Hemodialysis Use and Practice Patterns: An International Survey Study

Htay Htay, Aminu K. Bello, Adeera Levin, Meaghan Lunney, Mohamed A. Osman, Feng Ye, Gloria E. Ashuntantang, Ezequiel Bellorin-Font, Mohammed Benghanem Gharbi, Sara N. Davison, Mohammad Ghnaimat, Paul Harden, Vivekanand Jha, Kamyar Kalantar-Zadeh, Peter G. Kerr, Scott Klarenbach, Csaba P. Kovesdy, Valerie A. Luyckx, Brendon Neuen, Donal O'Donoghue, Shahrzad Ossareh, Jeffrey Perl, Harun Ur Rashid, Eric Rondeau, Emily J. See, Syed Saad, Laura Sola, Irma Tchokhonelidze, Vladimir Tesar, Kriang Tungsanga, Rumeyza Turan Kazancioglu, Angela Yee-Moon Wang, Chih-Wei Yang, Alexander Zemchenkov, Ming-hui Zhao, Kitty J. Jager, Fergus J. Caskey, Vlado Perkovic, Kailash K. Jindal, Ikechi G. Okpechi, Marcello Tonelli, David C. Harris, and David W. Johnson

Rationale & Objective: Hemodialysis (HD) is the most common form of kidney replacement therapy. This study aimed to examine the use, availability, accessibility, affordability, and quality of HD care worldwide.

Study Design: A cross-sectional survey.

Setting & Participants: Stakeholders (clinicians, policy makers, and consumer representatives) in 182 countries were convened by the International Society of Nephrology from July to September 2018.

Outcomes: Use, availability, accessibility, affordability, and quality of HD care.

Analytical Approach: Descriptive statistics.

Results: Overall, representatives from 160 (88%) countries participated. Median country-specific use of maintenance HD was 298.4 (IQR, 80.5-599.4) per million population (pmp). Global median HD use among incident patients with kidney failure was 98.0 (IQR, 81.5-140.8) pmp and median number of HD centers was 4.5 (IQR, 1.2–9.9) pmp. Adequate HD services (3-4 hours 3 times weekly) were generally available in 27% of low-income countries. Home HD was generally available in 36% of high-income countries. 32% of countries performed monitoring of patient-reported outcomes; 61%, monitoring of small-solute clearance; 60%, monitoring of bone mineral markers; 51%, monitoring of technique survival; and 60%, monitoring of patient survival. At initiation of maintenance dialysis, only 5% of countries used an arteriovenous access in almost all patients. Vascular access education was suboptimal, funding for vascular access procedures was not uniform, and copayments were greater in countries with lower levels of income. Patients in 23% of the low-income countries had to pay >75% of HD costs compared with patients in only 4% of high-income countries.

Limitations: A cross-sectional survey with possibility of response bias, social desirability bias, and limited data collection preventing in-depth analysis.

Conclusions: In summary, findings reveal substantial variations in global HD use, availability, accessibility, quality, and affordability worldwide, with the lowest use evident in low- and lower-middle–income countries.

Visual Abstract online

Complete author and article information provided before references.

Correspondence to D.W. Johnson (david.johnson2@health.qld.gov.au)

Am J Kidney Dis. 77(3):326-335. Published online August 13, 2020.

doi: 10.1053/j.ajkd.2020.05.030

Although kidney replacement therapy (KRT) is essential for treating patients with kidney failure, many patients (particularly those in low- and lower-middle–income countries) do not have access to KRT.[1] In a systematic review, Liyanage et al[2] reported that substantial numbers (at least 2.28 million) of patients with kidney failure did not have access to KRT and might have died prematurely. These numbers are expected to increase with time in parallel with population growth and aging around the world.[3]

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Hemodialysis (HD) remains the primary mode of KRT for patients with kidney failure in most countries worldwide and accounts for 90% of all dialysis globally.[4] Compared with peritoneal dialysis, HD is more challenging from a technical perspective and often more expensive.[4] Despite its widespread use, very little information is available about access to and quality of maintenance HD care for patients with kidney failure worldwide.[1,2,4,5]

The first Global Kidney Health Atlas (GKHA) reported the number of countries with HD capacity.[6] The present study is specifically aimed at examining the incidence, prevalence, availability, accessibility, affordability, and quality of HD care for patients with kidney failure around the world. A similar analysis regarding peritoneal dialysis is reported separately.[7]

Methods

Data Collection

This study is based on data from the 2019 edition of the GKHA survey, a cross-sectional study of the global access and treatment characteristics of kidney failure care

PLAIN-LANGUAGE SUMMARY

Hemodialysis is the main life-support therapy for patients with kidney disease. This international survey administered by the International Society of Nephrology aimed to examine the epidemiology of patients with kidney failure receiving hemodialysis worldwide, availability of hemodialysis in each country, proportion of patients receiving dialysis at the onset of kidney failure, and funding for hemodialysis. The literature search and survey responses by key stakeholders (nephrologists and policy makers) from 160 countries suggested a wide variation in the use of hemodialysis worldwide, with limited access to hemodialysis mainly in low- and lower-middle–income countries. Similarly, funding for hemodialysis treatment varied substantially, with patients from low- and lower-middle–income countries generally bearing higher out-of-pocket expenses. The survey also noted differences in practice patterns of hemodialysis globally.

conducted by the International Society of Nephrology (ISN). The study was approved by the University of Alberta Research Ethics Committee and all participants provided informed consent. The methods have been discussed in detail elsewhere.[8] In short, 2 approaches, including desk research and the GKHA survey, were used to gather data for the study. The desk research was literature searches that were conducted in collaboration with an information specialist to synthesize global data on the epidemiology and treatment of kidney failure. These data were extracted from key reports including US Renal Data System (USRDS), European Renal Association–European Dialysis and Transplant Association (ERA-EDTA) registry, Australia and New Zealand Dialysis and Transplant Registry (ANZDATA), and other relevant published and gray literature. The cost of maintenance HD was obtained from a scoping review.

