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Global variability of vascular and peritoneal access for chronic dialysis

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Abstract

Aim: Vascular and peritoneal access are essential elements for sustainability of chronic dialysis programs. Data on availability, patterns of use, funding models, and workforce for vascular and peritoneal accesses for dialysis at a global scale is limited.

Methods: An electronic survey of national leaders of nephrology societies, consumer representative organizations, and policymakers was conducted from July to September 2018. Questions focused on types of accesses used to initiate dialysis, funding for services, and availability of providers for access creation.

Results: Data from 167 countries were available. In 31 countries (25% of surveyed countries), >75% of patients initiated haemodialysis (HD) with a temporary catheter. Seven countries (5% of surveyed countries) had >75% of patients initiating HD with arteriovenous fistulas or grafts. Seven countries (5% of surveyed countries) had >75% of their patients starting HD with tunnelled dialysis catheters. 57% of low-income countries (LICs) had >75% of their patients initiating HD with a temporary catheter compared to 5% of high-income countries (HICs). Shortages of surgeons to create vascular access were reported in 91% of LIC compared to 46% in HIC. Approximately 95% of participating countries in the LIC category reported shortages of surgeons for peritoneal dialysis (PD) access compared to 26% in HIC. Public funding was available for central venous catheters, fistula/graft creation, and PD catheter surgery in 57%, 54% and 54% of countries, respectively.

Conclusion: There is a substantial variation in the availability, funding, workforce, and utilization of vascular and peritoneal access for dialysis across countries regions, with major gaps in low-income countries.

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KEYWORDS
dialysis, global health, kidney failure, peritoneal access, vascular access

Summary at a glance

An electronic survey-based study was used to highlight variations in vascular and peritoneal catheter access for dialysis among world regions. Lower income countries reported higher rates of haemodialysis initiation using temporary central venous catheters, shortages of surgeons for dialysis access creation, and reliance on private funding models for access creation.

1 | INTRODUCTION

Previous work has shown significant variation in availability of services for haemodialysis (HD)[1] and peritoneal dialysis (PD)[2] across world regions, with the lowest uptake in low-income countries (LICs) and lower-middle income countries (LMIC). Reduced access to kidney replacement therapy (KRT) for patients results in premature death from kidney failure, which was estimated to be the case for more than 2 million people globally in 2010.[3] This burden may be further compounded by shortages in nephrology workforce in these economic regions.[4]

A crucial step in the delivery of dialysis is the creation of access (arteriovenous fistula [AVF], arteriovenous graft [AVG], central venous catheter [CVC], or peritoneal catheter). The type of dialysis access at initiation is impacted by multiple factors including patient values (such as avoiding needling pain and bruising associated with AVF, preserving cosmetics, reducing complication rates, etc), availability of interventionalists (surgeons, interventional radiologists, or nephrologists), availability of resources such as catheters/materials required, indication or urgency for dialysis, native vascular anatomy, and provider preferences.[5] Although definitive trials comparing different forms of haemodialysis access are not available, AVFs are preferred by some patients and many providers due to their associations with better quality of dialysis and reduced risk of infections.[6,7] However, AVF creation requires skilled operators and trained personnel to preoperatively assess vascular status and to monitor for postoperative complications and maturation. Further, there is increasing recognition that practitioners should focus more on patient values and preferences when choosing the type of vascular access with careful consideration of their previous access-related complications, goals of care, projected life expectancy and quality of life.[6] It is also worth noting that although haemodialysis may still happen even if the patient has not obtained this 'ideal' vascular access, peritoneal dialysis can only be an option if a PD catheter is placed appropriately; thus, the prevalence of PD as a form of kidney replacement therapy will depend on availability of a trained work-force to insert peritoneal catheters.

Data on availability, patterns of use, funding models, and workforce for vascular and peritoneal accesses for dialysis at a global scale remains limited. In 2019, the International Society of Nephrology Global Kidney Health Atlas (ISN-GKHA)[8] conducted a global survey to enhance understanding of the capacity and structures for kidney care globally and to highlight gaps in availability, accessibility, and affordability of different forms of KRT and kidney care.[1,2,4,8–10] The survey included an assessment of types of access available when initiating dialysis, methods of funding for surgical services for creation/insertion of dialysis accesses, and the extent of shortages of workforce to carry out surgical services for access creation. We leveraged ISN-GKHA data to explore global differences and gaps in dialysis access utilization, patterns of use, workforce, and available funding structures for access creation.

