of anemia management.

The median transferrin saturation was 27.5% (IQR 21.5–35.0%), and the median ferritin level was 410.2 ng/mL (IQR 217.3–681.7 ng/mL). Iron deficiency was common, with 19.7% of patients having transferrin saturation <20%, and 39.8% having levels between 20% and 29%. Additionally, 22.6% had ferritin levels <200 ng/mL, indicating iron depletion. Conversely, 15.1% had transferrin saturation >40%, suggesting potential iron overload, while 40.2% had ferritin levels >500 ng/mL, also indicative of iron overload.

The majority of ESAs were administered intravenously (77.1%), with recombinant human erythropoietin (Epoetin Alfa) being the most commonly used (97.3%). Epoetin Beta accounted for only 2.0% of ESA prescriptions.

Table 3.10. Hemoglobin, Iron Status, and Erythropoietin Stimulating Agents in Dialysis Patients

Parameters	Mean ± SD	Median (IQR)	N (%)
Hemoglobin (g/dL)	9.8 ± 1.5	9.92 (8.9, 10.8)	
Hemoglobin (g/dL) by Range			
10–11.5			34,042 (37.9)
<10			46,537 (51.8)

>11.5–13			8,245 (9.2)
>13			1,063 (1.2)
Hemoglobin (g/dL) in Universal Coverage Scheme (UCS)	9.5 ± 1.5	9.5 (8.5, 10.5)	
10–11.5			12,406 (29.7)
<10			26,307 (62.9)
>11.5–13			2,659 (6.4)
>13			452 (1.1)
Hemoglobin (g/dL) in Social Security Scheme (SSS)	10.0 ± 1.5	10.11 (9.1, 11.)	
10–11.5			6,717 (38.8)
<10			8,077 (46.6)
>11.5–13			2,263 (13.1)
>13			269 (1.6)
Hemoglobin (g/dL) in Civil Servant Medical Benefit Scheme (CSMBS)	10.4 ± 1.2	10.5 (9.8, 11.1)	
10–11.5			10,209 (55.1)
<10			5,753 (31.1)
>11.5–13			2,336 (12.6)
>13			222 (1.2)
Hemoglobin (g/dL) in Self-Payment Group	9.7 ± 1.4	9.8 (8.8, 10.6)	
10–11.5			2,680 (36.9)
<10			4,039 (55.6)
>11.5–13			492 (6.8)
>13			55 (0.8)
Transferrin Saturation (%)	29.6 ± 12.6	27.5 (21.5, 35.0)	
30–40			17,918 (25.3)
<20			13,961 (19.7)
20–29			28,216 (39.8)
>40			10,720 (15.1)
Ferritin (ng/mL)	532.9 ± 488.3	410.2 (217.3, 681.7)	
200–500			27,966 (37.2)
<200			16,952 (22.6)
>500			30,205 (40.2)
Erythropoietin Stimulating Agents (ESA) Use			
Intravenous route			70,907 (77.1)
Subcutaneous route			17,741 (19.3)
Missing			3,363 (3.8)
Types of Erythropoietin Stimulating Agents			
Recombinant Human Erythropoietin (Epoetin Alfa)			20,855 (97.3)
Recombinant Human Erythropoietin (Epoetin Beta)			434 (2.0)
Darbepoetin Alfa			86 (0.4)
Methoxy Polyethylene Glycol-Epoetin Beta			69 (0.7)

The data was analyzed using the average laboratory results for each patient and then classified into each category group.

Hepatitis & HIV Serology and Vaccination in Dialysis Patients

Data on viral hepatitis and HIV serology were significantly incomplete, with 28%–44% missing data. Among the available results, only 2.6% of dialysis patients tested positive for hepatitis B surface antigen, 1.9% for anti-HCV antibodies, and 0.7% for HIV antibodies **(Table 3.11).**

Vaccination rates were generally low: 29.6% of patients received the COVID-19 vaccine, 36.7% received the influenza vaccine, and 19.6% were vaccinated for hepatitis B. Alarmingly, only 1.2% had received the pneumococcal vaccine, indicating a significant gap in vaccination coverage for this vulnerable population.