The GKHA survey was conducted using an online questionnaire (Item S1).[9] All countries with kidney societies were invited to participate in the survey. Three key opinion leaders from each country, including a leader or president of a nephrology society, a leader of a patient representative organization, and a policy maker, were purposefully identified by project leaders of each region. Project leaders were identified through international contacts, collaborators, ISN leaders, and regional board members, who played crucial roles to ensure: (1) appropriate identification of key opinion leaders in each country, (2) organization and follow-up on responses from all countries within a specific world region, (3) attainment of additional data sources and contacts for surveys when required, and (4) provision of support to review regional data as needed. Key stakeholders identified by project leaders were subsequently sent invitations to participate in the survey (available in English, French, and Spanish), which included a link to the survey's online portal (www.redcapcloud.com). The survey was conducted from July to September 2018.

Definitions

The present study examined the global use of maintenance HD, availability (defined as generally available if HD is available in ≥50% of centers, hospitals, or clinics or generally not available if HD is available in <50% of centers, hospitals, or clinics as a treatment option for patients with kidney failure in a country), global HD center density, accessibility (defined as the proportion of patients with kidney failure able to access dialysis at the onset of kidney failure in a country), within-country variation in access to dialysis, affordability (defined as the proportion of the HD treatment cost paid for directly by the patient), vascular access type on HD initiation, and availability of services for kidney failure care using data extracted from key reports and the GKHA survey.

Statistical Analysis

Data are presented as frequency and percentage for categorical variables and median and interquartile range (IQR) and range for continuous variables. Survey data were analyzed and stratified based on the 4 World Bank income groups and the 10 ISN regions. Results of the online survey were reported in accordance with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) guidelines.[10] Data were analyzed using Stata 14 software (Stata Corp).

Results

Characteristics of Participating Countries

Of 182 countries contacted, 160 (88%), including 58 of 66 high-income countries (HICs), 41 of 48 upper-middle–income countries (UMICs), 38 of 42 lower-middle–income countries (LMICs), and 23 of 26 low-income countries (LICs), responded to items designed to assess the various domains of access to and quality of maintenance HD for patients with kidney failure. By ISN region, data were collected from 42 countries in Africa, 19 countries in Eastern and Central Europe, 18 countries in Latin America, 11 countries in the Middle East, 10 countries in the Newly Independent States and Russia, 10 countries in North America and the Caribbean, 7 countries in North and East Asia, 15 countries in Oceania and South East Asia, 7 countries in South Asia, and 21 countries in Western Europe. Overall, 317 participants (82% [n = 260] nephrologists, 7% [n = 22] non-nephrologist physicians, 2% [n = 7] other health professionals, 5% [n = 17] administrators/policy makers/civil servants, and 3% [n = 11] others) responded to the survey (Table S1).

Availability of Maintenance HD Service

The GKHA questionnaire included a single-item question asking respondents if maintenance HD (adult and pediatric)

Table 1. Summary Table of Use of HD and KRT patients Classified by World Bank Income Groups, ISN Regions, and Globally

	HD Use		HD Use in Incident Kidney Failure		Prevalent KRT for Kidney Failure		Incident KRT for Kidney Failure	
Variables	n[a]	pmp	n[a]	pmp	n[a]	pmp	n[a]	pmp
Globally	126	298.4 [80.5-599.4]	26	108.8 [81.5-150.1]	91	759.0 [433.0-1,048.0]	79	141.0 [103.1-200.2]
ISN region								
Africa	30	13.8 [4.4-103.0]	0	Not reported	5	541.0 [181.0-624.0]	4	100.0 [39.0-151.5]
Eastern & Central Europe	16	477.6 [280.5-571.4]	6	105.4 [81.5-122.5]	15	759.0 [620.0-1,008.3]	16	144.5 [108.5-178.5]
Latin America	20	310.6 [191.1-552.3]	0	Not reported	20	558.1 [313.3-868.5]	18	167.5 [94.8-208.3]
Middle East	10	256.7 [184.1-409.5]	0	Not reported	8	636.0 [295.4-728.5]	6	132 [120.0-145.0]
NIS and Russia	4	137.6 [89.8-178.2]	0	Not reported	5	289.0 [211.0-310.0]	4	60.5 [44.0-132.5]
North America & the Caribbean	11	630.1 [321.0-1,399.1]	2	243.4 [150.1-336.7]	7	682.5 [334.6-1,346.4]	2	289.1 [200.2-378.0]
North & East Asia	4	1,661.4 [646.2-2,127.6]	1	94.4 [94.4-94.4][b]	3	2,599.0 [1,816.0-3,392.0]	3	311.0 [296.0-493.0]
Oceania & South East Asia	8	553.7 [239.9-896.8]	4	139.8 [110.6-176.5]	8	1,170.0 [644.5-1,594.0]	8	215.5 [127-339.5]
South Asia	4	26.2 [14.1-73.2]	0	Not reported	1	117 [117.0-117.0][b]	1	51.0 [51.0-51.0][b]
Western Europe	19	473.3 [319.6-662.8]	13	82.1 [74.6-116.1]	19	979.0 [885.0-1,234.0]	17	128.0 [106.0-165.0]
World Bank income group								
LICs	11	3.9 [0.9-8.3]	0	Not reported	1	4.4 [4.4-4.4][b]	0	Not reported
LMICs	27	67.9 [15.4-162.0]	0	Not reported	12	321.0 [227.4-567.9]	12	129.9 [53.5-174.4]
UMICs	34	334.1 [178.8-531.2]	7	122.5 [94.4-173.5]	27	550.2 [289.0-780.0]	22	126.0 [80.0-194.0]
HICs	54	513.7 [333.4-738.8]	19	101.5 [74.6-140.8]	51	966.0 [759.0-1,269.0]	45	149.0 [119.0-207.5]

Note: Data are presented as median [interquartile range].
Abbreviations: HD, hemodialysis; HIC, high-income country; ISN, International Society of Nephrology; KRT, kidney replacement therapy; LIC, low-income country; LMIC, lower-middle–income country; NIS, Newly Independent States; pmp, per million population; UMIC, upper-middle–income country
[a]Number of countries reporting data.
[b]Single-country report.

was available in their country. Overall, 156 countries responded to the survey, and all participating countries reported that maintenance HD service was available.