2 | METHODS

Detailed methodology of the ISN-GKHA is presented elsewhere as are details about the development and validation of the survey.[11] Here, we summarize pertinent aspects of the methods related to use and funding of dialysis accesses from the second iteration of the ISN-GKHA. The ISN-GKHA survey was designed to assess national and regional profiles for readiness, capacity, and responsiveness to kidney failure care, including funding models for dialysis access placement such as the creation/insertion of CVCs, AVFs or AVGs, and PD catheters. Types of dialysis accesses at initiation of dialysis were also evaluated.

A non-probability (opt-in), purposive sampling approach was used to identify survey respondents. National and regional nephrology leaders affiliated with the ISN identified key stakeholders, including representatives of national nephrology societies, policymakers, patient organizations, foundations, and other advocacy groups. Key stakeholders were sent invitations to participate in the survey through a link to the survey's online portal, an electronic questionnaire via REDCap Cloud (www.redcapcloud.com). The survey was conducted from 1st July to 30th September 2018. During this period, intensive follow-up was conducted by e-mail and phone with ISN regional and national leaders to ensure complete and timely responses. An electronic survey was administered to three key opinion leaders from each country: a nephrology society leader, a leader of a consumer representative organization, and a policymaker. The survey was completed by representatives from 182 countries recognized by the World Bank. Regional and national project leaders were identified through international contacts, collaborators, ISN leaders, and 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, the Newly Independent States (NIS) and Russia, South Asia, and Western Europe.

2.1 | Data analysis

Numerical data were extracted from all individual questionnaires and cleaned using Microsoft Excel. Responses were merged into a single file to create the global database. Using country as the unit of analysis, we imported data into Stata 17 software (Stata Corporation, 2021) and analysed it using a well-validated framework developed by the World Health Organization (WHO): Assessing National Capacity for the Prevention and Control of Non-Communicable Diseases.[1] The data were reported as counts and percentages of countries. As each country had multiple responses for each question, the ISN regional boards leadership reviewed and cleared any ambiguities and inconsistencies between survey respondents. Any significant inconsistencies were resolved with follow up inquiries involving stakeholders that were involved with the surveys. Each participating country was taken as the unit of analysis. Descriptive statistics applied for data analysis, and information presented as counts and percentages. The results stratified by ISN region and World Bank country income group: low income, lower-middle income, upper-middle income, and high income.

2.2 | Definitions

AV access creation is defined as an AVF (a structure that connects a vein directly to an artery) or an AVG (a structure which connects a vein to an artery via an interposed synthetic or biological tube). A permanent central venous catheter is defined as a catheter tunnelled subcutaneously before entering a central vein, whereas a temporary central venous catheter is not tunnelled and placed directly into the central veins. A PD catheter is defined as any device inserted into the peritoneal cavity for the purpose of allowing PD-related fluid exchanges. Funding models were described as publicly funded by the government and free at the point of delivery, publicly funded but require some fees at the point of delivery, a mix of a publicly funded system provided by government resources and private systems, solely private and out of pocket, solely private through health insurance providers, a mix of multiple systems, and an option was given if kidney replacement therapy (KRT) was not available in the country. Lastly, an 'other' option was given for answers that did not fit the previously described funding options.

2.3 | Ethics approval

The University of Alberta Research Ethics Committee approved this project (Protocol number: PRO00063121)

3 | RESULTS

3.1 | Types and availability of vascular access for HD initiation

Overall, seven countries (5% of surveyed countries) had >75% of patients starting dialysis with a functioning vascular access (AVF or

