Global Perspectives in Dialysis: Singapore

Christopher Cheang Han Leo¹*, Gek Cher Chan¹

¹ Division of Nephrology, Department of Medicine, National University Hospital, Singapore

*Corresponding Author:
Christopher Cheang Han Leo, Division of Nephrology, Department of Medicine, National University Hospital, Singapore. NUHS Tower Block Level 10, 1E Kent Ridge Road, Singapore 119228. Phone: +65 6779-5555; Email: christopher_leo@nuhs.edu.sg
Introduction: Epidemiology of Kidney Diseases in Singapore

The first hemodialysis in Singapore was conducted in September 1961 for acute kidney failure with the twin coil artificial kidney. It was not until 1968 when the chronic hemodialysis program was instituted. Since then, the incidence and prevalence of chronic kidney disease stage 5 (CKD5) and dialysis have increased significantly. The Singapore Renal Registry is maintained by the National Registry of Diseases Office. Based on its Annual Report 2018, the crude incidence rate (CIR) of CKD5 increased from 341.5 per million population (pmp) in 2009 to 504.1 pmp in 2017. Although the age-standardized incidence rate (ASIR) of CKD5 remained stable (256.6 to 289.2 pmp), the ASIR of dialysis increased significantly from 159.0 pmp in 2009 to 187.0 pmp in 2018 (Table 1). 80% of the new dialysis patients were aged 50-79 years in 2018, supporting the notion that the greater incidence of dialysis was related to aging population. However, the CIR of dialysis also increased significantly for those aged 30-39 years and 40-49 years over a 10-year period, which could possibly be explained by the increase in incidence of diabetes.

The age-standardized prevalence rate (ASPR) of dialysis also increased from 890.6 pmp in 2009 to 1081.7 pmp in 2018. The ASIR of hemodialysis (HD) was consistently higher compared to peritoneal dialysis (PD). Whilst the ASIR for HD remained relatively stable, the ASIR for PD increased significantly over the years (Figure 1). Similarly, the prevalence rates of HD were consistently higher than PD across the years. However, the increment in ASPR for HD was higher than PD (Figure 2).
All-cause mortality for HD has been stable over the years (11.5% to 13.5% from 2009-2018) but there was proportionally higher mortality among PD patients which could possibly be due to higher prevalence of diabetes mellitus in Singapore population, or patient selection bias\(^3\). The disparity in mortality between both modalities narrowed as the death rate fell from 22.35% in 2009 to 13.4% in 2018 for PD\(^2\).

The incidence of CKD due to diabetes progressively increased over the years. 65.8% of new dialysis patients had diabetic nephropathy while 14.4% had glomerulonephritis in 2018, compared to 61.8% and 18.7% respectively in 2009\(^2\).

**Healthcare Funding and Dialysis Subsidies**

**Cost of dialysis**

For an average of 13 dialysis sessions a month, the cost of HD treatment in private centers starts from $2500 (USD $1,792) per month and depending on the center, it may include routine bimonthly laboratory tests. Additional charges are levied for Transonic\(^\oplus\) access flow measurements (where available) and administration of medications during dialysis treatments. The cost of PD treatment ranges between $1,110 (USD $790) to $1800 (USD $1,295) per month depending on the PD regimen, as well as the type of dialysate used.

**Hemodialysis & peritoneal dialysis subsidy**

As of the 1\(^{st}\) of July, 2019, the Singapore government subsidize Singapore citizens with a monthly household income of < $2,800 (USD $ 2,007) for HD based on per capita household monthly income, ranging from $357 (USD $256) to $1,230 (USD $882) per month\(^4\). The PD subsidy rates per patient range from $407 (USD $292) to $1,280 (USD $918) per month for
per capita household monthly incomes for citizens with a monthly household income of < $2,800 (USD $2,007)\textsuperscript{4}.

**Funding**

Funding for dialysis is through a combination of cash, medical insurance, and medical savings account, and additional government subsidies or not-for-profit voluntary welfare organizations (VWOs) for eligible patients. These consists of the MediSave and MediShield Life schemes, private health insurance, VWOs which includes the National Kidney Foundation (NKF) and Kidney Dialysis Foundation (KDF) portable funding and Ministry of Health (MOH) Subsidy. The latter 3 options are subject to eligibility via a household means test.