The Global Maintenance HD Use

Overall, data for maintenance HD use were available from 126 countries (Table 1). The median global use of maintenance HD was 298.4 (IQR, 80.5-599.4) per million population (pmp) but varied widely across countries, from 0.3 pmp in the Democratic Republic of Congo to 2,148 pmp in Japan (Table 1). HD use was very low in LICs; for example, 5.8 pmp in Ethiopia, 2.8 pmp in Zimbabwe; and 0.5 pmp in Tanzania.

Data for HD use among incident patients with kidney failure were available from 26 countries. Of these countries, median use was 108.8 (IQR, 81.5-150.1) pmp (Table 1). No such data were available for LMICs and LICs. Only 1 country in North and East Asia reported the use of HD among incident patients with kidney failure.

Density of HD Centers

The questionnaire also asked respondents how many centers in their country provided maintenance HD. Overall, 154 countries responded to this item. The median number of centers providing maintenance HD was 4.5 (IQR, 1.2-9.9) pmp (Table 2). HD center density was extremely low in LICs: 0.13 pmp in Chad, 0.17 ppm in Uganda, and 0.18 pmp in Ethiopia.

Availability of HD

Overall, 154 countries responded to survey items designed to assess the availability of HD. Of these, 129 countries (84%) indicated that HD service was available in most hospitals or centers in the country. Most LICs (15/22) reported less than half the hospitals providing HD services in a country (Table 2).

Adequate Frequency of Center-Based HD Services

A total of 77% (118/154) of countries reported that HD of adequate frequency (3-4 hours thrice weekly) was available in most centers in their countries. This proportion ranged from 95% (53/56) in HICs to 27% (6/22) in LICs (Fig S1).

Home-Based HD Services

Overall, 13% (20/154) of countries reported that home-based HD services were available in most centers, whereas 32% (49/154) of countries reported that they were available in less than half the centers. Home-based HD service was not available in 55% (85/154) of countries (Fig S2).

Table 2. HD Center Density, Availability of HD Services in a Country, and Accessibility of Dialysis at the Onset of Kidney Failure, by World Bank Income Groups, ISN Regions, and Globally

Category	n[a]	HD Center Density, pmp	N[b]	Availability at Hospitals/Clinics[c]		Accessibility of HD[d]				
				≥50%	<50%	0%	1%-10%	11%-25%	26%-50%	>50%
Overall	154	4.5 [1.2-9.9]	154	129 (84%)	25 (16%)	4 (3%)	26 (17%)	6 (4%)	10 (6%)	108 (70%)
ISN region										
Africa	39	0.5 [0.2-2.2]	41	24 (59%)	17 (41%)	1 (2%)	20 (49%)	2 (5%)	4 (10%)	14 (34%)
Eastern & Central Europe	19	9.2 [6.5-10.8]	19	19 (100%)	0 (0%)	1 (5%)	0 (0%)	0 (0%)	0 (0%)	18 (95%)
Latin America	18	4.6 [2.9-10.9]	18	16 (89%)	2 (11%)	0 (0%)	1 (6%)	0 (0%)	0 (0%)	17 (94%)
Middle East	11	3.8 [2.1-5.7]	11	11 (100%)	0 (0%)	1 (9%)	1 (9%)	0 (0%)	0 (0%)	9 (82%)
NIS & Russia	7	3.7 [2.2-5.5]	7	7 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (14%)	6 (86%)
North America & the Caribbean	9	18.1 [10.4-19.6]	9	7 (78%)	2 (22%)	0 (0%)	2 (22%)	0 (0%)	0 (0%)	7 (78%)
North & East Asia	7	14.2 [1.8-34.8]	7	7 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (14%)	0 (0%)	6 (86%)
Oceania & South East Asia	15	5.7 [1.5-14.4]	15	13 (87%)	2 (13%)	0 (0%)	1 (7%)	2 (13%)	2 (13%)	10 (67%)
South Asia	7	1.4 [0.6-1.7]	7	5 (71%)	2 (29%)	1 (14%)	1 (14%)	2 (29%)	2 (29%)	1 (14%)
Western Europe	21	6.9 [4.5-9.9]	20	20 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)
World Bank income group										
LICs	20	0.2 [0.2-0.4]	22	7 (32%)	15 (68%)	1 (5%)	16 (73%)	1 (5%)	3 (13%)	1 (5%)
LMICs	36	1.6 [0.8-3.8]	35	30 (86%)	5 (14%)	2 (6%)	4 (11%)	4 (11%)	5 (14%)	20 (57%)
UMICs	41	5.3 [3.5-9.9]	41	38 (93%)	3 (7%)	1 (3%)	4 (10%)	1 (2%)	2 (5%)	33 (80%)
HICs	57	9.5 [4.7-14.2]	56	54 (96%)	2 (4%)	0 (0%)	2 (4%)	0 (0%)	0 (0%)	54 (96%)

Note: Data are presented as median [interquartile range] or frequency (percentage).
Abbreviations: HD, hemodialysis; HIC, high-income country; ISN, International Society of Nephrology; LIC, low-income country; LMIC, lower-middle–income country; NIS, Newly Independent States; pmp, per million population; UMIC, upper-middle–income country.
[a]Number of countries reporting HD center density.
[b]Number of countries providing availability and accessibility data.
[c]Proportion of hospitals or clinics providing HD service in a country.
[d]Proportion of patients receiving dialysis at the onset of kidney failure.

Affordable Patient Transport Services for Dialysis

Overall, 44% (67/154) of countries indicated that affordable patient transport services for dialysis were available in most centers in their countries. This proportion ranged from 77% (43/56) of HICs to 9% (2/22) of LICs. This service was never available in 16% (24/154) of countries.

