How to Cite this article: Youssef Farag and Enass El-Sayed, Global Dialysis Perspectives: Egypt, *Kidney360*, Publish Ahead of Print, 10.34067/KID.0007482021

**Article Type:** Global Communication

**Global Dialysis Perspectives: Egypt**

**DOI:** 10.34067/KID.0007482021

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**Key Points:**

**Abstract:**

Disclosures: Dr. Farag reports employment at Bayer U.S., LLC. Dr. Farag is a member in the Kidney Health Initiative (KHI) workgroup on ESKD Data Standards, the technical advisor for Harvard Medical School programs in Egypt, the Lead Director of the Harvard-Egypt Clinical Scholars Research Training (Harvard ECSRT), and the Co-Founder and Co-Director of the Clinical Nephropathology Certificate (CNC) programs of the International Society of Nephrology and the American Nephrologists of Indian Origin (ISN-ANIO).

Funding:

Author Contributions: Youssef Farag: Conceptualization; Data curation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Writing - original draft; Writing - review and editing Enass El-Sayed: Data curation; Project administration; Resources; Validation; Visualization; Writing - review and editing

Data Sharing Statement:

Clinical Trials Registration:

Registration Number:

Registration Date:

The information on this cover page is based on the most recent submission data from the authors. It may vary from the final published article. Any fields remaining blank are not applicable for this manuscript.
Global Dialysis Perspectives: Egypt

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Background

Egypt is the most populous country across the Middle East and North Africa (MENA) with over 102.3 million residents, and a GDP of 303 billion (USD). Approximately 43% of the population is urbanized living in major cities such as Cairo, Alexandria, and Mansoura (1). The transcontinental country is located at the northeast corner of Africa, split by the great Nile River Valley at its center and borders the Red and Mediterranean Seas (2). The World Bank classifies Egypt in the lower-to-middle income economies, which relies on tourism, agriculture, and manufacturing industries (2).

From a demographic perspective, the annual rate of population growth is 1.94%, adding approximately 2 million people to the total population every year, even though the fertility rates have decreased from 7.2 (1960’s) to 2.94 (2019) children born per woman (3). There is a steady increase of the prevalence of diabetes mellitus in the Egyptian population, with most recent statistics reporting a prevalence of type 2 diabetes at approximately 15.6% of all adults aged 20-79 (PMID: 27108148). A government-sponsored major initiative called the “100 Million Seha” that measured the weight and height of millions in the country, reported that approximately 40% of all adults have obesity (Sedky, A., et.al., 2021) and approximately 26% have hypertension; over half of which are unaware of their current blood pressure status, leaving them at a high risk for major cardiovascular disease (PMID: 33082518). And there is an overall 8% increase of smokers yearly, with nearly 21% of the young population aged 15-24 participating in tobacco use (Fouda, S. et.al., 2018).

The total health expenditure on Egypt in 2017 consisted of 5.63% of the total GDP, with a continuous declining trend and it stood at 4.74% in 2019 (6). By 2017, 58.8% of the population was insured under the national health insurance scheme. Uninsured individuals may spend up to 21% of their total income on health costs (5).

Similar to the global trend, the burden of chronic kidney disease (CKD) has increased by 35.7% in Egypt, ranking CKD as the 5th in leading causes of death from 2009 to 2019 (4). This has become a major public health concern in Egypt, as untreated CKD can progress to kidney
failure and early cardiovascular disease. The following discussion will present the available information on dialysis services for end-stage kidney disease (ESKD) in Egypt.

**Epidemiology of CKD and dialysis**

In 2017, The Global Burden of Disease (GBD) Chronic Kidney Disease (CKD) Collaboration estimated that there were 7.1 million individuals (95% uncertainty interval [UI] 6.6 to 7.7) with CKD in Egypt with an age-standardized prevalence of 106 (95% UI; 98 to 115) patients with CKD per 1000 population. This represented a 5.3% (95% UI; 1.4 to 9.6%) increase in prevalence between 1990 to 2017 (7). Disability-adjusted life years (DALY) for CKD in Egypt in 2017 were 463,360 (95% UI; 407,936 to 521,558), with an age-standardized DALYs per 100,000 population of 702 (95% UI; 614 to 789), which represents -7.1% reduction (95% UI; -17.5 to 4.4) in age-standardized DALYs from 1990 to 2017 (7). The most recent available estimate for the prevalence of dialysis in Egypt is in 2019 and is reported to be 0.61 per 1,000 people with an incidence estimate of 0.192 per 1,000 people (10).