MediSave is a national healthcare saving scheme that can be used for patient’s own, or for their dependents’ healthcare expenses. Each patient can withdraw up to $450 (USD $323) per month for dialysis treatments from their MediSave accounts\textsuperscript{4}. MediShield Life is a mandatory national medical insurance scheme for all Singapore citizens and Permanent Residents. It is designed to help pay for part of expenses curtailed from hospitalizations and government-approved outpatient dialysis treatments. Each patient can claim up to $1,000 (USD $717) per month for dialysis treatments from MediShield Life\textsuperscript{4}.

The amount of assistance that patients can receive from VWOs are subject to financial assessments and are generally reserved for those who are financially needy. In addition, there are institution-based charity funds available for eligible patients who initiate on dialysis emergently and require financial assistance for interim HD (while awaiting approval of VWO funding). Lastly, the Civil Services Card is a government medical scheme for civil servants,
pensioners and their dependents, which subsidizes some of the cost of dialysis treatments. The amount of subsidy depends on the scheme the patient is enrolled in. Under this scheme, the dialysis center will be reimbursed for the government’s share of medical bills incurred by eligible dialysis patients at private dialysis centers.

In summary, a typical dialysis patient will first be able to utilize their MediShield and MediSave for part of the dialysis cost. The remainder of payment will either be out of pocket, or if the patient is eligible, subsidies by from VWOs. This funding mechanism applies to both HD and PD patients.

**Dialysis practices**

**HD practices**

As of 2018, the majority of prevalent HD patients were undergoing dialysis treatments at freestanding ambulatory satellite dialysis centers managed by VWOs (62.8%), followed by private dialysis centers (35.6%), and public hospitals or their affiliated dialysis centers (1.6%)². In 2019, National Kidney Foundation, the largest VWO in Singapore, operates 37 dialysis centers with a total of 802 dialysis stations⁵. Fresenius Medical Care in Singapore is the largest private sector provider of HD with 28 dialysis centers and 249 dialysis stations.

HD sessions are usually 4 hours of treatment time (98.6% of patients underwent thrice weekly dialysis in 2018²) with a blood flow rate of 250-300 mL/min and dialysate flow of 500-800 mL/min. Most of the freestanding ambulatory satellite dialysis centers use high-flux dialyzers and dialyzer reuse is uncommon.
Dialysis treatments are managed by registered or enrolled nurses and nurse-aides. The ratio of dialysis center staff to patient per dialysis shift is minimally 1:5 and it varies by dialysis centers. In-center dialysis patient reviews are conducted monthly by a nephrologist or a physician-in-charge and laboratory tests are performed at regular 2-monthly intervals. Some centers practice vascular access surveillance with a Transonic® access flow measurement every 3-6 months. Additionally, these patients are reviewed by their primary nephrologists, bi- or tri-annually, in their dialysis clinics to oversee their treatments received. Currently, there is no formal program for home HD but there are a few patients who are doing home-based HD that are either self-assisted or nurse assisted.

**PD practices**

In 2018, 99.7% of the PD patients were under the care of nephrologists from public hospitals and affiliated dialysis centers. The PD patients are enrolled in the public hospital respective PD programs, which are helmed by nephrologists and experienced nurses. All PD treatments are performed by the patient or their caregivers at home, or by trained nursing staff in community nursing homes.

**Dialysis access**

**Vascular dialysis access**

Arteriovenous fistulae (AVF) remain the preferred vascular access of HD patients in Singapore. These are predominantly created by vascular surgeons. Overall AVF maturation rates vary from 65.6% to 72.6% with a median maturation time of 66-78 days.

PTFE Arteriovenous grafts (AVG) have been in use in Singapore since 1989 but graft survival was limited by infective complications during the early 1990s. A total of 2% to 5%
of patients on HD had an AVG as an initial vascular access\textsuperscript{7, 8}. The prevalence of patients dialyzing via an AVG is unknown and is institution dependent.