Table 3.11. Hepatitis and HIV Serology Status, as well as Vaccination Rates and Coverage, Among Dialysis Patients

Serology/Vaccination	Result (N, %)	Missing (N, %)
Positive HBs Antigen	5,305 (2.6%)	58,234 (40.5%)
Positive Anti-HBs Antibody	49,750 (22.6%)	40,856 (28.4%)
Positive Anti-HCV Antibody	3,766 (1.9%)	59,442 (41.3%)
Positive HIV Status	1,411 (0.7%)	63,746 (44.3%)
Vaccination		
COVID-19 Vaccine	17,527 (29.5%)	
Hepatitis-B Vaccine	11,627 (19.6%)	
Influenza Vaccine	21,781 (36.7%)	
Pneumococcal Vaccine	700 (1.2%)	

Clinical Outcomes in Dialysis Patients

From 2017 to 2023, the cumulative percentage of death among dialysis patients was 32.0%. Of these deaths, 30.0% were attributed to patients undergoing hemodialysis, while 49.0% were among those on peritoneal dialysis **(Table 3.12).** The disparity between hemodialysis and peritoneal dialysis patients reflects the unique challenges and risks associated with each dialysis modality, highlighting the need for tailored clinical approaches.

When analyzing the primary causes of death within this population, the leading contributors were cardiac disease (34.7%), infectious diseases (19.7%), and cerebrovascular disease (7.7%). These causes of death are consistent with previous studies showing that cardiovascular-related events and infections are among the top mortality risk factors for dialysis patients. Other causes included malignancies (3.4%), liver disease (1.2%), and kidney disease (2.7%). The "uncertain" category, which includes cases where the cause of death could not be definitively determined, accounted for 13.3% of all deaths.

Cardiac disease remains the most significant contributor to mortality, with hemodialysis patients experiencing a notably higher percentage of deaths (37.8%) from cardiac-related issues compared to peritoneal dialysis patients (18.3%). Similarly, infectious diseases caused a higher percentage of deaths in peritoneal dialysis patients (23.7%) compared to hemodialysis patients (18.9%). This difference suggests that infection risk may be more pronounced in patients undergoing peritoneal dialysis, likely due to the nature of the treatment itself, which requires frequent catheter use and direct exposure of the peritoneal cavity.

Table 3.12: Causes of Death in Dialysis Patients

Cause of Death	Total (N = 46,075)	Hemodialysis (N = 38,828)	Peritoneal Dialysis (N = 7,247)
Cardiac Disease	15,672 (34.7%)	14,364 (37.8%)	1,308 (18.3%)
Infectious Disease	8,889 (19.7%)	7,195 (18.9%)	1,694 (23.7%)
Uncertain	5,987 (13.3%)	4,938 (13.0%)	1,049 (14.7%)
Cerebrovascular Disease	3,469 (7.7%)	2,946 (7.7%)	523 (7.3%)
Kidney Disease	1,231 (2.7%)	1,144 (3.0%)	87 (1.2%)
Malignancy	1,537 (3.4%)	1,447 (3.8%)	90 (1.3%)
Liver Disease	520 (1.2%)	493 (1.3%)	27 (0.4%)
Accident	525 (1.2%)	495 (1.3%)	30 (0.4%)
Suicide	112 (0.3%)	86 (0.2%)	26 (0.4%)
Other	7,130 (15.8%)	4,826 (12.7%)	2,304 (32.2%)
Missing	878 (1.9%)	784 (2.0%)	94 (1.3%)
Overall Mortality Rate	**46,075/143,892 (32.0%)**	**38,828/129,113 (30.1%)**	**7,247/14,779 (49.0%)**

CHAPTER 5

DIALYSIS CENTER PROVIDERS IN THAILAND

Number of Hemodialysis Centers in Thailand

The number of hemodialysis centers in Thailand has steadily increased from 2007 to 2023, reflecting the rising burden of ESKD in the country, as shown in **Figure 4.1.** By 2023, a total of 1,106 hemodialysis centers had been established across Thailand, highlighting both the growing demand for dialysis services and efforts to expand access to renal care. This expansion underscores the increasing prevalence of CKD and ESKD, as well as the healthcare system’s response to meet the growing need for dialysis treatment.