Accessibility of Dialysis at the Onset of Kidney Failure

Data regarding accessibility of dialysis were provided by 154 countries (Table 2). Overall, 70% (108/154) reported that most patients with kidney failure had access to dialysis. However, LICs reported very limited access to dialysis at the onset of kidney failure (Table 2).

Within-Country Variation in Access to Dialysis

Overall, 61% (94/154) of participating countries reported no within-country variation in access to dialysis. This figure varied by income group (HIC, 95% [53/56]; UMIC, 56% [23/41]; LMIC, 40% [14/35]; and LIC, 18% [4/22]). Overall, 79% (122/154) of countries reported no variation in access to dialysis based on patients' characteristics (eg, age, sex, and employment status).

Affordability of HD Service

Data regarding national average copayments (including medications but no other ancillaries) for HD patients were obtained from 154 countries (Table 3). In general, people from HICs paid less or were not required to provide copayment for HD costs, whereas people from LICs such as Ethiopia, Sierra Leone, and Chad had to pay 100% of HD costs out of pocket. People from Madagascar, Zimbabwe, Burkina Faso, Democratic Republic of the Congo, and Haiti (also LICs) had to pay >75% of HD costs out of pocket.

Within-Country Variation in Copayments for HD Services

Overall, 75% (116/154) of participating countries reported no within-country variation in copayments for HD services. This percentage varied by country income level, namely 93% of HICs, 68% of UMICs, 74% of LMICs, and 45% of LICs. Overall, 67% (103/154) of countries reported no variation in HD copayments based on patients' characteristics, including age, sex, and employment status.

Funding for Vascular Access Creation in HD

A total of 159 countries provided information about vascular access creation. Of these countries, 38% (n = 61)

Table 3. Annual Maintenance HD Cost and Copayments for HD Patients by World Bank Income Groups, ISN Regions, and Globally

Category	Annual Cost of HD[a]	n[b]	National Average Copayment Proportions by Patients for HD Service						
			0%	1%-25%	26%-50%	51%-75%	>75%	100%	Unknown
Overall	22,616.8 [14,882-49,690.3]	154	41 (27%)	59 (38%)	12 (8%)	8 (5%)	11 (7%)	12 (8%)	11 (7%)
ISN region									
Africa	12,059.7 [5,980.0-23,605.6]	41	9 (22%)	13 (31%)	2 (5%)	0 (0%)	6 (15%)	5 (12%)	6 (15%)
Eastern & Central Europe	20,077.0 [16,133.0-27,290.1]	19	6 (32%)	8 (42%)	0 (0%)	0 (0%)	0 (0%)	4 (21%)	1 (5%)
Latin America	19,712.3 [16,147.7-39,695.1]	18	5 (28%)	6 (33%)	3 (16%)	1 (6%)	1 (6%)	0 (0%)	2 (11%)
Middle East	19,489.1 [15,860.0-50,739.5]	11	2 (18%)	7 (64%)	0 (0%)	1 (9%)	0 (0%)	0 (0%)	1 (9%)
NIS & Russia	5,876.0 [5,070.0-14,882.0]	7	3 (43%)	2 (29%)	1 (14%)	1 (14%)	0 (0%)	0 (0%)	0 (0%)
North American & the Caribbean	73,788.5 [25,374.0-88,395.1]	9	2 (22%)	2 (22%)	1 (11%)	2 (22%)	0 (0%)	1 (11%)	1 (11%)
North and East Asia	28,845.5 [21,214.4-43,953.9]	7	0 (0%)	7 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Oceania & South East Asia	20,204.7 [8,759.7-28,558.5]	15	1 (7%)	5 (33%)	4 (27%)	0 (0%)	3 (20%)	2 (13%)	0 (0%)
South Asia	5,201.9 [4,873.3-9,849.5]	7	2 (29%)	0 (0%)	1 (14%)	3 (43%)	1 (14%)	0 (0%)	0 (0%)
Western Europe	60,037.0 [50,846.9-76,642.1]	20	11 (55%)	9 (45%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
World Bank income group									
LICs	20,463.2 [7,603.5-36,174.0]	22	5 (23%)	2 (9%)	2 (9%)	1 (5%)	5 (23%)	3 (14%)	4 (18%)
LMICs	9,994.7 [5,579.0-19,023.8]	35	6 (17%)	10 (29%)	5 (14%)	3 (9%)	4 (11%)	4 (11%)	3 (9%)
UMICs	17,118.7 [13,829.6-25,797.2]	41	8 (20%)	20 (49%)	3 (7%)	3 (7%)	2 (5%)	3 (7%)	2 (5%)
HICs	49,720.5 [25,374.0-60,498.0]	56	22 (39%)	27 (48%)	2 (4%)	1 (2%)	0 (0%)	2 (4%)	2 (4%)

Note: The denominator used in the calculation of proportion is the number of countries that had HD available.
Abbreviations: HD, hemodialysis; HIC, high-income country; ISN, International Society of Nephrology; LIC, low-income country; LMIC, lower-middle–income country; NIS, Newly Independent States; UMIC, upper-middle–income country.
Abbreviations: HD, hemodialysis; ISN, International Society of Nephrology; NIS, Newly Independent States.
[a]Data from 97 countries and presented in USD; presented as median [interquartile range].
[b]Number of countries reporting data on copayments.

of countries reported that catheter insertion costs for HD were fully paid by the government (Fig S3). Overall, 40% (n = 64) of countries reported that costs for arteriovenous fistulas or grafts were fully covered by the government (Fig S4). The health care system's coverage for vascular access creation varied by country income level. People from LICs, including Uganda, Madagascar, Guinea, Zimbabwe, Haiti, Chad, and Niger, had to pay solely private or out of pocket for vascular access procedures (central venous catheter insertion or creation of fistula/graft) for HD.

HD Cost

Data for maintenance HD cost were obtained from 97 countries (Table 3). The global median annual HD cost was $22,616.8 (2016 USD), with a wide variation from $1,560.0 USD in Cameroon to $103,186.60 USD in the Netherlands.

