2022 Annual Report of Organ Transplantation in Thailand

- Heart and Lung Transplantation
- Kidney Transplantation
- Kidney Transplantation for recipients younger than 18 years old
- Liver Transplantation for adults and children
- Liver Transplantation for recipients younger than 18 years old

Thai Transplantation Society

Message from the President of the Thai Transplantation Society

The information was collected as a report, and its purpose was to develop organ transplantation in Thailand. As we are aware, organ transplantation is important in the medical profession advancement which helps improve their lives from chronic diseases such as chronic kidney disease, cirrhosis, and last stage of heart failure to perform their activities like usual once again. Nowadays, transplant knowledge has fast evolution in both width and depth related to basic transplantation Immunology and new immunosuppressive medications for organ transplant recipients. It is very necessary that physicians who work in this field should follow up with the recent knowledge.

Even though there are a lot of advantages to organ transplantation, the main problem is the shortage of organ donors when compared to recipients (There are 6,279 total recipients – 5,866 kidney recipients (5,081 with ready status), 334 liver recipients, 39 heart-lung patients, 23 pancreas and kidney patients, 6 liver and kidney patients, and 1 pancreas patient as of 31 December 2022

Therefore, it is challenging for the Organ Transplantation Society to collaborate with network partners from various organizations to lay out strategies and guidelines for increasing organ donors. and the quality of organ transplantation so that the recipient has a better quality of life.

On behalf of the President and a committee of the Thai Transplantation Society, I would like to thank you, the registration subcommittee, for reporting on organ transplantation in 2022. I hope this will be useful for future reference for physicians, nurses, and medical staff.

Assoc. Prof. Cholatip Pongskul

President of Thai Transplantation Society

Preface

The Thai Transplantation Society has collected transplant information since 2002 and has presented in annual meetings since 2004, which informed the membership, doctors, and nurses to be aware of the situation in transplantation each year. In 2012, the registration subcommittee first published an annual report and presented the society website in Thai and English to make it convenient for information searching and references and useful for planning, strategic planning, and research nationally and internationally.

This report covers heart and lung transplants. adult and pediatric kidney transplants, and adult and pediatric liver transplants in Thailand. These data are the results of collaboration and excellent cooperation from the organ transplant coordinator nurses, organ transplant surgeons, kidney specialists, pediatric nephrologists, hepatologists and pediatrician hepatologists from all transplant institutions. allowing such data to be analyzed and informed about the organ transplant situation in Thailand.

For heart and lung transplant surgery information, Dr. Pat Ongcharit and his team collected information on patients who received surgery in 2022. For kidney transplant information for that year. Assoc. Prof. Dr. Nuttasith Larpparisuth and his team have taken data in various areas to analyze in many dimensions, which has continued from last year. The information on kidney recipients under 18 years old was provided by Prof. Dr.Pornpimol Rianthavorn. For the liver transplant information, courtesy of Prof. Dr. Suporn Treepongkaruna, Assoc. Prof. Dr. Sunhawit Junrungsee, and Dr. Goragoch Gesprasert and their teams have collected and analyzed data in this group completely.

The registration subcommittee sincerely thanks the Thai Transplantation Society's organizing committee for supporting and establishing the annual report on organ transplantation, the transplant coordinator nurses for providing the patients' information from each institution, Dr. Pat Ongcharit, Assoc. Prof. Dr. Nuttasith Larpparisuth, Prof. Dr. Pornpimol Rianthavorn, Prof. Dr. Suporn Treepongkaruna, Assoc. Prof. Dr. Sunhawit Junrungsee, Dr. Goragoch Gesprasert and their colleagues for data gathering and analysis. , Ms. Nongnuch Kuttiya and Ms. Pharita Keelee for general coordination, and all staff, doctors and nurses from all transplant institutions who have made this report completely successful. We believe the 2022 annual report will be useful for reference for transplant surgeons, physicians, nurses, and those interested in organ transplantation, including academic staff, public health economists, and policymakers. Finally, we hope this information will be beneficial for strategic and research plans for further improvement of organ transplantation in Thailand.

The registration subcommittee of organ transplantation

Thai Transplantation Society

Year 2023-2025

Executive Committee, Thai Transplantation Society

Year 2023 - 2025

Name	Surname	Position
Assoc.Prof.Dr. Cholatip	Pongskul	President
LTG.Dr. Thanom	Supaporn	Advisory
Dr. Surazee	Prommool	Advisory
Dr. Pat	Ongcharit	Vice-President and Liver and Pancreas Standard and Supportive
Prof. Dr. Yingyos	Avihingsanon	Vice-President
Assoc.Prof.Dr. Attapong	Vongwiwatana	Secretary General
Prof.LTG.Dr. Prajej	Ruangkanchanasetr	Treasurer
Prof.Dr. Adis	Tasanarong	Committee
Col.Dr. Adisorn	Lumpaopong	Registration and Information
Prof.Dr. Atiporn	Ingsathit	International Liaison
Assoc.Prof.Dr. Kajohnsak	Noppakun	Scientific Chairman Cardiothoracic Organ Transplantation Standard of Practice Development
Assoc.Prof.Dr. Natavudh	Townamchai	Research
Asst.Prof.Dr. Somchai	Limsrichamrern	Liver / Pancreatic Transplantation Standard of Practice Development
Assoc.Prof.Dr. Supanit	Nivatvongs	Thai Red Cross Organ Donation Centre Coordination
Prof.Dr. Suporn	Treepongkaruna	Pediatric and Adult Hepatology Coordination
Asst.Prof.Dr. Siros	Jitpraphai	Urological Surgery Coordination
Dr. Goragoch	Gesprasert	Committee for Promoting Organ Donation
Assoc.Prof.Dr.Nuttasith	Larpparisuth	Social Co-Ordinator & Public Relation

Organ Transplant Registration Subcommittee

Year 2023 - 2025

Name	Surname	Position
Col.Dr.Adisorn	Lumpaopong	President
LTG.Dr.Thanom	Supaporn	Advisory
Prof.Dr.Kriengsak	Vareesangthip	Advisory
Assoc.Dr.Supanit	Nivatvongs	Subcommittee
Dr. Pat	Ongcharit	Subcommittee
Prof.Dr.Pornpimol	Rianthavorn	Subcommittee
Assoc.Prof.Dr. Nutavudh	Townamchai	Subcommittee
Prof.Dr. Atiporn	Ingsathit	Subcommittee
Asst.Prof.Dr. Sathit	Kurathong	Subcommittee
Assoc.Prof.Dr. Cholatip	Pongskul	Subcommittee
Ms.Pawinee	Kupatawintu	Subcommittee
Ms.Aroonee	Juengsa-ngasom	Subcommittee
Dr.Sirin	Jiwakanon	Subcommittee
Prof.Dr.Suporn	Treepongkaruna	Subcommittee
Prof.Dr.Abhasnee	Sobhonslidsuk	Subcommittee
Dr.Goragoch	Gesprasert	Subcommittee
Asst.Prof.Dr.Tanun	Ngamvichukorn	Subcommittee
Asst.Prof.Dr.Somchai	Limsrichamrern	Subcommittee
Assoc.Prof.Dr.Kajohnsak	Noppakun	Subcommittee
Asst.Dr.Pichaya	Tantiyavarong	Subcommittee
Assoc.Prof.Dr.Nuttasith	Larpparisuth	Subcommittee and secretary

Liver Transplant Registration Subcommittee

Year 2023 - 2025

Name	Surname	Position
Prof.Dr.Suporn	Treepongkaruna	Subcommittee President
LTG.Dr.Thanom	Supaporn	Subcommittee Advisory
Col.Dr.Adisorn	Lumpaopong	Subcommittee Advisory
Assoc.Prof.Dr.Surasak	Leelaudomlip	Subcommittee Advisory
Assoc.Prof.Dr.Yongyut	Sirivatanauksorn	Subcommittee Advisory
Dr.Goragoch	Gesprasert	Subcommittee
Assoc.Prof.Dr.Voranush	Chongsrisawat	Subcommittee
Assoc.Prof.Dr.Bunthoon	Nonthasoot	Subcommittee
Assoc.Dr.Chalermrat	Bunchorntavakul	Subcommittee
Dr. Ake	Pugkhem	Subcommittee
Assoc.Prof.Dr.Sunhawit	Junrungsee	Subcommittee
Asst.Prof.Dr.Somchai	Limsrichamrern	Subcommittee and Secretary
Asst.Prof.Dr.Chutwichai	Tovikkai	Subcommittee and Assistant Secretary

Data Manager

Name	Surname	Hospital
Thararat	Phudpart	Bangkok
Napaporn	Boonnaj	Chulalongkorn
Salin	Wattanatorn	Chulalongkorn
Wongkhae	Kanthawong	Chulalongkorn
Piyaporn	Wanawongsawad	Chulalongkorn
Watcharee	Ratanawong	Chonburi
Pol.Lt.Col.Supan	Chunhanant	Police General
Pol.Lt.Col.Sirilux	Inka	Police General
Sasipim	Pairojkittrakul	Thammasat
Watinee	Yoosabai	Thammasat
Panarat	Nopacoon	Bumrungrad
Suwapee	Chantornjetsada	Phyathai 1
Benjawan	Sookruan	Phyathai 1
Kanokporn	Ratanatrisri	Buddhachinaraj
Sunisa	Pikhulkhao	Phramongkutklao
Nuttakarn	Naitook	Praram 9
Panatchana	Aroonrojsiri	Bhumibol Adulyadej
Anchalee	Saikam	Maharajnakornchiangmai
Kanya	Udomsin	Maharajnakornchiangmai
Jugkree	Korsakul	Maharajnakhonratchasima
Panida	Opakawinkul	Rajavithi
Mallika	Sitthisarn	Rajavithi
Ladda	Wudhinitikornkij	Rajavithi
Chutima	Charoenthanakit	Ramathibodi
Piyaphorn	Thakoorabutr	Ramathibodi
Napapat	Butsriphum	Ramathibodi
Wararat	Wongwean	Vajira
Jongruk	Pongskul	Srinagarind

Tassanee	Phimsawat	Srinagarind
Nartsiri	Ratchawang	Siriraj
Punika	Pongpisit	Siriraj
Pera	Panprom	Siriraj
Nutjanat	Rintawut	Khonkaen
Monrutai	Thammaroekrit	Songklanagarind
Madee	Bussayanampetch	Samitivej Srinakarin
Pisinee	Namprom	Samitivej Sukhumvit
Kotchaphorn	Triphob	Samitivej Sukhumvit
Manaphan	Utthong	Sappasitthiprasong
Jamaree	Pondee	Surat Thani
Kingkarn	Sirikarin	Hatyai
Sasipin	Monkolchai	Udonthani
Amnuayporn	Nammun	Udonthani
Sirilak	Leawseng	Bumirajanagarindra Kidney Institute
Nitikan	Jaiklom	Chiang Rai Prachanukroh
Puttachad	Pupotpong	Vichaiyuth

Contents

Information of Heart and Lung Transplantation

Information of Heart and Lung Transplantation

From 2008 – 2022, 271 patients received heart transplantation from 5 hospitals i.e. Chulalongkorn, Siriraj, Rajavidhi, Ramathibodi and Bumrungrad.

Table 1.1 Number of heart transplant recipients separated by year and hospital.

Hospital	2016 - 2022						
	2016	2017	2018	2019	2020	2021	2022
Chulalongkorn	10	9	14	15	16	10	14
Siriraj	4	8	8	13	10	7	10
Ramathibodi	-	1	4	3	3	4	2
Rajvidhi	1	3			1	-	1
Bamrungrad	-	-			-	1	1
Total	**15**	**21**	**26**	**31**	**30**	**22**	**28**

Hospital	2008 - 2015							
	2008	2009	2010	2011	2012	2013	2014	2015
Chulalongkorn	3	5	3	7	8	6	14	12
Siriraj	-	1	2	1	4	4	4	8
Ramathibodi	-	-	-	-	-	-	-	-
Rajvidhi	1	-	-	-	-	2	5	5
Central Chest Insitute	-	2	-	-	-	-	-	-
Bamrungrad	1	-	-	-	-		-	-
Total	**5**	**8**	**5**	**8**	**12**	**12**	**23**	**25**

In 2022, 28 patients received heart transplantation which increased from 2021 by 6 patients as shown in table 1.1.

Information of Kidney Transplantation

Information of Kidney Transplant Recipients

Number of Kidney Transplant Recipients in 2022

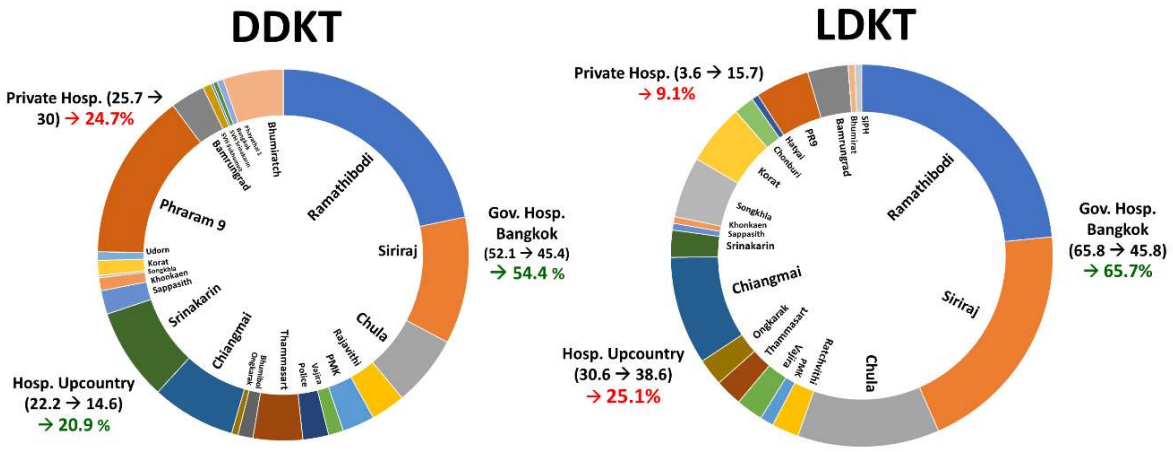
In 2022 (1 January 2022 – 31 December 2022), 710 patients received kidney transplantation from 27 hospitals, by 535 of living donors and 175 of deceased donors, separated by hospitals as shown in table 2.1.

Table 2.1 Number of Recipients in 2022, separated by hospitals.

	Kidney Transplant Recipients from Deceased donors	Kidney Transplant Recipients from Living donors	Total
Ramathibodi	116	41	157
Siriraj	59	35	94
Praram 9	78	8	86
Maharaj Nakorn Chiangmai	39	16	55
Chulalongkorn	33	21	54
Srinagarind	43	4	47
Bhumirajanagarindra	28	1	29
Thammasat	23	4	27
Bumrungrad	16	6	22
Rajavidhi	16	4	20
Phramongkutklao	15	2	17
Maharaj Nakornrachasima	7	9	16
Supphasitprsong	1	11	12
Police General	0	12	12
Vachira	4	7	11
Songklanakarin	1	9	10
Srinakarinwirot Ongkharak	4	3	7
Khon Kaen	6	1	7
Bhumibol Adulyadej	7	0	7

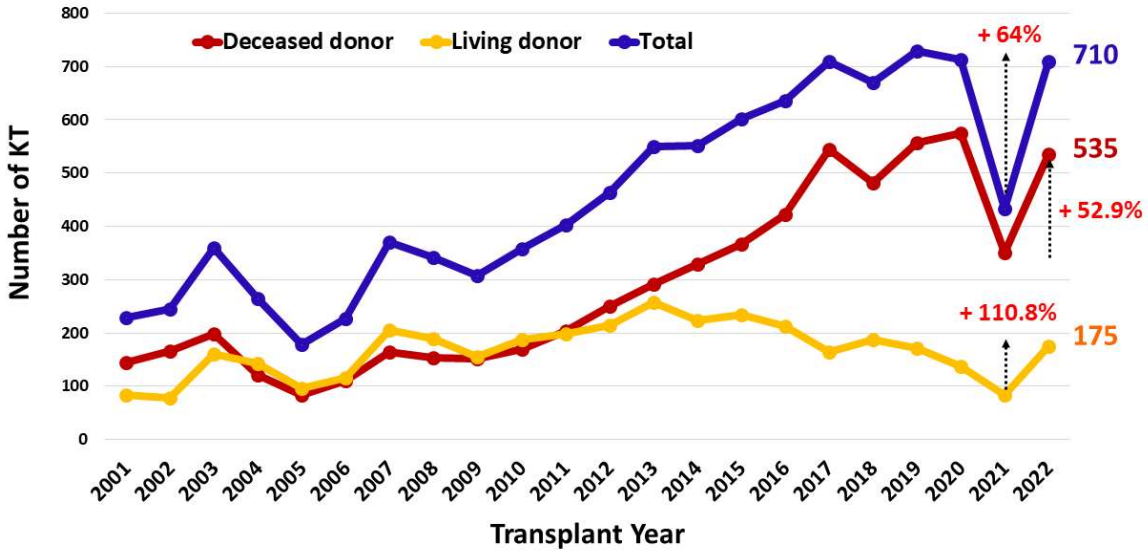
Udonthani	4	0	4
Smithivej Sukhumvit	4	0	4
Chonburi	0	3	3
Phayathai 1	3	0	3
Hat Yai	1	1	2
Bangkok	2	0	2
Siriraj Piyamaharajkarun	0	1	1
Smithivej Srinakarin	1	0	1
Total	535	175	710

54.4% kidney transplantation from deceased donor in 2022, occurred in government hospitals in Bangkok and its vicinity, 24.7% were done in private hospitals and 20.9% were done in provincial government hospitals. While kidney transplantation from living donor in 2021, 65.7% was done in government hospitals in Bangkok and its vicinity and 25.1% at provincial government hospitals. Private hospitals accounted for 9.1% as shown in picture 2.1 The trend in the distribution of kidney transplants in various institutions has returned to the same level as in 2020. Last year (2021), the increasing trend of kidney transplantation in private hospitals is likely due to the nationwide outbreak of Coronavirus Disease 2019 that has resulted in the restriction of medical services in government hospitals. This includes hospitals in the region as well. While kidney transplantation in private hospitals is still normal. However, the number of kidney transplants from living donors still tends to be higher in private hospitals compared to 2020 or previous years, while the proportion decreased in regional government hospitals.



Picture 2.1 Shows kidney transplantation from both brain dead and living donors in 2022, separated by hospitals.

In 2022, there was an increase of 64% in total kidney transplant patients (from 433 patients to 712 patients) when compared to the year 2020. Kidney transplants from deceased donors and from living donors increased by 52.9% (decreased from 350 to 535 cases), and kidney transplants from living donors increased by 110.8 percent (increased from 83 to 175 cases). According to picture 2.2, due to the outbreak situation of Corona 2019 disease has resolved and there is a large backlog of patients waiting for a kidney transplant from a living donor who cannot be operated on in 2021. As a result, surgeries have increased significantly this year. The number of kidney transplants performed from deceased donors has returned to levels close to before the 2019 coronavirus outbreak.



Picture 2.2 Number of kidney transplantation from each year since 2001, separated by kidney transplantation categories.

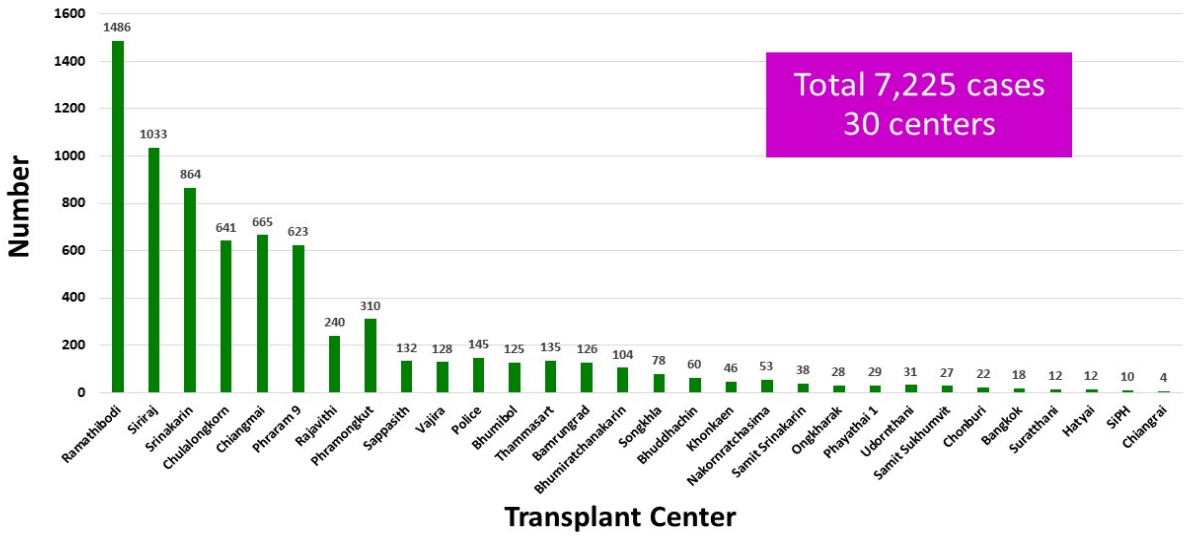
From picture 2.2 showed patients information of kidney transplantation since 2001, who officially registered for kidney transplantation in Thailand. There were a lot of kidney transplant recipients who received kidney transplantation in 2003 and 2007. In 2003, The Kidney Foundation of Thailand established the occasion to give a royal charity dedicated to HRH Princess Galyani Vadhana Kromma Luang Naradhiwas Rajanagarindra for her 80th Birthday and in 2007, then established "The kidney is the charity dedicated 80/ 84 years "to give a royal charity dedicated on the occasion of 80th Birthday Anniversary for His Majesty King Bhumibol Adulyadej The Great and HRH Princess Galyani Vadhana Kromma Luang

Naradhiwas Rajanagarindra on the occasion of 84th Birthday Anniversary which caused the increasing of kidney transplant recipients.

In 2015, in honor of the Celebrations on the Auspicious Occasion of Her Royal Highness Princess Maha Chakri Sirindhorn's 60th Birthday Anniversary, Kidney Foundation of Thailand and cooperated parties organizing "the kidney transplant give a royal charity 60 years, Her Royal Highness Princess Maha Chakri Sirindhorn " during 2 April 2015 – 1 April 2016 which encouraged kidney donation campaign, gave additional support to hospital, staffs, harvesting and retrieval team, altogether with covering the cost of special medication for kidney transplant patients by providing medical expenses from original affiliation such as Comptroller General's Department, Social Security Office and National Health Security Office which were cooperated parties of campaign.

In 2004, the Social Security Office implemented kidney transplant coverage for employees and in 2008, National Health Security Office approved to add the kidney transplant in the universal health care coverage. In addition, the Ministry of Public Health implemented the decreased donor campaign and establishes the donor Hospital which showed that the number of kidney transplants from deceased brain donors has increased and is likely to continue to increase until it has just decreased in the year 2021 as a result of the epidemic of the corona virus in 2019. Conversely, the number of kidney transplants from living donors has continued to decline over the past eight years. In 2023, The Kidney Foundation of Thailand and various partners have established the "Kidney Transplant Project in honor of the 100th anniversary of the birth of Her Royal Highness Princess Maha Chakri Sirindhorn. Princess Galyani Vadhana Prince Narathiwat Rajanagarindra" between 6 May 2023 – 5 May 2024, with a budget to support 1,000 kidney transplants throughout the project period. This should result in an increase in the volume of surgeries next year.

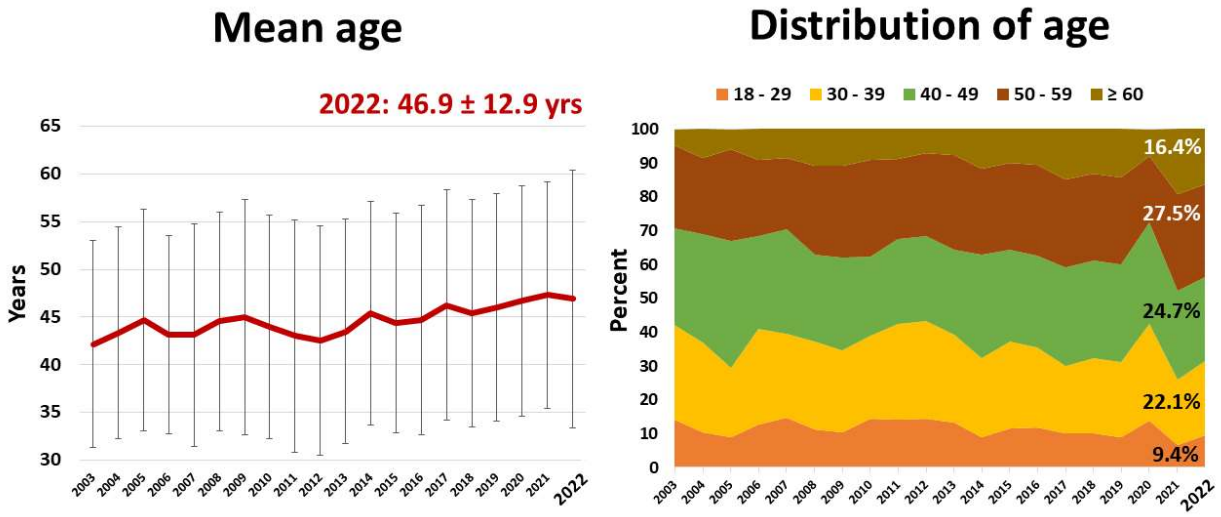
The number of kidney transplant recipients who are still under follow-up as of 31 December 2022 from 30 institutions totaled 7,225, increase from 6,495 in 2020 as shown in picture 2.3 This is because the number of kidney transplants is increasing after the decrease during the 2019 coronavirus disease situation that caused the death of many kidney transplant recipients and the loss of kidney function.



Picture 2.3 The number of kidney transplant patients who are still following their treatment as of 31 December 2022.

