Peritoneal Dialysis Use and Practice Patterns: An International Survey Study

Yeoungjee Cho, 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, Htay Htay, Vivekanand Jha, Kamyar Kalantar-Zadeh, Peter G. Kerr, Scott Klarenbach, Csaba P. Kovesdy, Valerie 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, Kailash K. Jindal, Ikechi G. Okpechi, Marcello Tonelli, David C. Harris, and David W. Johnson

Rationale & Objective: Approximately 11% of people with kidney failure worldwide are treated with peritoneal dialysis (PD). This study examined PD use and practice patterns across the globe.

Study Design: A cross-sectional survey.

Setting & Participants: Stakeholders including clinicians, policy makers, and patient representatives in 182 countries convened by the International Society of Nephrology between July and September 2018.

Outcomes: PD use, availability, accessibility, affordability, delivery, and reporting of quality outcome measures.

Analytical Approach: Descriptive statistics.

Results: Responses were received from 88% (n = 160) of countries and there were 313 participants (257 nephrologists [82%], 22 nonnephrologist physicians [7%], 6 other health professionals [2%], 17 administrators/policy makers/civil servants [5%], and 11 others [4%]). 85% (n = 156) of countries responded to questions about PD. Median PD use was 38.1 per million population. PD was not available in 30 of the 156 (19%) countries responding to PD-related questions, particularly in countries in Africa (20/41) and low-income countries (15/22). In 69% of countries, PD was the initial dialysis modality for ≤10% of patients with newly diagnosed kidney failure. Patients receiving PD were expected to pay 1% to 25% of treatment costs, and higher (>75%) copayments (out-of-pocket expenses incurred by patients) were more common in South Asia and low-income countries. Average exchange volumes were adequate (defined as 3-4 exchanges per day or the equivalent for automated PD) in 72% of countries. PD quality outcome monitoring and reporting were variable. Most countries did not measure patient-reported PD outcomes.

Limitations: Low responses from policy makers; limited ability to provide more in-depth explanations underpinning outcomes from each country due to lack of granular data; lack of objective data.

Conclusions: Large inter- and intraregional disparities exist in PD availability, accessibility, affordability, delivery, and reporting of quality outcome measures around the world, with the greatest gaps observed in Africa and South Asia.

Complete author and article information provided before references.

Correspondence to Y. Cho (yeoungjee.cho@health.qld.gov.au)

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Globally, the number of people with kidney failure is growing; without kidney replacement therapy (KRT), these people face death from kidney failure.[1] Each year, approximately 5 to 10 million people die due to a lack of access to dialysis for treatment of kidney failure or acute kidney injury.[2,3] Data published recently in the second Global Kidney Health Atlas (GKHA) commissioned by the International Society of Nephrology (ISN) revealed extraordinary disparities in the provision of KRT (dialysis or kidney transplantation) around the world.[4-9] Patients living in low-income countries (LICs) typically confront the most barriers to KRT access. Often these challenges are exacerbated by the need to contribute personal funds for dialysis treatment.[5,8] Residents of remote communities with limited access to facilities that provide nephrology care also must overcome significant barriers to access treatment.[4]

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Within these challenging contexts, peritoneal dialysis (PD) may serve as an attractive KRT modality relative to hemodialysis. As a home-based therapy, the technique is relatively simple and easy to master, thereby obviating the need to relocate closer to a dialysis unit. PD is also the most cost-effective form of dialysis in many parts of the world[10,11] and has been shown to yield important benefits compared with hemodialysis, including better preservation of residual kidney function[12] and higher levels of patient satisfaction and quality of life.[13] These unique advantages of PD may facilitate growth in equitable access to KRT, particularly in LICs and lower-middle-income countries (LMICs).

However, questions remain regarding the accessibility and affordability of PD in different countries, especially because PD is reported to be the most expensive form of

PLAIN-LANGUAGE SUMMARY

The number of patients with kidney failure requiring kidney replacement therapy to sustain life is increasing. Peritoneal dialysis (PD) is a form of home-based kidney replacement therapy. This study used data collected from an international survey to evaluate the global use of PD and patterns of treatment delivery. Participants from 160 countries responded. Survey results suggest that PD was not available in 30 countries, especially from Africa and low-income countries. There was high variability in the proportion of incident patients with kidney failure receiving PD, costs borne by patients, PD prescription, and reporting of quality outcome measures. The findings from this study highlight large inter- and intraregional disparities in the use and adoption of PD.

KRT in some countries.[14] The present study is part of the second iteration of the GKHA survey and examines the availability, accessibility, affordability, and reporting of quality outcome measures of PD worldwide. A similar analysis regarding hemodialysis is reported separately.[15]

Methods

The second iteration of the GKHA followed previously published methods.[6,16-18]

Survey Administration

An electronic survey was administered to individuals representing 182 countries within the ISN's 10 regional boards (Africa, Eastern and Central Europe, Latin America, the Middle East, North America and the Caribbean, North and East Asia, Oceania and South East Asia, Newly Independent States and Russia, South Asia, and Western Europe).[19] The project was approved by the University of Alberta Research Ethics Committee (protocol number: PRO00063121) and all survey participants provided informed consent.

Three key opinion leaders from each country (nephrologist/physician/nonphysician, administrator/policy maker/civil servant, or others including patient representatives) were purposefully identified by project leaders for 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 if necessary. 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 between July and September 2018. The questionnaire examined the national and regional profiles for kidney failure care, including different KRT modalities. If there were any inconsistencies within country responses, the ISN regional leaders were asked to clarify and resolve discrepancies.[19]

PD-Related Data

Survey items assessed a broad range of indicators to better understand the availability, capacity, and process of PD delivery in each country. These included availability of PD (defined as PD was available as a treatment option in a country), accessibility (defined as proportion of incident patients with kidney failure receiving PD), affordability (defined as copayment requirements and funding model for PD delivery), and any intracountry variations in practice patterns. The proportion of units reporting PD quality outcome measures (ie, patient-reported outcome measures, blood pressure, small-solute clearance, hemoglobin/hematocrit levels, bone mineral marker levels, technique survival, and mortality) were also evaluated in the questionnaire. Participants were able to provide reasons for several questions (eg, for variation in proportion of incident PD patients across PD centers in a country).