HD Quality

Overall, 144 countries contributed data regarding HD quality (Figs 1 and S5), which was assessed by examining the proportion of centers routinely monitoring the following outcomes or parameters in a country.

Monitoring of Patient-Reported Outcomes

Globally, 15% (n = 22) of participating countries did not monitor patient-reported outcomes, whereas 32% (n = 46) of countries reported that almost all (>75%) HD centers performed such monitoring (Fig S5).

Blood Pressure Monitoring

Most (86%) countries monitored blood pressure in almost all (>75%) HD centers. Only 8% (n = 11) of countries reported no monitoring of blood pressure in HD centers.

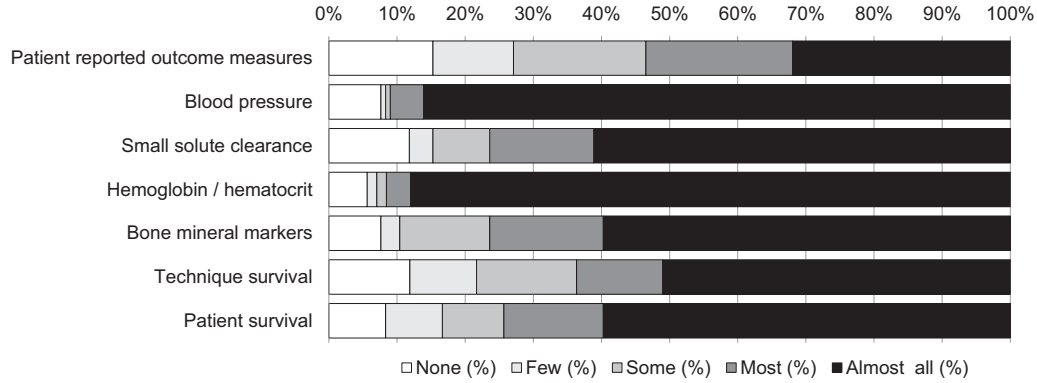

Figure 1. Hemodialysis quality indicators monitored and reported in 144 countries. (None, 0%; few, 1%-10%; some, 11%-50%; most, 51%-75%; and almost all, >75%).

Small-Solute Clearance Monitoring

Most countries (61% [n = 88]) monitored small-solute clearance in almost all (>75%) HD centers, whereas small-solute clearance was not monitored in 12% (n = 17) of countries. By country income level, monitoring solute clearance in almost all HD centers varied from 87% of HICs to 28% of LICs.

Monitoring of Hemoglobin Level

Overall, 88% of countries monitored hemoglobin levels in almost all (>75%) HD centers. By country income level, this proportion varied from 98% of HICs to 71% of LICs. However, 6% of countries did not monitor hemoglobin levels in any of their centers.

Monitoring of Bone Mineral Markers

Most (60% [n = 86]) countries monitored bone mineral marker levels in almost all (>75%) HD centers. By country income level, this proportion varied from 85% of HICs to 17% of LICs, whereas 8% (n = 11) of countries did not monitor them at all.

Monitoring of Technique and Patient Survival

Overall, technique and patient survival were monitored in almost all (>75%) HD centers in 51% (n = 73) and 60% (n = 86) of countries, respectively. These proportions varied across country income groups, ranging from 17% to 81% for technique survival and 22% to 89% for patient survival. However, technique and patient survival were not monitored in 12% (n = 17) and 8% (n = 12) of countries, respectively.

Vascular Access for HD

A total of 152 countries provided information about vascular access. Only 13% (n = 19) of participating countries reported having most patients with kidney failure initiating dialysis using functioning vascular access (arteriovenous fistula or graft; Fig S6). Nearly half (46% [n = 69]) the countries reported having most patients with kidney failure initiating dialysis using a temporary catheter.

Education on choice of vascular access and timing of access creation education was not provided in Afghanistan, Azerbaijan, The Gambia, or Sierra Leone, and only 41% (n = 61) of countries reported that most patients routinely received education about the best means of access and timely surgery for access creation.

Discussion

To our knowledge, the GKHA is the largest international survey ever conducted in nephrology. The findings demonstrate marked variations and large disparities in HD population availability, accessibility, affordability, and quality of HD care provided within and between different countries around the world.

The present study included data from all available national renal registries and published literature, thereby providing broader coverage of the epidemiology of kidney failure and dialysis than the USRDS database, in which data for LICs were not reported under the USRDS international comparisons. Findings from this study reveal substantial (>130-fold) variation in HD populations between LICs and HICs and a remarkable lack of these data, particularly in LMICs and LICs. Health information and renal registries play a critical role in defining the burden of kidney failure, monitoring the quality and outcomes of kidney failure care, and more importantly, helping to better inform health care–related policy making and health services planning.[11–13] A lack of or limited availability and quality of kidney registries in these under-resourced countries[14] prevents proper understanding of the true epidemiology of people with kidney failure, which further impedes informed guidance for the allocation of limited available resources to kidney failure care. To close this gap, establishing robust health information systems, including dialysis registries, is crucial. The ISN has established the "Sharing Expertise to Support the Set-up of Renal Registries" (SharE-RR) initiative to support the development

and maintenance of renal registries worldwide by providing a way to share registry resources.[15]

HD was provided in facilities in most countries; home HD services were generally unavailable except in a small proportion of HICs. Although HD was available in all participating countries, access to this dialysis modality at the onset of kidney failure was highly variable and generally decreased as country income level decreased. Even if patients were able to access dialysis, most LICs and African countries were unable to provide treatment with adequate frequency. The main predictor of access was the wealth of the individual country and the amount of resources each country spent on kidney failure care, such as HD.[1,16–18] In a universal health care coverage system, dialysis should be made available to the people who need it in an equitable manner regardless of their financial status. However, in practice, we found that funding strategies for HD services around the world were diverse, with primarily public funding in HICs and UMICs, but primarily private or out-of-pocket funding in LMICs and LICs, with copayments greater than 75% of total HD costs borne by patients in a quarter of all LICs. Consequently, many patients in LICs were at high risk for financial ruin if they accessed HD.[19] This resulted in inequity of access to HD services, particularly in LMICs and LICs.