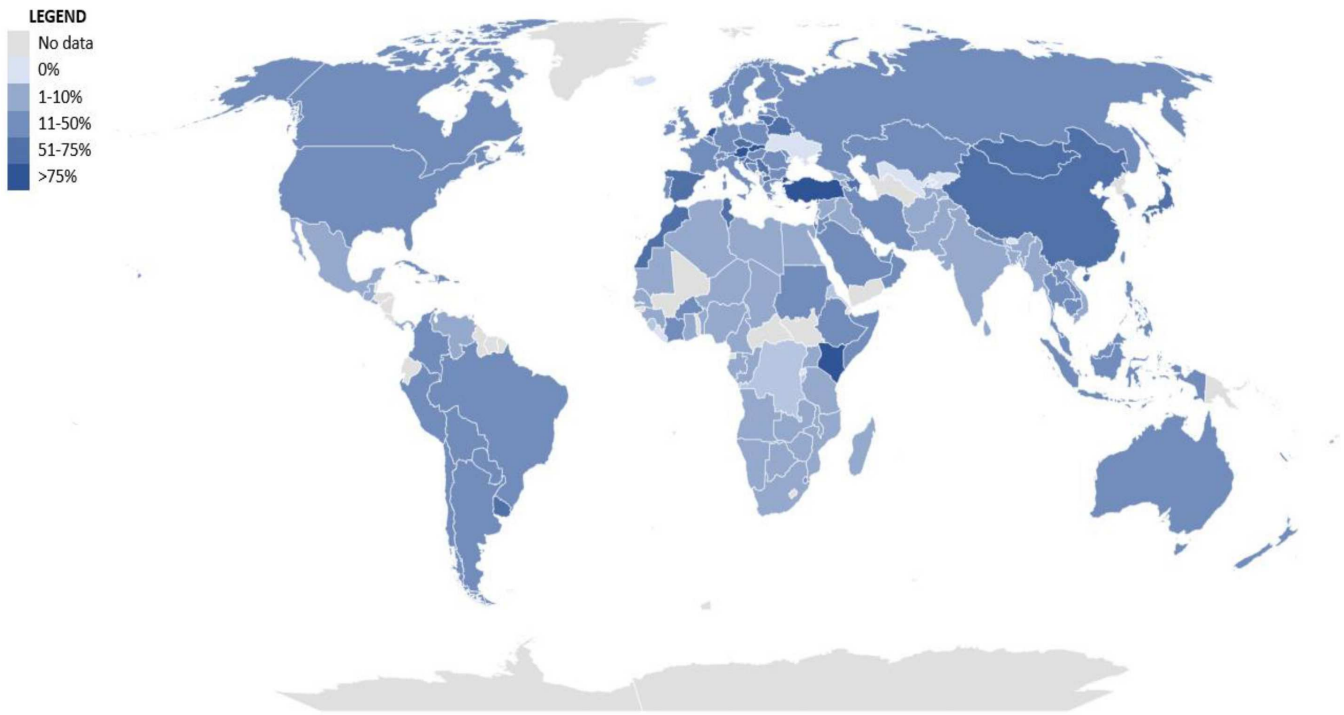

FIGURE 1 Proportion of patients initiating haemodialysis with a functioning AVF/AVG. AVF, arteriovenous fistula; AVG, arteriovenous grafts.

AVG). Two of these countries were in Eastern and Central Europe and four in Western Europe. Of these seven countries, five were high income countries (HICs), one was an upper middle-income country, and one was a LMIC corresponding to 9% of all HIC surveyed, 2% of all UMIC surveyed, and 3% of all LMIC surveyed. (Figure 1). Similarly, 7 countries (5% of surveyed countries) had >75% of their patients initiating dialysis with a tunnelled dialysis catheter. Tunnelled dialysis catheter use for HD initiation was higher than the global median in Africa (10%), North America and the Caribbean (22%), and Oceania and South East Asia (OSEA) (7%). Tunnelled catheters were more commonly in used in LICs (14%) than other income categories (Figure 2). Thirty-one countries (25% of surveyed countries) had >75% of patients initiating dialysis with a temporary CVC. The proportion of countries in which dialysis was initiated with a temporary CVC