Using US Renal Data System (USRDS) analytical methods, the incidence (newly reported cases of kidney failure or treatment modality initiation) and prevalence (prevalent cases of kidney failure or specific treatment modality) estimates were directly extracted from the most up-to-date registry reports (regional and national registries, including European Renal Association–European Dialysis and Transplant Association [ERA-EDTA] registry, the USRDS, and Australia and New Zealand Dialysis and Transplant Registry [ANZDATA]) and from published literature when registry data were not available. Survey respondents were asked about the absolute numbers of PD treatment centers in their respective country. The density overall, by World Bank income group and at the country level, was computed by dividing the total number of treatment centers by the total number of general population in millions (population estimates obtained from The CIA World Factbook midyear 2018).[20] Cost estimates were obtained from the literature surveys. Detailed methodology has been published previously.[21]

Data Analysis

The detailed description of data handling and reporting in relation to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES)[22] has been published.[18] Data from survey respondents were synthesized into a single response per country by contacting Regional Board representatives to address any data discrepancies. These country-specific responses were analyzed using a descriptive statistical approach and counts and percentages reported, stratified by ISN region and by World Bank income group. Comparisons of characteristics between ISN regions and income groups

were performed using χ^2 or Fisher exact test as appropriate for categorical variables. Estimates of the hemodialysis to PD cost ratio were determined by following previously published methods by Karopadi et al.[17] Analyses were performed using STATA 15 software (Stata Corp).

Results

Characteristics of Participating Countries

During the second iteration of GKHA, responses from 313 participants (82% [n = 257] nephrologists, 7% [n = 22] non-nephrologist physicians, 2% [n = 6] other health professionals, 5% [n = 17] administrators/policy makers/civil servants, and 4% [n = 11] others) representing 156 of the 182 surveyed countries provided data for the PD domain. This corresponded to an 86% response rate (22/26 LICs, 36/42 LMICs, 41/48 upper-middle-income countries [UMICs], and 57/66 high-income countries [HICs]; Table S1). Most survey respondents were nephrologists (82% [n = 257]), followed by other health professionals (9% [n = 28]) and administrators/policy makers/civil servants (9% [n = 28]).

PD Use

Information on the use of PD was available from 110 countries (Table 1). Within these countries, median use of PD was 38.1 (interquartile range, 10.9-68.3) per million population (pmp), ranging from 0.1 pmp in Egypt to 531 pmp in Hong Kong. PD use was highest in HICs (53 pmp) followed by UMICs (26.5 pmp), LMICs (5.8 pmp), and LICs (0.9 pmp).

Data for PD use among incident patients with kidney failure were available in only 24 countries. Overall, median PD use was 20.8 pmp, ranging from 2.4 pmp in Romania to 140.6 pmp in Thailand.

Availability of PD

PD was available in 126 (81%) countries, most especially in Eastern and Central Europe and the Middle East regions, and was more commonly available in HICs than in LICs (Table 2; Fig 1). Most countries in which PD was not available were LICs (68%) located in Africa, followed by Oceania and South East Asia. The median density of PD centers in countries with PD availability was 1.3 pmp, ranging from 0.01 pmp in Pakistan to 26.5 pmp in New Caledonia (Fig 1; Table S2). Among countries in which PD was available, PD was not the initial mode of treatment in 11 countries: 7 of these countries were in Africa and most belonged to LIC or LMIC groups (Table 2).

Accessibility and Use of PD as the Initial Dialysis Modality

In the 126 countries with PD available, 96% (n = 121) provided information about the proportion of incident

Table 1. Global Use of Maintenance PD and KRT, by ISN Region and World Bank Income Group

	PD Use		PD Use in Incident Kidney Failure		Prevalent KRT for Kidney Failure		Incident KRT for Kidney Failure	
	n[a]	pmp	n[a]	pmp	n[a]	pmp	n[a]	pmp
Overall	110	38.1 [10.9-68.3]	24	20.8 [13.8-38.3]	91	759.0 [433.0-1,048.0]	79	144.0 [103.1-200.2]
ISN region								
Africa	16	2.1 [0.8-10.4]	0	—	5	541.0 [181.0-624.0]	4	100.0 [39.0-151.5]
Eastern & Central Europe	16	37.2 [23.3-51.9]	5	5.0 [2.8-11.2]	15	759.0 [620.0-1,008.3]	16	144.5 [108.5-178.5]
Latin America	20	53.3 [30.2-98.3]	0	—	20	558.1 [313.3-868.5]	18	167.5 [94.8-208.3]
Middle East	10	17.5 [10.9-35.0]	0	—	8	636.0 [295.4-728.5]	6	132.0 [120.0-145.0]
NIS & Russia	4	14.5 [11.3-22.1]	0	—	5	289.0 [211.0-310.0]	4	60.5 [44.0-132.5]
North America & the Caribbean	6	85.1 [42.4-156.2]	2	41.1 [37.4-44.8]	7	682.5 [334.6-1,346.4]	2	289.1 [200.2-378.0]
North & East Asia	4	107.5 [42.0-179.5]	0	—	3	2,599.0 [1,816.0-3,392.0]	3	311.0 [296.0-493.0]
Oceania & South East Asia	9	101.1 [11.5-170.4]	4	57.5 [35.3-105.0]	8	1,170.0 [644.5-1,594.0]	8	215.5 [127.0-339.5]
South Asia	6	1.7 [0.6-5.8]	0	—	1	117.0 [117.0-117.0]	1	51.0 [51.0-51.0]
Western Europe	19	49.9 [43.5-67.3]	13	18.0 [15.8-28.5]	19	979.0 [885.0-1,234.0]	17	128.0 [106.0-165.0]
World Bank income group								
LIC	5	0.9 [0.7-1.5]	0	—	1	4.4 [4.4-4.4]	0	—
LMIC	23	5.8 [1.1-14.4]	0	—	12	321.0 [227.4-567.9]	12	129.9 [53.5-174.4]
UMIC	32	26.5 [13.3-63.8]	5	5.0 [2.8-25.0]	27	550.2 [289.0-780.0]	22	126.0 [80.0-194.0]
HIC	50	53.0 [40.6-89.8]	19	23.5 [14.9-39.2]	51	966.0 [759.0-1,269.0]	45	149.0 [119.0-207.5]