Increasing the global accessibility and quality of HD for people with kidney failure through more affordable and sustainable models of HD care is therefore of paramount importance. The ISN recently published suggested financial strategies and funding models to achieve equitable kidney failure care around the world.[20] One of these strategies involved the use of health technology assessments to evaluate the cost-effectiveness and clinical benefits of available KRT (including HD). Doing so helps direct limited funding resources toward the most cost-effective KRT option that could also provide acceptable clinical effectiveness for all patients.[20–22] Appropriate governance and health system organizational factors also need to be put in place to ensure equitable use of expensive HD resources. In addition, the financing model should allocate resources for HD ancillary costs (particularly vascular access), registries, workforce training, and early detection and management of chronic kidney disease to prevent or reduce the incidence of kidney failure.[20] Defining minimum appropriate standards for HD service delivery may also help establish more sustainable models of care that maximize utilitarian gain for people with kidney failure.

The widely variable accessibility of dialysis observed between countries in the present study was often linked to local health workforce capacities. Workforce shortages were common in LICs and LMICs, in which access to dialysis was generally the lowest and kidney failure growth rates were generally the fastest.[1,2,16] Understanding facilitators of and barriers to the development of the health workforce and evaluating training and educational needs is clearly important to enhance the availability and utility of dialysis. Moreover, developing innovative alternative models of workforce care through task substitution, telemedicine, mobile health (mHealth), and web-based education systems may help maximize the efficiency of the available workforce for HD service delivery.[20,23]

Apart from making HD more accessible and affordable, it is also important to ensure that HD treatments align with standardized safety practices and yield acceptable quality outcomes based on available evidence and guidelines.[24,25] Unfortunately, findings from the present study show that many recognized dialysis quality indicators were not routinely monitored, particularly in LICs and LMICs. In the context of limited resources, it can be challenging to follow all the standardized practices used in HICs and still meet fiscal responsibilities. Nevertheless, LICs and LMICs should adapt existing guidelines to local settings using available validated tools, such as the ADAPTE framework,[26] to ensure delivery of safe high-quality dialysis.[20] Recently, the International Society for Peritoneal Dialysis published guidelines for the provision of goal-directed high-quality peritoneal dialysis that specifically included recommendations for adaptation in LICs and LMICs.[27] Similar guidelines should be developed for HD and should cover areas such as incremental HD, dialyzer reuse, machine sterilization, minimum reported quality indicators, and infection control procedures.

Another important component of care for patients with kidney failure is vascular access for HD initiation. Despite substantial evidence that the initiation of HD using a central venous catheter is associated with higher risk for morbidity and mortality,[28] only 5% of countries in the present study reported that >75% of patients initiate HD using permanent vascular access. Timely provision of vascular access education could potentially improve this statistic because patient dialysis knowledge has been shown to be associated with higher use of permanent vascular access.[29]

The present study is one of the largest global health surveys ever conducted, with data from 160 countries covering >98% of the world's population. A validated framework was used to assess chronic diseases, with broad coverage across all regions and country income levels. Data accuracy was ensured by collecting responses from multiple sources within a country (leading clinicians, policy makers, and consumer representatives) and verifying the provided information with regional and national stakeholders. Rather than just considering the incidence, prevalence, and availability of HD, the survey also included items designed to evaluate HD center density, accessibility, affordability, and quality monitoring and reporting.

These strengths should be balanced against the study's limitations, including the fact that it was a cross-sectional study based on an online survey that relied largely on respondents' knowledge. The possibility of response bias, including social desirability bias, could not be excluded. The findings from this study required further validation with more participants from each country and consideration of probabilistic sampling. In addition, the granularity of data collection was limited to obtain a high response rate, but resulted in restricted ability to provide more in-depth

explanations for the observed outcomes from each country. Finally, the study presented and compared the accessibility of dialysis across countries in percentages, which should be interpreted with caution given the widely varying population sizes (and therefore widely varying absolute numbers of people affected per percentage point) between different countries.

In summary, this global survey of maintenance HD care revealed considerable within- and between-country variations in HD use, availability, accessibility, affordability, quality monitoring, and reporting. These disparities were more marked in LICs and LMICs, particularly in Africa and South Asia. The findings from this study carry significant implications for policymakers and advocacy groups with respect to delivering equitable, cost-effective, high-quality HD to patients around the globe in the future.

Supplementary Material

Supplementary File (PDF)

Figure S1: Availability of adequate frequency HD by World Bank income group and ISN region.

Figure S2: Availability of home-based HD services by World Bank income group and ISN region.

Figure S3: Funding for central venous catheter placement by World Bank income group and ISN region.

Figure S4: Funding for arteriovenous fistula or graft creation by World Bank income group or ISN region.

Figure S5: HD quality indicators measured and reported, by World Bank income group.

Figure S6: Types of vascular access and availability of vascular access education by World Bank income group.

Table S1: Response rate for each country.

Item S1: Global Kidney Health Atlas topical survey: questions specific to hemodialysis service.

Article Information

Authors' Full Names and Academic Degrees: Htay Htay, MBBS, Aminu K. Bello, MD, PhD, Adeera Levin, MD, Meaghan Lunney, MSc, PhD, Mohamed A. Osman, MD, Feng Ye, MSc, Gloria E. Ashuntantang, MD, Ezequiel Bellorin-Font, MD, Mohammed Benghanem Gharbi, MD, Sara N. Davison, MD, MSc, Mohammad Ghnaimat, MD, Paul Harden, MD, Vivekanand Jha, MD, Kamyar Kalantar-Zadeh, MD, Peter G. Kerr, MBBS, PhD, Scott Klarenbach, MD, MSc, Csaba P. Kovesdy, MD, Valerie A. Luyckx, MBBCh, MSc, PhD, Brendon Neuen, MBBS, MSc, Donal O'Donoghue, MD, Shahrzad Ossareh, MD, Jeffrey Perl, MD, Harun Ur Rashid, MBBS, PhD, Eric Rondeau, MD, PhD, Emily J. See, MBBS, Syed Saad, BSc, Laura Sola, MD, Irma Tchokhonelidze, MD, Vladimir Tesar, MD, PhD, Kriang Tungsanga, MD, Rumeyza Turan Kazancioglu, MD, Angela Yee-Moon Wang, MD, PhD, Chih-Wei Yang, MD, Alexander Zemchenkov, MD, PhD, Ming-hui Zhao, MD, PhD, Kitty J. Jager, MD, PhD, Fergus J. Caskey, MD, Vlado Perkovic, MBBS, PhD, Kailash K. Jindal, MBBS, Ikechi G. Okpechi, MBBS, PhD, Marcello Tonelli, MD, David C. Harris, MD, and David W. Johnson, MBBS, PhD.