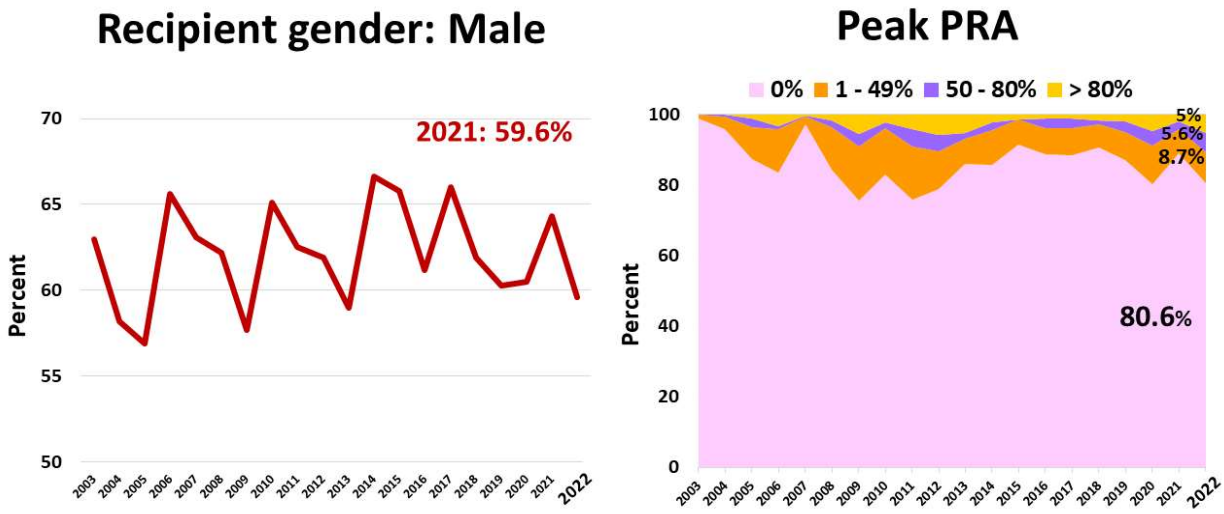
Information of kidney transplant recipients in 2022

The average age of kidney transplant recipients is greater than or equal to 18 years in 2021 was 46.9 years old which little increased form 2020 was 47.3 years old. The highest number of kidney transplant recipients is between the ages of 50-59. The proportion of kidney transplant recipients in 2022 by span of age, found that 9.4% of recipients ages 18-29 years old, 22.1% of recipients aged 30-39 years old, 24.7% of recipients aged 40-49 years old, 27.5% of recipients aged 50-59 years old and 16.4% of recipients aged more than 60 years old as shown in picture 2.4. When compared to 2021, the 18-29 and 30-39 age groups found a slight increase of 2.7% and 2.8%, respectively, while the older age group found a slight decrease of 1-2% in every group as shown in picture 2.4



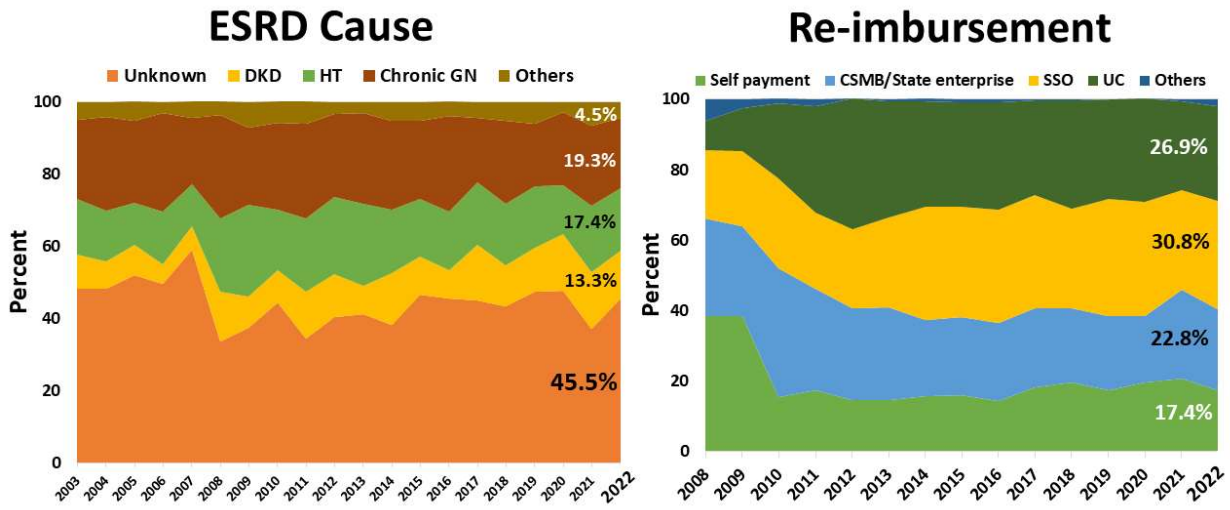
Picture 2.4 The average of age and the proportion of kidney transplant recipients separated by ages older than 18 years.

When divided by gender, it was found that Kidney transplant recipients in 2022 are more males than females. The proportion of males was 59.6%, which was lower than 64.3% in 2021. For the level of PRA, 88.9% of kidney transplant recipients had a PRA of 0 was 80.6%, PRA between 1-49. was 8.7%, PRA between 50-80 was 5.6%, and PRA greater than 80 was 5% as shown in Picture 2.5. The number of patients with PRA greater than 0 decreased by 8.3% when compared to 2021 and patients with PRA 1-49 increased by 1.7%, PRA 50-80 increased by 3.4% and PRA over 80 increased by 3.1% as shown in Picture 2.5.



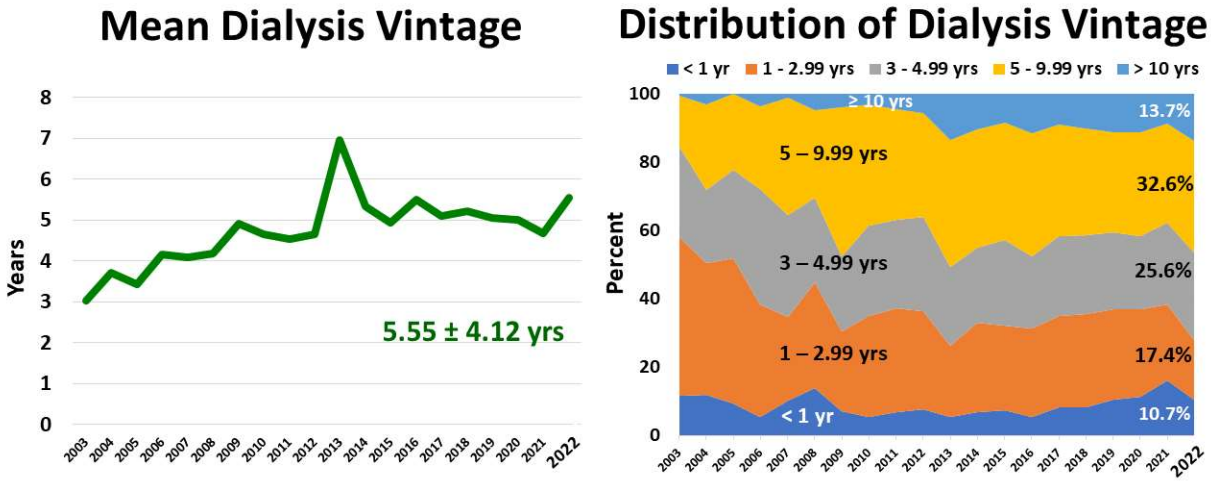
Picture 2.5 Sex and Panel Reactive Antibody (PRA) of kidney transplant recipients in 2022

45.5% of kidney transplant patients have no known cause of end-stage renal disease. Which is higher than the year 2021, found 37%, with the most common causes being chronic glomerulonephritis 19.3% (2.8% decrease), hypertension 17.4% (1% decrease) and diabetes 13.3% (2.5% decrease). When considering the right to receive medical care, it was found that 30.8% of kidney recipients were entitled to social security benefits, 26.9% were entitled to universal health insurance, 26.9% were entitled to government/state enterprise welfare benefits and 17.4% were responsible for the expenses themselves. This year, due to the decreasing proportion of kidney transplant surgery in private hospitals. This caused the kidney recipients to pay for their own expenses by 7.7% while the rights to government/state enterprise welfare increased by 6.4%, while social security rights. and universal health insurance changes only slightly as shown in Picture 2.6.

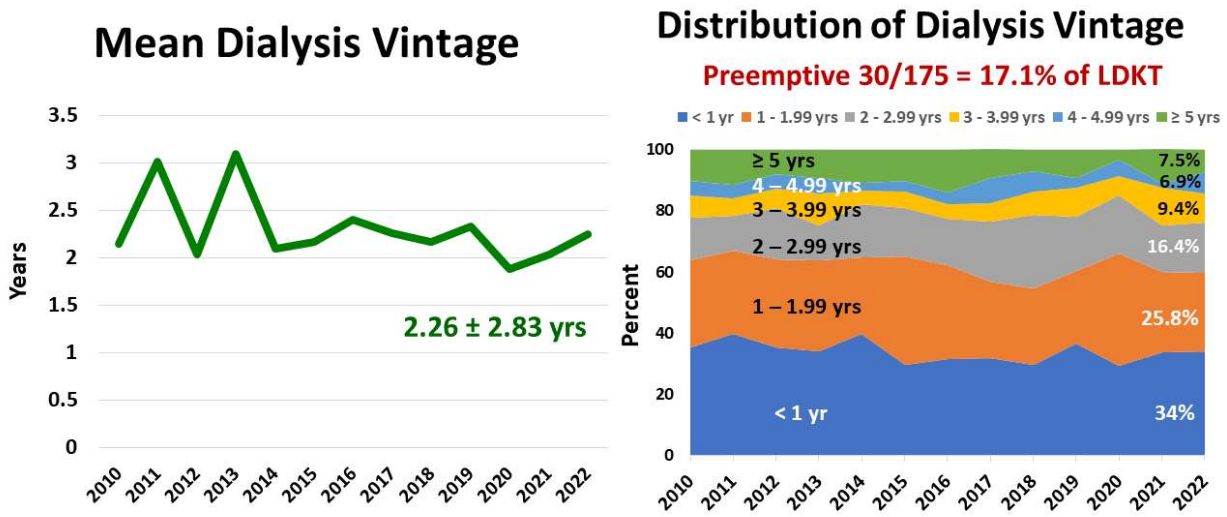


Picture 2.6 Show the causes of chronic kidney failure and medical treatment rights for kidney transplant patients in 2022.

The average waiting time to receive a kidney transplant of deceased donors in 2022 was 5.55 years which increased from 4.67 years in 2021, with most patients having a waiting period. in the range of 5 – 9.99 years, as shown in picture 2.7 while recipients from living donors had an average waiting time of 2.26 years, higher than 2021 which was 2.03 years. The waiting time was less than 1 year which was the largest proportion instead of the waiting time between 1 and 1.99 years. 30 patients representing 17.1% of all living donor kidney transplants underwent kidney transplantation. No need for hemodialysis by hemodialysis or peritoneal dialysis as shown in picture 2.8



Picture 2.7 The average waiting time for a kidney and classified according to the duration of kidney waiting in kidney recipients from deceased donors.



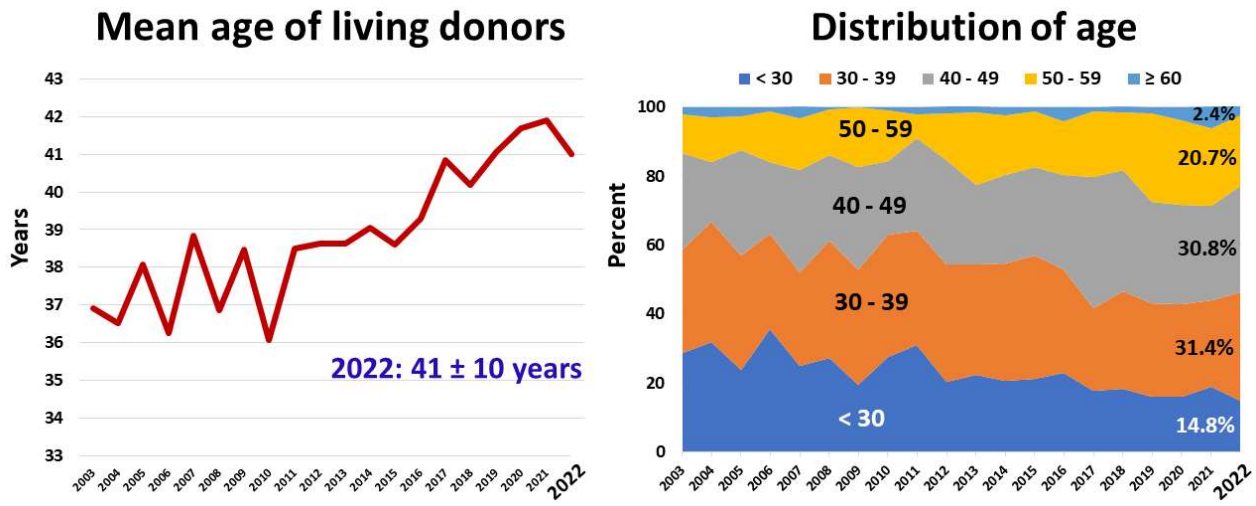
Picture 2.8 The average waiting time for a kidney and classified according to the duration of kidney waiting in kidney recipients from living donors.

In Summary of year 2022

- The number of kidney transplant patients was clearly higher than in 2021, approximately 64%, especially kidney transplants from living donors, which increased by 110.8% which is likely a result of Remaining sick during the COVID-19 epidemic last year
- The average age of most kidney recipients was in the range of 50-59 years, the average age slightly decreased 59% more males than females.
- The causes of chronic kidney failure are decreasing. For treatment rights, social security rights, government welfare / state enterprises Followed by paying yourself in order
- The waiting time for a kidney transplant was 2.3 years from living donors and 5.6 years from deceased donors.

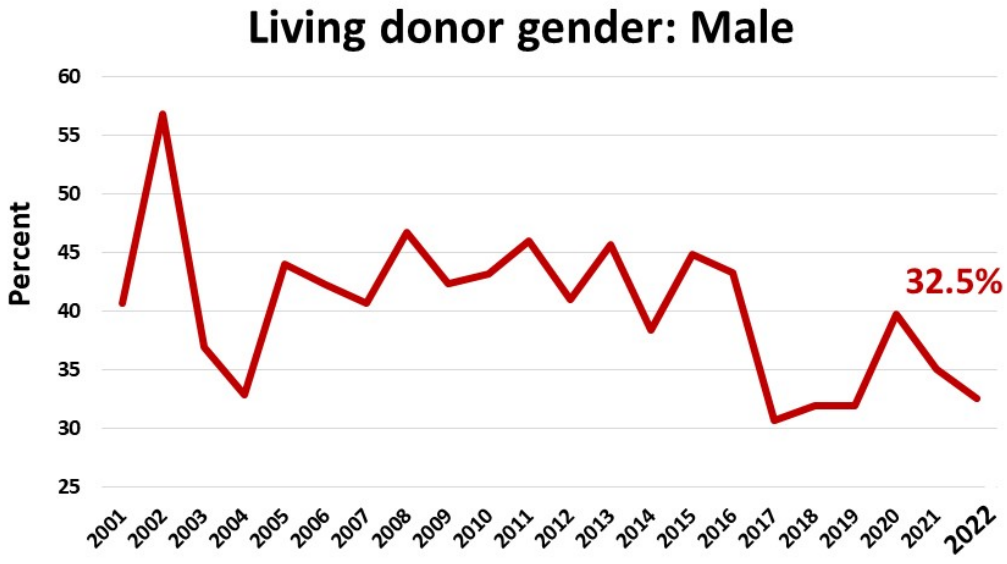
Information of living donors

In 2022, the average age of a living donor was 41 years, which is like last year. However, the trend of the average age of living donors has been steadily increasing since 2010. Most of them are between 40-49 years old which is 30.8%. In 2022, the proportion of donors who are younger than 30 and over 60 years decreased by 4% and 3.9%, respectively, while donors aged 30-39 increased by 6.4%, while donors in other age groups increased slightly as shown in Picture 2.9



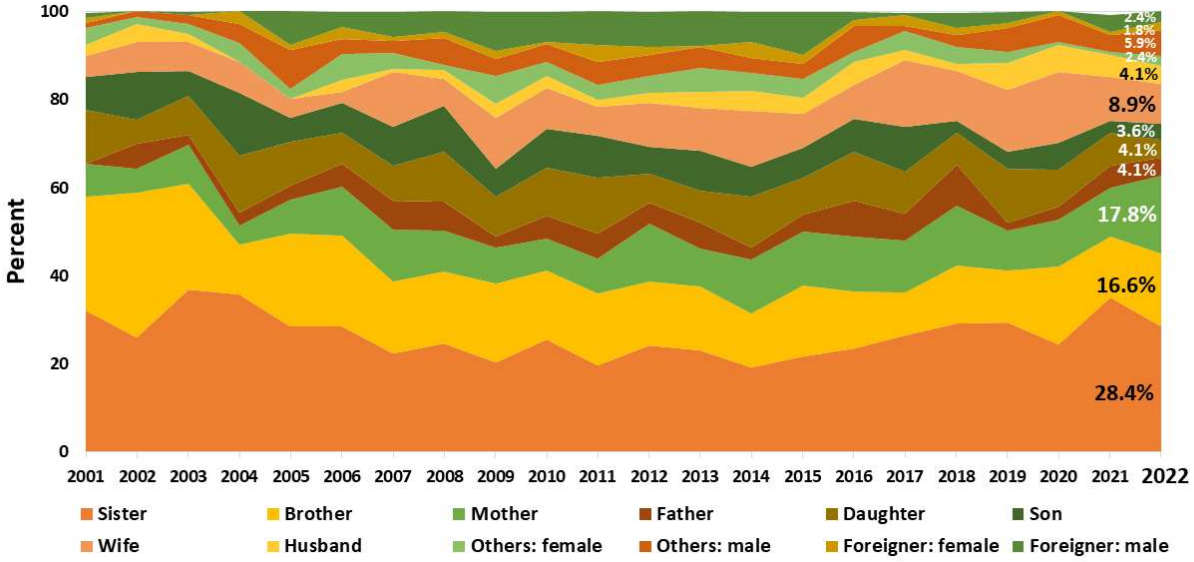
Picture 2.9 The average age and age range of the living donor.

32.5% of kidney living donor are male which decreased from 2021 was 35%, with a trend of declining male donor proportion since 2016 as shown in picture 2.10.



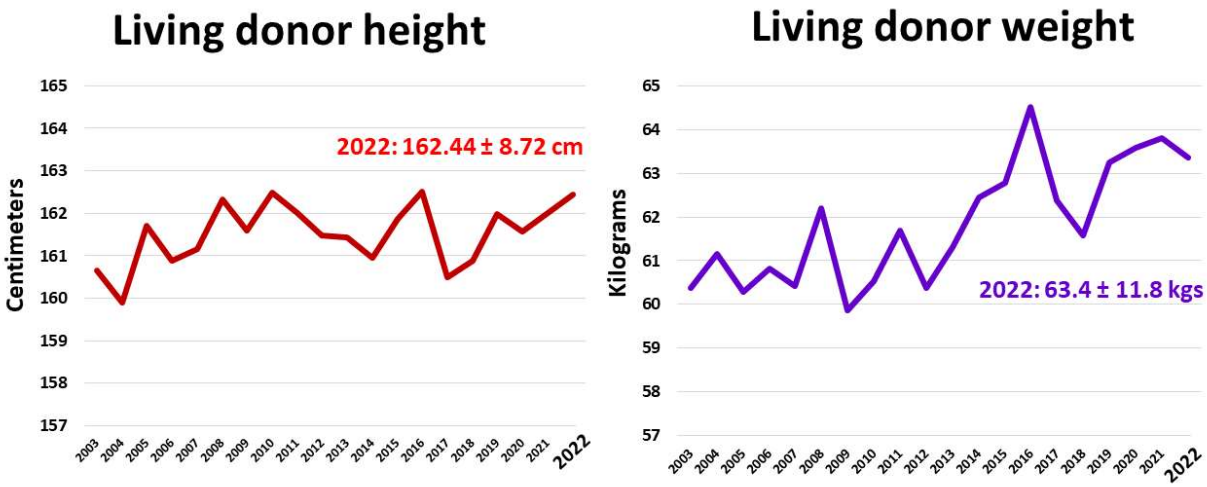
Picture 2.10 The proportion living donor in male.

For the relationship between the donor and the kidney recipient, The group that donated the most was older brothers or sisters at 28.4% down from 35% last year, followed by mothers donating to their children at 17.8%, older brothers or sisters at 16.6%, wives donating to their husbands at 8.9%, and male relatives 5.9% The relationship between the kidney donor is a male sibling. and daughter decreased as for living donors, 4.2% were foreigners which increased from only 0.8% last year as shown in Picture 2.11.



Picture 2.11 Relationship between donor and kidney recipient in 2022.

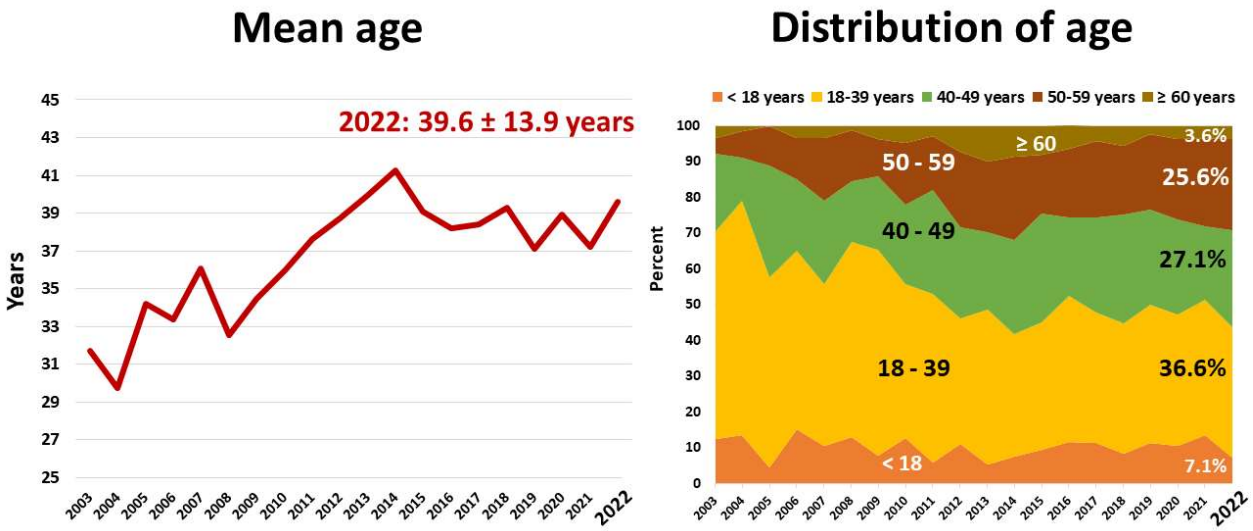
The donor average height 162 cm, average weight 63.4 kg, and average BMI 24.3 kg/sq.m. which has the same trend over the past 10 years as shown in Picture 2.12.



Picture 2.12 The average of height and weight of the living donor in 2022.

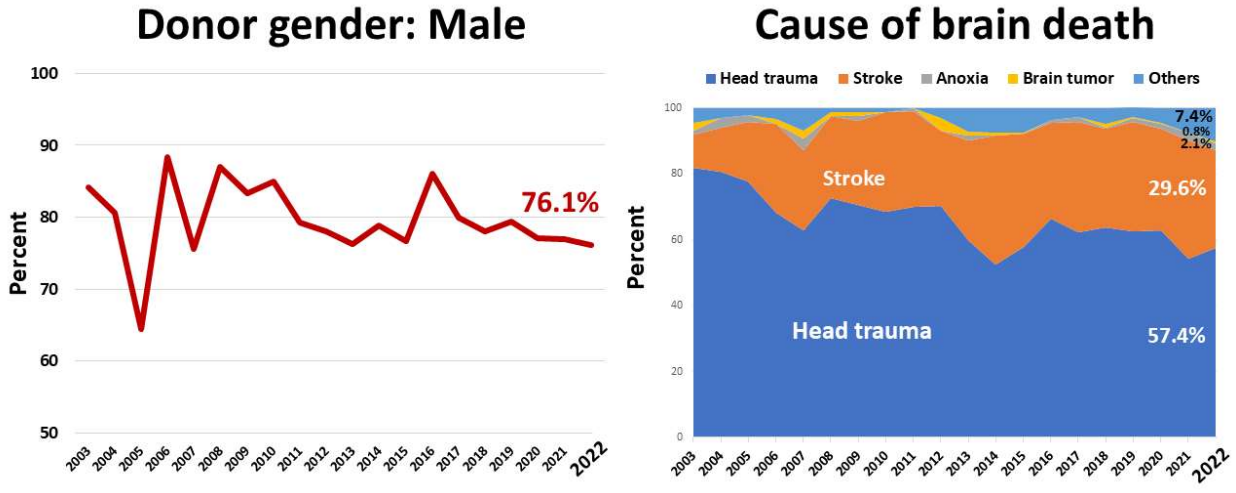
Information of kidney deceased donors

For the group of deceased donors, it was found that the average age was 39.6 years which had a similar trend for 10 years. The age group 18 - 39 years was the age group with the highest proportion at 36.6% like the previous year. 38%, donors aged 40 – 49 increased from 20.6% to 27.1%, while those under 18 years of age decreased from 13.4% to 7.1% in 2022, as shown in Picture 2.13.