Note: Use and treatment data reported as median [interquartile range]. Data extracted from the most up-to-date registry reports (regional and national registries including European Renal Association–European Dialysis and Transplant Association, the US Renal Data System, and Australia and New Zealand Dialysis and Transplant Registry) and from published literature when registry data were not available.

Abbreviations: HIC, high-income country; ISN, International Society of Nephrology; KRT, kidney replacement therapy; LIC, low-income country; LMIC, low-middle–income country; NIS, Newly Independent States; PD, peritoneal dialysis; pmp, per million population; UMIC, upper-middle–income country.

[a]Number of countries reporting data.

Table 2. Availability and Proportion of Incident Dialysis Patients Receiving PD, by ISN Region and World Bank Income Group

Category	N[a]	PD Available[b]	Proportion of Incident Dialysis Patients Receiving PD[c]					
			0%	1%-10%	11%-25%	26%-50%	>50%	Unknown
Overall	156	126 (81%)	11 (9%)	74 (59%)	22 (17%)	9 (7%)	5 (4%)	5 (4%)
ISN region								
Africa	41	21 (51%)	7 (33%)	12 (57%)	1 (5%)	1 (5%)	0 (0%)	0 (0%)
Eastern & Central Europe	19	19 (100%)	1 (5%)	12 (63%)	4 (21%)	0 (0%)	1 (5%)	1 (5%)
Latin America	18	16 (89%)	1 (6%)	12 (75%)	1 (6%)	0 (0%)	2 (13%)	0 (0%)
Middle East	11	11 (100%)	1 (9%)	6 (55%)	3 (27%)	0 (0%)	0 (0%)	1 (9%)
NIS & Russia	8	6 (75%)	0 (0%)	4 (67%)	0 (0%)	0 (0%)	1 (17%)	1 (17%)
North America & the Caribbean	9	7 (78%)	0 (0%)	3 (43%)	3 (43%)	1 (14%)	0 (0%)	0 (0%)
North & East Asia	7	7 (100%)	0 (0%)	5 (71%)	1 (14%)	0 (0%)	1 (14%)	0 (0%)
Oceania & South East Asia	15	12 (80%)	0 (0%)	6 (50%)	3 (25%)	3 (25%)	0 (0%)	0 (0%)
South Asia	7	6 (86%)	1 (17%)	4 (67%)	0 (0%)	0 (0%)	0 (0%)	1 (17%)
Western Europe	21	21 (100%)	0 (0%)	10 (48%)	6 (29%)	4 (19%)	0 (0%)	1 (5%)
World Bank income group								
LIC	22	7 (32%)	3 (43%)	4 (57%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
LMIC	36	27 (75%)	7 (26%)	15 (56%)	1 (4%)	0 (0%)	1 (4%)	3 (11%)
UMIC	41	37 (90%)	1 (3%)	26 (70%)	4 (11%)	3 (8%)	2 (5%)	1 (3%)
HIC	57	55 (96%)	0 (0%)	29 (53%)	17 (31%)	6 (11%)	2 (4%)	1 (2%)

Abbreviations: HIC, high-income country; ISN, International Society of Nephrology; LIC, low-income country; LMIC, low-middle–income country; NIS, Newly Independent States; PD, peritoneal dialysis; UMIC, upper-middle–income country.
[a]Number of countries reporting data.
[b]The denominator used in the calculation of proportion is the number of countries responded to the PD domain of the survey.
[c]The denominator used in the calculation of proportion is the number of countries that had PD available.

dialysis patients receiving PD. For most of these countries, only 1% to 10% of incident dialysis patients received PD, which was consistent across ISN regions and World Bank income groups (Table 2; Fig 2). None of the LICs initiated treatment with PD for >10% of incident patients with kidney failure. More than 50% of incident dialysis patients received PD as the initial dialysis modality in 5 countries dispersed across 4 ISN regions and 3 World Bank income groups (Table 2). The use of PD as the initial dialysis modality in the 100 countries in which dialysis was accessible to >50% of patients with kidney failure (national average) was highly variable: 0% of patients for 6 countries (1 LIC and 5 LMICs), 1% to 10% of patients for 60 countries (9 LMICs, 24 UMICs, and 27 HICs), 11% to 25% of patients for 20 countries (1 LMIC, 2 UMICs, and 17 HICs), 26% to 50% of patients for 9 countries (3 UMICs and 6 HICs), and >50% of patients for 5 countries.