However, only 19.5\% of incident end-stage kidney disease patients have a permanent access created prior to initiation of dialysis\textsuperscript{7}. In the authors’ institution, majority of patients (up to 63\%) are still initiated via a tunneled dialysis catheter, of which 35\% are inserted by interventional nephrologists (unpublished data, 2019).

In recent years, there has been a welcomed interest in interventional nephrology with nephrologists inserting tunneled dialysis catheters\textsuperscript{10}, peritoneal dialysis catheters\textsuperscript{11} and performing endovascular interventions for AVF/AVG\textsuperscript{12}.

**Peritoneal dialysis access**
Peritoneal dialysis catheter insertions were mainly performed by surgical specialties until recent years, there has been a significant rise in catheters inserted by interventional nephrologists across the country. The method of insertion by nephrologists varies by institution and it includes percutaneous PD catheter insertion under fluoroscopy, Y-TEC peritoneoscoposcopic (Merit Medical) technique and the traditional open surgical method. In the authors’ institution, more than 90\% of the PD catheter insertions are placed percutaneously under fluoroscopy by interventional nephrologists (unpublished data, 2019).

**Conclusion**
Singapore has limited natural resources and land. This is further compounded by an aging population characterized by longer life expectancy and multiple co-morbidities. Given the growing prevalence of dialysis, a sustainable dialysis care delivery system needs to expand in
parallel to include greater infrastructure and manpower support, as well as exploring options of home-based therapies.

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Table 1. Age-Standardized Incidence Rate (ASIR) of CKD5 and Dialysis

| Year | CKD5 (ASIR) | Dialysis (ASIR) |
|------|-------------|-----------------|
|      | N | Pmp | N | Pmp |
| 2009 | 1275 | 256.5 | 769 | 159.0 |
| 2010 | 1448 | 273.8 | 741 | 144.7 |
| 2011 | 1587 | 288.9 | 903 | 169.6 |
| 2012 | 1557 | 274.0 | 921 | 169.6 |
| 2013 | 1570 | 266.7 | 978 | 171.2 |
| 2014 | 1785 | 295.0 | 1041 | 175.8 |
| 2015 | 1712 | 270.4 | 1090 | 177.7 |
| 2016 | 1925 | 290.9 | 1170 | 186.2 |
| 2017 | 1999 | 289.2 | 1174 | 179.5 |
| 2018 | - | - | 1257 | 187.0 |

CKD5, chronic kidney disease stage 5. CKD5 is defined when serum creatinine $\geq$ 500μmol/L, estimated glomerular filtration rate <15 ml/min/1.73m², or renal replacement therapy has been initiated for at least 6 months.
### Table 2. Summary of dialysis delivery in Singapore in 2018

| Description                                      | Details                                                                 |
|--------------------------------------------------|-------------------------------------------------------------------------|
| Number of patients on dialysis (N, pmp)          | N = 7,405, 1,081.7 pmp                                                  |
| Percentage of patients by modality               | Hemodialysis: 86.3%                                                    |
|                                                   | Peritoneal dialysis: 13.7%                                              |
| Dialysis centers                                 | VWO: 62.8%                                                             |
|                                                   | Private: 35.6%                                                         |
|                                                   | Public hospitals: 1.6%                                                 |
| Location of dialysis center                      | Community: 98.4%                                                       |
|                                                   | Institution: 1.6%                                                      |
| Cost per hemodialysis session                    | Approx. USD $150                                                       |
| Reimbursement per dialysis session               | Approx. USD $63, not inclusive of VWO subsidy which is dependent on means testing |
| Dialysis delivery staff                          | Registered/enrolled nurse                                              |
|                                                   | Nurse aides                                                            |
| Ratio of dialysis center staff to patients       | 1:5                                                                    |
| Average hemodialysis session length (h)          | 4                                                                     |
| Nephrologist review (times per month)            | At least once a month                                                  |

Pmp, per million population; VWO, voluntary welfare organizations.
Figure 1. Incidence rate (pmp) of dialysis by modality from 2009-2018. Adapted from the Singapore Renal Registry².

Figure 2. Prevalence rate (pmp) of dialysis by modality. Adapted from the Singapore Renal Registry².