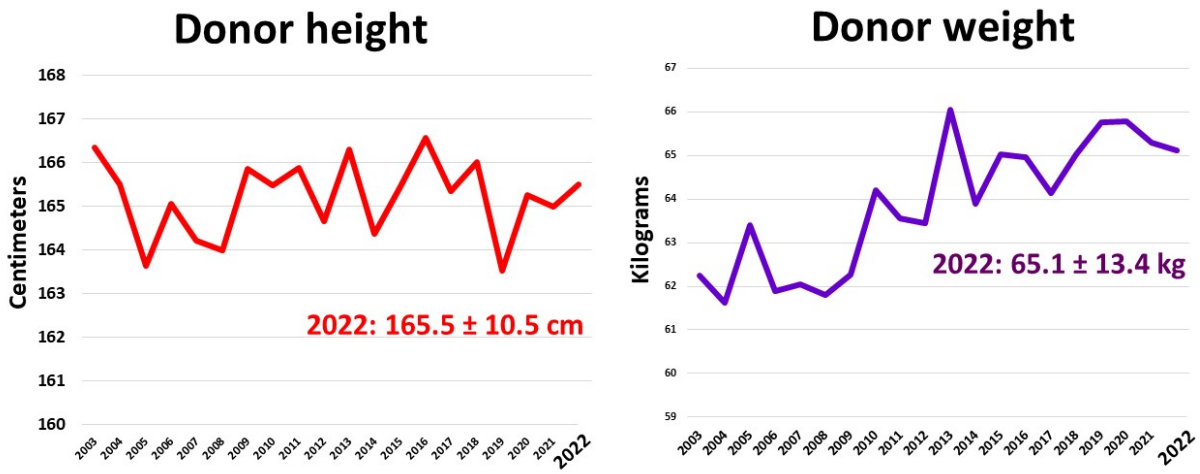
Picture 2.13 The average of age and age range of deceased donor.

76.1% of deceased donors were males which similar to the previous year. The main causes of cerebral death were head trauma and stroke, respectively, as shown in picture 2.14 when compared to 2021. the proportion of brain death donors caused by stroke increased from 35.7% to 29.6%, while the proportion of deceased donors caused by head trauma appeared to increase.



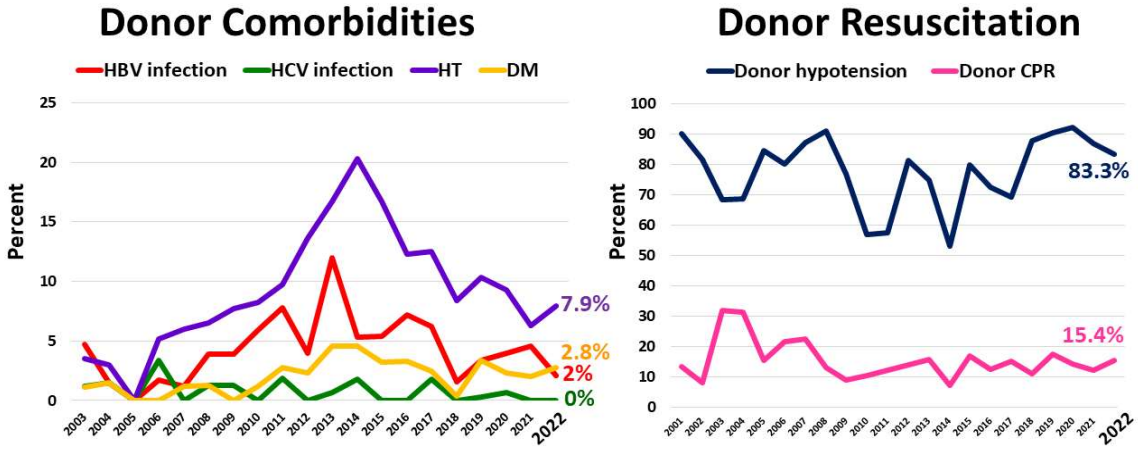
Picture 2.14 The proportion sex and cause of brain death in deceased donor.

The height of deceased donor in 2022 averaged 165.5 cm. which is close to the average in previous years, while the average weight was 65.1 kg which is close to the year 2021 with the trend has been increasing steadily over the past 10 years but remaining stable over the last 3 years as shown in picture 2.15.



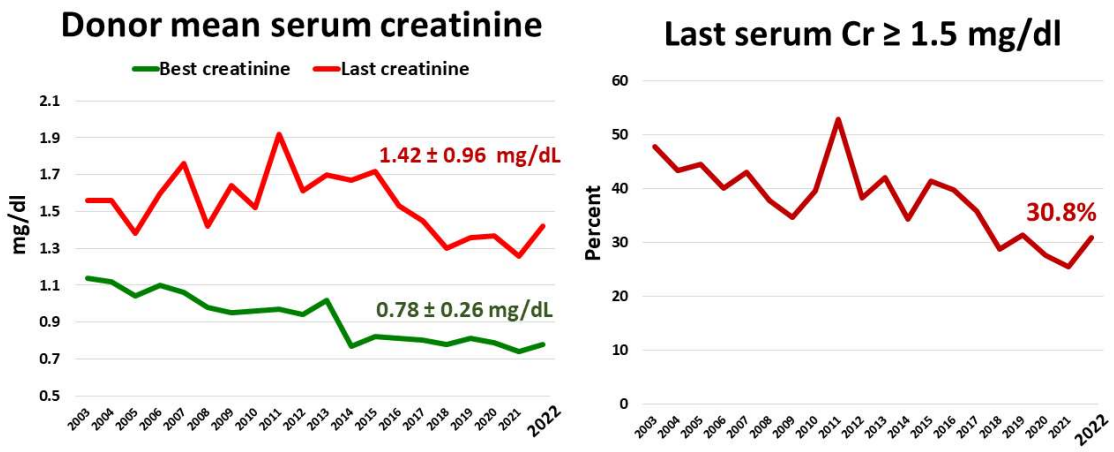
Picture 2.15 The average of height and weight of deceased donor.

Comorbidities found in deceased donors were high blood pressure, 7.9%, which was higher than the 6.3%found last year. Diabetes was found in 2.8%, hepatitis B infection in 2%, and no viral infections were found. Hepatitis C at all. For the care of brain-dead donors before organ removal, hypotension (systolic blood pressure less than 90 mmHg for more than 1 hour) was found in 83.3% of patients, which is trending lower than last year. and 15.4% of patients required resuscitation. (cardiopulmonary resuscitation), which increased slightly than last year as shown in Picture 2.16.



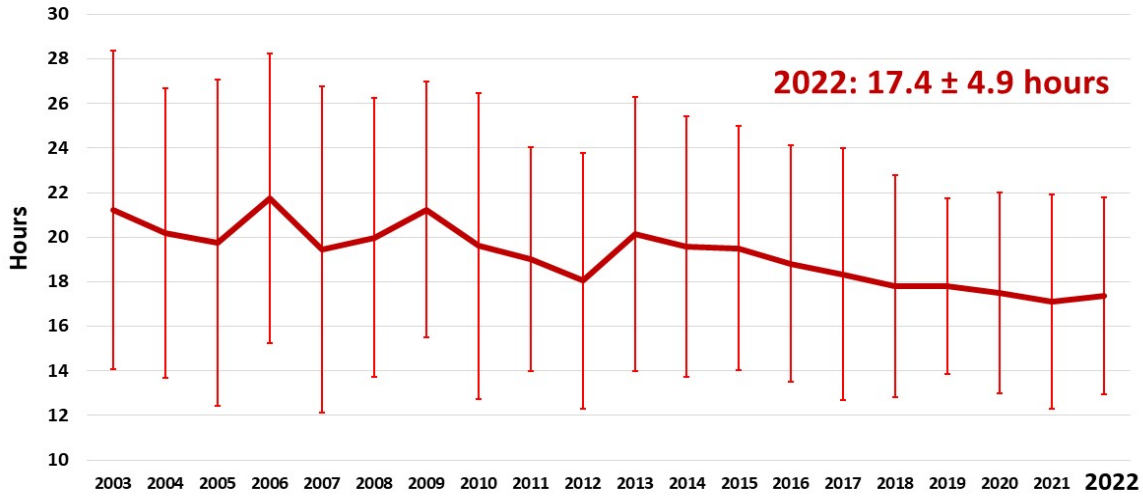
Picture 2.16 The prevalence of major comorbidities, hypotension, and need for resuscitation. (Cardiopulmonary resuscitation; CPR) in deceased donor.

Kidney function in deceased donors based on serum creatinine levels in blood showed that the average best creatinine level was 0.78 milligrams per deciliter, similar to the previous year. Meanwhile, the creatinine level before the surgery to remove the organ (terminal creatinine) was 1.42 milligrams per deciliter. which is higher than last year 30.8% of deceased donors had serum creatinine levels greater than or equal to 1.5 milligrams per deciliter before organ removal surgery. This is higher than the previous year's finding of 25.4% as shown in picture 2.17.



Picture 2.17 The optimal mean serum creatinine levels and prior organ removal in deceased donor and the proportion of deceased donor with serum creatinine prior to organ removal was ≥1.5 mg/dL.

The period of cold ischemic time for donating a deceased donor kidney in 2022 was 17.4 ± 4.9 hours, which is nearby 2021 at 17.1 ± 5.2 hours as shown in picture 2.18



Picture 2.18 The duration of cold ischemic time for kidney recipients from deceased donors.

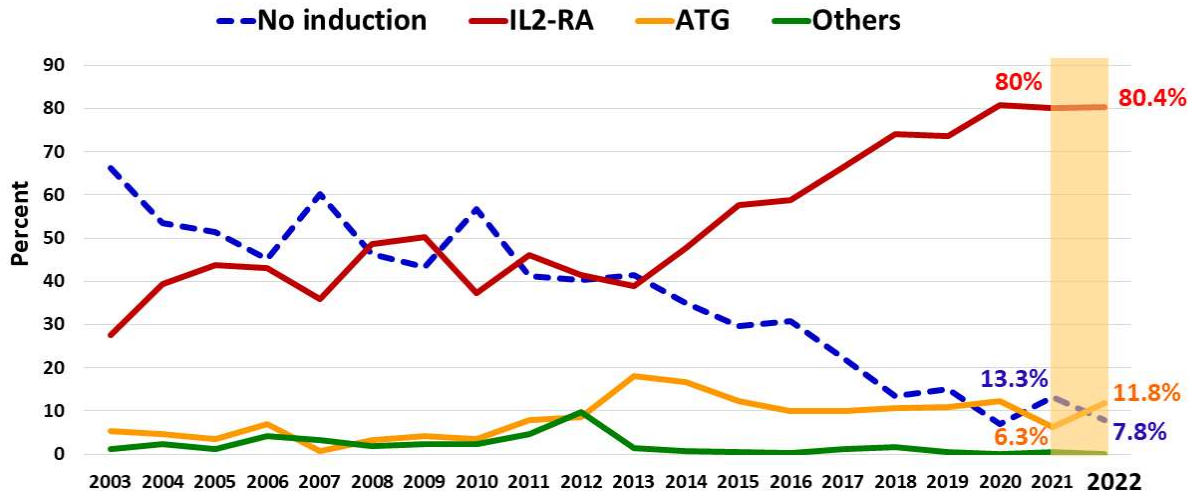
In Summary of kidney transplant in year 2022

- The kidney living donors and deceased donors had average age between 41 and 39.6 years old, respectively.
- Among living donors, most kidney donors are female sister. followed by male brother and mother, with females more kidney donors than males.
- In deceased donors, found that
    - The major causes of brain death were head trauma and stroke respectively.
    - When compared to 2021, the deceased donors who had serum creatinine and cold ischemic time was similar in the past as well as the prevalence of hypotension and the need for resuscitation to be close to the same.

Information of Immunosuppressive medication and Kidney Transplant Results

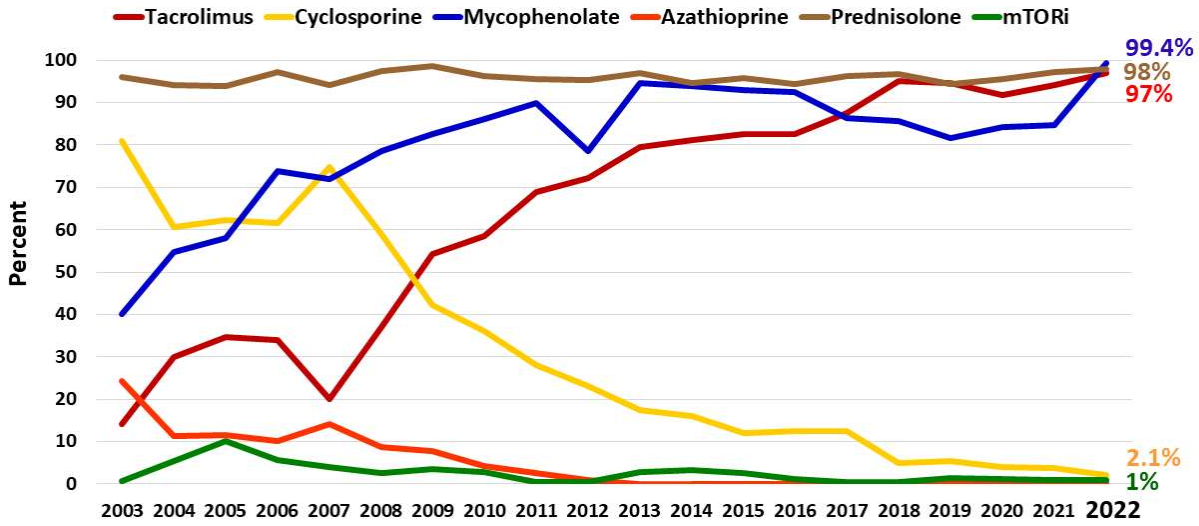
Immunosuppressive medication

In 2022, antibody induction therapy was used at 92.2%, which is slightly more than in 2021, with interleukin-2 receptor antagonist (IL-2RA) used at 80.4% similar to before and anti-thymocyte globulin (ATG) 11.8%, which increased. 7.8% of patients did not receive antibody induction therapy at all which decrease from 2021 as shown in picture 2.19



Picture 2.19 The proportion of recipients who received antibody induction therapy, separated by year of transplantation.

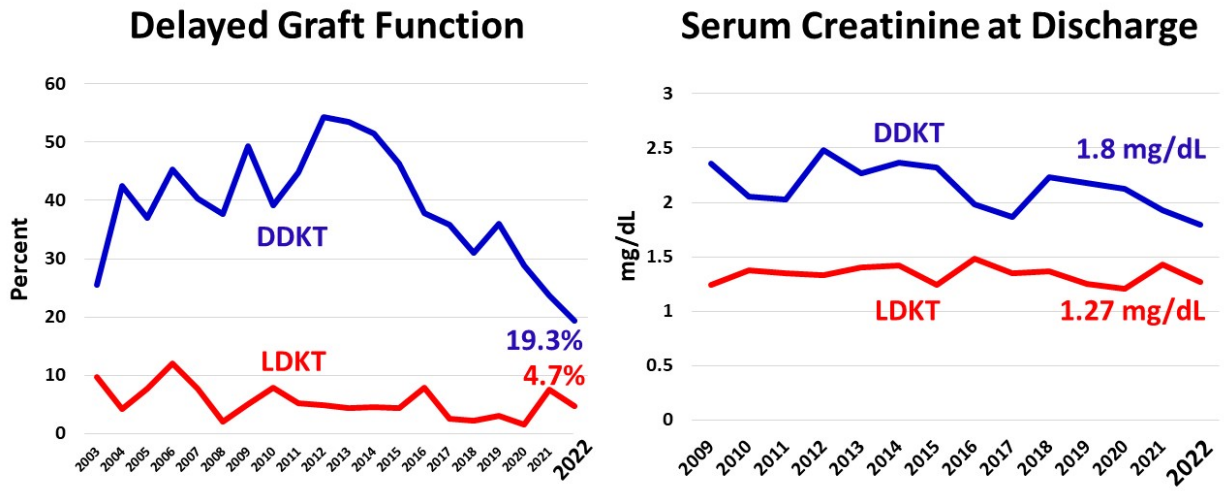
The proportion and trend of use immunosuppressive drugs as of the date of patient discharge from hospital in 2022 is shown in picture 2.20. For calcineurin inhibitors, the majority of patients (97%) received tacrolimus, while those 2.1% of patients received cyclosporine. As for anti-proliferative agents, 99.4% of patients received anti-proliferative agents. mycophenolate and none of the patients received azathioprine. 98% of patients received prednisolone and 1% received mTOR inhibitors, sirolimus or everolimus. Trends in exposure to immunosuppressive drugs were no different over the past 3 years.



Picture 2.20 The proportion of immunosuppressive treatment on discharge date, separated by year of kidney transplantation.

The proportion of delayed graft function (DGF) in recipients of kidneys transplanted from living donors was 4.7%, down from 7.5 % the previous year. In recipients of kidneys transplanted from deceased

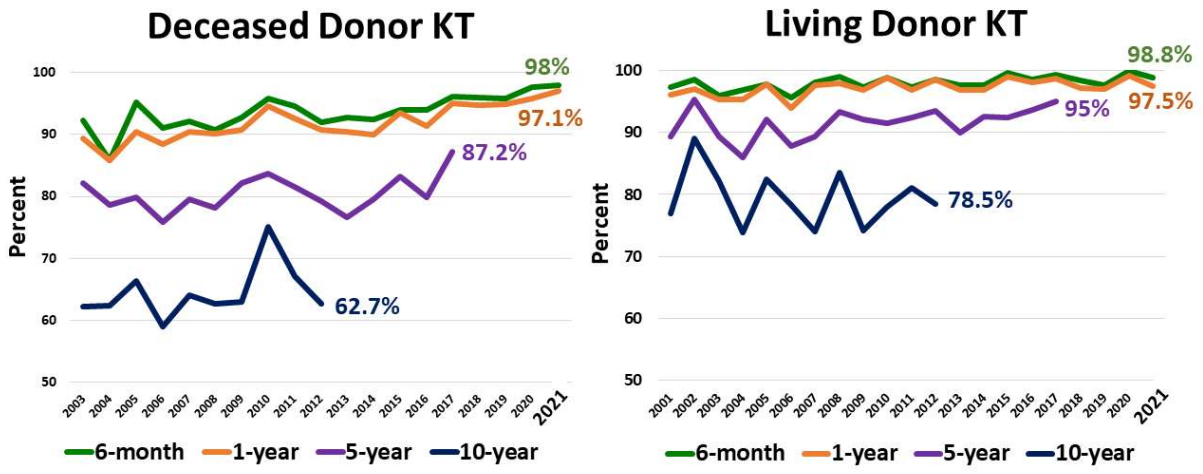
donors, it was 19.3% which was lower than that found in 2021 in 23.7% of patients. The serum creatinine level of patients on the day of discharge from the hospital in living donors was 1.27 milligrams per deciliter. and in deceased donors it was 1.8 milligrams per deciliter which decreased than the previous year as shown in picture 2.21.



Picture 2.21 Delayed graft function and serum creatinine on discharge date, separated by transplant types.

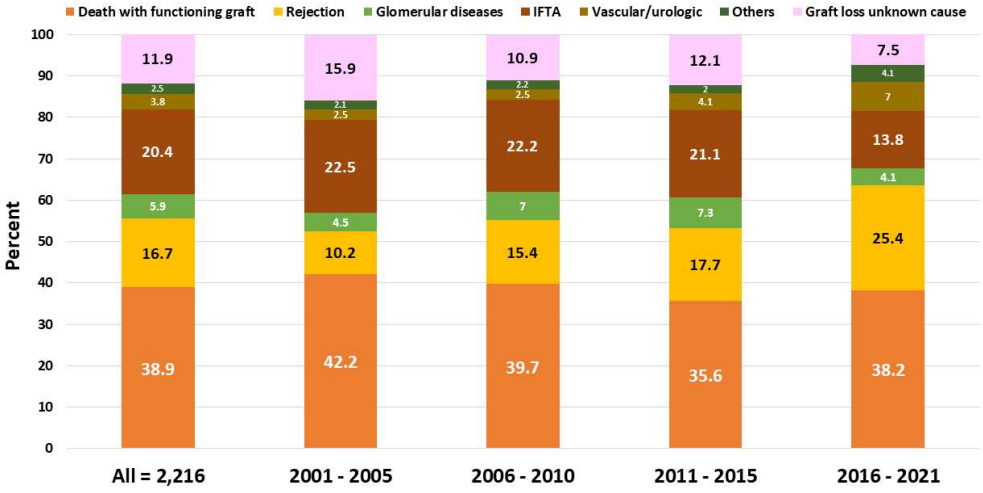
Graft Survival Rate

The graft survival rate has increased markedly over the past period. In both living donors and deceased donors, the survival rate of kidneys at one year after kidney transplantation from deceased donors in present year is high up to 98%. While survival rate of kidney transplantation at 10 years is 62.7% which lower than living donors. The graft survival rate of graft transplants each year is shown in picture 2.22.



Picture 2.22 Graft survival rate separated in each year by types of kidney transplantation.

The causes of graft loss over the years undergoing a kidney transplant are shown in picture 2.23. Approximately 40% of the patients die with the transplanted kidney to function (death with functioning graft) transplantation was performed more than 5 years prior to 2014, the number one cause was interstitial fibrosis / tubular atrophy (IF / TA). Kidney transplantation less than 5 years between 2015 to 2021, the number one cause of kidney transplant loss was rejection. In these 3 years, the rate of kidney loss was transplanted higher than before Probably the result of the outbreak of the COVID-19 virus.



Picture 2.23 Causes of graft loss in kidney recipients by kidney transplant year.

Patient Survival Rate

The patient survival rate after kidney transplantation increased significantly over the past period, especially the first-year survival rate was high over 95% regardless of how you received a donated kidney, and the 10 years survival rate after kidney transplantation was as high as 90.3%. and 83.9% in kidney recipients from living donor and kidney recipients from deceased donors, respectively, as shown in picture 2.24

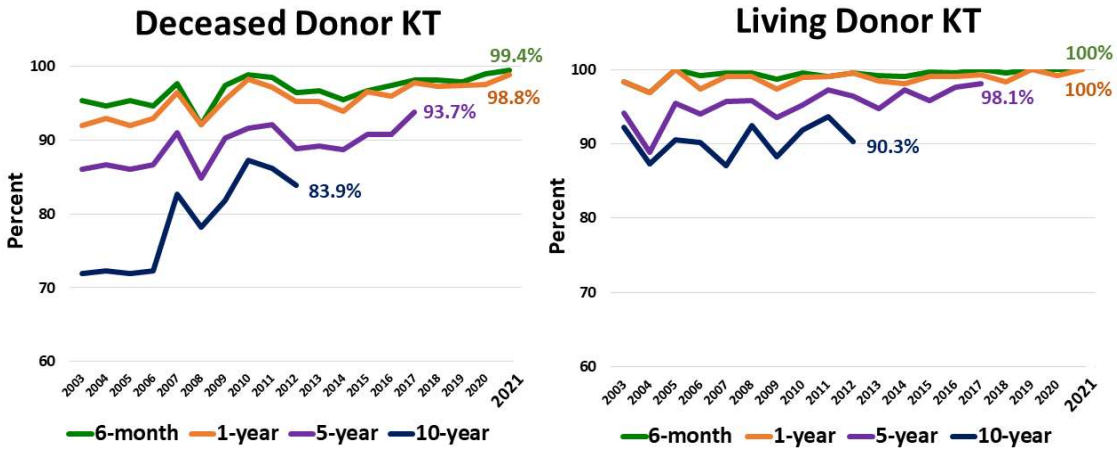
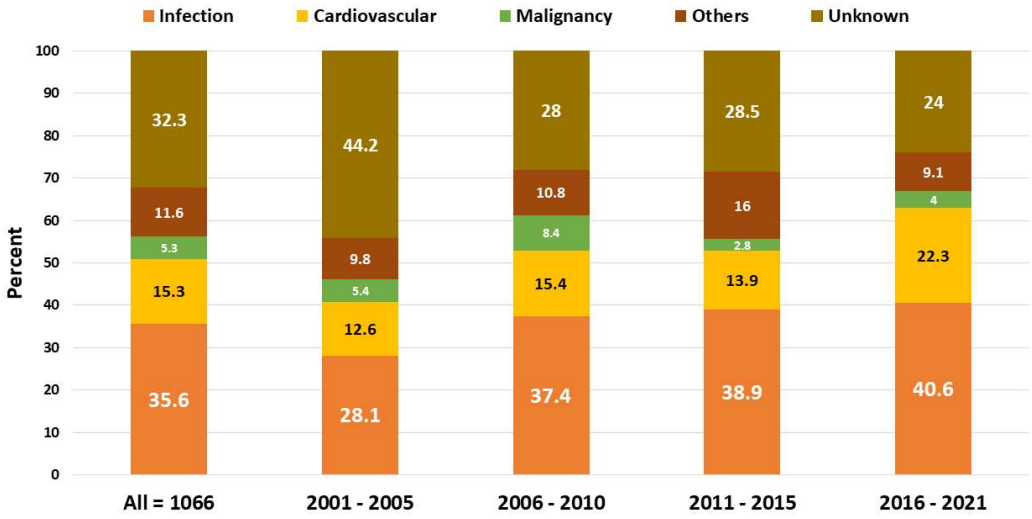


Table 2.24 The patient survival rate each year, separated by types of kidney transplantation.

Cause of death of the patient

Cause of death in patients after kidney transplantation regardless of the year a patient has had a kidney transplant is an infection followed by cardiovascular disease as shown in picture 2.25



Picture 2.25 Causes of death of kidney recipients by kidney transplant year.

Kidney transplant 2022 Summary

- Antibody induction therapy was used in 92.2%, compared to the previous period, the tendency for antibody induction therapy in most patients was stable.
- Immunosuppressants on the day of discharge from the hospital, it was found that 97% of the calcineurin inhibitor group used tacrolimus, and 99.4% of the anti-proliferative group used mycophenolate.
- Delayed graft function was found in 19.3% of patients receiving kidney transplants from brain-dead patients and 4.7% of patients receiving kidney transplants from living donors.
- Sepsis is the leading cause of death for patients.
- The major cause of graft loss was IF/TA and rejection.
- The tendency of patient survival rate and graft survival rate were increased compared to the past, both from living donors and deceased donors.