In 83 countries (66% of countries in which PD is available), more than half the dialysis centers in that country offered PD, especially in HICs (49/55) and UMICs (24/37). In contrast, PD was generally not accessible (defined as offered by <50% of dialysis centers in a country) in 39 (31%) countries, mostly in LICs (6/7) and LMICs (16/27). Less than half the responding countries with PD services available (58/126) reported within-country variation in the proportion of incident PD patients (relative to all incident KRT patients), particularly countries located in Latin America (13/16) and LICs (5/7). This was variably attributed to a lack of PD units in less populated areas, a lack of expertise among health care providers, and/or health care system characteristics (ie, different health priorities across various provinces/states and private vs public). Although patient characteristics such as age, sex, and employment did not influence the decision to initiate PD in 96 countries, younger less frail patients with a supportive social network were more likely to receive PD in the remaining countries.

Affordability of PD

The financial burden of PD was separately analyzed for PD catheter insertion and costs related to maintenance treatment, including medication costs. The governments of 64 countries fully covered the costs of PD catheter insertion with no out-of-pocket expenses for patients (Table 3). Patients partially covered costs in 47 countries in the context of a mix of public and private funding systems and incomplete public funding coverage (Table 3). Patients from Africa and LICs were most likely to pay for all costs related to PD catheter insertion.

Most commonly, patients receiving PD were expected to cover 1% to 25% of costs related to maintenance treatment (Table 4), particularly those in HICs and UMICs. In contrast, those receiving PD in LMICs and the Eastern and Central Europe region were most likely to bear a high cost burden, with requirements to cover 100% of treatment costs. Among 15 countries with extremely high patient copayments (including medications but not ancillaries; defined as >75% paid for directly [out of

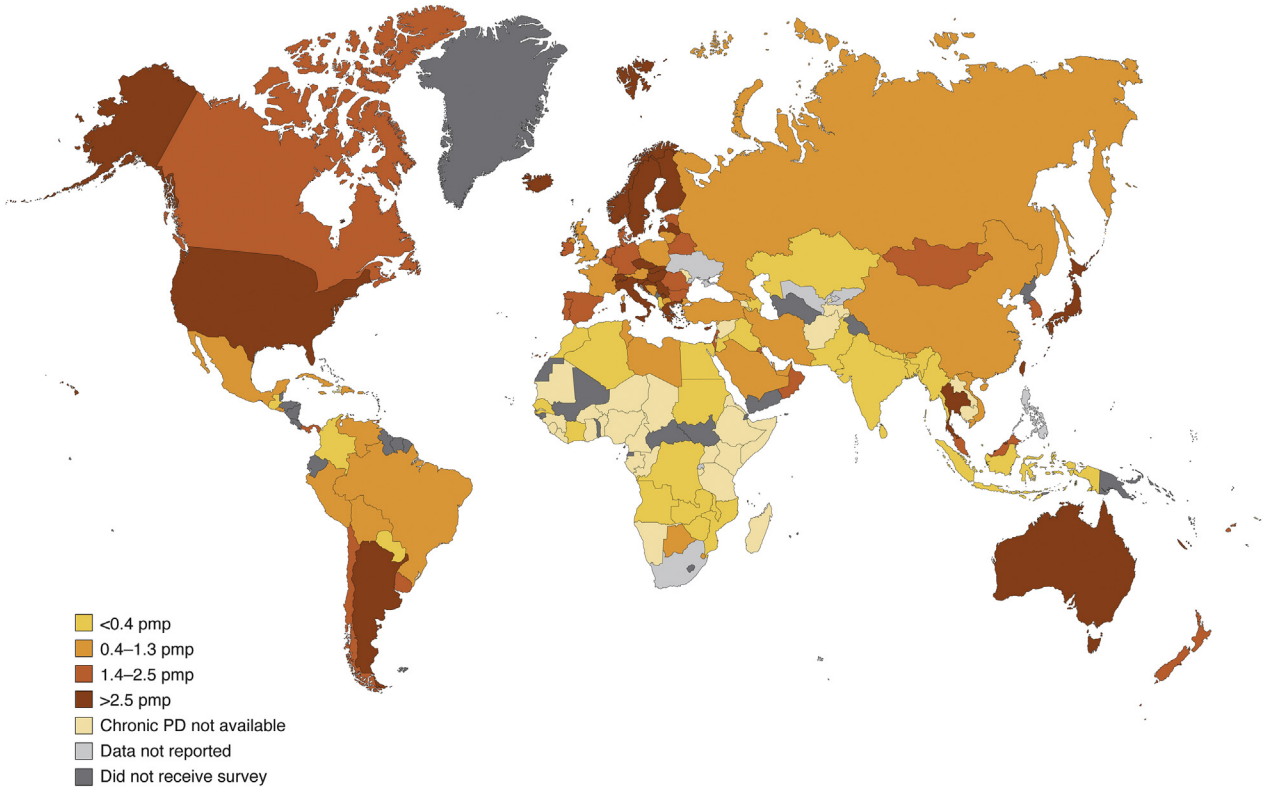

Figure 1. Availability of centers that provide maintenance peritoneal dialysis (PD). Abbreviation: pmp, per million population.

pocket] by patients), 53% had a national governance structure overseeing kidney failure care (ie, publicly funded by government and free or with some fees at the point of delivery). Thus, the existence of a national governance structure does not always translate into lower copayments for patients with kidney failure.

Data regarding the annual cost of maintenance PD were available for 87 countries. Overall, the median annual cost of PD was $20,524 (2016 USD), ranging from $5,520 in Tunisia to $99,280 in the United Arab Emirates. The median cost ratio of hemodialysis to PD was 1.08 (with PD costing less), ranging from 0.43 in Bosnia and Herzegovina to 4.27 in Iceland. PD costs were 2.8 times higher in HICs than in LICs.