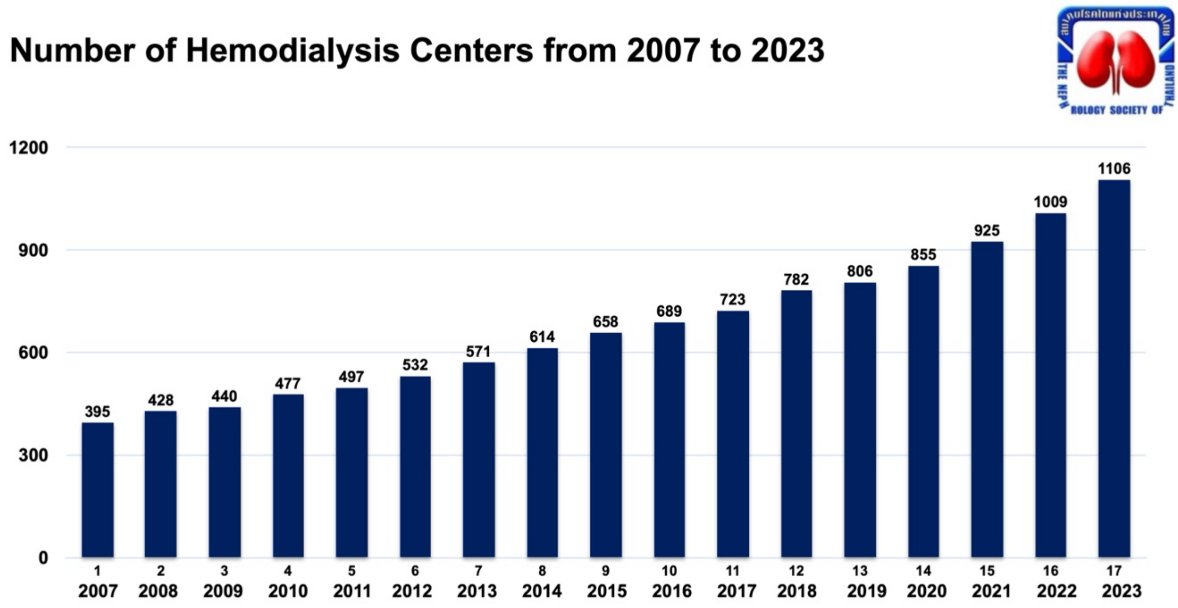


Figure 4.1. Increase in the Number of Hemodialysis Centers in Thailand

Number of Peritoneal Dialysis Centers in Thailand

The prevalence of peritoneal dialysis centers in Thailand has shown a consistent, though slight, increase from 2007 to 2023, as shown in **Figure 4.2.** Notably, between 2017 and 2018, the number of peritoneal dialysis centers increased from 145 to 193, reflecting a period of significant growth in the availability of this treatment modality. However, from 2018 to 2023, the establishment of new peritoneal dialysis centers stabilized, with the total number rising modestly from 193 to 203 centers across Thailand. This suggests that while there has been a steady expansion of peritoneal dialysis services, the rate of growth has slowed in recent years, likely due to factors such as capacity limitations, regional healthcare needs, and the shifting landscape of renal care.

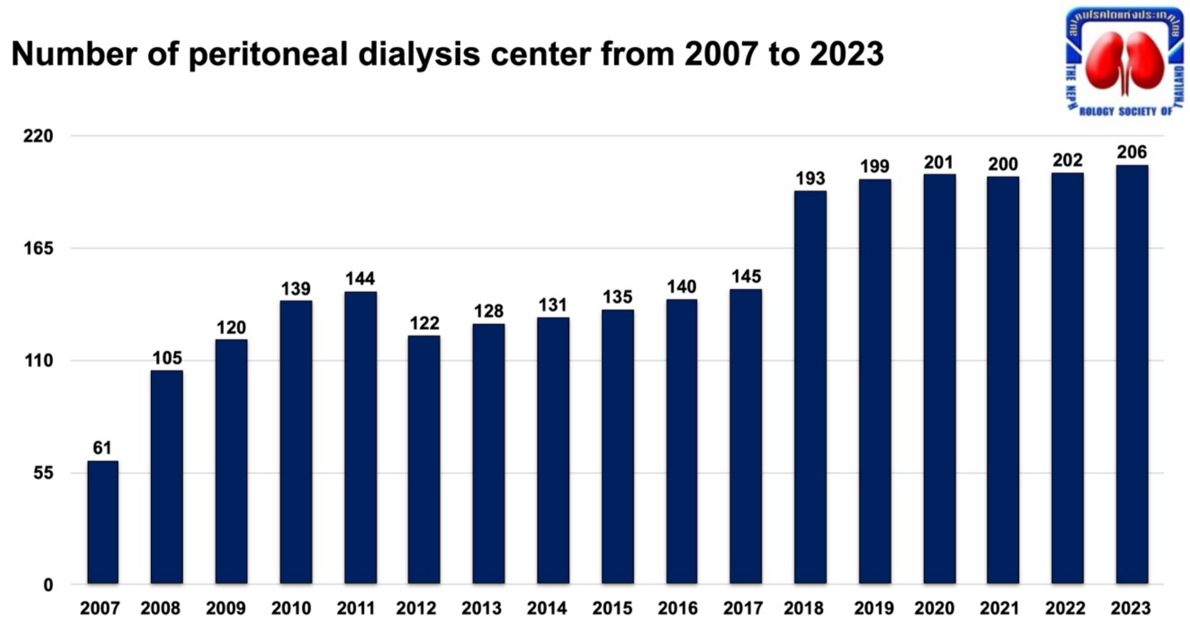


Figure 4.2. Increase in the Number of Peritoneal Dialysis Centers in Thailand

Distribution of Hemodialysis Centers Across Regions in Thailand

The distribution of hemodialysis centers across regions in Thailand has remained relatively consistent over the years, as shown in **Table 4.1.**