**Demographics and medical characteristics of patients undergoing dialysis**

Patients undergoing dialysis in Egypt in 2020 were mostly males (58.7%) and half of them are aged 55 years and older. Hypertension was the most common case of ESKD at 41%, followed by diabetes at 14%, while glomerulonephritis was the primary diagnosis in 3% of patients undergoing dialysis. The prevalence of unknown causes of ESKD varied between 13% (10) and 22% (9). Several studies identified high prevalence of CKD of unknown origin (CKDu) ranging between 13-27% (10, 11). CKDu has also been described in India (12) and Central America (13). Notably, the first annual report of the Egyptian Society of Nephrology in 1996 (14) listed hypertension as the most common causes of ESKD in Egypt (30%) followed by glomerulonephritis (16%) while diabetes was 13%. This changing paradigm could be explained by evolving disease definitions, earlier diagnosis or changes in treatment recommendation in the clinical practice guidelines. More details are presented in Table 1.

Hepatitis C virus (HCV) infection is a serious health problem in Egypt since it had the highest prevalence of HCV infection worldwide because of repleaded use of unsterilized injections of tartar emetic, an anti-schistosomiasis treatment, in mid-twentieth century. This
makes the surveillance of HCV indicators of importance especially in dialysis population. In the Egypt Renal Data System (ERDS) 2020, one third of the patients undergoing dialysis tested positive for the HCV antibodies, and one third of those received treatment. Among those who received HCV treatment, HCV PCR was undetectable in 93% of those patients (Table 2). In 2019, a national HCV treatment campaign in Egypt was kicked off through the “100 Million Health Lives” initiative. Treatment regimen included sofosbuvir (400 mg daily) with daclatasvir (60 mg daily) with or without ribavirin for 12 or 24 weeks. Approximately 1.1 million Egyptian patients started treatment regimen and two thirds of them completed treatment, with 99% sustained virologic response (15).

**Dialysis modalities**

Hemodialysis was first introduced in Egypt in 1964 (16) while peritoneal dialysis (PD) was introduced to Egypt in 1997 (17). PD gained some traction but has declined as a dialysis modality over the years. Virtually all patients undergoing dialysis in Egypt are being treated with intermittent hemodialysis. In 2010, one large dialysis center reported that they had only treated 33 patients on PD over a 13 year time-period (17). More recent personal communication indicates that the number of patients on PD in the entire country ranges from 15-20 patients. While PD in Egypt is reserved as a very last resort for patients with no vascular access, deterrents of the use of PD in Egypt are multifaceted. These include the high cost of treatment, difficulty to secure financial coverage from the government, lack of motivation or unawareness of the patients, potential risk of peritonitis that could be driven by hot and humid weather or poor hygiene, and the lack of national program to promote CAPD. The high cost of the treatment itself encompasses the need for highly trained healthcare providers, high cost of machine, and the import of PD fluids.

**Dialysis centers in Egypt**

Although there is no publicly available data on size and location of outpatients dialysis centers, it has been estimated in 2009 that there are 3000 dialysis machines in over 600 dialysis units (18). Most dialysis centers in Egypt are affiliated with the government, as described in Table 1 (10). One third of the dialysis centers are under the direct jurisdiction of MOHP while one fifth of the dialysis centers are university affiliated.
**Hemodialysis equipment characteristics**

The top 3 manufacturers of dialysis machines in Egypt are Fresenius, Allmed and Baxter with an approximate cost of 350,000 EGP ($22,245 USD) per dialysis machine. Most patients are using dialyzer membranes of polysulfone material (83%) with most common dialyzer surface area ranging from 1.3-1.8 m² (19,10). Most dialyzers were sterilized by steam (59%). Bicarbonate dialysate buffer was reported to be used in 72% in one report (19) and 97% in another (10). Nearly half the patients had high calcium dialysate (1.75 mmol/L), followed by dialysate Calcium concentrations of 1.5 mmol/L, and only a minority (10%) had low calcium dialysate (1.25 mmol/L). The majority (76%) of hemodialysis patients had low magnesium dialysate (0.5 mmol/L). (19,10).