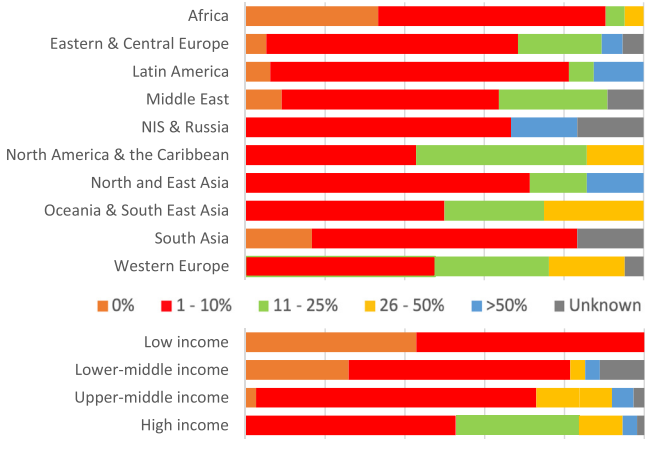

Figure 2. Proportion of patients typically initiating treatment with peritoneal dialysis, by International Society of Nephrology region and World Bank income group (n = 126). Abbreviation: NIS, Newly Independent States.

PD Quality

Responses about PD quality were received from 121 countries (5/126 countries had either missing or unknown responses). More than half the PD centers from 91 countries offered "adequate PD treatment frequency," defined as provision of 3 to 4 exchanges on continuous ambulatory PD per day or equivalent cycles on automated PD. Patients who received care in PD centers located in HICs (50/55) and UMICs (28/37) were most likely to receive adequate PD treatments. In contrast, patients receiving PD in 24% (n = 30) of countries were unable to reliably access similar "adequate PD treatment frequency" (13/27 LMICs, 5/7 LICs, 8/37 UMICs, and 4/55 HICs). These disparities were particularly pronounced among LICs from Africa (3/21 African countries; 3/7 of LICs), where such PD treatment frequency was never available to patients.

Quality measures assessing biochemical, hematologic, and patient-reported outcomes were measured and reported variably among countries providing response to this domain (Fig 3).

Table 3. Health Care System Coverage for PD Catheter Insertion, by ISN Region and World Bank Income Group

Category	N[a]	Publicly Funded; Free at Point of Delivery	Publicly Funded; Some Fees at Point of Delivery	Mix of Public[b] and Private Funding	Solely Private and Out-of-Pocket	Solely Private, via Health Insurance Providers	Multiple Systems[c]	Other
Overall	126	64 (51%)	21 (17%)	26 (21%)	6 (5%)	1 (1%)	5 (4%)	3 (2%)
ISN region								
Africa	21	6 (29%)	3 (14%)	5 (24%)	5 (24%)	0 (0%)	2 (10%)	0 (0%)
Eastern & Central Europe	19	16 (84%)	2 (11%)	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Latin America	16	3 (19%)	1 (6%)	11 (69%)	0 (0%)	0 (0%)	0 (0%)	1 (6%)
Middle East	11	9 (82%)	0 (0%)	2 (18%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
NIS & Russia	6	5 (83%)	1 (17%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
North America & the Caribbean	7	4 (57%)	0 (0%)	2 (29%)	0 (0%)	1 (14%)	0 (0%)	0 (0%)
North & East Asia	7	0 (0%)	5 (71%)	1 (14%)	1 (14%)	0 (0%)	0 (0%)	0 (0%)
Oceania & South East Asia	12	7 (58%)	2 (17%)	1 (8%)	0 (0%)	0 (0%)	1 (8%)	1 (8%)
South Asia	6	1 (17%)	1 (17%)	2 (33%)	0 (0%)	0 (0%)	2 (33%)	0 (0%)
Western Europe	21	13 (62%)	6 (29%)	1 (5%)	0 (0%)	0 (0%)	0 (0%)	1 (5%)
World Bank income group								
LIC	7	2 (29%)	2 (29%)	0 (0%)	2 (29%)	0 (0%)	1 (14%)	0 (0%)
LMIC	27	7 (26%)	5 (19%)	8 (30%)	2 (7%)	0 (0%)	4 (15%)	1 (4%)
UMIC	37	20 (54%)	4 (11%)	10 (27%)	2 (5%)	0 (0%)	0 (0%)	1 (3%)
HIC	55	35 (64%)	10 (18%)	8 (15%)	0 (0%)	1 (2%)	0 (0%)	1 (2%)

Note: Publicly funded indicates funded by government. The denominator used in the calculation of proportion is the number of countries that had PD available.
Abbreviations: HIC, high-income country; ISN, International Society of Nephrology; LIC, low-income country; LMIC, low-middle–income country; NIS, Newly Independent States; PD, peritoneal dialysis; UMIC, upper-middle–income country.
[a]Number of countries with PD available.
[b]Whether or not the publicly funded component is free at point of delivery; private means "not publicly funded"—funding can be solely private (out of pocket) and/or via private health insurance.
[c]Government, nongovernmental organizations, and communities.

Patient-Reported Outcome Measures

Respondents from 53 countries (42%; unknown status from 15 countries [12%]) indicated that most PD programs in their countries did not collect and report patient-reported outcome measures (defined as ≤50% of PD centers), with variability across all ISN regions and World Bank income groups. However, such outcomes were more frequently reported (defined as >50% of PD centers) by PD centers in HICs (34/55) than in LICs (2/7) or LMICs (6/27).

Blood Pressure

In 93 of 126 countries (4/7 LICs, 10/27 LMICs, 27/37 UMICs, and 52/55 HICs), blood pressure was measured and reported by most (defined as >75% of centers in country) PD centers to assess the quality of PD provided. However, in South Asia, only 1 of 6 countries met this threshold. The status of 16 (13%) countries was unknown.