Authors' Affiliations: Department of Renal Medicine, Singapore General Hospital, Singapore (HH); Division of Nephrology and Immunology, Department of Medicine, University of Alberta, Edmonton, Alberta (AKB, MAO, FY, SND, SK, SS, KKJ, IGO); Division of Nephrology, Department of Medicine, University of British Columbia, Vancouver, British Columbia (AL); Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada (ML); Faculty of Medicine and Biomedical Sciences, Yaounde General Hospital, University of Yaounde I, Yaounde, Cameroon (GEA); Division of Nephology and Hypertension, Department of Medicine, Saint Louis University, Saint Louis, MO (EBF); Urinary Tract Diseases Department, Faculty of Medicine and Pharmacy of Casablanca, University Hassan II of Casablanca, Casablanca, Morocco (MBG); Nephrology Division, Department of Internal Medicine, The Specialty Hospital, Amman, Jordan (MG); Oxford Kidney Unit, Oxford University Hospitals NHS Foundation Trust, Oxford, United Kingdom (PH); George Institute for Global Health, UNSW, New Delhi (VJ); Manipal Academy of Higher Education, Manipal, India (VJ); School of Public Health, Imperial College, London, United Kingdom (VJ); Division of Nephrology and Hypertension and Kidney Transplantation, University of California Irvine Medical Center, Orange, CA (KK-Z); Department of Nephrology, Monash Medical Centre, Monash Health (PGK); Department of Medicine, Monash University, Clayton, Victoria, Australia (PGK); University of Tennessee Health Science Center, Memphis, TN (CPK); Institute of Biomedical Ethics and the History of Medicine, University of Zurich, Zurich, Switzerland (VAL); Renal Division, Brigham and Women's Hospital, Harvard Medical School, Boston, MA (VAL); The George Institute for Global Health, Newtown, New South Wales, Australia (BN); Salford Royal NHS Foundation Trust, Salford (DO); University of Manchester, Manchester, United Kingdom (DO); Division of Nephrology, Department of Medicine, Hasheminejad Kidney Center, Iran University of Medical Sciences, Tehran, Iran (SO); Division of Nephrology, St. Michael's Hospital and the Keenan Research Centre in the Li Ka Shing Knowledge Institute, St. Michael's Hospital (JP); Division of Nephrology, Department of Medicine, University of Toronto, Toronto, Ontario, Canada (JP); Department of Nephrology, Kidney Foundation Hospital and Research Institute, Dhaka, Bangladesh (HUR); Intensive Care Nephrology and Transplantation Department, Hopital Tenon, Assistance Publique-Hopitaux de Paris (ER); Sorbonne Université, Paris, France (ER); Department of Intensive Care, Austin Health (EJS); School of Medicine, University of Melbourne, Melbourne, Australia (EJS); Dialysis Unit, CASMU-IAMPP, Montevideo, Uruguay (LS); Nephrology Development Clinical Center, Tbilisi State Medical University, Tbilisi, Georgia (IT); Department of Nephrology, General University Hospital, Charles University, Prague, Czech Republic (VT); Department of Medicine, Faculty of Medicine, King Chulalong Memorial Hospital, Chulalongkorn University (KT); Bhumirajanagarindra Kidney Institute, Bangkok, Thailand (KT); Division of Nephrology, Bezmialem Vakif University, Istanbul, Turkey (RTK); Department of Medicine, The University of Hong Kong, Queen Mary Hospital, Hong Kong (AY-MW); Kidney Research Center, Department of Nephrology, Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Taoyuan, Taiwan (C-WY); Department of Internal Disease, Clinical Pharmacology and Nephrology, North-Western State Medical University named after I.I. Mechnikov (AZ); Department of Nephrology and Dialysis, Pavlov First Saint Petersburg State Medical University, Saint Petersburg, Russia (AZ); Renal Division, Department of Medicine, Peking University First Hospital (M-hZ); Key Lab of Renal Disease, Ministry of Health of China (M-hZ); Key Lab of Chronic Kidney Disease Prevention and Treatment, Ministry of Education of China (M-hZ); Peking-Tsinghua Center for Life Sciences, Beijing, China (M-hZ); ERA-EDTA Registry, Department of Medical Informatics, Academic Medical Center, Amsterdam Public Health Research Institute, University of Amsterdam, Amsterdam, the Netherlands (KJJ); Population Health Sciences, University of Bristol (FJC); Renal Unit, Southmead Hospital, North Bristol NHS Trust, Bristol, United Kingdom (FJC); The George Institute for Global Health,

University of New South Wales Sydney, Sydney, New South Wales, Australia (VP); Division of Nephrology and Hypertension (IGO), and Kidney and Hypertension Research Unit (IGO), University of Cape Town, Cape Town, South Africa; Department of Medicine (MT), and Pan-American Health Organization/World Health Organization's Collaborating Centre in Prevention and Control of Chronic Kidney Disease (MT), University of Calgary, Calgary, Alberta, Canada; Centre for Transplantation and Renal Research, Westmead Institute for Medical Research, University of Sydney, Sydney, New South Wales (DCH); Centre for Kidney Disease Research, University of Queensland (DWJ); Translational Research Institute (DWJ); and Metro South and Ipswich Nephrology and Transplant Services (MINTS), Princess Alexandra Hospital, Brisbane, Australia (DWJ).