**Cost and Funding of dialysis services**

Most of the patients undergoing dialysis in Egypt had their dialysis treatments covered by the ministry of health and population (MOHP) and/or other government organizations, including military and university hospitals. Patients undergoing dialysis who are government employees are covered under the government health insurance. Other patients receive coverage benefits from private health insurance companies through their employers. Patients who are unemployed or self-employed are eligible to apply for, and ultimately receive, ‘Government Commission’ which funds 61% of patients undergoing dialysis in Egypt. However, the amount of subsidy offered for each of the dialysis services vary by funding government coverage vs private insurance coverage. For example, both the government health insurance and the government commission subsidize 325 Egyptian pounds (EGP) for each session of hemodialysis treatment (approximately $21 USD with exchange rate $1 USD = 15.73 EGP). In total, it is estimated that the annual cost of hemodialysis treatment for 156 sessions to be $3,276 USD per patient. The 325 EGP refers to the average cost covered by the government deemed reasonable for a single hemodialysis session. However, each institution and/or entity determines its own cost and the patients are expected to cover the remaining difference, if any.

The cost of PD is much higher compared to HD costs. While the cost of a PD session is subsidized at 325 EGP, for 13 sessions per month, totaling the monthly cost to 4,225 EGP, with a
monthly allowance for medications of 1,800 EGP (total subsidy is 6,025 EGP), the actual cost of PD is much higher, and the patients pay significant costs out of pocket. Specifically, the average monthly cost of PD lines is 4,800 EGP, and the average monthly cost of PD solutions is 3,180 EGP. These two items only total 7,980 EGP per month ($507 USD). Furthermore, there are added costs of routine laboratory investigations and consumables (~500 EGP), all of which must be paid out of pocket. Thus, the total monthly cost of PD to be 7,980 EGP, and annually 101,760 EGP ($6,469 USD). Most recently and through the advocacy of nephrologists and patients to the judicial system in Egypt, patients on hemodialysis have gained eligibility for a transportation allowance to and from the hemodialysis center, reported up to 170 EGP ($11 USD) for each dialysis session (annual transportation reimbursement $1,716 USD).

**Dialysis quality indicators for meeting clinical practice guidelines**

*Hemodialysis sessions*

Ninety four percent of hemodialysis patients were dialyzing three times per week, with 81% of them spend 4 hours of dialysis during each session (19).

*Dialysis adequacy*

Most patients undergoing dialysis had urea reduction ratio (URR) of <65% (mean URR was 59.99±8.5 (19)), and most of them had Kt/V of <1.2 (10) (mean Kt/V 1.09±0.18 (19)). These are much lower estimates compared to what was reported in the United States (20). Risk factors that are contributing to low dialysis adequacy are yet to be explored (Table 3). Contributing factors to low dialysis adequacy are multifactorial; these could include that given where most dialysis centers are centrally located in city centers/downtowns, it is not uncommon for patients to arrive late due to traffic congestion and not to receive their scheduled 4 hours of dialysis. In addition, complications that occur during dialysis sessions, e.g., intradialytic hypotension, may lead to dialysis interruptions.

*Vascular access*

Data on the vascular access for dialysis differed at the time of initiation of dialysis and at the time of survey data collection. At the time of initiation of dialysis, 80% patients had temporary catheter in place, and arteriovenous fistula (AVF) in 17% of patients. AVF had the
highest history of vascular access failure (81%) followed by temporary catheter (10%). These are similar to statistics reported by USRDS 2020 (20).