Small-Solute Clearance

Most PD centers measured small-solute clearance (eg, Kt/V_{urea}) in approximately half the respondent countries (64/126; unknown status in 16 countries [13%]). This was driven primarily by PD centers from UMICs (15/37) and HICs (46/55). None of the PD centers in LICs that provided responses to this component (5/7; unknown status in 2 countries [29%]) measured small-solute clearance. Moreover, PD centers in countries in which "adequate PD treatment frequency" (defined as 3-4 exchanges per day or equivalent cycles on automated PD) was not always or never available (30 countries) were least likely to report small-solute clearance (0% of PD centers: 6/30; 1%-10%: 4/30; 11%-50%: 6/30; 51%-75%: 1/30; >75%: 3/30; and unknown: 10/30).

Hemoglobin/Hematocrit

In 92 countries (73%; unknown status from 16 countries [13%]), hemoglobin was measured by almost all PD centers in their borders.

Bone Mineral Markers

In 75 countries (60%; unknown status from 16 countries [13%]), PD centers almost always measured and reported bone mineral markers, such as parathyroid hormone, calcium, and phosphate levels. This practice pattern was particularly common among PD centers in UMICs (23/37) and HICs (46/55).

Technique Survival

In 3 of 7 LICs, many PD centers did not measure and report technique survival (but status was unknown in 2 of these

Table 4. Annual Cost of Maintenance PD and National Average Copayment Proportions for PD Patients, by ISN Region and World Bank Income Group

Category	Annual Cost of PD[a]	N[b]	National Average Copayment Proportions[c]						
			0%	1%-25%	26%-50%	51%-75%	>75%	100%	Unknown
Overall	$20,075.0 [$14,155.0-$33,644.0]	126	35 (28%)	51 (40%)	7 (6%)	2 (2%)	7 (6%)	8 (6%)	16 (13%)
ISN region									
Africa	$13,251.9 [$6,895.5-$16,353.0]	21	5 (24%)	4 (19%)	2 (10%)	0 (0%)	2 (10%)	2 (10%)	6 (29%)
Eastern & Central Europe	$21,488.0 [$18,210.0-$24,617.0]	19	7 (37%)	7 (37%)	0 (0%)	0 (0%)	0 (0%)	4 (21%)	1 (5%)
Latin America	$16,825.9 [$15,276.5-$20,075.0]	16	3 (19%)	7 (44%)	2 (13%)	1 (6%)	0 (0%)	0 (0%)	3 (19%)
Middle East	$20,075.0 [$13,025.9-$42,444.4]	11	4 (36%)	3 (27%)	2 (18%)	0 (0%)	0 (0%)	0 (0%)	2 (18%)
NIS & Russia	$10,064.0 [$6,789.0-$23,640.0]	6	3 (50%)	1 (17%)	0 (0%)	0 (0%)	1 (17%)	0 (0%)	1 (17%)
North America & the Caribbean	$56,286.4 [$44,434.0-$68,138.9]	7	0 (0%)	6 (86%)	0 (0%)	1 (14%)	0 (0%)	0 (0%)	0 (0%)
North and East Asia	$15,264.4 [$11,660.5-$36,716.7]	7	0 (0%)	7 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Oceania & South East Asia	$16,012.7 [$9,977.5-$23,463.6]	12	2 (17%)	6 (50%)	1 (8%)	0 (0%)	2 (17%)	1 (8%)	0 (0%)
South Asia	$8,763.2 [$7,912.2-$12,229.2]	6	1 (17%)	1 (17%)	0 (0%)	0 (0%)	2 (33%)	1 (17%)	1 (17%)
Western Europe	$43,688.7 [$30,247.6-$65,716.0]	21	10 (48%)	9 (43%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (10%)
World Bank income group									
LIC	$34,165.1 [$34,165.1-$34,165.1]	7	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (29%)	1 (14%)	4 (57%)
LMIC	$11,632.9 [$7,676.4-$16,008.3]	27	5 (19%)	6 (22%)	4 (15%)	1 (4%)	2 (7%)	3 (11%)	6 (22%)
UMIC	$15,330.0 [$10,926.9-$20,786.2]	37	10 (27%)	16 (43%)	3 (8%)	0 (0%)	3 (8%)	2 (5%)	3 (8%)
HIC	$31,505.5 [$20,523.6-$51,196.0]	55	20 (36%)	29 (53%)	0 (0%)	1 (2%)	0 (0%)	2 (4%)	3 (5%)

Note: The denominator used in the calculation of proportion is the number of countries that had PD available.
Abbreviations: HIC, high-income country; ISN, International Society of Nephrology; LIC, low-income country; LMIC, low-middle–income country; NIS, Newly Independent States; PD, peritoneal dialysis; UMIC, upper-middle-income country.
[a]Data contributed by 87 countries, in US dollars; expressed as median [interquartile range].
[b]Number of countries with PD available.
[c]Including medications but not other ancillaries.

LICs). In contrast, in 47 of 55 HICs, almost all PD centers tracked technique survival.

Patient Survival

Mortality was not universally measured and reported across PD centers, with a lack of reporting among PD centers in 9 countries (7%), located in South Asia (4/6), Africa (2/21), Latin America (2/16), and Western Europe (1/21). Three of these countries were LICs (representing 43% of all LICs).

Discussion

Large global disparities exist in the availability, accessibility, affordability, and quality of PD. Even in countries in which PD was easily accessible, the proportion of patients receiving PD was variable. From a health funder's point of view, PD may be considered the more economical dialysis modality in many countries,[11,17] yet cost associated with receiving PD was variable, with patients in LICs incurring high out-of-pocket expenses. The quality of PD treatment received and the processes in place to measure and report outcomes also appeared highly variable.