Information of Kidney Transplantation in patients younger than 18 years old

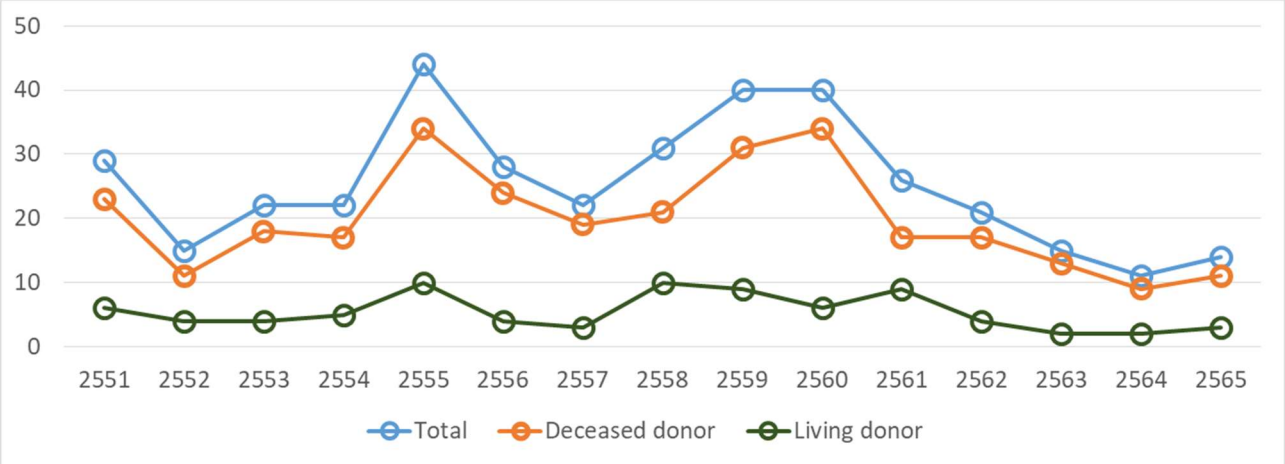
Number of kidney transplant recipients younger than 18 years old in 2022

From 1 January to 31 December 2022, there were 14 patients of kidney transplant recipients younger than18 years old which 3 recipients from living donors and 11 recipients from deceased donors, separated by hospital as shown in table 3.1.

Table 3.1 Number of kidney transplant recipients younger than 18 years old in 2020, separated by hospital.

Hospital	Kidney transplant recipients of Living donor	Kidney transplant recipients of Deceased donors	Total
Chula	2	0	2
Siriraj	4	3	7
Ramathibodhi	1	3	4
Phramongkutklao	0	4	4
Chiang Mai	0	3	3
Sirnagarind Konkhon	0	1	1
Total	**7**	**14**	**21**

When comparison in 2021, the kidney transplantation for child patients increased by 27.3% from 2022. (Picture 3.1)



Picture 3.1 Number of the kidney transplantation for child patients each year since 2008, separated by transplant types.

Information of kidney donors and patients younger than 18 years who receiving kidney transplants in 2022

The kidney transplant recipients who were younger than 18 years old in 2022 which were 14 males (57.1%) 3 patients received kidney transplants from living donors, 2 were male (66.7%). The patients received kidney transplants at the ages of 15, 17, and 18 years, all patients received transplants for first time kidney transplant. The patient received hemodialysis before a kidney transplant. The duration of kidney replacement therapy before kidney transplant for living donors were 0, 29.4 months, and 31.3 months. The patients' serum creatinine levels on the day of discharge from the hospital were 0.55, 1.05, and 1.06 mg/dL. Data on the 3 living donors found that all 3 were female, ages 26, 44, and 47 years.

There were 11 kidney transplant recipients from cerebral dead donors, 6 of them were male (54.5%). The mean age of patients after kidney transplantation was 13.0 ± 2.8years. All patients received their first kidney transplant. 6 patients (54.5%) received peritoneal dialysis before kidney transplantation. 4 patients (36.4%) received hemodialysis. Artificial kidney before kidney transplant.

Deceased donors were 10 males (90.9%). The average age of the donors was 28.9 ± 10.1 years. The duration of cold ischemic time was 16.6 ± 3.9 hours. Patients who received kidney transplants from deceased donors have duration of kidney replacement therapy before kidney transplantation was 85.5 ± 60.0 months, as shown in Table 3.2.

Table 3.2 Information of kidney transplant recipients younger than 18 years old from deceased donor.

	Recipient	Donor
Male gender, %	54.5	90.9
Age (mean ± SD), years (range)	13.0 ± 2.8 (9-17)	28.9 ± 10.1 (15-47)
Number of transplant, %		
1	100	
Mode of renal replacement therapy, %		
Peritoneal dialysis	54.5	
Hemodialysis	36.4	
Unknown	9.1	
Serum creatinine at discharge (mg/dL)		
	0.85 ± 0.34	

Cold ischemic time (hour)		
	16.6 ± 3.9	
Waiting time (month)		
	85.5 ± 60.0	

SD, standard deviation

Immunosuppressive medication usage and result of kidney transplant recipients younger than 18 years old in 2022

14 patients receiving kidney transplants in 2022 will all receive induction therapy with basiliximab. 7.14% of immunosuppressive regimen of tacrolimus, mycophenolate mofetil, and prednisolone was the mostly used immunosuppressive regimen on the day patients were discharged from the hospital. (Table 3.3)

Table 3.3 The immunosuppressive regimen received on the day of discharge

Immunosuppressive regimen	N (%)
Prednisolone + tacrolimus + mycophenolate mofetil	10 (71.4)
Prednisolone + tacrolimus + mycophenolate sodium	4 (28.6)
Total	**14 (100)**

In 2022, no kidney transplant patients developed delayed graft function and required dialysis after kidney transplantation. 12 patients (85.7%) had serum creatinine levels decreased within 24 hours while another 2 patients (14.3%) had serum creatinine levels decrease within 24-72 hours.

In 2022, patient survival and graft survival in 1 year was 100% and 100% respectively.

Information of kidney transplant recipients younger than18 years old during 1994 - 2022

Number of kidney transplant recipient younger than 18 years old by year of transplantation

From kidney transplant database by Thai Transplantation Society between 1994-2022, there were 464 recipients younger than 18 years old, which divided into 111 (23.9%) recipients from living donors and 353 (76.1%) recipients from deceased donors. The average age was equal to 13.9 $\pm$ 3.5 years old, 59.7% were male. Data of kidney transplant recipients classified by kidney transplantation type are shown in Table 3.4.

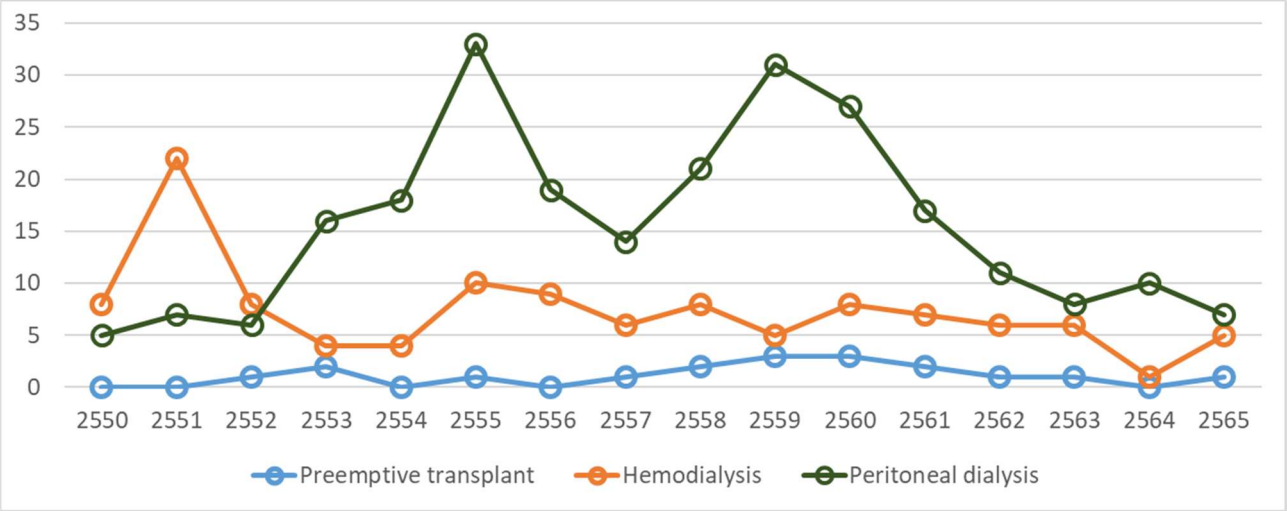
Table 3.4 The information of kidney transplant recipients of living donors and deceased donors.

	Kidney Transplant Recipient of Living donor	Kidney Transplant Recipient of Deceased donor
Number	111	353
Male gender, %	56.8	60.6
Recipient age, years (mean ± SD, range)	14.1 ± 3.4 (5–18)	13.9 ± 3.6 (0–18)
Number of first transplant, %	98.2	98.6
1		
Peak PRA (%, range)	0 (0–55)	0 (0–89)
Last PRA (%, range)	0 (0–55)	0 (0–54)
Mode of renal replacement therapy, %		
Preemptive transplant	14.4	0.9
Hemodialysis	34.6	33.2
Peritoneal dialysis	45.2	62.5
Previous kidney transplant	0	0.3
Missing	5.8	3.1
Waiting time, months (Interquartile range)	32.1 (15.8–61.3)	53.5 (28.8–84.3)

Payment type, %		
Government Healthcare	55.9	70.8
Social Security Office	11.7	8.5
National Health Security Office	1.8	0.3
Self-Support	1.8	2.0
Others	6.3	2.6
N/A	1.8	6.8

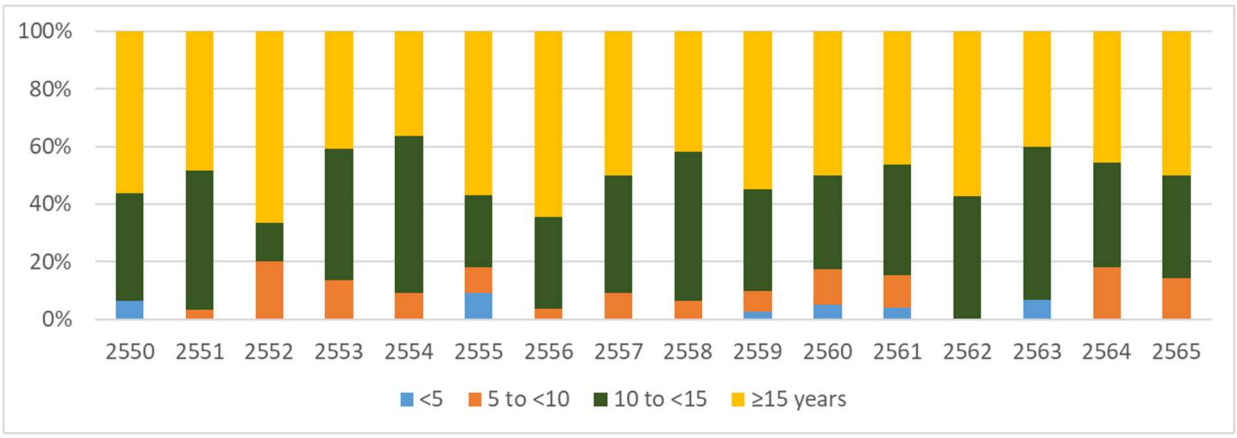
SD, standard deviation

The number of kidney transplant patients under 18 years of age classified by type of renal replacement therapy prior to kidney transplantation is shown in picture 3.2. Most pediatric patients received peritoneal dialysis prior to transplantation. kidney representing 57.8% of all kidney transplant recipients.



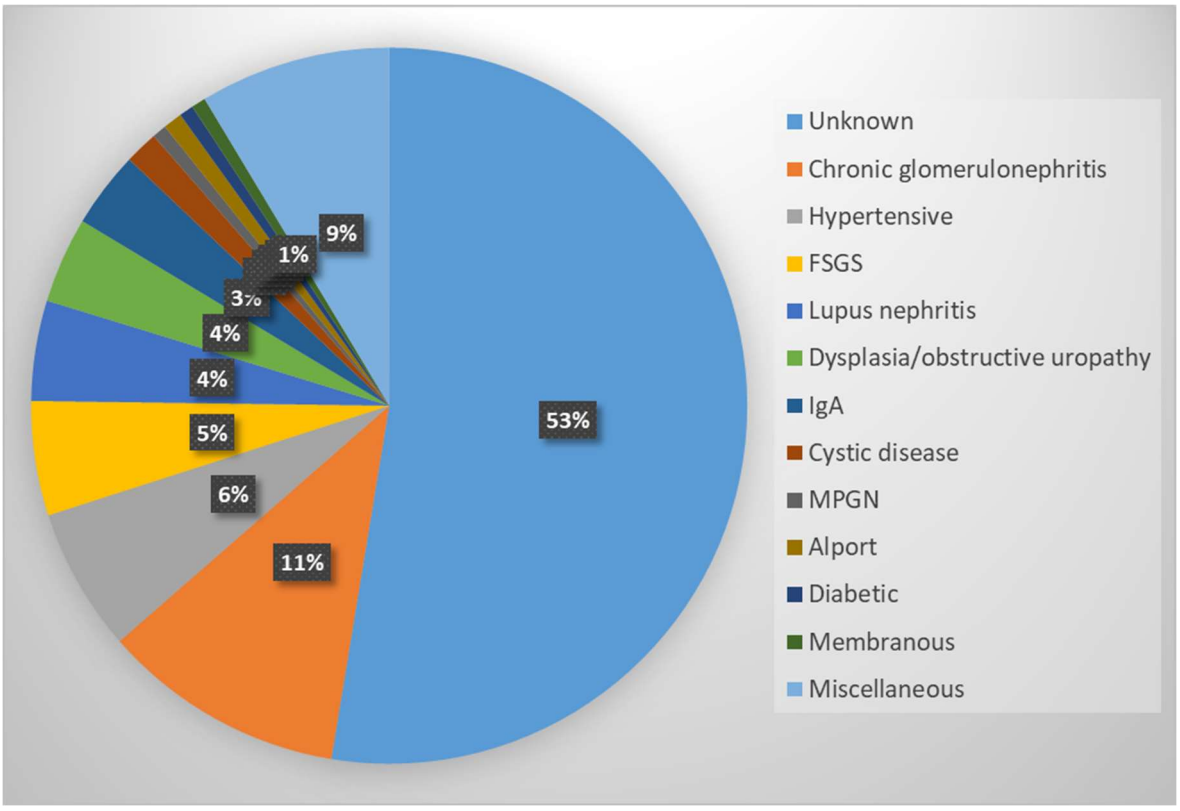
Picture 3.2 The number of child recipients since 2007, separated by renal replacement therapy.

The number and proportion of kidney transplant patients younger than18 years old by age as shown in picture 3.3.



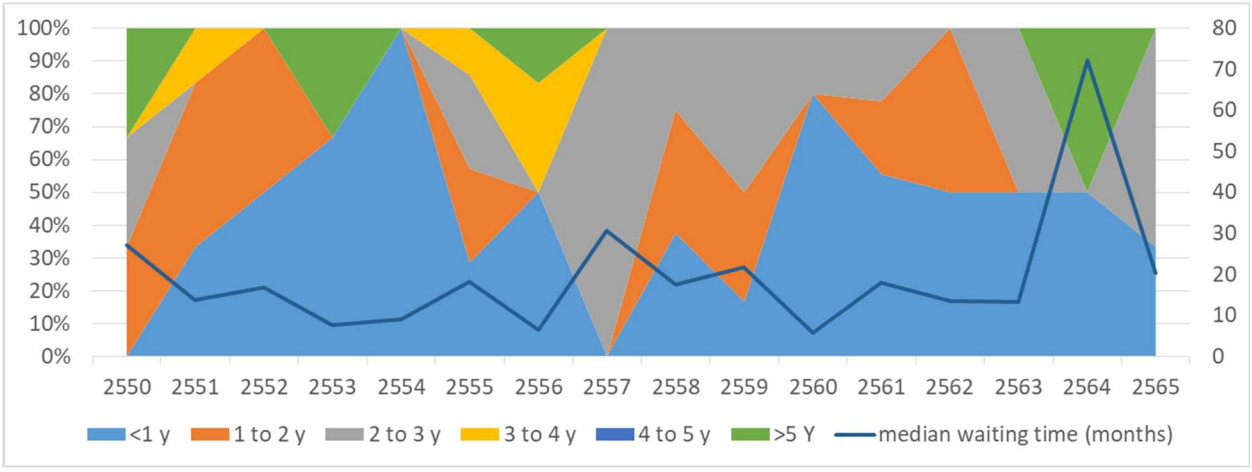
Picture 3.3 The proportion of kidney transplant patients younger than 18 years old, separated by ages.

The major causes of chronic kidney disease were 11% of chronic glomerulonephritis, 6.9% of Hypertensive nephropathy, 6% of focal segmental glomerulosclerosis (FSGS), 5% of dysplasia/ obstructive uropathy, 4% of lupus nephritis and 3% of IgA nephropathy and 53% of patients with idiopathic chronic kidney disease (picture 3.4)

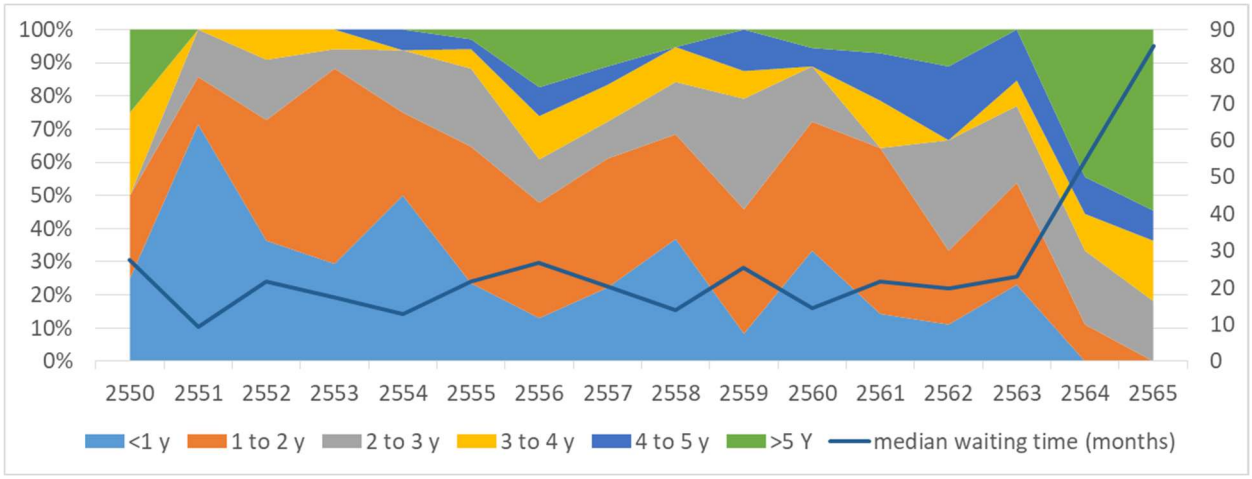


Picture 3.4 Causes of chronic kidney disease in child recipients.

The kidney recipients from deceased donors had longer period of renal replacement therapy before transplantation than living donors (table 3.4). The period of renal replacement therapy before transplantation of child kidney recipients from living donors and deceased donors were separated by year as shown in picture 3.5 and 3.6 respectively.



Picture 3.5 The period of renal replacement therapy before kidney transplantation from living donors.



Picture 3.6 The period of renal replacement therapy before kidney transplantation from deceased donors.

Information of Organ Donors

The information of kidney transplantation separated by transplant types (table 3.5) of 85 of living donors, 27% were male. The relationship between donors and recipients as shown in table 3.6.

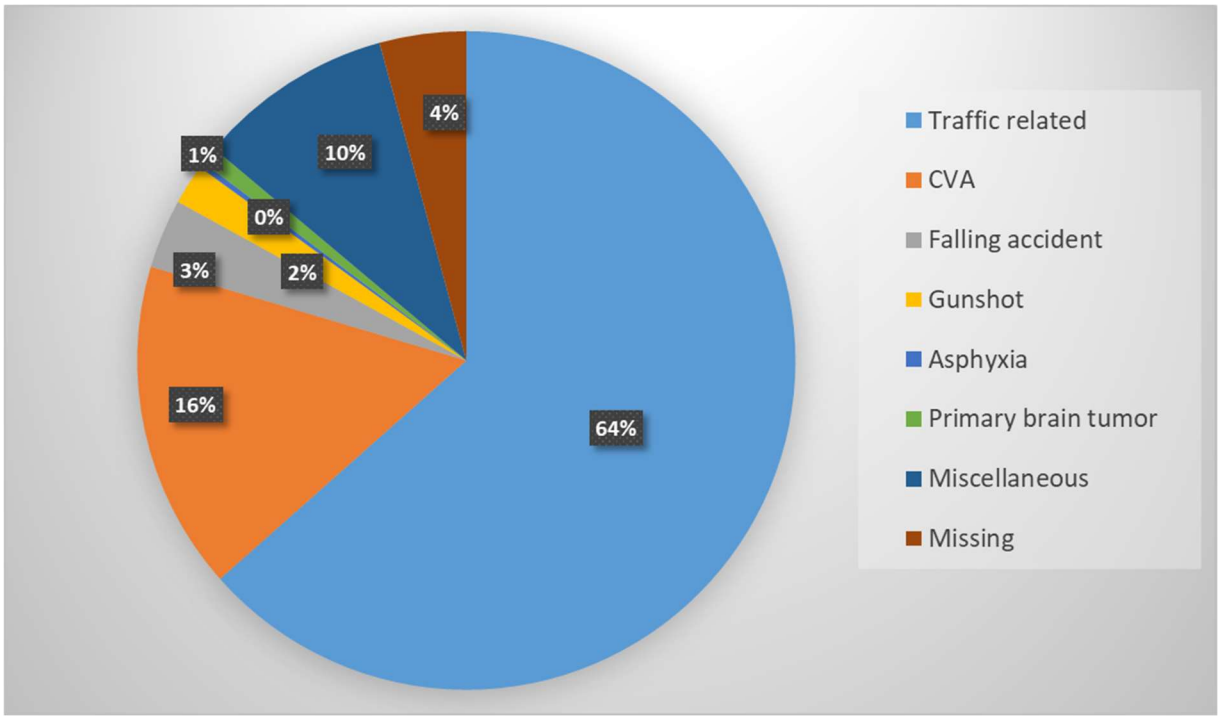
Table 3.6 The information of living donors and deceased donors.

	Living donor	Deceased donor
Number	111	353
Male gender, %	32.4	77.9
Donor age, years (mean ± SD, range)	39.3 ± 9.0 (18–58)	31.8 ± 12.1 (3–59)
Donor best serum creatinine, mg/dL	0.58 ± 0.43	0.80 ± 1.02
Donor last serum creatinine, mg/dL	0.86 ± 0.42	1.19 ± 0.63
Donor hypotension, %	3.6	74.5
Donor CPR, %	0	10.5

Table 3.6 The relationship between living donors and recipients.

Relationship between recipient	Number of donor (%)		
	Male	Female	Total
Parents	16 (14.4)	64 (57.7)	80 (72.1)
Siblings	5 (4.5)	5 (4.5)	10 (9.0)
Others e.g. twin, cousin	12 (10.8)	9 (8.1)	21 (18.9)
Total	33 (29.7)	78 (70.3)	111 (100)

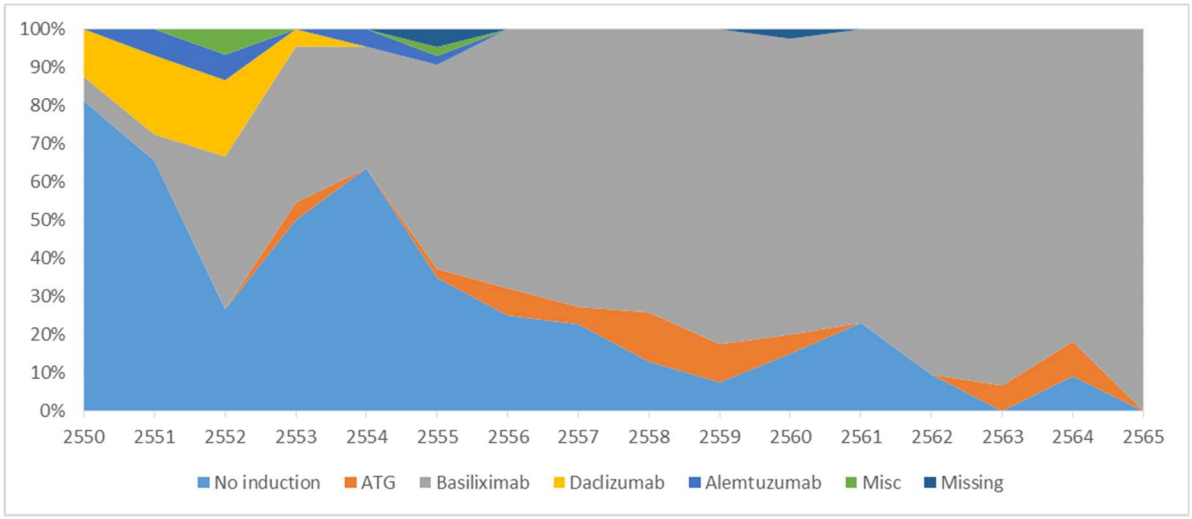
From 353 deceased donors, 77.9% were male and 74.5% had hypotension before amputation, 10.5% had cardiopulmonary resuscitation (table 3.5 The causes of brain death in brain death donors are shown in picture 3.7. The majority of brain death donors (64%) were caused by traffic accidents.