Address for Correspondence: David W. Johnson, MBBS, PhD, Department of Nephrology, Level 2, ARTS Building, Princess Alexandra Hospital, 199 Ipswich Road, Woolloongabba, Brisbane Qld 4102 Australia. E-mail: david.johnson2@health.qld.gov.au

Authors' Contributions: Research idea and study design: DWJ, AKB, HH, AL; data acquisition: AKB, ML, MAO, FY, GEA, EB-F, MBG, SND, MG, PH, VJ, KKZ, PGK, SK, CPK, VAL, BN, DO, SO, JP, HUR, ER, EJS, SS, LS, IT, VT, KT, RTK, AY-MW, C-WY, AZ, M-hZ, KJJ, FC, VP, KKJ, IGO, MT, DCH, DWJ; data analysis/interpretation: HH, AKB, MAO, FY, DWJ; statistical analysis: HH, FY, MAO; supervision and mentorship: AKB, AL, ML, MAO, FY, GEA, EB-F, MBG, SND, MG, PH, VJ, KKZ, PGK, SK, CPK, VAL, BN, DO, SO, JP, HUR, ER, EJS, SS, LS, IT, VT, KT, RTK, AY-MW, C-WY, AZ, M-hZ, KJJ, FC, VP, KKJ, IGO, MT, DCH, DWJ. Each author contributed important intellectual content during manuscript drafting or revision and agrees to be personally accountable for the individual's own contributions and to ensure that questions pertaining to the accuracy or integrity of any portion of the work, even one in which the author was not directly involved, are appropriately investigated and resolved, including with documentation in the literature if appropriate.

Support: This study was supported by the ISN as part of the GKHA project (grant RES0033080 to the University of Alberta). Dr Johnson is supported by a National Health and Medical Research Council (NHMRC) Practitioner Fellowship. The ISN provided administrative support for the design and implementation of the study and data collection activities. The authors were responsible for data management, analysis, and interpretation, as well as manuscript preparation, review, and approval and the decision to submit the manuscript for publication.

Financial Disclosure: Dr Johnson has received consultancy fees, research grants, speaker's honoraria, and travel sponsorships for Baxter Healthcare and Fresenius Medical Care. Dr Htay has received consultancy fees and travel sponsorships from AWAK technology, speaker's honoraria and travel sponsorships from Baxter Healthcare, and research grants from Johnson & Johnson Company and Singhealth. Dr Bello has received consultancy fees from Janssen and a grant from the Canadian Institute of Health Research. Dr Wang has received speaker honoraria and travel grants from Sanofi Renal and Fresenius Kabi and research grants from Sanofi Renal and Baxter Healthcare. Dr Perkovic has received personal fees for advisory boards or scientific presentations from Janssen, Merck, Retrophin, and Servier; fees paid to his institution for advisory boards, steering committee roles, or scientific presentations from Abbvie, Astellas, AstraZeneca, Baxter, Boehringer Ingelheim, Dimerix, Durect, Gilead, Janssen, Novartis, Novo Nordisk, Pfizer, Pharmalink, Relypsa, Sanofi, and Tricida; grants from the NHMRC of Australia, Janssen, and Pfizer; and senior research fellowship from the NHMRC of Australia. Dr Kovesdy has received personal fees from Amgen, Sanofi-Aventis, Fresenius Medical Care, Keryx, Bayer, Abbott, Abbvie, Dr. Schar, GSK, AstraZeneca, and Takeda outside the submitted work and a grant from Shire. Dr Kalantar-Zadeh reports personal fees from Abbott, Abbvie, Alexion, Amag Pharma, Amgen, AstraZeneca, Aveo, Baxter, Chugai, Dr Shaer, Fresenius Medical Care, Genentech, Haymarket, Hospira, Kabi, Keryx, Novartis, PCORI, Pfizer, Relypsa, Resverlogix, Sandoz, Sanofi, Vifor, ZS-Pharma, and UpToDate; free access to national data and biobank specimens from DaVita; and grants and personal fees from Shire and the National Institutes of Health. Dr Harden reports grants from Chiesi Pharmaceuticals. Dr Kerr has received honorarium from Bayer and AstraZeneca. Dr Jha has received consultancy fees from NephroPlus. Dr Tesar has received consulting fees from Amgen, Calliditas, FMC, and Retrophin. Mr Neuen reports travel expenses from Janssen. Dr Perl reports grants and personal fees from Baxter Healthcare, Fresenius Medical Care, and Davita Healthcare partner. Dr Kazancioglu reports personal fees from Baxter. Dr Jager reports personal fees from Fresenius Medical Care. The remaining authors declare that they have no relevant financial interests.

Acknowledgements: We thank Sandrine Damster, BSci, Research Project Manager at the ISN, and Alberta Kidney Disease Network staff (G. Houston, BA; S. Szigety, RN, BSci; and S. Tiv, BSci) for helping organize and conduct the survey and providing project management support. The prominent role by Jo-Ann Donner (Awards, Endorsements, ISN-ANIO Programs Coordinator) in the manuscript management and submission process is well acknowledged. We thank ISN staff (Charu Malik, Claire Van Der Linden, Luisa Strani, and Luca Segantini) for support; the GKHA steering committee, executive committee of the ISN, ISN regional leadership, and leaders of the ISN Affiliate Societies at the regional and country levels for help, particularly with identification of survey respondents and data acquisition, which ensured the success of this initiative. None of the persons acknowledged received compensation for their role in the study.

Peer Review: Received February 12, 2020. Evaluated by 2 external peer reviewers, with direct editorial input from a Statistics/Methods Editor and an Associate Editor, who served as Acting Editor-in-Chief. Accepted in revised form May 26, 2020. The involvement of an Acting Editor-in-Chief was to comply with *AJKD*'s procedures for potential conflicts of interest for editors, described in the Information for Authors & Journal Policies.

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