Table 4.1. Distribution of Hemodialysis Centers Across Regions

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

However, data from 2023 indicates that the majority of hemodialysis centers are concentrated in two key regions: Bangkok and its vicinity, which account for 31.1% of the total hemodialysis centers, and the Northeastern region, which houses 27.3% of the centers. This distribution reflects the centralization of healthcare services in urban areas, particularly in Bangkok, while the Northeastern region also plays a significant role in providing dialysis care. The remaining centers are spread across the Southern, Northern, and Central regions, contributing to the nationwide availability of hemodialysis services

Distribution of Peritoneal Dialysis Centers Across Regions in Thailand

The distribution of peritoneal dialysis centers across regions in Thailand has remained relatively proportional over the years, as shown in **Table 4.2.** However, data from 2023 indicates that the majority of peritoneal dialysis centers are concentrated in two key regions. The Northeastern region hosts the largest proportion, with 30.6% of the total peritoneal dialysis centers, reflecting the region's significant need for renal care. Bangkok and its vicinity follow, accounting for 18% of the total peritoneal dialysis centers, highlighting the centralization of healthcare services in the capital and surrounding areas. The remaining centers are distributed across the Southern, Northern, and Central regions, contributing to broader access to peritoneal dialysis treatment nationwide.

Table 4.2. Distribution of Peritoneal Dialysis Centers Across Regions

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

Number of Hemodialysis Machines

The number of hemodialysis machines in Thailand has consistently increased from 2012 to 2023, reflecting the growing burden of ESKD and the corresponding demand for dialysis services, as shown in **Table 4.3.** By 2023, a total of 12,353 hemodialysis machines had been installed across the country, demonstrating the healthcare system's efforts to expand capacity in response to the rising prevalence of ESKD. This increase in hemodialysis machines highlights the country's focus on enhancing renal care infrastructure, ensuring more machines are available to meet the increasing demand for dialysis treatments. The expansion underscores the significant healthcare challenges posed by ESKD and the continued need for resources to manage this chronic condition.

Table 4.3. Growth in the Number of Hemodialysis Machines in Thailand (2012–2023)

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

Human Resources of Dialysis Centers

The number of full-time qualified physicians, dialysis nurse specialists, and trained nurses who completed 4- or 6-month short courses in hemodialysis and peritoneal dialysis in Thailand has consistently increased from 2018 to 2023, reflecting the rising burden of ESKD and the growing need for specialized renal care professionals, as shown in **Table 4.4.** By 2023, the data indicated the following totals for healthcare professionals:

- 931 full-time qualified physicians
- 2,048 dialysis nurse specialists
- 1,932 nurses trained in hemodialysis through 4- or 6-month short courses
- 282 nurses trained in peritoneal dialysis through 4- or 6-month short courses

This steady increase in the number of qualified professionals highlights the healthcare system's efforts to expand the workforce to meet the growing demand for dialysis treatments. The data also underscores the importance of specialized training programs to equip healthcare workers with the necessary skills to manage the complexities of dialysis care, ultimately supporting improved outcomes for ESKD patients.

Table 4.4. Human Resources in Dialysis Centers Across Thailand

Category	2018	2019	2020	2021	2022	2023
Full-time qualified physicians	482	782	716	722	799	931
Full-time dialysis nurse specialists	918	1,464	1,479	1,393	1,541	2,048
4/6 months short course hemodialysis trained nurses	1,089	1,767	1,724	1,930	1,913	1,932
4/6 months short course peritoneal dialysis trained nurses	132	229	181	157	165	282

Sharing Dialysis Center by Provider

The establishment of hemodialysis centers in Thailand has been predominantly within private and government centers, with a consistent increase in the number of centers from 2019 to 2023, as shown in **Table 4.5.** By 2023, data indicated that a total of 623 hemodialysis centers had been established in the private sector, while 467 centers were set up in the government sector across the country. This steady growth reflects ongoing efforts to expand dialysis services in both the private and government sectors to address the increasing demand for ESKD care. The higher number of private centers suggests a growing role for the private sector in providing dialysis services, while government centers continue to play a critical role in serving the broader population, particularly in rural and underserved areas.