Picture 3.7 Causes of brain death in deceased donors

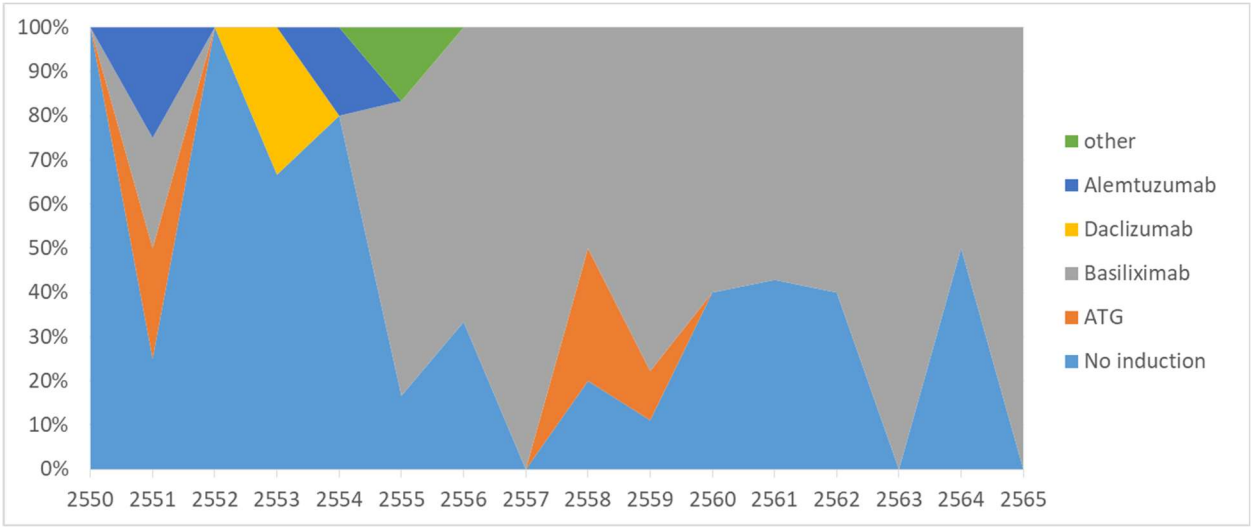
Immunosuppressive medication used and kidney transplant result.

The patients younger than18 years old received induction therapy and its significantly increased every year and decreased in non-induction therapy (picture 3.8). The kidney transplant recipients were 44.1% of living donors and 28.9% of deceased donors.

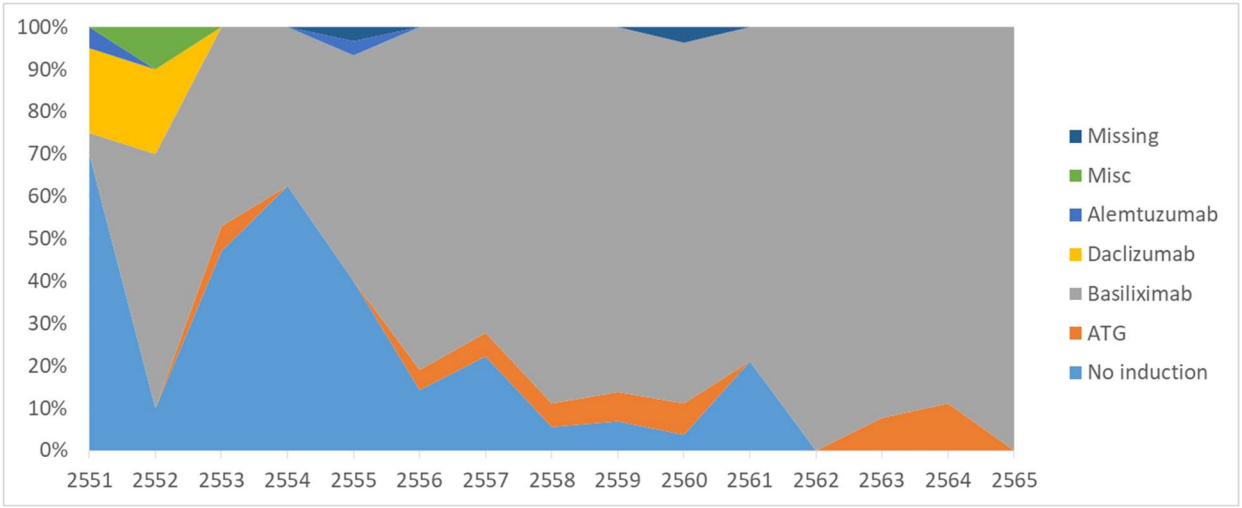


Picture 3.8 The proportion of patients received induction therapy, separated by year of transplantation.

The proportion of induction therapy in patients receiving kidney transplant from living donors and in patients who received kidney donation from deceased donors classified by year of kidney transplantation are shown in picture 3.9 and picture 3.10 respectively.

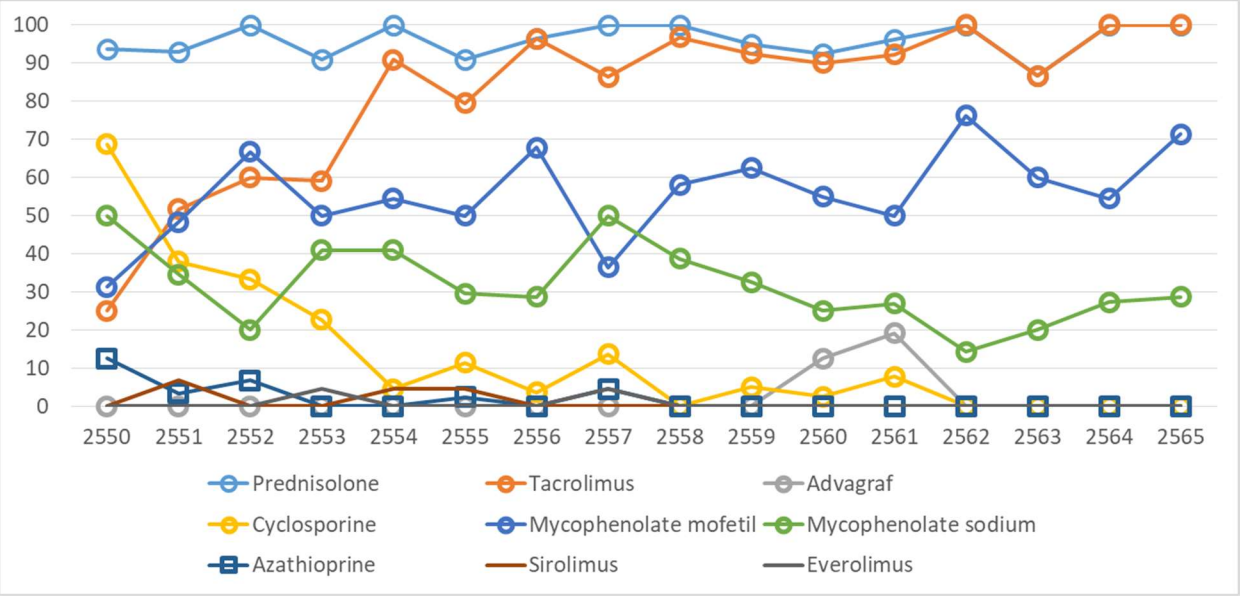


Picture 3.9 The proportion of antibody induction therapy in renal transplant patients living donors classified by year of kidney transplantation



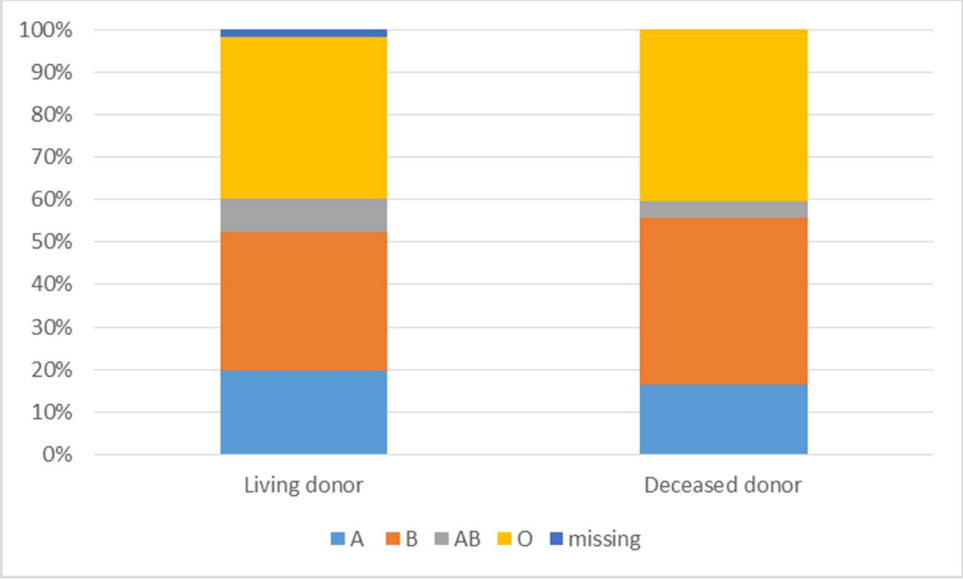
Picture 3.10 The proportion of antibody induction therapy in renal transplant patients deceased donors classified by year of kidney transplantation.

The proportion and tendency of immunosuppressive medication used on discharge date was shown in picture 3.11. The patients younger than18 years old received prednisolone, tacrolimus and mycophenolate mofetil were significantly increased.



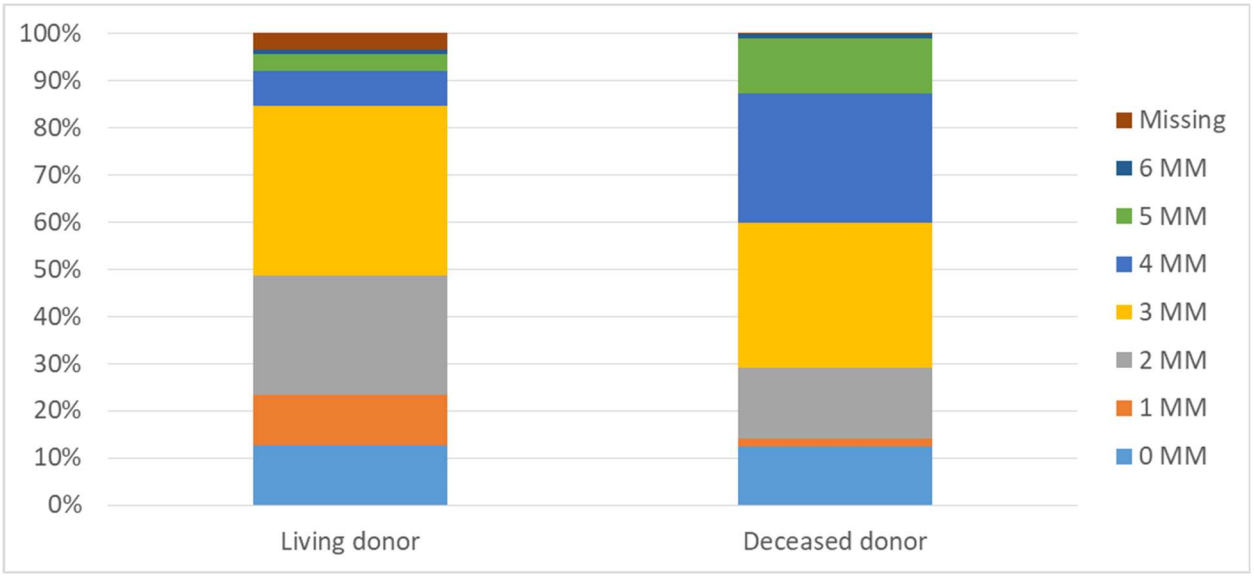
Picture 3.11 The proportion of patients receiving immunosuppressant medication at discharge date from the hospital classified by year of kidney transplantation.

Regarding the blood groups of kidney transplant recipients, the proportion of kidney transplant recipients from blood group O was 37.8%, group B was 32.4%, and blood group A was 19.8%. and 8.1% of blood group AB. For kidney transplant from cerebral dead donors, the proportion of kidney recipients was 40.5% of blood group O, 39.4% of blood group B, 16.4% of blood group A, and 3.7% of blood group AB. (picture 3.12)

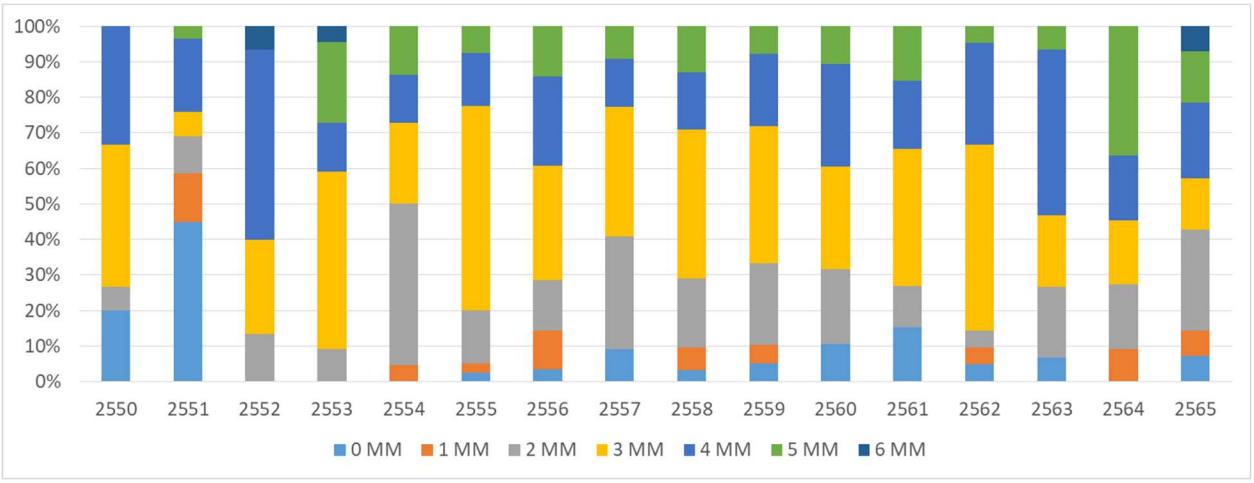


Picture 3.12 The proportion of kidney transplant recipients separated by blood types.

There were tissue matching of 3 HLA mismatch which the proportion was separated by transplantation types as shown in picture 3.13 and separated by transplantation year as shown in picture 3.14.



Picture 3.13 The tissue matching of child patients, separated by transplant types.



Picture 3.14 The tissue matching of child patients, separated by transplant year.

The kidney recipients from deceased donors had both high delayed graft function and serum creatinine level at discharge date than from living donors. The number of recipients from deceased donors had longer stay in hospital than from living donors. (Table 3.7)

Table 3.7 The delayed graft function and serum creatinine on discharge date and the number of patient admission, separated by transplant types.

	kidney transplant from living donor	kidney transplant from deceased donor
Delayed graft function, %	6.3	22.1
Serum creatinine at discharge, mg/dL	1.06 ± 1.04	1.36 ± 1.20
Admission days after transplantation, days (median, interquartile range)	15.0 (11–22)	22 (16–33)

Cytomegalovirus Infection in child patients who received a kidney transplant

The child patients tended to have Cytomegalovirus (CMV) infection; 343 patients (73.9%) had Anti-CMV IgG positive and 13 patients (2.9%) had Anti-CMV IgM positive; 6 patients had Anti-CMV IgM positive had Anti-CMV IgG negative. The relationship between recipients and donors were separated by CMV infection as shown in table 3.8.

Table 3.8 The relationship between recipients and donors, separated by Cytomegalovirus (CMV) infection.

Recipient	Donor		
	Anti-CMV IgG positive	Anti-CMV IgG negative	Unknown
Anti-CMV IgG positive	63.1	3.0	7.8
Anti-CMV IgG negative	7.8	3.9	0.6
Unknown	3.0	0.2	10.6

Infectious status and immunity to viral hepatitis in pediatric kidney transplant patients.

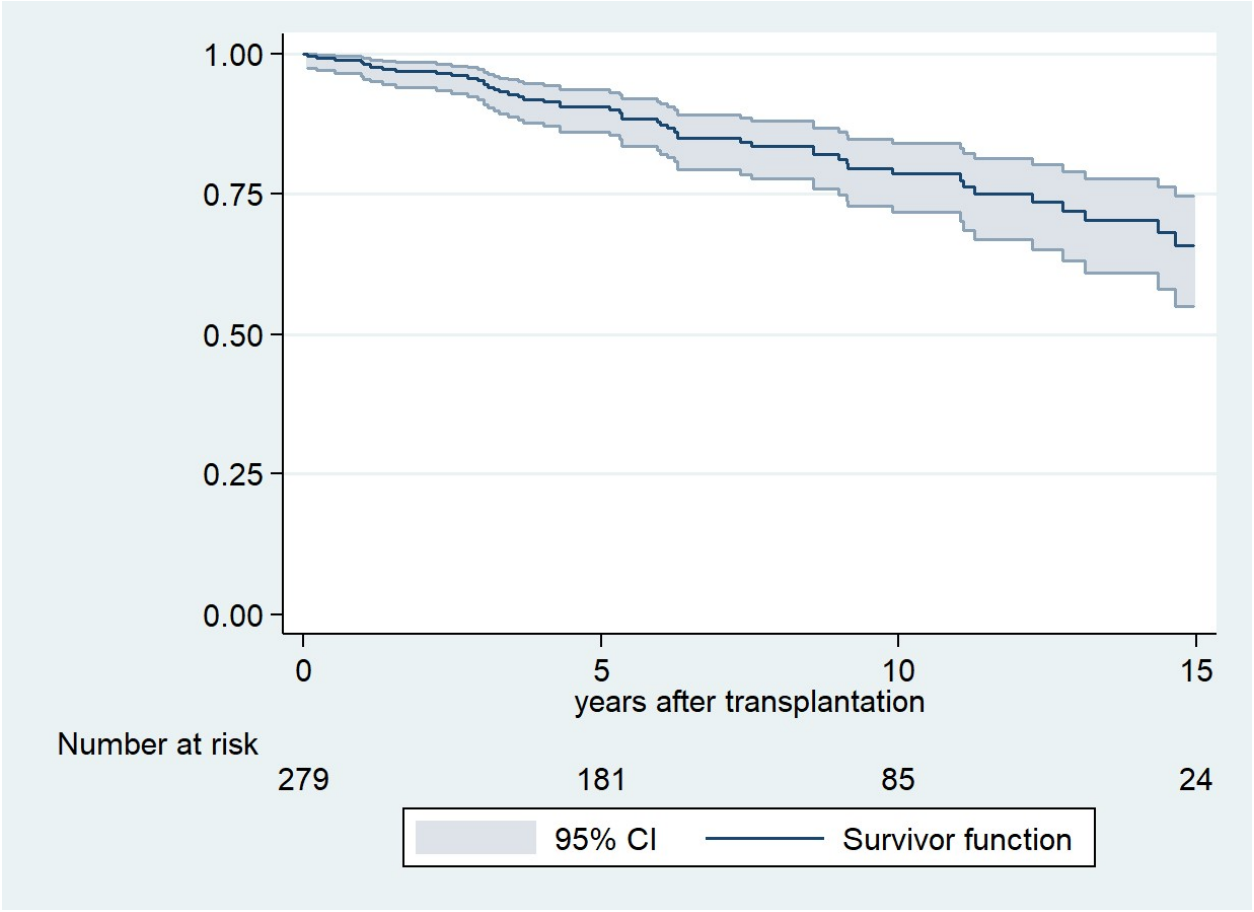
39.2% of pediatric kidney transplant patients were anti-HBs Ab positive, 4.3% were anti-HBc Ab positive, and 5 patients were hepatitis B surface antigen positive.

Among pediatric kidney transplant recipients who were anti-HBs Ab negative (anti-HBs Ab negative), 4 patients were transplanted from a donor kidney with Hepatitis B e detection. antigen (HBeAg).

2 pediatric kidney transplant patients tested positive for anti-HCV Ab and 4 pediatric patients received kidney transplantation from kidney donors who tested positive for anti-HCV Ab.

Patient survival rate

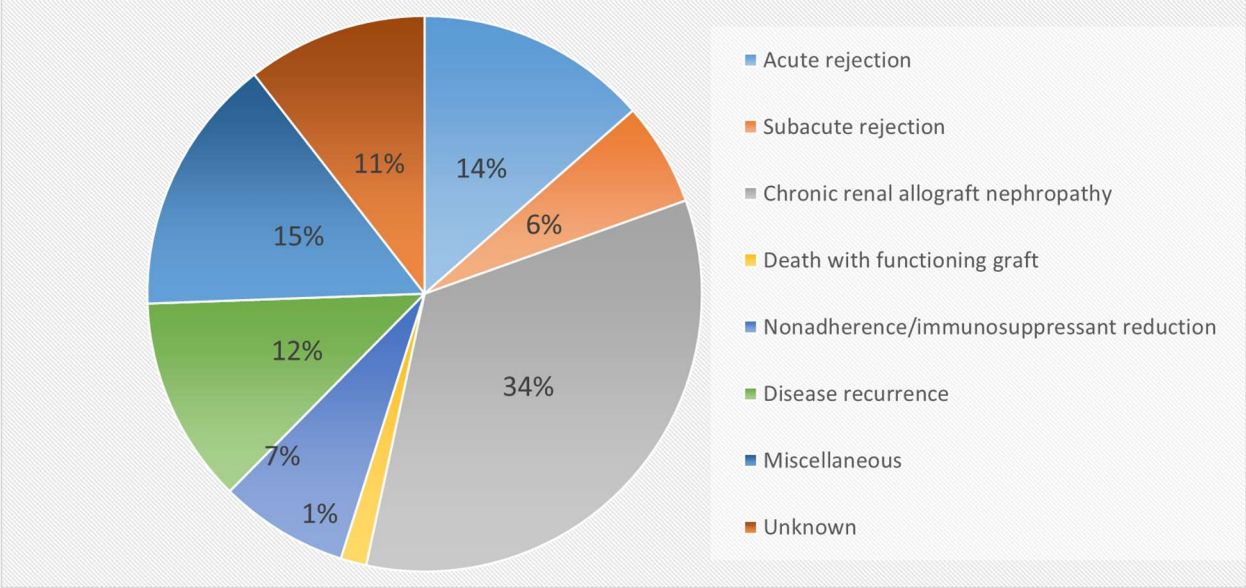
The patient survival rate after kidney transplant had significantly increased. During 1996 – 2021, 54 patients died after kidney transplantation which was 11.6%. The causes of death were 10 cases of infection, 3 case of cardiovascular failure, 2 cases of kidney failure, 5 cases of others and 34 cases of unknown causes. The patient survival rate of children age at 1,5, 10 and 15 years old were 98.5%, 90.5%, 78.5 and 65.5% respectively (picture 3.15). There was no difference between kidney transplant from living and deceased donors in statistic.



Picture 3.15 The patient survival rate of kidney transplant in children.

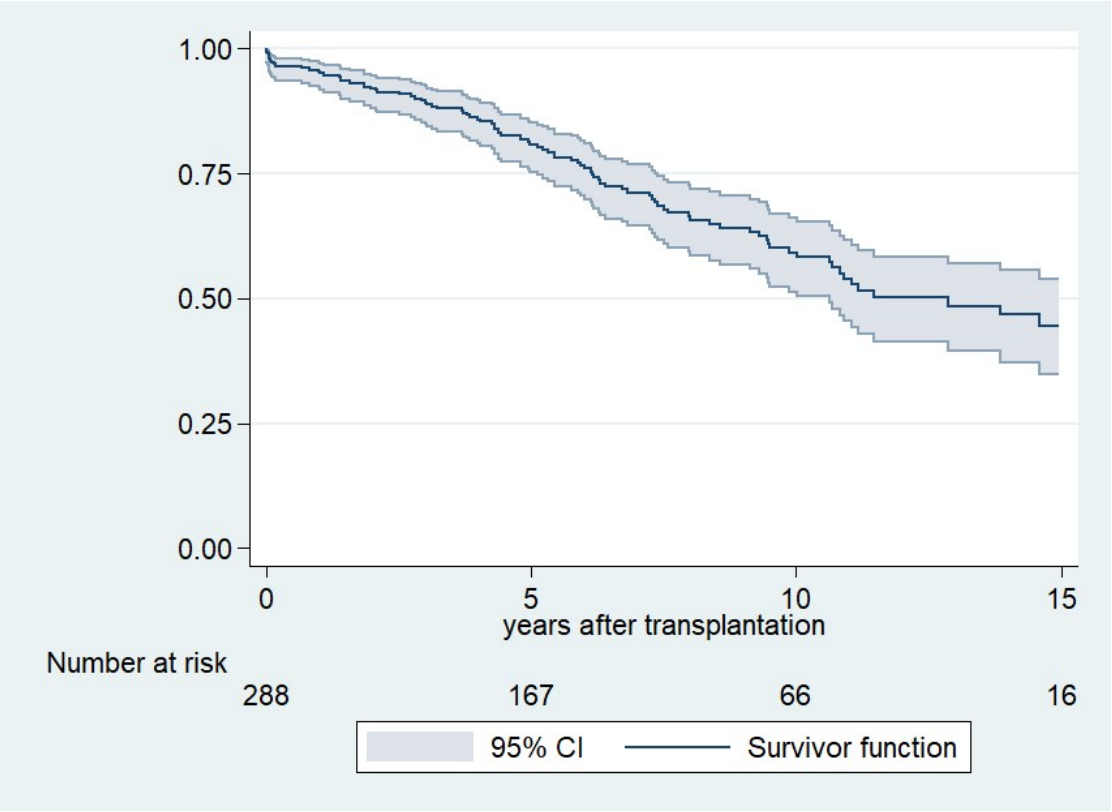
Graft survival rate

During 1996 – 2021, there were 133 (29.3%) cases lost their kidneys, 45 causes were chronic renal allograft nephropathy, 16 causes recurrence of primary disease, 10 causes were withdrawal immunosuppression/ non-adherance, , 18 causes were acute rejection, 8 cause of subacute rejection, 2 causes were death with functioning graft, 20 causes of other and 14 unidentified caused cases (picture 3.16)



Picture 3.16 Causes of child kidney transplant recipients who lost their kidneys.