Although PD has a potential to be a useful treatment to manage the growing global burden of kidney failure, PD was not available in 30 countries (19% of responding countries). Most of these countries were LICs in Africa (13/30 [67%]), suggesting inequitable access possibly imposed by the economic burden of dialysis,[23] which may relate to direct medical (eg, cost of PD solutions and blood tests) and nonmedical costs (eg, utility costs), indirect costs (eg, loss of economic productivity among patients), and intangible costs associated with reduced quality of life.[24,25]

Traditionally, PD has been considered the most economical dialysis modality, with variability in actual costs across countries. For example, in the United States,

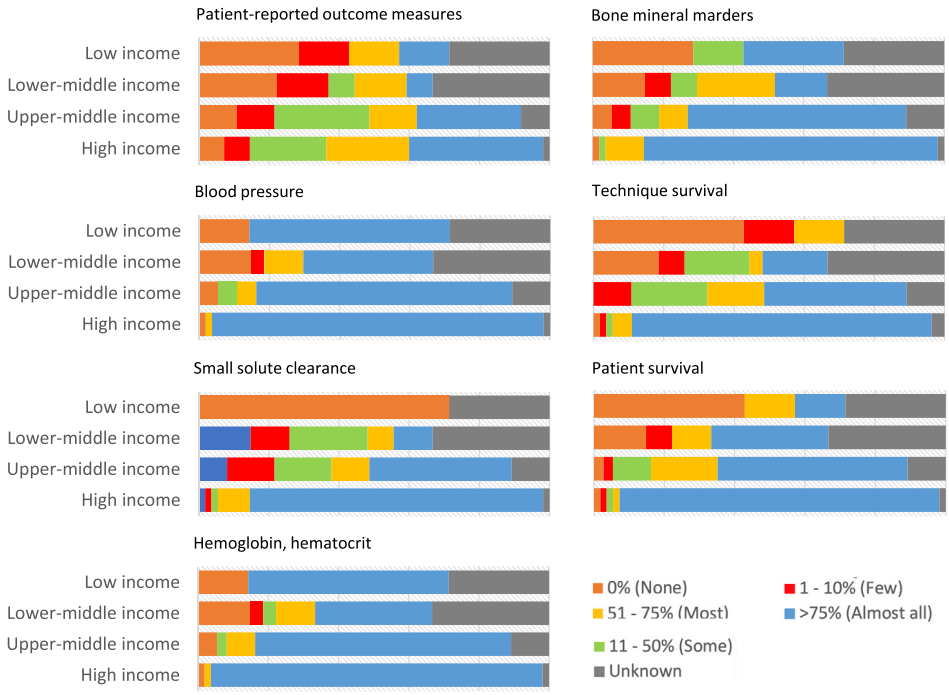

Figure 3. Proportion of centers that measured and reported quality indicators for peritoneal dialysis service delivery (n = 126).

the annual per-person treatment cost of PD is US $76,177 compared with US $90,971 for hemodialysis.[26] Although the average cost of PD treatment was almost 3-fold higher in HICs (compared with LICs) in the present study, this may relate to differences in PD prescription (eg, lower frequency of PD exchanges in LICs), treatment delivery (eg, automated PD use), and both labor and facility (overhead) costs. These cost estimations may not be directly applicable to LICs or LMICs, in which PD has been reported to cost on average 1.25 times more than hemodialysis.[14] For example, the cost of a 2-L bag of PD solution is approximately US $8 in Sri Lanka (LMIC) compared with a global median cost of US $5. Moreover, the annual cost of PD can exceed the per-capita gross national income of residents in LICs,[27] in which patients typically are responsible for higher proportions of maintenance treatment costs, as revealed in the present study. For example, in an LMIC such as Egypt, the cost of PD was almost 5 times that of hemodialysis due to high transport costs and border tariffs on imported PD solutions.[14] Unfortunately, similar issues affect many other LICs and LMICs.[14] Importantly, results of this study show no relationship between the existence of a national governance structure to oversee kidney failure care and out-of-pocket expenses incurred by patients for treatment (including medication costs).

To overcome these barriers, countries such as India have begun to manufacture PD solutions locally. In countries in which this is not feasible due to low demand, some governments have waived or reduced import tariffs, as is the case in Nepal (LIC; South Asia).[14] However, achieving cost parity with hemodialysis is insufficient to increase PD penetration. For example, in India, hemodialysis is prioritized due to higher reimbursement[14] and additional financial incentives for nephrologists who own private hemodialysis units.[28] Other barriers to PD use in LICs may include social circumstances, such as availability of suitable housing (eg, space for storage of PD solutions and number of occupants), adequate sanitation, and water and electricity supply, which if not met can lead to an increase in risk for peritonitis. HICs are not exempt from similar issues, as shown in Australia, where a lack of reimbursement for PD in the private sector has limited access to this dialysis modality to the public health care system. Conversely, reimbursement strategies favoring PD can have a positive impact on PD penetration. This has been exemplified by a recent increase in PD use in the United States following the introduction of a reimbursement strategy in 2010 to incentivize dialysis providers to place more patients on PD, with an increase in proportion of incident PD patients from 9.4% to 12.6%.[29]

Governments can also take the lead to promote PD at a national level, as observed in Thailand, Hong Kong, and Mexico.[30,31] For example, in 2008, the government of Thailand implemented steps to introduce a policy to promote the use of PD as the initial mode of treatment, which involved training medical personnel, developing policies and guidelines, providing insurance coverage, and establishing a renal registry to monitor practices and patient outcomes.[31] Between 2008 and 2011, the PD training

centers increased from 51 to 111 and the proportion of dialysis patients receiving PD went from <10% to 46%.[31-33]

The importance of leadership and implementation at a national level is broadly recognized as exemplified in the United States, where the Advancing American Kidney Health Initiative was announced in 2019 and aims to reduce the incidence of kidney failure and make more treatment options for dialysis available to a larger number of patients (with a stated goal of 80% of incident patients with kidney failure receiving home-based dialysis or kidney transplantation by 2025).[34] This health care value–based initiative incorporates concepts of quality and cost through improvement in care coordination and education for safer transition to treatment of kidney failure and attaches value-based payment models to more closely align incentives. However, such strategies will not translate into sustained PD growth unless outcomes meet the expectations of patients and their health care providers, which can be facilitated by effectively using registries and accurately measuring and reporting outcomes.