Vascular access in Egypt is managed by vascular surgeons and takes place in hospitals. Similar to dialysis session funding, the government subsidizes the cost of vascular access placement and related procedures. For example, the cost of temporal central line placement, permanent catheter and AVF is 300 EGP (~$19 USD), 1800 EGP (~$115 USD) and 3000 EGP (~$190 USD), respectively, per procedure, inclusive of materials, physician fees and hospital stay, if needed. Declotting and fistula elevation procedures (superficialization) are also subsidized at 1500 EGP (~$95 USD) and 1800 EGP (~$115 USD) per procedure, respectively.

Anemia management

Less than half of the patients undergoing dialysis had their hemoglobin level between 10-12 g/dl, while 23% were between 9-10 g/dl and 23% less than 9 g/dl. Despite 83% of patients undergoing dialysis were on ESA treatment, 90% of them are receiving epoetin alfa. The weekly dose of half of those receiving epoetin alfa is <4000 units per week, nearly half the dose reported for US patients (20). Paradoxically, 22% and 26% of patients undergoing dialysis have TSAT <20% and ferritin level <200 ng/ml, respectively, while 39% of them are on IV iron treatment. This data could signal that large proportion of hemodialysis patients in Egypt are undertreated for anemia (Table 4).

High cost of anemia treatment is a potential contributing factor to high prevalence of anemia in patients on dialysis in Egypt. While the government issues a bundled credit towards medications for dialysis patients for 150 EGP (~$9 USD) per month, iron preparations (IV or oral) are fully covered in this bundle. While the ESAs were sub-optimally subsidized, most recently, the annual cost of ESA is subsidized by the government for 3000 EGP (~$190 USD) per year which can cover the cost of ESA treatment for an entire year. Although blood transfusion is cheaper (150 EGP, ~$9 USD per unit, but costs more from non-government centers), it is not subsidized by the government, except if the patient's hemoglobin is <7g/dL, deeming it financially burdensome to patients.
**Diabetes and hypertension care**

Seventy percent of hemodialysis patients with diabetes are being treated with insulin and 30% are on oral hypoglycemic drugs. The most commonly used treatment for hypertension in patients undergoing dialysis is calcium channel blockers (~75%) followed by beta blockers (46%), with ~60% and ~30% of patients use one and two types of anti-hypertensive therapy, respectively.

**Future directions**

*Existing Deficiencies or Limitations*

There is paucity of data on the epidemiology of CKD and dialysis in Egypt in the peer-reviewed medical literature. The current data are scattered and not well organized, and generally based on small epidemiologic studies, single-center studies, imputations, or historical anecdotes. While there has been increasing efforts to generate more data, this is insufficient.

*Infrastructure Requirements*

There is a dire need to establish a government-funded central registry of patients undergoing dialysis with mandatory reporting requirements. A registry could provide a near-complete data source on patients undergoing dialysis and dialysis centers in Egypt, very similar to registries in the US and Europe. A registry would allow centralized data collection for a comprehensive list of variables. Clinical researchers around the world could utilize the forthcoming ESKD Data Standards by Kidney Health Initiative (KHI) to support the development of such a registry. Potential linkage to the ongoing ambitious project of universal healthcare coverage and national mortality data will allow the longitudinal analysis of patient outcomes in a systematic, consistent and comprehensive methodology.