The graft survival rate at the 1,5, 10 and 15 years were 95.4% ,80.8%, 59.2% and 44.9% respectively (picture 3.17). When compare in statistic, there were no difference between living donors and deceased donors



Picture 3.17 The graft survival rate of child kidney transplant recipients.

Annual Report on Liver Transplantation 2022

The Liver Transplant Registration Subcommittee of the Thai Transplantation Society was first established in 2018, and they had a meeting in March of the same year to create a Thai liver transplant registry, starting from the year 2016 to 2018. Since then, the liver transplant annual report has been presented at the meeting of the Thai Transplant Society every year. The liver transplant registry aims to collect information on recipients, donors, immunosuppressive medications used, and the outcomes of liver transplants nationwide.

This is the 5th report on liver transplants during the past 7 years (2016-2022) in which information was cumulative collected and analyzed. This report is divided into three parts: adult liver transplantation, pediatric liver transplantation (less than 18 years old), and the liver transplant recipients recently followed up in each institution.

Liver transplantation in adults

During 2016-2022, there were 590 liver transplants in adults (aged 18 years and over) and the numbers each year were as follows: 2016, 77 cases; 2017, 96 cases; 2018, 76 cases; 2019, 92 cases; 2020, 90 cases; 2021, 56 cases; and 2022, 103 cases (Table 1). In 2022, the number of liver transplants increased by 84 % compared to 2021 and was the highest in 7 years. The rising number occurred after the COVID-19 outbreak during 2020-2021, which limited liver transplantation across the country.

The number of liver transplantation according to transplant centers is shown in Table 1. The top 3 liver transplantation institutions were Srinagarind Hospital, Khon Kaen University (160 cases), Siriraj Hospital (150 cases), and Chulalongkorn Hospital (142 cases), respectively.

Table 1. Number of liver transplantation in adults during 2016-2022,divided by transplant centers

Hospital	2016	2017	2018	2019	2020	2021	2022	Total
Srinagarind	8	23	24	25	33	16	31	160
Siriraj	26	28	19	23	21	9	24	150
Chulalongkorn	23	21	16	29	20	10	23	142
Maharaj Nakorn Chiangmai	7	8	5	6	9	13	8	56
Ramathibodi	6	8	4	6	5	3	10	42
Vichaiyuth	5	4	4	0	2	3	2	20
Rajavidhi	2	3	3	1	0	0	3	12
Bumrungrad	0	0	1	1	0	2	0	4
Smithivej Sukhumvit	0	1	0	1	0	0	0	2
Bangkok	0	0	0	0	0	0	2	2
Total	**77**	**96**	**76**	**92**	**90**	**56**	**103**	**590**

Types of liver transplants were divided into first liver transplants (569 cases, 96.4%) and the second liver transplant (21 cases, 3.6%) Types of donors were deceased donors (donor after brain death) (554 cases,93.9%) and living donors (36 cases,6.1%).

Recipient characteristics

The mean age of recipients was 52.7 years old (standard deviation, SD was 13.2 years) with the youngest age of 19 years old and the oldest age of 77 years old. There were more male recipients than female recipients; male 438 (74.2%) and female 152 (25.8%). Most donors had blood group O (36.8%), followed by blood group B (34.2%) (Table 2). The average body mass index (BMI) was 24.4 kg/m^2(SD 4.3 kg/m^2) with the minimum of 14.2 kg/m^2 and the maximum of 39.8 kg/m^2. There were 48 (8.1%) patients with a BMI of 30-35 kg/m^2 (obesity) and 13 (2.2%) cases with a BMI of greater than 35 kg/m^2 (morbid obesity). Recipient demographic data are shown in Table 2.

Table 2. Demographic data of adult liver transplant recipients during 2016-2022

Type	Average, Number	SD (range), %
Age (Year)	52.7	13.2
Sex: Male	438	74.2 %
Female	152	25.8 %
Blood Type: A	119	20.2 %
B	202	34.2 %
O	217	36.8 %
AB	52	8.8 %
BMI (kg/m^2)	24.4	4.3

The main indications for liver transplants included hepatocellular carcinoma (270 cases, 46.8%), acute hepatitis B infection/chronic hepatitis B cirrhosis (166 cases, 28.1%), hepatitis C cirrhosis (131 cases, 22.2%), alcoholic cirrhosis (99 cases, 16.8%), non-alcoholic steatohepatitis cirrhosis (37 cases, 6.3%), acute liver failure (31 cases, 5.3%), and others (Table 3). Wilson disease was the most common cause of acute liver failure. Most individual patients had more than one underlying liver disease, such as hepatocellular carcinoma together with acute hepatitis B infection.

Table 3 Indications for liver transplantation in adults during 2016-2022.

Cause	Number	%
Hepatocellular carcinoma	270	45.8
Underlying liver diseases		
• Hepatitis B infection/cirrhosis	101	
• Hepatitis C cirrhosis	96	
• Alcoholic cirrhosis	21	
• Non-alcoholic steatohepatitis cirrhosis	10	
• Hepatitis B and C infection	6	
• Autoimmune hepatitis	3	
• Cryptogenic cirrhosis	2	
• Primary biliary cholangitis	1	
• Alcohol and NASH cirrhosis	1	
Cirrhosis	221	37.5
Hepatitis B infection/cirrhosis	63	
Alcoholic cirrhosis	57	
Hepatitis C cirrhosis	35	
Non-alcoholic steatohepatitis cirrhosis	23	
Primary biliary cholangitis	10	
Overlap syndrome	9	
Autoimmune hepatitis	9	
Cryptogenic cirrhosis	9	
Hepatitis B and C coinfection	3	
Primary sclerosing cholangitis	3	

Acute fulminant hepatic failure (Wilson disease, herbal use, autoimmune hepatitis, disseminated varicella-zoster virus infection, hepatitis B infection hepatitis E infection, amanita, indeterminate cause)	31	5.3
Biliary atresia	25	4.2
Wilson disease (acute liver failure or cirrhosis)	11	1.9
Budd-Chiari syndrome	6	1.0
Post transplant-related		
Hepatic artery thrombosis	6	1.0
Primary graft non-function	2	0.3
Chronic rejection	2	0.3
Others		
Polycystic liver disease	6	1.0
Calori's disease	5	0.8
Familial amyloidosis polyneuropathy	4	0.7
Cholangiocarcinoma	3	0.5
Hemangioma	2	0.3
Common bile duct stricture	1	0.2
Hepatoblastoma	1	0.2
Intraductal papillary neoplasm of bile duct	1	0.2
Metabolic disease	1	0.2
Post-hepatectomy liver failure	1	0.2
Hemochromatosis with bile duct injury	1	0.2
Parenteral nutrition-associated Liver Disease	1	0.2
Liver metastasis from gastrointestinal stromal tumor (GIST)	1	0.2

NASH: Non-alcoholic steatohepatitis

Common pre-liver transplant complications in adult recipients included refractory ascites (112 cases, 23%), variceal bleeding (94 cases, 19.3%), recurrent spontaneous bacterial peritonitis 57 cases, 11.7%) and others as shown in table 4.

Table 4. Pre-liver transplant complications in adult recipients during 2016-2022

Symptom and Complication	Number	%
Refractory ascites	137	23.2
Variceal bleeding	108	18.3
Recurrent spontaneous bacterial peritonitis	65	11.0
Hepatorenal syndrome	31	5.3
Recurrent cholangitis	26	4.4
Hepatic hydrothorax	5	0.8
Polyneuropathy	4	0.7
Hepatopulmonary syndrome	4	0.7

The common comorbidities in liver transplant recipients included diabetes (154 cases, 27.4%), dyslipidemia (55 cases, 6.7%), 32 (5.1%) of chronic kidney disease (55 cases, 6.7%), and hypertension (35 cases, 3.3%). Moreover, 7 (1%) patients had previous cancers other than liver cancer, i.e., 2 of breast cancer, 1 of ovarian cancer, and 1 of lymphoma, as shown in Table 5.

Table 5. Comorbidities in adult liver transplant recipients during 2016-2022

Comorbidity	Number	%
Diabetes mellitus	154	26.1
Dyslipidemia	55	9.3
Chronic kidney disease	32	5.4
Hypertension	35	5.9
Heart disease (CAD, heart block, ASD)	11	1.9
Hematologic disease (thalassemia, ITP, G6PD def)	6	1.0
Previous cancer (CA breast, CA ovary, CA bladder, lymphoma)	7	1.2
Autoimmune (SLE, Scleroderma, Sjogren)	3	0.5

Old cerebrovascular accident	3	0.5
Pulmonary disease (asthma, old TB)	2	0.3
Hyperthyroid	2	0.3
Gout	2	0.3
Myasthenia gravis	1	0.2

(CAD: coronary artery disease, ASD: atrial septal defect, ITP: idiopathic thrombocytopenic purpura, G6PD def: glucose-6-phosphase dehydrogenase deficiency, CA: carcinoma, SLE: systemic lupus erythematosus, TB: tuberculosis)

Baseline data of liver transplant recipients showed median total bilirubin 2.6 mg/dL, albumin 3.1 g/dL, creatinine 0.9 mg/dL, serum sodium 136 mmol/L, INR 1.4 and model of end-stage liver disease - sodium (MELD-Na) score19 with the lowest score of 6 and the highest score of 40, as shown in Table 6. The median ischemic time, defined as donor clamp time to reperfusion time, was 6 hours 33 minutes. Median length of postoperative hospital stay of liver transplant patients, counting from the day of liver transplantation until the day of discharge from the hospital, was 17 days. Patients who died during surgery or hospitalization were not included in the data on the length of hospital stay to reduce data discrepancy.

Table 6. Baseline data of liver transplant recipients during 2016-2022

	Median	IQR
Total bilirubin (mg/dL)	2.6	1.3, 8.9
Albumin (g/dL)	3.1	2.6, 3.6
Creatinine (mg/dL)	0.9	0.7, 1.3
Serum sodium (mmol/L)	136	133, 139
INR	1.4	1.2, 1.7
AFP (ng/mL)	4.1	2.2, 12.3
MELD-Na score	19	14, 26
Ischemic time (hours: minutes)	6:33	5:10, 8:03
Length of hospital stay* (day)	17	12, 27

*\ “hospital stay is defined as duration from transplant date until discharge date with exclusion of the patients who died during transplant or hospital stay

IQR: inter-quartile range, INR: international normalized ratio of prothrombin time, MELD-Na: Model of end-stage liver disease-sodium score

The median waiting time for donated organs, from the start of registration to the date of transplant surgery, was 78 days, and a mean of 257 days, or approximately 8.5 months. The shortest waiting time was 1 day and the longest waiting time was 4,210 days (approximately 11.5 years). The waiting time for each year is shown in Table 7. The shortest waiting time was in 2020, with a median of 56 days.

Table 7. The waiting time of adult liver transplant recipients for each year during 2016-2022.

Year	Number of liver transplant (cases)	Median waiting time (days)	Inter-quartile range (days)	Range (days)
2516-2022	**590**	**78**	**24, 235**	**1-4210**
2016	77	76	27, 381	1-1180
2017	96	114	31, 330	1-2655
2018	76	83	28, 226	1-4010
2019	92	77	20, 186	1-3139
2020	90	56	24, 147	1-3014
2021	56	74	16, 202	1-4210
2022	103	89	24, 306	1-3941

In terms of healthcare expenses for liver transplantation, 42.2% of patients used the civil servant medical benefit scheme, followed by self-payment at 19.3% and social security at 15.7%. Additionally, there are also payments made from other funds or foundations of the transplant hospitals. As for those who use the National Health Insurance coverage, there has been an increase to 10.7%, specifically in the second year of the coverage (since 2021), with the proportion of patients utilizing National Health Insurance reaching as high as 43% in the year 2022. The detailed breakdown of healthcare expenses for liver transplantation surgery is shown in Table 8.

Table 8. Healthcare expense for liver transplant in adults during 2016 2022

Expense type	Number	%
Civil servant medical benefit scheme	249	42.2
Self-payment	114	19.3
Social security	93	15.7
State enterprise	17	2.8
National Health Security Office (NHSO)	63	10.7
Others	50	10.3

Donor characteristics

The median age of donors was 33 (IQR 22, 45) years. There were more male than female liver donors, 457 males (77.4 %) and 133 females (22.5 %). Overall, blood group O was the most common at 262 cases (44.4 %), followed by blood group B at 188 cases (31.9%), followed by blood group A and blood group AB, respectively, which corresponded to the proportion of blood groups of recipients. Liver donors' median body mass index was 22.88 (IQR 20, 25) kg/m2. The number of liver donors with low blood pressure (systolic blood pressure less than 80 mmHg for more than 60 minutes) was 450 cases (76.27 %), and 76 donors (12.8%) received cardiopulmonary resuscitation, CPR). The median highest alanine aminotransferase (ALT) value was 42 (IQR 23, 76) IU/L with the highest value of 823 IU/L. The final ALT level before transplantation was 30 (IQR 17, 54) IU/L and peaked at 630 IU/L. Causes of death of liver donors (excluding living donors) were brain injury (62 %), followed by cerebrovascular disease (25 %) and falls (5 %), respectively. Anti-hepatitis B core antibody was positive in 206 cases (34.9%). Donor characteristics were shown in Table 9.

Table 9 Characteristics of donor for adult liver transplantation during 2016 2021

	Median	IQR
Age (Year)	33	22, 45
BMI (kg/m^2)	22.9	20, 25
Highest ALT (IU/L)	42	23, 76
Last ALT (IU/L)	30	17, 54
	Number	%
Sex: Male	457	77.4
Female	133	22.5
Blood Type: A	110	18.6
B	188	31.9
O	262	44.4
AB	30	5.1
Hypotension	376	77.4
CPR	58	11.9
Cause of Death: Accident	343	61.9
Cerebrovascular disease	139	25.1
Fall from a height	27	4.8
Shot	15	2.7
Asphyxiation	10	1.8
Brain tumor	1	0.2
Others	19	3.4
Anti-HBcAb positive	206	34.9

IQR: inter-quartile range, BMI: body mass index, ALT: alanine aminotransferase, Anti-HBcAb: Anti-hepatitis B core antibody

Immunosuppressive medications

Liver transplant recipients received immunosuppressive drugs in the first 24 hours (induction) and corticosteroids (methylprednisolone) were used most frequently (90.2%), followed by tacrolimus (44.9%). In addition, basiliximab was used in combination with other drugs in 32.5% (Figure 1). The most commonly used immunosuppressive regimen was basiliximab with mycophenolic acid and corticosteroids at 24.8%, followed by a calcineurin inhibitor with mycophenolic acid and corticosteroids at 22.7%.

When the patients were discharged from the hospital, 95.9% of patients received prednisolone, 86.3% received tacrolimus, and 49.3% received mycophenolate mofetil, while 43.6% of patients received mycophenolate sodium and 10.2% received sustained released tacrolimus (Figure 2). The most used immunosuppressive protocol was a calcineurin inhibitor combined with mycophenolic acid and corticosteroids (89.6%), as shown in Table 11.

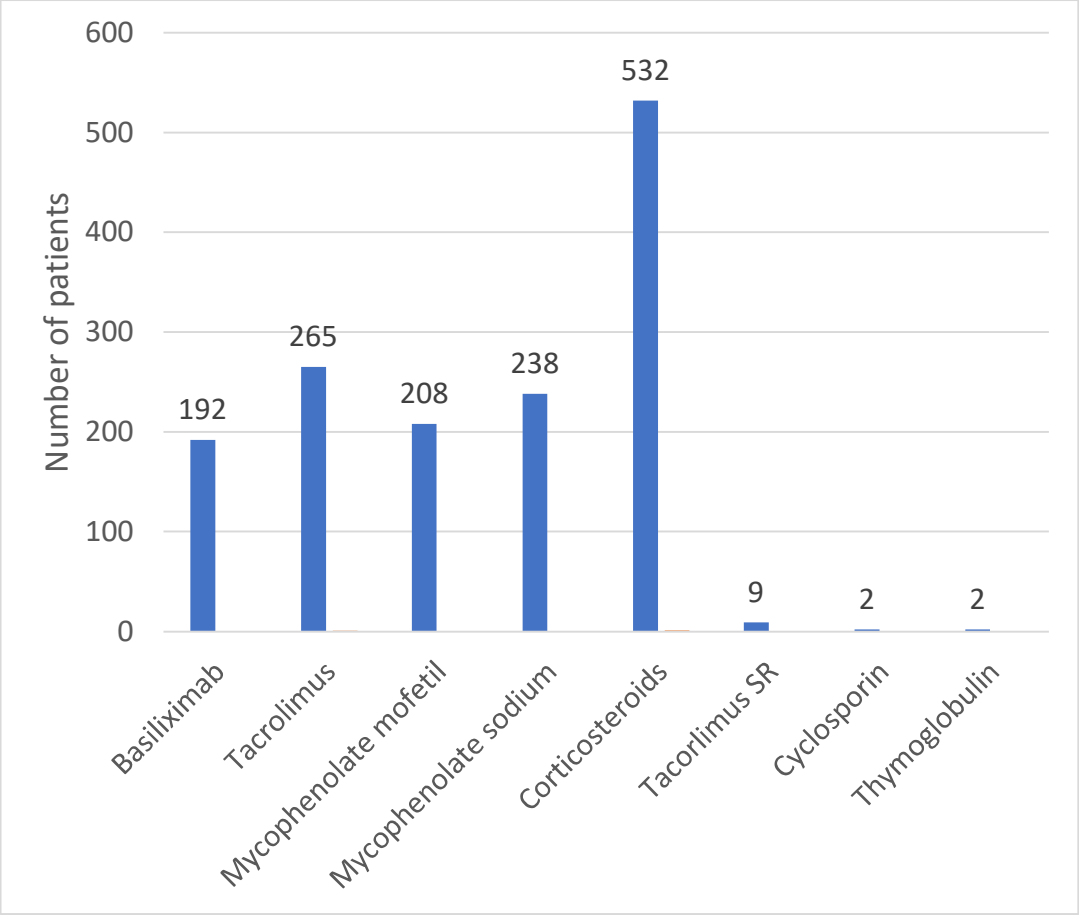


Figure 1 The number of liver transplant patients who received induction immunosuppressive medications during the first 24 hours

Table 10 The regimens of immunosuppressive medications for induction in the first 24 hours

Immunosuppressant medication	Number	%
Basiliximab + MPA + steroids	**148**	**25.1**
MPA + steroids	146	24.8
CNI + MPA + steroids	134	22.7
CNI + steroids	88	14.9

CNI: calcineurin inhibitor, MPA: mycophenolic acid

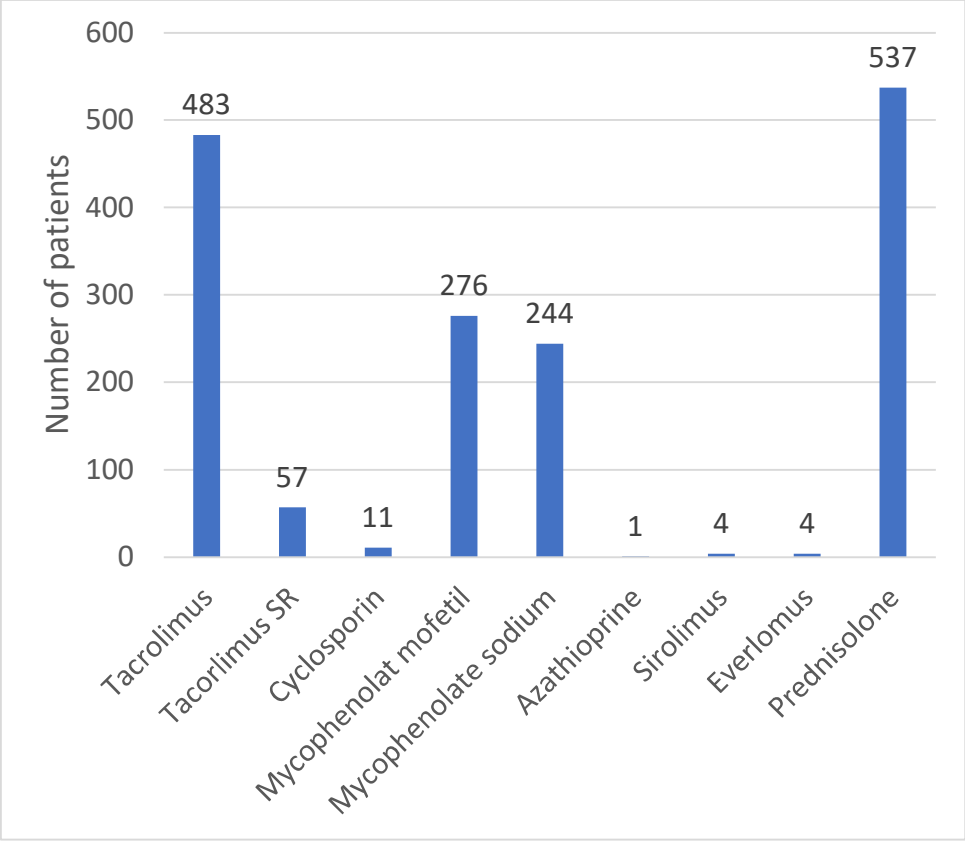


Figure 2. The number of liver transplant patients who received different immunosuppressive medications on discharge from the hospitals

Table 11 The regimens of immunosuppressive medications on discharge from hospitals

Immunosuppressant medication	Numbers of patients	%
CNI + MPA + steroids	502	89.6
CNI + steroids	32	5.71
CNI + MPA	12	2.14

CNI: calcineurin inhibitor, MPA: Mycophenolic acid

During the last follow-up, 82.4% of patients received tacrolimus, including sustained release tacrolimus (36.2%), 70.8% received mycophenolic acid, divided into mycophenolate mofetil (45.4%), and mycophenolate sodium (25.4%), and 36.9% received prednisolone. The drugs used in the minority included everolimus (14.5%), sirolimus (4.3%), cyclosporin (3.2%), and azathioprine (0.2%) (Figure 3). The most used immunosuppressive protocol was calcineurin inhibitors with mycophenolic acid (37.7%) as shown in Table 12.

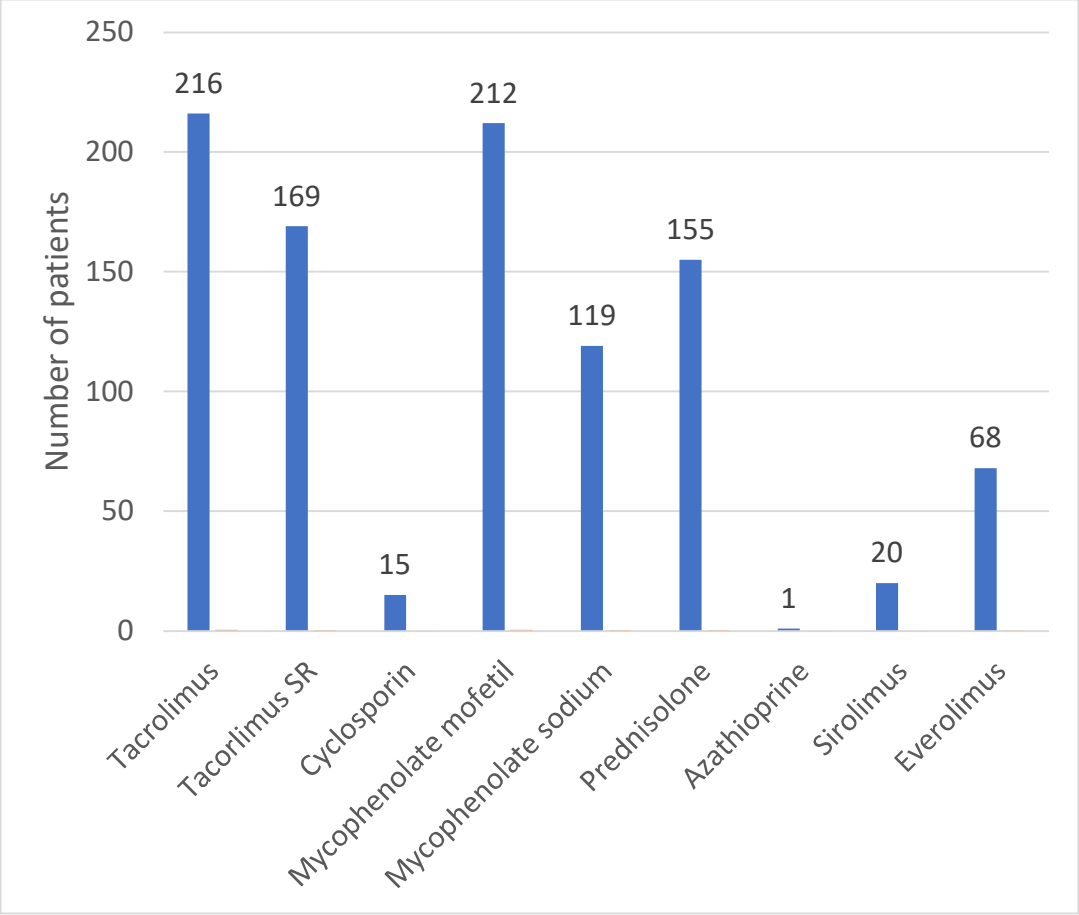


Figure 3. The number of liver transplant patients who received different immunosuppressive medications during follow up.

Table 12 The regimens of immunosuppressive medications during follow-up

Immunosuppressants Medication	Numbers of patients	%
CNI + MPA	176	37.7
CNI + MPA + steroids	96	20.5
CNI monotherapy	58	12.4
CNI + steroids	24	5.14
CNI + mTORi	28	5.9
MPA + mT ORi	25	5.35

CNI: calcineurin inhibitor, MPA: Mycophenolic acid, mTORinh: mammalian target of rapamycin inhibitor

Patient and graft survival

The patient survival rates at 1 year, 3 years, and 5 years were 88%, 81.5% and 76.6%, respectively. The Kaplan-Meier's survival rate shown Figure 4 calculated from the first liver transplantation and excluded 21cpatients with repeated liver transplants.