However, peritoneal dialysis centers in Thailand have been exclusively established within government hospitals, with a consistent but slow increase in the number of centers from 2019 to 2023. This gradual rise in the number of peritoneal dialysis centers reflects the government's efforts to expand renal care services, particularly in response to the growing burden of ESKD. The slower pace of expansion, compared to hemodialysis centers, may be due to various factors such as infrastructure requirements, patient population, and the need for specialized training and equipment for peritoneal dialysis.

Table 4.5. 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

Status of Dialysis Center

The establishment of hemodialysis centers in Thailand has primarily occurred within in-hospital dialysis centers, though there has been a dramatic increase in the number of out-hospital dialysis centers from 2019 to 2023, as shown in **Table 4.6.** By 2023, data indicated that a total of 780 hemodialysis centers were set up within in-hospital dialysis facilities, while 326 centers were established in out-hospital dialysis centers across the country. This shift highlights the growing trend of providing dialysis services outside traditional hospital settings, likely driven by the demand for more accessible treatment options and the expansion of outpatient services.

In contrast, peritoneal dialysis centers in Thailand have been exclusively established within in-hospital settings, with a consistent, though slow, increase in the number of centers from 2019 to 2023. This gradual growth underscores the importance of hospital-based infrastructure for peritoneal dialysis, which requires specialized monitoring and support services. The limited expansion in the outpatient sector for peritoneal dialysis reflects the unique requirements for the modality, including patient selection, training, and care coordination.

Table 4.6. Growth in the Number of Dialysis Centers by Type

Year	In-Hospitalized Dialysis Centers (HD)	In-Hospitalized Dialysis Centers (PD)	Out-Hospitalized Dialysis Centers (HD)	Out-Hospitalized Dialysis Centers (PD)
2019	640	199	166	-
2020	674	201	181	-
2021	718	200	207	-
2022	738	202	271	-
2023	780	206	326	-

Operation Type of Dialysis Center

The establishment of hemodialysis centers in Thailand has predominantly relied on in-house dialysis facilities. However, between 2019 and 2023, there was a significant increase in the number of centers offering outsourced dialysis services and private standalone clinics, as shown in **Table**

4.7. By 2023, data revealed that 587 hemodialysis centers were operated directly by in-house dialysis facilities, while 208 centers and 311 centers provided outsourced dialysis services and private standalone clinics, respectively, across the country.

This notable growth in outsourced services highlights efforts to expand access to dialysis treatment, particularly in regions where establishing and managing in-house facilities is logistically or economically challenging. Furthermore, the number of private standalone clinics also increased substantially during this period.

Table 4.7. 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

Outsourced dialysis services and private standalone clinics have become essential strategies to address the rising demand for care among patients with ESKD. These approaches are crucial for improving access to life-saving dialysis treatments for patients in both urban and rural areas, ensuring that the growing need for ESKD care is met more effectively. This report has several notable strengths and limitations. One major strength lies in its comprehensive scope, as it leverages the TRT Registry, a national database, to provide a thorough analysis of dialysis services, resources, and infrastructure across the country. Additionally, the longitudinal nature of the data, spanning from 2018 to 2023, offers valuable insights into trends over time, enabling the identification of areas of growth and persistent challenges. The dataset is also highly detailed, encompassing demographic factors, regional distributions, equipment availability, and workforce metrics, which collectively provide a holistic view of dialysis care in Thailand.

CHAPTER 6

SUMMARY DIALYSIS STATUS IN THAILAND

The growing burden of ESKD in Thailand underscores the urgent need for comprehensive healthcare strategies to manage the rising demand for RRT, such as dialysis and kidney transplantation. Despite the Universal Health Coverage (UHC) scheme's efforts to provide equitable dialysis access, challenges persist, including resource limitations, geographic disparities, and the influence of underlying conditions like hypertension and diabetes. The TRT Registry offers crucial insights into patient demographics, treatment trends, and outcomes, aiding in policy development and healthcare optimization.

Key focus areas include prevention, early diagnosis, timely treatment, expanding kidney transplantation programs, and improving access to specialized care. While Thailand has made progress by increasing dialysis centers, machines, and trained professionals, the healthcare system must address infrastructure limitations to meet future patient needs. Updating hemodialysis policies, expanding resources, and strategic planning informed by the TRT Registry are essential to ensuring equitable, high-quality care for ESKD patients.

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