*Challenges to Overcome*

While there are great opportunities to build this infrastructure for dialysis patients in Egypt, and even for CKD and kidney transplantation, financial and personnel challenges still exist. Financial constraints contribute to the difficulty in developing and sustaining a registry system. A centralized and government-funded registry will not only mitigate this, but also will help incentivize dialysis centers to provide their data and improve care, especially when it
becomes contingent on receiving subsidies. In addition, there could be a potential lack of
dedicated personnel with appropriate training in clinical research and epidemiologic methods,
database building, data management and analysis, and program management. More recently, a
paradigm shift in this aspect is underway in building capacity in clinical research expertise. The
Egyptian Ministry of Health and Population signed a 4-year agreement with Harvard Medical
School in 2019 to train over 6000 Egyptian physicians, dentists, pharmacists and nurses, who are
government- or university-employed, in two training programs: clinical research methods and
medical education pedagogy. This is achieved through a 6-month certificate program specifically
designed and tailored to the Egyptian audience and their needs. As of February 2022,
approximately 1600 Egyptian healthcare professionals have successfully graduated from each of
the two programs. They are expected to be the seed that will contribute to and lead the
transformation of healthcare in Egypt. We look forward to witnessing the return on investment
from the commitment and dedication from the Egyptian Ministry of Health and Population and
the Ministry of Higher Education to transform the health of the Egyptians.
Disclosures
Dr. Farag reports employment at Bayer U.S., LLC. Dr. Farag is a member in the Kidney Health Initiative (KHI) workgroup on ESKD Data Standards, the technical advisor for Harvard Medical School programs in Egypt, the Lead Director of the Harvard-Egypt Clinical Scholars Research Training (Harvard ECSRT), and the Co-Founder and Co-Director of the Clinical Nephropathology Certificate (CNC) programs of the International Society of Nephrology and the American Nephrologists of Indian Origin (ISN-ANIO).

Funding
None

Acknowledgments
The authors would like to thank Dr. Ajay K. Singh (Harvard Medical School and Brigham and Women’s Hospital) for his critical input and review during the preparation of this manuscript. The authors are grateful for the exceptional support from Ms. Aqsa Dar in the data curation of the background section, editorial support and managing the timelines and tasks for this project to its completion.

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Youssef Farag: Conceptualization; Data curation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Writing - original draft; Writing - review and editing. Enass Elsayed: Data curation; Project administration; Resources; Validation; Visualization; Writing - review and editing.
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Table 1: Overview of dialysis services in Egypt

| Characteristic                                                                 | Value                                                                                                                                 |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Number of patients undergoing dialysis in your country (total number and per 1,000 people in the general population) | ~54,000 patients undergoing dialysis; prevalence: 0.65 patients per 1,000 people                                                     |
| Percent of patients on home dialysis in your country.                         | Not available                                                                                                                      |
| Are all dialysis sessions covered by insurance, or do some patients have out-of-pocket expenses? | Mainly government coverage. Others include private health insurance, and to lesser extent out-of-pocket                               |
| Are the dialysis units hospital-based or freestanding?                        | Both                                                                                                                                |
| Are the dialysis units for-profit?                                           | Private for profit 11%                                                                                                             |
| Are the dialysis units for non-profit?                                       | Ministry of Health and Population 32%                                                                                               |
|                                                                                | University affiliated 21%                                                                                                           |
|                                                                                | Charitable 14%                                                                                                                      |
|                                                                                | Institute 14%                                                                                                                       |
|                                                                                | Government Health Insurance 4%                                                                                                      |
|                                                                                | Others 4%                                                                                                                          |
| Funding of dialysis treatment                                                 | Ministry of Health and Population Commission 61%                                                                                     |
|                                                                                | Government Health Insurance 30%                                                                                                     |
|                                                                                | Company-sponsored 4%                                                                                                                |
|                                                                                | Out-of-pocket 2%                                                                                                                     |
|                                                                                | Other government or other health insurance 3%                                                                                         |
|                                                                                | Military 0.18%                                                                                                                       |
| What is the reimbursement per dialysis session in $US?                         | HD $19, PD exchange $83                                                                                                             |
| Are all the staff who deliver dialysis nurses or do you also use patient care technicians? | Nephrologists, non-specialized physicians, nurses and assistant nurses                                                             |
| What is the typical patient to staff ratio in the dialysis units?             | 4:1                                                                                                                                  |
|                                                                                | Ratio of patients per consultant 31.1                                                                                               |
|                                                                                | Ratio of patients per physician 11.6                                                                                                 |
|                                                                                | Ratio of patients per nurse (actual) 4.7                                                                                             |
|                                                                                | Ratio of patients per nurse (21) 4.0                                                                                                 |
| What is the average length of a dialysis session?                             | 4 hours per session                                                                                                                 |
|                                                                                | By a nephrology resident: every dialysis session (12 times per month)                                                              |
| How many times per month are patients seen by a nephrologist during dialysis sessions? | By a nephrology consultant: weekly (4 times per month)                                                                              |
What is the proportion of HD patients in your country using an AVF, AVG and CVC?