The patient survival rates at 1 year after liver transplantation divided by year were as follows: 90.3% in 2016, 89.4% in 2017, 82.8% in 2018, 86.0 in 2019, 86.7 % in 2020 and 92.6% in 2021. The 1-year patient survival rate of those who received a liver transplant in 2022 cannot be calculated yet because there is not enough follow-up time.

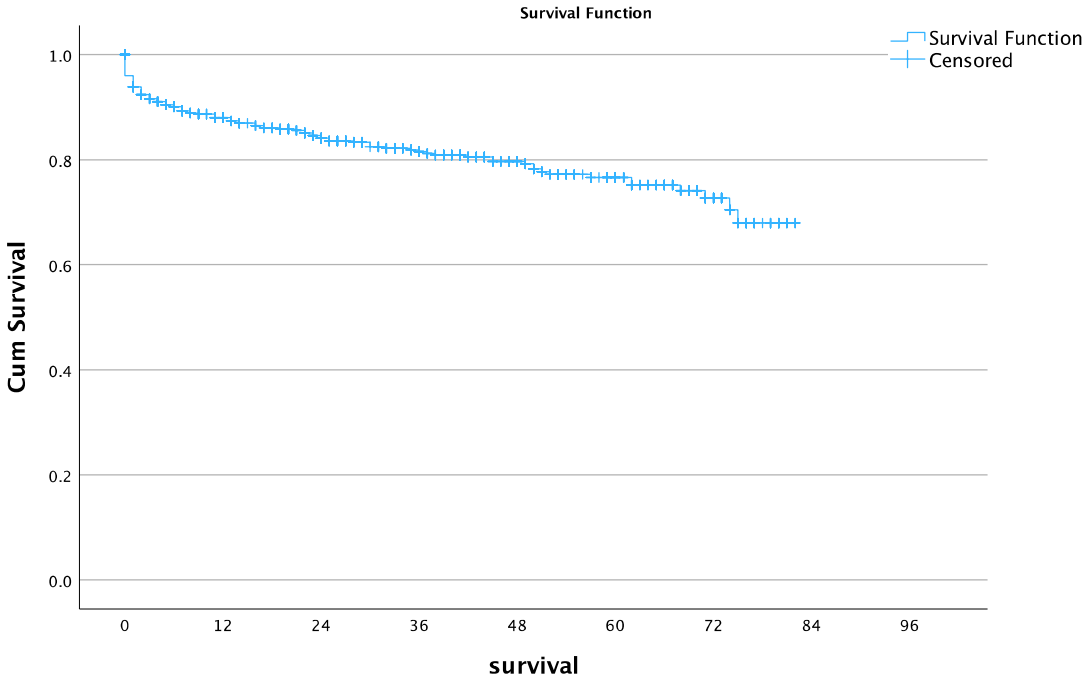


Figure 4. Patient survival rate during 2016-2022, calculated by Kaplan-Meier

Mortality rates of patients within 30 and 90 days after liver transplants during 2016 - 2022 ware 4% and was 8.4%, respectively. Mortality rates within 90 days after liver transplantation divided by year were as follows: 6.9%, 5.3%, 13.2%, 11.6%, 6.7%, 3.6% and 10.4% in 2016, 2017, 2018, 2019, 2020, 2021 and 2022, respectively.

Among 31 patients diagnosed with acute fulminant liver failure, survival rates at 30 days, 90 days, and 1 year after liver transplantation were 80.6%, 77.3%, and 73.6%, respectively, as shown in Figure 5, which were significantly lower than the patinets without acute fulminant liver failure (p value = 0.010).

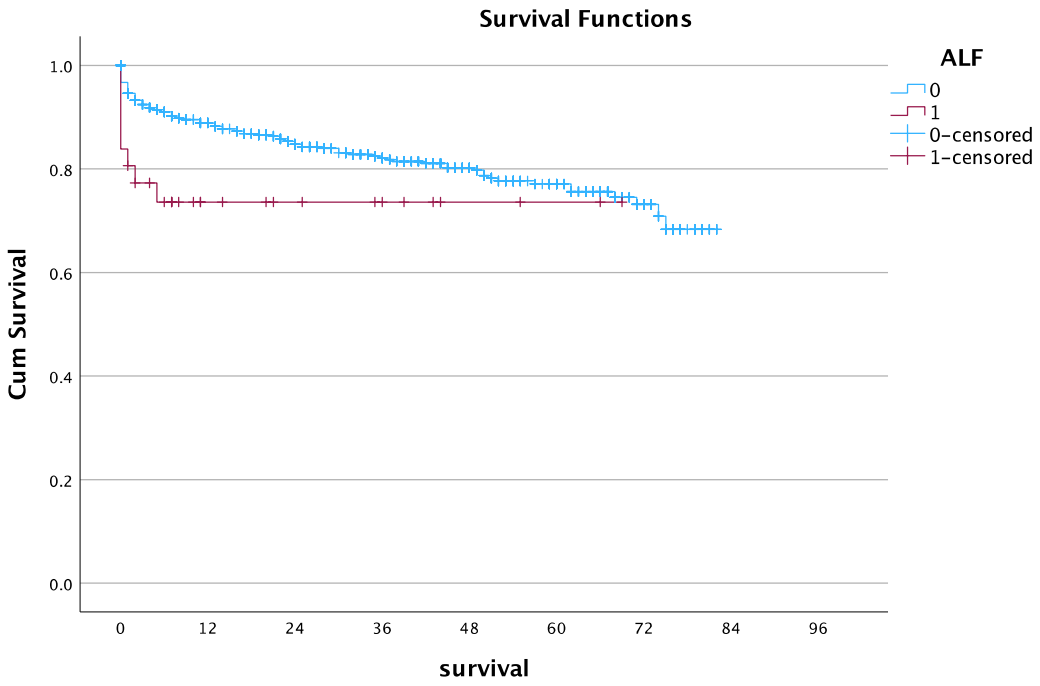


Figure 5. The survival rates of adult liver transplant patients between 2016 and 2022, compared those with and without acute fulminant liver failure, calculated by Kaplan-Meier method.

During follow-up after liver transplantation during 2016 - 2022, a total of 108 patients died. The most common cause of death was infection (41.6%), followed by cancer recurrence (20.4%), of which 54.5% was primary liver cancer, and a few cases of biliary tract cancer and gastrointerstinalstromal tumor (GIST). Other new cancers included colon cancer, lung cancer, lymphoma, prostate cancer, and cancer with an unknown primary cause. Other causes were the third most common cause of death (13.9%), of which 1 case of COVID-19 infection. Details of the cause of death after liver transplantation are shown in Table 13.

Table 13 Causes of death in adult's liver transplant between 2016 - 2022.

Cause of death	Number	%
Infection	45	41.6
Cancer	22	20.4
Recurrence of cancer that is the reason for needing a liver transplant.		
● Primary liver cancer	13	12.0
● Biliary tract cancer.	2	1.8
● Gastrointerstinalstromal tumor (GIST)	1	0.9
Emerging cancer		
● Lung cancer, colon cancer, lymphoma, prostate cancer.	4	3.7
● Cancer in which the organ of origin is unknown.	2	1.8
Circulatory system and heart	7	6.5
The transplanted liver failed.	5	4.6
Cerebral artery	4	3.7
Other (COVID 19, acute pancreatitis, intraoperative massive bleeding, hypoxia, end stage renal disease, electrolyte imbalance, ruptured common hepatic artery aneurysm, suicide)	15	13.9
N/A	10	9.3

The graft survival rates in patients who received a liver transplant during 2016 - 2021 at 30 and 90 days, 1 year, 5 years were 92.1%, and 89.9%, 85.5% and 74.4%, respectively. The graft survival rate calculated from the total number of liver transplants using the Kaplan-Meier method is shown in Figure 6.

Graft survival rates at 90 days divided by year were as follows: 88.3% in 2016, 92.7% in 2017, 87% in 2018, 86.7% in 2019, 92.3% in 2020 and 92.9% in 2021 and 88.4% in 2022.

Graft survival rates at 1 year divided by year were as follows 85.6% in 2016, 86.5% in 2017, 84.3% in 2018, 84.4% in 2019, 86.8% in 2020, 89.2% in 2021. The 1-year graft survival rate in patients who received a liver transplant in 2022 cannot be calculated yet because there is not enough follow-up time.

Among the patients receiving liver transplants during 2016 – 2021, 30 cases had liver graft loss, with the most common cause being hepatic vascular complications accounting for 30%. The second most common cause was primary graft non-function and disease recurrence (20 %) (Table 14).

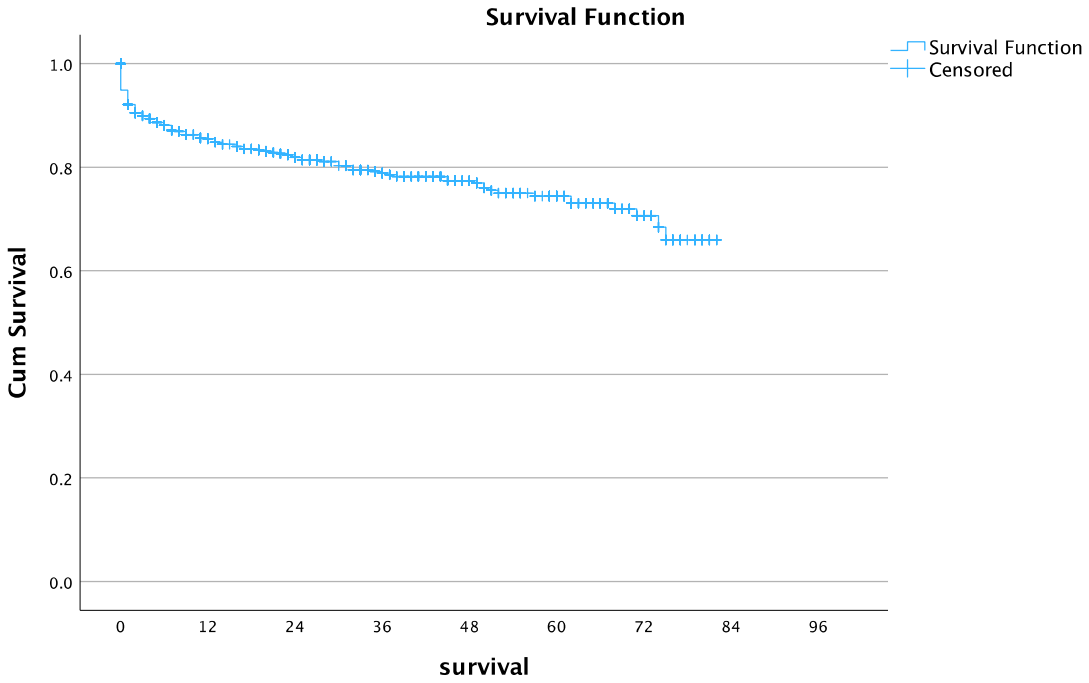


Figure 6. Graft survival of liver transplantation during 2016-2022 calculate by Kaplan-Meier

Table 14 The causes of graft failure in adult liver transplantation during 2016-2021

Cause of graft failure	Number	%
Vascular Complications	9	30
Primary graft non-function	6	20
Recurrence of the disease	6	20
Biliary complications	1	3.3
Chronic rejection	1	3.3
Other causes	3	10
N/A	4	13.3

Pediatric Liver transplantation (patients' ages below 18 years)

Between 2016 and 2022, 249 children had liver transplants in 5 hospitals (Table 1) with 185 children received livers from living donors and 64 children from deceased donors (Figure. 1). In 2019, one patient received the first liver transplant from a living donor and the second liver transplant from a deceased donor at the same admission. The highest number of 44 pediatric liver transplantation was performed in 2022 after the COVID-19 pandemics during 2020-2021..

Table 1. Number of liver transplantation in children between 2016-2020 divided by transplant centers

Hospital	Years							Total
	2016	2017	2018	2019	2020	2021	2021	
Siriraj	4	4	3	4	2	6	8	31
Chulalongkorn	11	15	15	16	10	14	15	96
Ramathibodi	15	12	16	19	19	9	17	107
Srinagarind	-	2	1	-	2	2	1	8
Maharaj Nakorn Chiangmai	-	-	1	1	1	1	3	7
Total	30	33	36	40	34	32	44	249

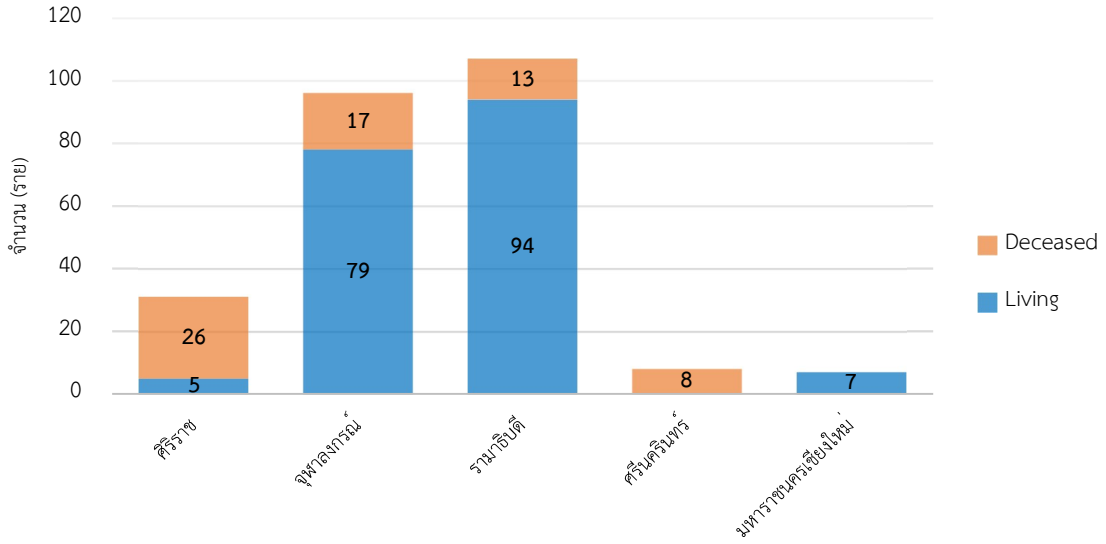


Figure 1. Number of liver transplants in pediatric patients divided by hospitals and donor types during 2016 – 2021

Recipient characteristics

Most pediatric liver transplant recipients were under 2 years of age (55.8%), followed by the age group of 2-10 years (25.7%) and 10-18 years of age (18.5%), respectively. Most young children had a living donor liver transplantation (74.3%) (Figure 2). The median age of pediatric recipients was 1 year and 10 months. Females were 1.2 times more than males (Table 2). Patients had relatively severe liver disease before liver transplantation with a median PELD/MELD score of 20, and there was no difference between the groups of living donors and deceased donors (p = 0.6). The median waiting time for a liver transplant was 152 days, with 131 and 237 days in living donor and deceased donor groups, respectively. The waiting time for a liver transplant in 2021-2022 was shorter when compared to 2016-2020 period (59-123 days in 2021-2022 and 164.5-176 days in 2016-2020) (Table 4). It could be because of the hospital's policy in 2021 to provide transplantation for only patients with urgent needs, due to the COVID-19 pandemic, resulting in a reduction in waiting time.

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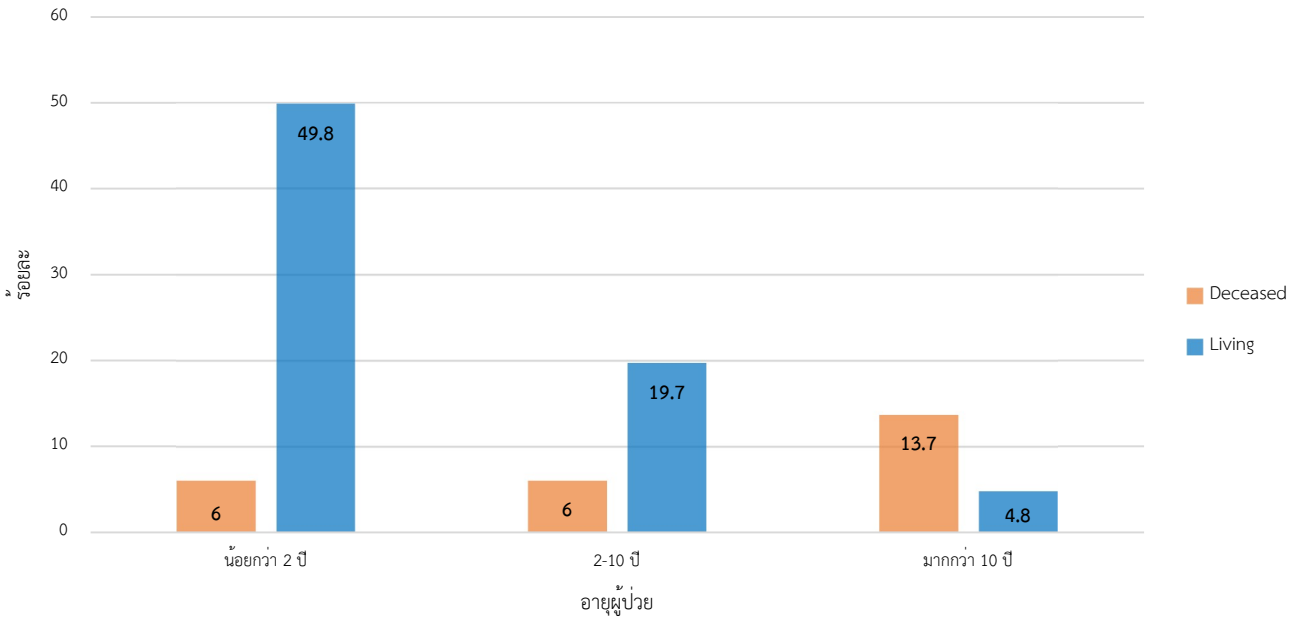

Figure 2. Pediatric liver transplantation during 2016 and 2022, stratified by age and donor types.

Table 2. Characteristics of pediatric liver transplant recipients during 2016-2022

		Deceased donor (n=64)	Living donor (n=185)	Total (n=249)
Sex	Male (n, %)	27 (42.2)	86 (46.5)	113 (45.4)
	Female (n, %)	37 (57.8)	99 (53.5)	136 (54.6)
Age (Month)	Median (IQR Q1, Q3)	130.72 (24.4, 185.1)	18.16 (12.6, 32)	22.17 (13.2, 83.4)
Waiting time (Day)	Median (IQR Q1, Q3)	237 (46, 555)	131 (28.5, 265)	152 (35, 301.5)
PELD/MELD Score	Median (IQR Q1, Q3)	21 (17, 26.75)	19 (14.5, 25)	20 (15, 25)

IQR: interquartile range, Q1: 25th percentile, Q3: 75th percentile

Table 3 Median waiting time for liver transplantation of pediatric patients each year during 2016-2021

Year (Number)	Waiting time (Day)		
	Median	IQR (Q1, Q3)	Range
2016 (30)	168	46.25,310	1-1830
2017 (33)	173	54, 354	2-3189
2018 (36)	164	73., 291	4-882
2019 (40)	176	18, 293	4-3920
2020 (34)	173	43, 377	2-3105
2021 (32)	59	5, 236	0-2198
2022 (44)	123	46, 248	1-3271
รวม (249)	152	35, 301	0-3920

IQR: interquartile range, Q1: 25th percentile, Q3: 75th percentile

Indications for liver transplantation

The most common underlying cause for liver transplantation in children was biliary atresia (173 cases, 69.5%), followed by acute liver failure (22 cases, 8.8%), Alagille syndrome (11 cases, 4.4%), metabolic liver disease (8 cases, 3.2%) (Wilson disease, maple syrup urine disease, glycogen storage disease and tyrosinemia), hepatoblastoma (6 cases, 2.4%), hepatocellular carcinoma (HCC) (5 cases, 2.0%), as shown in Figure 3. In addition, there were other causes in 20 cases, including idiopathic cirrhosis 11 cases, Caroli disease 2 cases, choledochal cyst 2 cases, and Abernethy malformation, congenital hepatic fibrosis, bile acid synthetic defect, non-syndromic bile duct paucity, 1 case each. One patient had a re-transplantation due to vascular thrombosis.

Indications for pediatric liver transplantation by year are shown in Table 4 and some patients had more than one comorbid disease, such as one patient with Budd Chiari syndrome also had hepatocellular carcinoma.

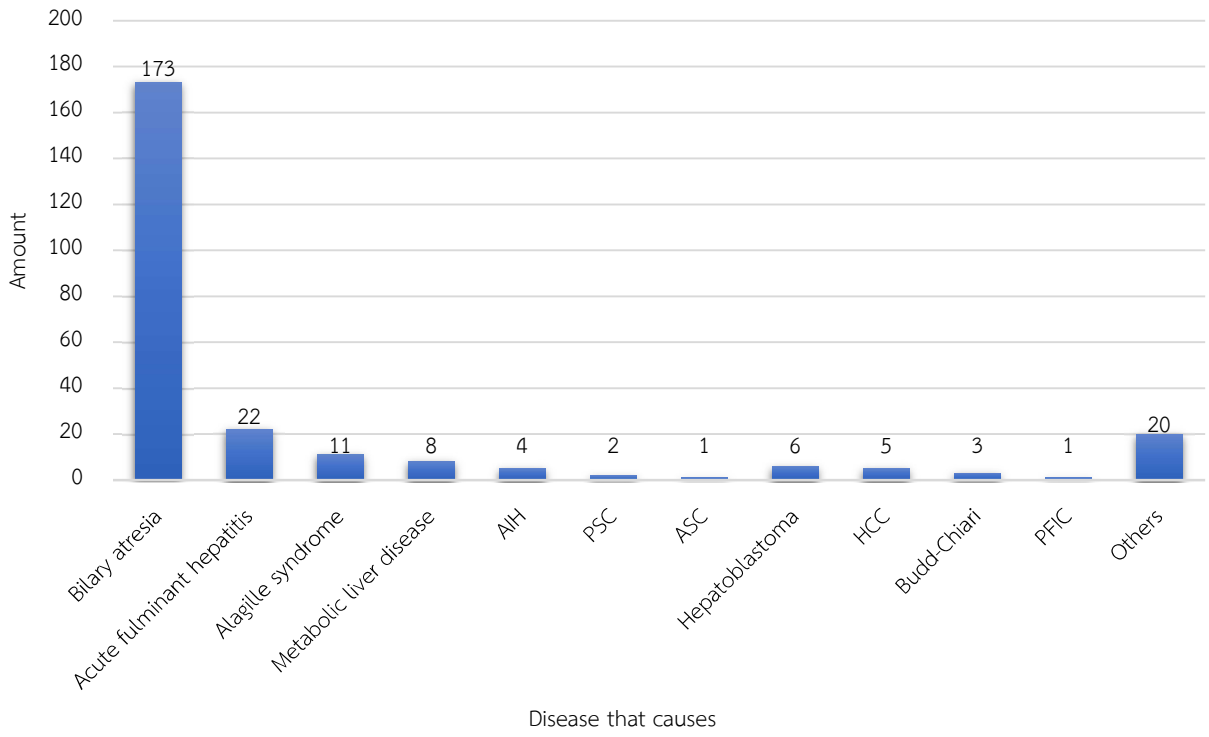

Figure 3. Underlying causes for liver transplantation children between 2016 and 2022

AIH: autoimmune hepatitis, PSC: primary sclerosing cholangitis, ASC: autoimmune sclerosing cholangitis, HCC: hepatocellular carcinoma, PFIC: progressive familial intrahepatic cholestasis

Table 4. Number of underlying causes for pediatric liver transplantation by year during 2016- 2022

Disease / Year	2016	2017	2018	2019	2020	2021	2022	Total
Biliary atresia	22	25	27	30	22	14	33	173
Acute fulminant hepatitis	2	2	3	2	1	9	3	22
Alagille syndrome	1	1	2	1	3	2	1	11
Metabolic liver disease	1	1	0	0	2	2	2	8
Autoimmune hepatitis	1	0	0	1	0	1	1	4
Primary sclerosing cholangitis	0	0	0	1	0	0	1	2
Autoimmune sclerosing cholangitis	0	0	0	0	1	0	0	1
Hepatocellular carcinoma	0	0	0	0	3	2	0	5
Hepatoblastoma	0	0	0	1	2	0	3	6
Budd Chiari syndrome	0	1	0	0	1	1	0	3
Progressive familial intrahepatic cholestasis	1	0	0	0	0	0	0	1
Others	2	3	4	6	1	3	1	20

The three most common pre-liver transplant complications were growth failure (127 cases), variceal bleeding (72 cases), and refractory ascites (52 cases), respectively. Other complications included spontaneous bacterial peritonitis, hepatopulmonary syndrome, hepatocellular carcinoma, septicemia, growth failure, hepatorenal syndrome, etc. (Figure 4)

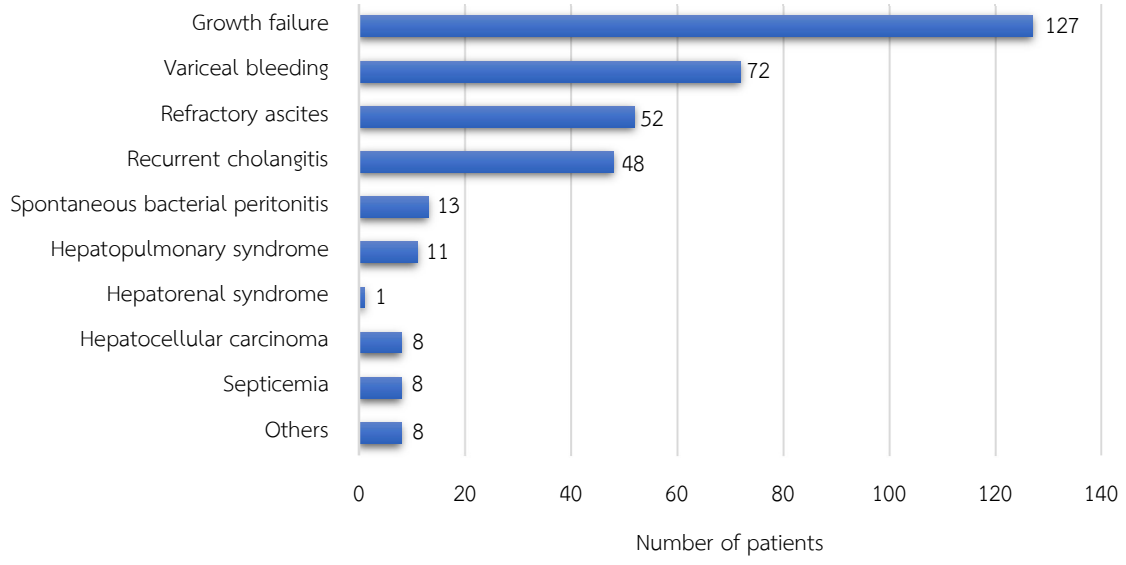

Figure 4. Number of pediatric patients with complications of liver disease before liver transplantation.