PD registries can be an important source of data to inform continuous quality improvement, research, and health care planning, as demonstrated in countries such as Australia and New Zealand (HICs; Oceania and South East Asia), in which a nationwide clinical registry captures data for all patients receiving KRT.[35] However, establishment and maintenance of a registry to capture and report outcomes related to PD requires funding support and therefore is often limited to HICs, as shown in the present study. Improvement in reporting of quality measures associated with PD requires further work, advocated through groups such as ISN and the International Society for Peritoneal Dialysis. A future international PD registry could consider capturing data related to program characteristics (eg, size of unit [PD and total dialysis], staffing ratio [medical and nursing]), geographical considerations (eg, distance from the center to patient living the furthest from the PD center), and patient outcomes (eg, peritonitis rate and technique survival).[36]

This study is strengthened by the data collection methods using a validated framework to assess chronic diseases from a large number of countries covering 97% of the world's population, with broad coverage across all regions and income levels. This served to increase confidence in the robustness of the findings. Accuracy was ensured by collecting data from multiple sources within a country and verifying responses with regional and national stakeholders. Although processes were implemented to minimize the risk for data inaccuracy, there could have been a residual risk of response bias, particularly social desirability bias (ie, providing socially acceptable answers) and was also limited by relatively low responses received from policy makers and use of multiple data sources to estimate use of PD. In addition, although using a survey promoted a high response rate, it led to a lack of granularity in data collection, which limited the ability to provide more in-depth explanations underpinning outcomes from each country.

In conclusion, this study has shown evidence of large inter- and intraregional variability in availability, accessibility, affordability, and quality of PD for patients requiring KRT around the world. In general, patients from LICs and LMICs were found to be most disadvantaged with respect to PD access, which incurred a higher cost burden when it was available. The delivery of PD treatment and reporting of PD-related quality measures were found to be similarly heterogeneous. The findings from this study carry significant implications for policy makers and advocacy groups with respect to delivering equitable cost-effective PD to patients around the globe in the future.

Supplementary Material

Supplementary File (PDF)

Table S1. Response rate for each country.

Table S2. Number and density of PD centers, by World Bank income groups and ISN regions.

Article Information

Authors' Full Names and Academic Degrees: Yeoungjee Cho, MBBS, PhD, Aminu K. Bello, MBBS, 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, Htay Htay, MBBS, Vivekanand Jha, MD, Kamyar Kalantar-Zadeh, MD, Peter G. Kerr, MBBS, PhD, Scott Klarenbach, MD, MSc, Csaba P. Kovesdy, MD, Valerie Luyckx, MBBCh, 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, Kailash K. Jindal, MBBS, Ikechi G. Okpechi, MBBS, PhD, Marcello Tonelli, MD, David C. Harris, MD, and David W. Johnson, MBBS, PhD.

Authors' Affiliations: Centre for Kidney Disease Research, University of Queensland (YC, DWJ); Translational Research Institute (YC, DWJ); Metro South and Ipswich Nephrology and Transplant Services (MINTS), Princess Alexandra Hospital, Brisbane, Australia (YC, DWJ); Division of Nephrology and Immunology, Department of Medicine, University of Alberta, Edmonton, Alberta (AKB, MAO, FY, SND, SK, SS); 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 (EB-F); 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); Department of Renal Medicine, Singapore General Hospital, Singapore (HH); George Institute for Global Health, UNSW, New Delhi, India (VJ, BN); George Institute for Global Health, University of Oxford, Oxford, United Kingdom (VJ); Manipal Academy of Higher Education, Manipal, India (VJ); Division of Nephrology and Hypertension, 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 (VL); Renal Division, Brigham and Women's Hospital, Harvard Medical School, Boston, MA (VL); 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 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, Beijing, China (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 (CLS), 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); Division of Nephrology and Hypertension (KKJ), and Kidney and Hypertension Research Unit (IGO), University of Cape Town, Cape Town, South Africa; Department of Medicine (IGO), 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; University of Leicester, Leicester, United Kingdom (MT); and Centre for Transplantation and Renal Research, Westmead Institute for Medical Research, University of Sydney, Sydney, New South Wales, Australia (DCH).

Address for Correspondence: Yeoungjee Cho, MBBS, PhD, Department of Nephrology, Level 2, Ambulatory Renal and Transplant Services (ARTS) Building, Princess Alexandra Hospital, 199 Ipswich Road, Woolloongabba, Brisbane, Queensland, 4102, Australia. E-mail: yeoungjee.cho@health.qld.gov.au

Authors' Contributions: Research idea and study design: YC, AKB, AL, MAO, FY, DWJ; data acquisition: AKB, ML, MAO, FY, GEA, MBG, PH, HH, VJ, KKZ, PGK, SK, CPK, VL, BN, DO, SO, JP, HUR, ER, ES, SS, LS, IT, VT, KT, RTK, AY-MW, C-WY, AZ, M-hZ, KJJ, FC, KKJ, IGO, MT, DCH, DWJ; data analysis/interpretation: AKB, MAO, FY, YC, DWJ; statistical analysis: FY, MAO, YC; supervision and mentorship: AKB, AL, ML, MAO, FY, GEA, EB-F, MBG, SD, MG, PH, HH, VJ, KKZ, PGK, SK, CPK, VL, BN, DO, SO, JP, HUR, ER, ES, SS, LS, IT, VT, KT, RTK, AY-MW, C-WY, AZ, M-hZ, KJJ, FC, 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.

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