| Temporary catheter | At Initiation | Current Type | History of failure |
|--------------------|--------------|--------------|--------------------|
| AVF                | 17%          | 87%          | 81%                |
| Graft              | 1%           | 5%           | 4%                 |
| Perm cath          | 2%           | 4%           | 5%                 |
|                    | 80%          | 4%           | 10%                |
Table 2: Characteristics of patients undergoing hemodialysis in Egypt, 2020

| Variable                        | %    |
|---------------------------------|------|
| Males (%)                       | 58.7%|
| Age categories                  |      |
| <18 years                       | 2%   |
| 18-35 years                     | 14%  |
| 35-55 years                     | 35%  |
| 55-75 years                     | 44%  |
| >75 years                       | 5%   |
| Causes of ESKD                  |      |
| Hypertension                    | 41%  |
| DM                              | 14%  |
| GN                              | 3%   |
| Unknown                         | 13%  |
| Others                          | 32%  |
| HCV antibody positive           | 31%  |
| HCV treatment scenarios in HCV Ab positive patients | |
| Yes                             | 35.4%|
| No                              | 62.9%|
| Treatment failure               | 1.6% |
| HCV PCR after treatment of HCV PCR positive patients | |
| Positive                        | 7%   |
| Undetectable                    | 93%  |
| HBV Positive                    | 1.6% |
| HBV vaccination                 | 67%  |
| HIV prevalence                  | 0.17%|
Table 3: Characteristics of dialysis-related variables in patients undergoing hemodialysis in Egypt, 2020

| Variable                        | %     |
|---------------------------------|-------|
| Urea reduction ratio            |       |
| <65%                            | 88%   |
| 65-70%                          | 4%    |
| >70%                            | 9%    |
| Kt/V                            |       |
| <1.2                            | 88%   |
| 1.2 to <1.6                     | 10%   |
| >=1.6                           | 4%    |
| Dialysate Type                  |       |
| Bicarbonate                     | 97%   |
| Acetate                         | 3%    |
| Dialysate Calcium Concentrations, mmol/L |     |
| 1.25                            | 10%   |
| 1.5                             | 51%   |
| 1.75                            | 39%   |
| Glucose-Containing Dialysate    | 9%    |
Table 4: Characteristics of anemia profiles and its management in patients undergoing hemodialysis in Egypt, 2020

| Variable                                | %   |
|-----------------------------------------|-----|
| **Hemoglobin categories**               |     |
| >=12                                    | 14% |
| >=11 to <12                             | 16% |
| >=10 to <11                             | 24% |
| >9 to <10                               | 23% |
| <9                                      | 23% |
| **TSAT**                                |     |
| >=50                                    | 9%  |
| 30 to <50                               | 32% |
| 20 to <30                               | 37% |
| <20                                     | 22% |
| **Ferritin ng/ml**                      |     |
| >=800                                   | 27% |
| 500 to <800                             | 17% |
| 200 to <50                              | 30% |
| <200                                    | 26% |
| **On ESA treatment**                    |     |
|                                        | 83% |
| Epo alpha                               | 90% |
| Darbe alpha or Epoetin-beta             | 10% |
| **Weekly Erythropoietin Alpha dose, units** |       |
| >8000                                   | 16% |
| >4000 to 8000                           | 35% |
| <=4000                                  | 50% |
| **Weekly Darbe alpha dose, mcg**        |     |
| <=20                                    | 17% |
| 20-30                                   | 35% |
| >30 to 40                               | 23% |
| >40                                     | 25% |
| **Weekly Epoetin-beta dose, IU**        |     |
| <=4000                                  | 41% |
| >4000 to 6000                           | 21% |
| >6000 to 8000                           | 23% |
| >8000                                   | 15% |
| **IV iron treatment**                   |     |
|                                        | 39% |
| **History of blood transfusion**        |     |
|                                        | 18% |