Children's nutritional status is assessed using weight and height for age. Weight for age indicates the child's current nutritional status and short-term malnutrition because weight changes rapidly when there is malnutrition. However, caution is needed when evaluating the weight of patients with ascites or enlarged liver and spleen, especially in young children. In practice, mid-upper arm circumference measurement is commonly used instead of weight. Using height for age can indicate long-term or chronic nutritional status. This is because long-term malnutrition can affect bone structure and formation.

When comparing weight and height according to age group, It was found that more than half of children who had living donor liver transplantation had significantly slower growth than normal (> -1.5 S.D.), while children who had deceased donor liver transplantation showed a tendency to grow closer to normal. (Table 5), which is explained by the fact that most children who received livers from living donors were younger than 2 years and had chronic liver diseases since infancy. Biliary atresia with failed Kasai Operation, Alagille syndrome, or various metabolic liver diseases, can cause chronic malnutrition. Meanwhile, most children who had deceased donor liver transplantation had biliary atresia with successful Kasai's operation, so their growth was normal until they developed late cirrhosis when they entered adolescence or early adulthood. In addition, children with acute liver failure, autoimmune hepatitis, hepatoblastoma, hepatocellular carcinoma, and other liver diseases often lost their liver function in late childhood resulting in nearly normal weight and height.

Table 5. Weight and height for age of children receiving liver transplantation during 2016-2022

Z-score	Weight-for-age		Weight-for-age	
	DDLT (%)	LDLT (%)	DDLT (%)	LDLT (%)
< -1.5 S.D.	31 (48.4)	77 (41.6)	29 (45.3)	67 (36.2)
-1.5 S.D. to -2.0 S.D.	5 (7.8)	28 (15.1)	4 (6.25)	22 (11.9)
> -2.0 S.D.	28 (43.8)	80 (43.3)	31 (48.45)	96 (51.9)

DDLT, deceased donor liver transplantation; LDLT, living donor liver transplantation

The most frequent blood group of pediatric patients underwent liver transplantation was O (39.4%), followed by B (35.8%) (Table 6), where all patients were Rh+. Among 249 liver transplant children, there were 16 patients (6.4%) with ABO incompatibility. The median age of these patients was 12.9 ± 2.3 months (youngest at 5.5 months and oldest at 25.8 months). When following up on the treatment of this group, 2 patients died due to infection and severe sepsis.

Table 6. Blood group of donors and recipients in pediatric liver transplants during 2016-2022.

Blood group		Recipient				Total
		O	A	B	AB	
Donor	O	85 (34.2%)	18 (7.2%)	26 (10.4%)	0 (0%)	129 (51.8%)
	A	**5 (2%)**	31 (12.5%)	**1 (0.4%)**	5 (2%)	42 (16.9%)
	B	**7 (2.8%)**	**0 (0%)**	61 (24.4%)	5 (2.1%)	73 (29.3%)
	AB	**1 (0.4%)**	**1 (0.4%)**	**1 (0.4%)**	2 (0.8%)	5 (2%)
Total		98 (39.4%)	50 (20%)	89 (35.8%)	12 (4.8%)	249 (100%)

Remark: Numbers in bold were ABO incompatibility

Laboratory results of pediatric patients before liver transplantation are shown in Table 6. The median total bilirubin, albumin, creatinine, INR and sodium were not different between those who had living and deceased donor liver transplantation. The serological examination showed that most patients had cytomegalovirus (CMV) IgG positive 79.1%. When compared with donor serology, D+/R+ group was the most common (76.3%), followed by D+/R- (17.7%) (Table 6)

Table 6. Patient information and laboratory results of pediatric patients underwent liver transplantation during 2016 – 2022.

	Deceased donor (n=64)	Living donor (n=185)	Total (n=249)
Laboratory values before liver transplantation, median (IQR)			
Total bilirubin (mg/dL)	19.5 (7.85, 27.51)	17.33 (9.7, 24.3)	17.9 (9.5, 24.39)
Albumin (g/dL)	2.94 (2.46, 3.46)	2.72 (2.3, 3.22)	2.8 (2.34, 3.3)
Creatinine (mg/dL)	0.3 (0.14, 0.49)	0.19 (0.14, 0.24)	0.19 (0.14, 0.3)
Sodium (mmol/L)	137 (134.25, 139)	136 (134, 138)	136 (134, 138)
INR	1.41 (1.25, 2)	1.3 (1.16, 1.57)	1.33 (1.19, 1.62)
PELD/MELD score	21 (17, 26.75)	19 (14.5, 25)	20 (15, 25)
CMV serology (Donor/Recipient) (Number, %)			
D- / R-	1 (1.6)	4 (2.2)	5 (2)
D- / R+	3 (4.7)	2 (1.1)	5 (2)
D+ / R-	7 (10.9)	37 (20)	44 (17.7)
D+ / R+	52 (81.3)	138 (74.6)	190 (76.3)

The median cold ischemic time in the group receiving livers from deceased donors was 6 hours 30.5 minutes, while those receiving livers from living donors was 1 hour 58 minutes. Among deceased donor liver transplants, there was a higher proportion of whole graft than partial graft, accounting for 59.4% and 40.6%, respectively (Table 8).

Table 8. Data on liver ischemia time and graft type in pediatric liver transplants during 2016-2022.

		Deceased donor (n=64)	Living donor (n=185)	Total (n=249)
Ischemic period (minute) (median, IQR)		390.5 (141.5, 496.5)	118 (91, 147)	128 (93, 263)
Type of graft (n, %)	Partial	26 (40.6%)	185 (100%)	211 (84.7%)
	Whole	38 (59.4%)	0 (0)	38 (15.3%)

In terms of healthcare expenses for pediatric liver transplantation, most patients used the National Health Insurance Office (NHSO) coverage (91.6%) (Figure 5). This is because liver transplantation for patients under 18 years of age has been approved by NHSO since 2011. Only a small proportion used civil servant medical benefit scheme (8%) and other rights (0.4 %).

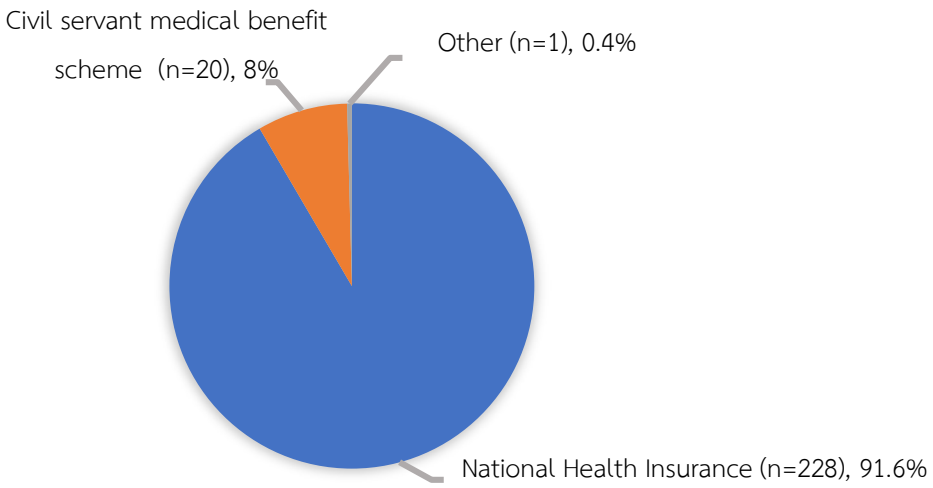

Figure 5. Health care expense for pediatric liver transplants during 2016-2022

Donor characteristics

Most donors were living donors (74.3%), with the proportion of females approximately 1.9 times more than males. Among the deceased donors, males were approximately 2.2 times greater than women. The average age of deceased donors was 8.6 years younger than that of living donors ($p < 0.001$). The mean body mass index of the two groups was not different, with a total mean of 22.2 ± 3.7 kg/m^2. There were 12 donors who had cardiopulmonary resuscitation (CPR) and 32 cases had hypotension (systolic blood pressure less than 80 mmHg) for longer than 60 minutes). Three types of perfusate solutions: University of Wisconsin (UW) solution (62.7%), Custodiol (36.1%), and Collins (0.8%) (Table 9)

Table 9. Donor characteristics and reagents used in organ preservation in pediatric liver transplant during 2016-2022

Information		Deceased donor (n=64)	Living donor (n=185)	Total (n=249)
Sex	Male (%)	44 (68.8%)	63 (34.1%)	107 (43%)
	Female (%)	20 (31.3%)	122 (65.9%)	142 (57%)
Age (month)	Median (IQR)	130.7 (24.9, 185.8)	18.2 (12.7, 35.9)	22.2 (13.4, 86.2)
BMI (kg/m^2)	Mean ± SD	20.5 ± 3.8	22.7 ± 3.5	22.2 ± 3.7
Hypotension	n (%)	32 (50)	-	-
CPR	n (%)	12 (19)	-	-
Peak ALT (IU/L)	Median (IQR)	33 (20, 55)	-	-
Last ALT (IU/L)	Median (IQR)	26 (17, 45)	-	-
Perfusate solution	Collins (n, %)	1 (1.6)	1 (0.6)	2 (0.8)
	UW (n, %)	58 (90.6)	98 (53)	156 (62.7)
	Custodiol (n, %)	5 (7.8)	85 (45.9)	90 (36.1)

BMI: body mass index, CPR: cardiopulmonary resuscitation, ALT: alanine aminotransferase, UW: University of Wisconsin

Immunosuppressive medications

Most pediatric recipients received methylprednisolone during the first 24 hours (induction) in combination with tacrolimus (89.5%). Mycophenolate mofetil (MMF) or mycophenolate sodium (MPS) were added in the minority, accounting for 11.2%. Basiliximab was used for induction in 15 cases, combined with different types of immunosuppressive drugs (Table 10 and Figure 6).

When patients were discharged from the hospital, tacrolimus was used mostly together with prednisolone and MMF (or MPS) (56.2%) (Table 10 and Figure 6).

At the last follow-up of 232 patients, tacrolimus was the main drug treatment (84.7%), with mostly in combination with MMF and prednisolone (26.9%). Other less commonly used agents included cyclosporine (4.4%) and mTOR inhibitor (3.2%) (Table 10 and Figure 6). During the follow-up period, a variety of immunosuppressive drugs were used which depended on many factors, including duration after liver transplant. liver function tests, kidney dysfunction, adverse effects of immunosuppressive agents, infections, and post-transplant lymphoproliferative disorder (PTLD), etc.

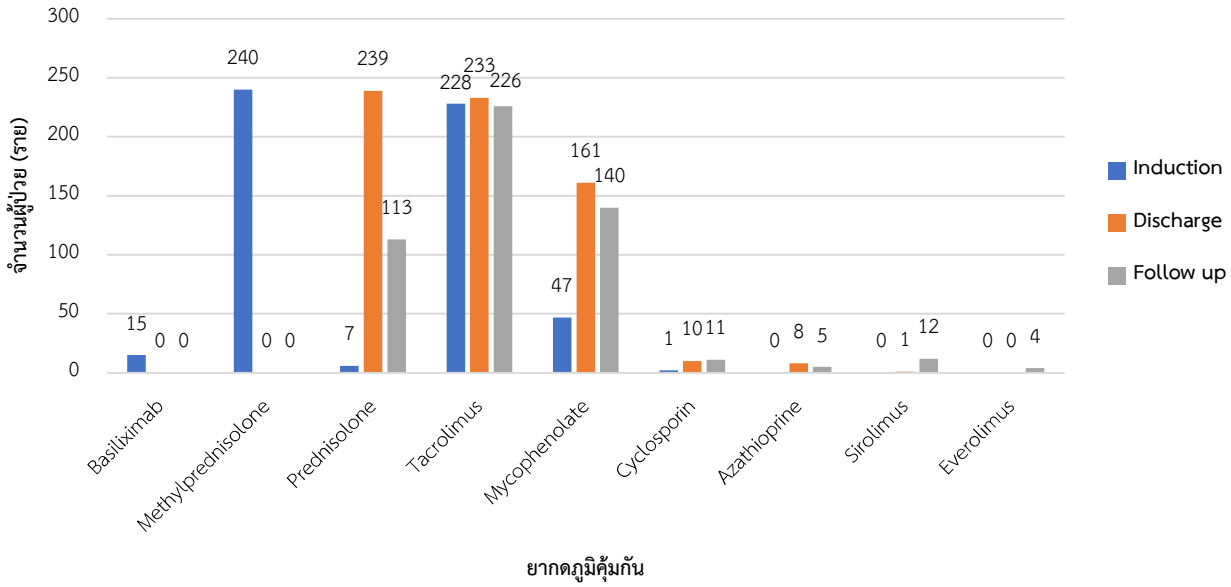

Figure 6. Number of liver transplant pediatric patients receiving immunosuppressive drugs during the first 24 hours (induction), upon discharge from the hospital, and at the last follow-up during 2016 – 2022

Table 10 Immunosuppressive drugs commonly used during each phase of treatment in pediatric liver transplant patients between 2016 and 2022.

Immunosuppressive Formula used each period	Number	%
Induction		
Methylprednisolone + tacrolimus	195	78.3
Methylprednisolone + tacrolimus + MMF/MPS	28	11.2
Methylprednisolone + MPS / MPS	8	3.2
Methylprednisolone + basiliximab + MMF/MPS	8	3.2
Methylprednisolone + basiliximab	3	1.2
Methylprednisolone + basiliximab + tacrolimus	2	0.8
Methylprednisolone + basiliximab + tacrolimus + MPS	1	0.4
Discharge		
Prednisolone + tacrolimus + MMF / MPS	140	56.2
Prednisolone + tacrolimus	84	33.7
Prednisolone + cyclosporine + MMF	4	1.6
Prednisolone + cyclosporine	3	1.2
Tacrolimus (monotherapy)	2	0.8
Tacrolimus + MMF	1	0.4
Follow up		
Tacrolimus + MMF + prednisolone	67	26.9
Tacrolimus monotherapy	55	22.1
Tacrolimus + MMF	52	20.1
Tacrolimus + prednisolone	29	11.6
Tacrolimus + mTOR inhibitor + prednisolone	5	2
Cyclosporine + MMF	4	1.6
mTOR inhibitor + prednisolone	4	1.6

MMF: mycophenolate mofetil, MPS: mycophenolate sodium, mTOR: mammalian target of rapamycin

Patient and graft survival

Patient survival rate after liver transplant using the Kaplan-Meier method, is shown in Figure 7, and included only children who had the first liver transplantation, but excluded those who had repeated liver transplant (1 patient). The patient survival rates at 90 days, 1 year, 3 years and 5 years were at 93%, 91%, 90% and 89%, respectively. The survival rate in children receiving liver from living donor was higher than those receiving liver from the deceased donors.

The patient survival rates according to the age group, children aged 10-18 year old had the highest survival rate of 98%, 96% and 96% at 30 days, 90 days and 1 year, respectively (Table 11). It could be because liver diseases in older children tended to be less virulent than those in young children resulting in better nutrition status and growth and leading to less complications from liver transplantation.

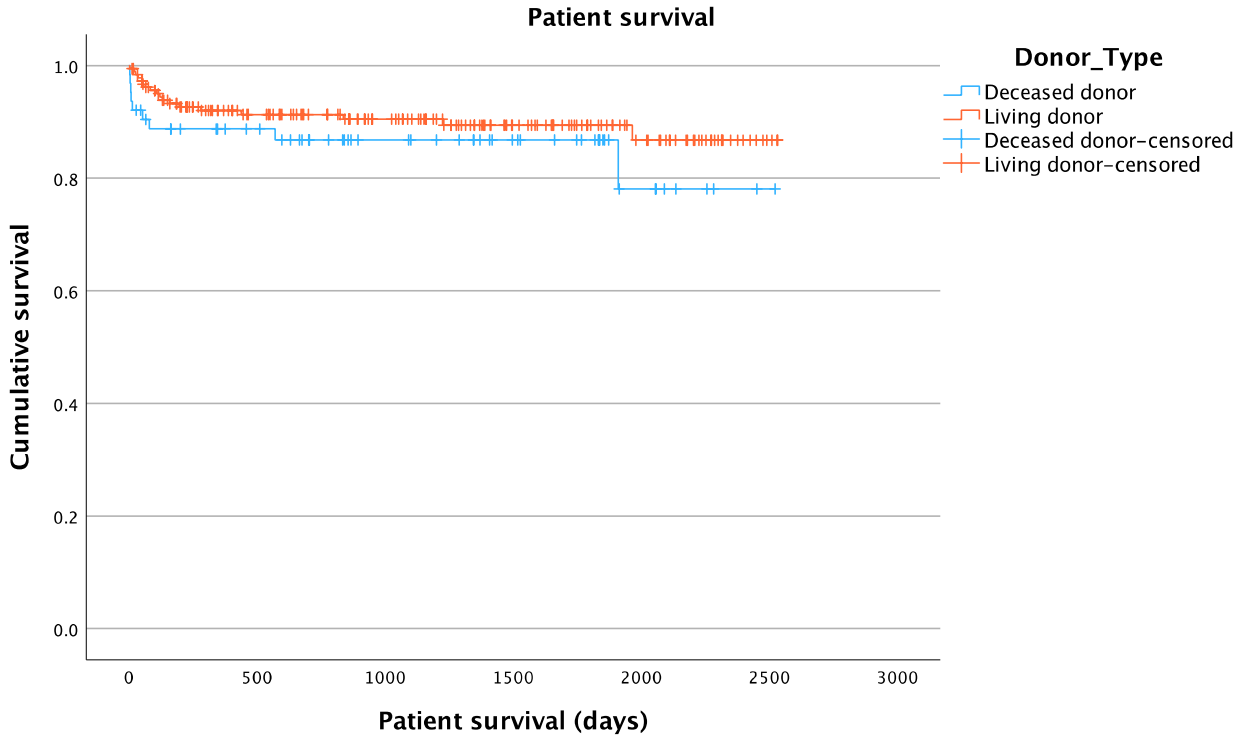

Figure 7. The patient survival rate in children underwent liver transplantation during 2016-2022

Table 11. Survival rate of pediatric liver transplant patients according to age groups and donor type during 2016 – 2022

		Age <2 Y (n=138)	Age 2-10 Y (n=64)	Age 10-18 Y (n=46)	Living donor (n=184)	Deceased donor (n=64)	Total (n=248)
Patient survival (%)	30 days	94	94	98	96	91	95
	90 days	93	92	96	95	89	93
	1 year	90	90	96	92	89	91
	3 years	90	88	89	91	87	90
	5 years	89	88	89	89	87	89

Remark: 249 liver transplants were performed, but 1 case with repeated transplant was excluded, therefore only 248 patients were included in the analysis.

Y, years

When follow-up the pediatric patients received liver transplants during 2016-2022, a total of 26 cases died (13, 16, and 21 patients died within 30, 90 days, and 1 year, respectively). The most common cause of death was infections, followed by surgical complications (including hepatic artery thrombosis 1, and primary nonfunction 2) and other diseases, as shown in Table 12.

Table 12 Causes of death in pediatric patients after liver transplant between 2016 and 2022

Causes of death	Number	(%)
Infection, sepsis	15	57.69
Graft-related, PNF, HAT	3	11.54
Post-transplant lymphoproliferative disorder (PTLD)	3	11.54
Cerebrovascular disease (brain hematoma)	1	3.85
Recurrent hepatocellular carcinoma	1	3.85
Metastasis hepatoblastoma	1	3.85
Others	2	7.7

HAT: hepatic artery thrombosis, PNF: primary non-function

The graft survival in pediatric patients who underwent liver transplantation during the year 2016-2022, calculated according to Kaplan-Meier, is shown in Figure 8. The graft survival rates at 30 days, 90 days, 1 year, 3 years, and 5 years were 94%, 93%, 91%, 89%, and 88%, respectively. The graft survival rate of a liver from a living donor was higher than the liver from a deceased donor. Causes of graft loss were similar to the causes of death as shown in Table 12. Additionally, 1 patient who had graft loss due to hepatic artery thrombosis required the 2nd liver transplant within 30 days after the first transplant. Therefore, graft survival rate at 30 days was lower than patient survival rate. The graft survival rate according to age groups are shown in Table 13. Children aged 10-18 years old had higher graft survival rate than younger children.

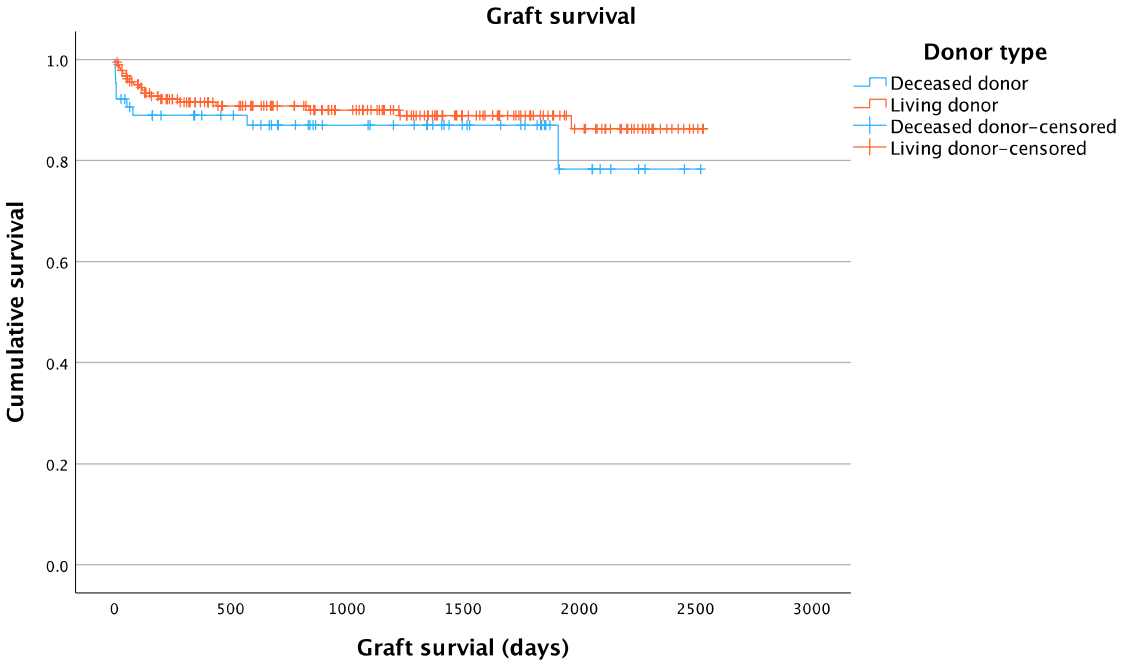

Figure 8 Graft survival rate in children underwent liver transplantation between 2016 and 2022

Table 13. Graft survival rate of pediatric liver transplant patients in each year between 2016 and 2022

Year (n)	2559 (n=30)	2560 (n=33)	2561 (n=36)	2562 (n=39)	2563 (n=33)	2564 (n=32)
30-day survival (%)	96.7	97	94.4	94.7	97	100
90-day survival (%)	96.7	93.9	91.7	89.5	93.9	-
1-year survival (%)	90.0	93.9	88.9	86.8	87.9	-
3-year survival (%)	90.0	93.9	88.9	86.8	-	-
5-year survival (%)	90.0	-	-	-	-	-

Report of liver transplant patients who were monitored at each institution

Report of liver transplant patients who were followed up in each institution

In 2022, the Liver Transplant Registration Subcommittee of the Thai Transplant Society surveyed the number of liver transplant patients who were followed up and monitored in each liver transplant institution, including reimbursement methods.

The results showed 1,092 liver transplant patients who had undergone liver transplantation and were followed up until December 31, 2022, with 760 adult patients and 332 pediatric patients (younger than 18 years), as shown in Tables 1 and 2.

Table 1 Number of adult liver transplant patients (18 years and over) who were monitored at liver transplant centers until 31 December 2022, divided by reimbursement methods.

Hospital	Civil servant medical benefit scheme, State enterprises	Social security	NHSO	Self-pay	Other rights	Total
Chulalongkorn	118	21	10	83	8	240
Siriraj	122	33	61	15	12	243
Srinagarind	83	11	21	3	35	153
Ramathibodi	38	5	5	12	0	60
Maharaj Nakorn Chiangmai	20	11	24	2	0	57
Bamrungrad	0	0	0	15	0	15
Rajvidhi	7	7	4	0	0	18
Vichaiyut	0	0	0	17	0	17
Smithivej Sukhumvit	0	0	0	9	0	9
Bangkok	0	0	0	0	3	3
Total	**384**	**88**	**35**	**196**	**57**	760

Table 2. Number of pediatric liver transplant patients (younger than18 years) who were monitored at liver transplant centers until 31 December 2021, divided by reimbursement methods.

Hospital	NHSO	Civil servant medical benefit scheme, State enterprises	Self-pay	Other rights	Total
Ramathibodi	168	20	0	0	188
Chulalongkorn	121	11	1	0	133
Siriraj	28	1	0	0	29
Maharaj Nakorn Chiangmai	11	0	0	0	11
Srinagarind	8	0	0	0	8
Total	**313**	**18**	**1**	**0**	**332**

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