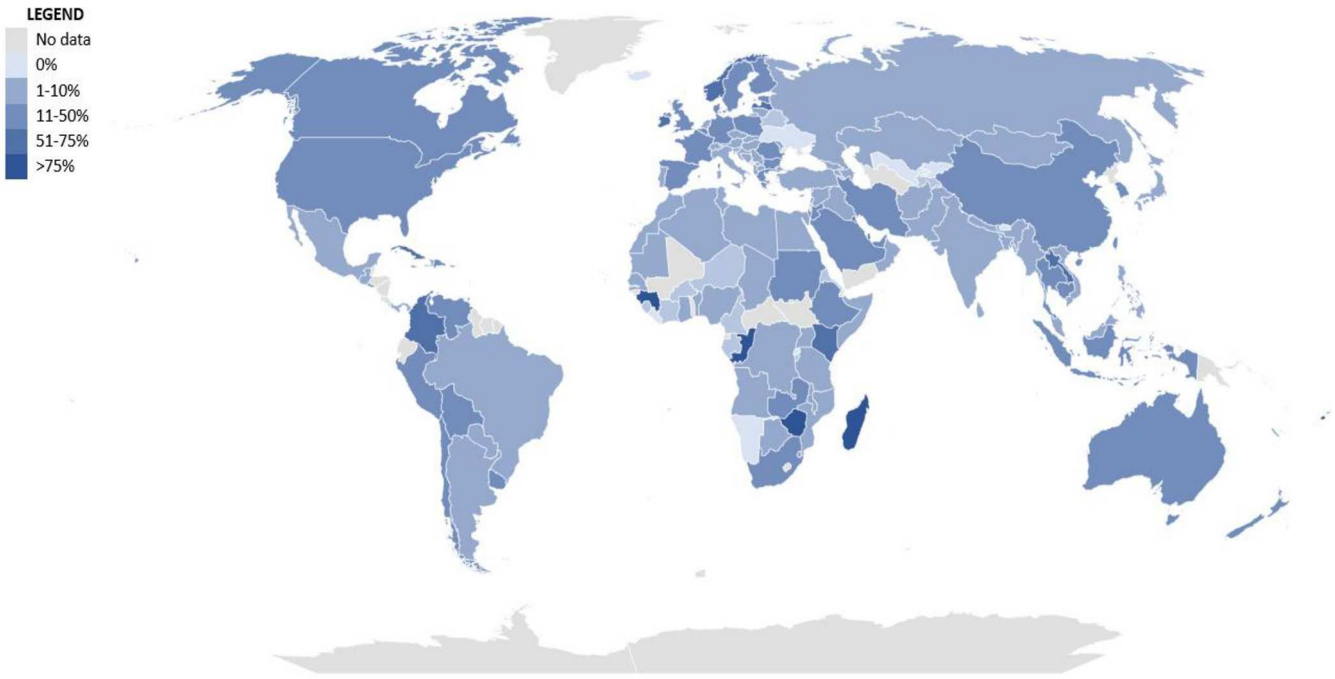

FIGURE 2 Proportion of patients initiating haemodialysis with a tunnelled dialysis catheter.

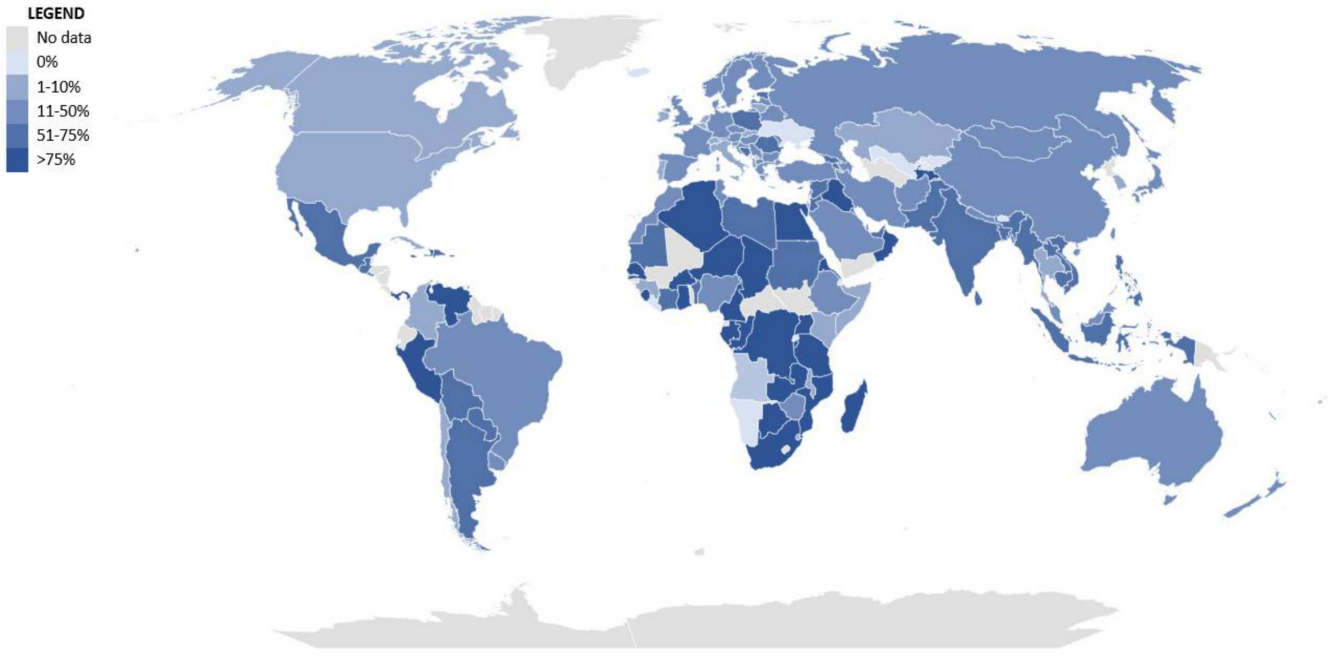

FIGURE 3 Proportion of patients initiating haemodialysis with a temporary central venous catheter.

in >75% of HD patients was highest in Africa (54% of respondent countries from Africa), compared to all other ISN regions; and was also higher in LICs (57% of respondent countries from all low income countries) than other income categories: LMICs (21%), UMICs (23%), and HICs (5%) (Figure 3).

3.2 | Funding models for creation/insertion of dialysis accesses

For creation of AVF/AVG, funding was free at the point of delivery, reimbursed through public funding, in 40% of all countries. CVC

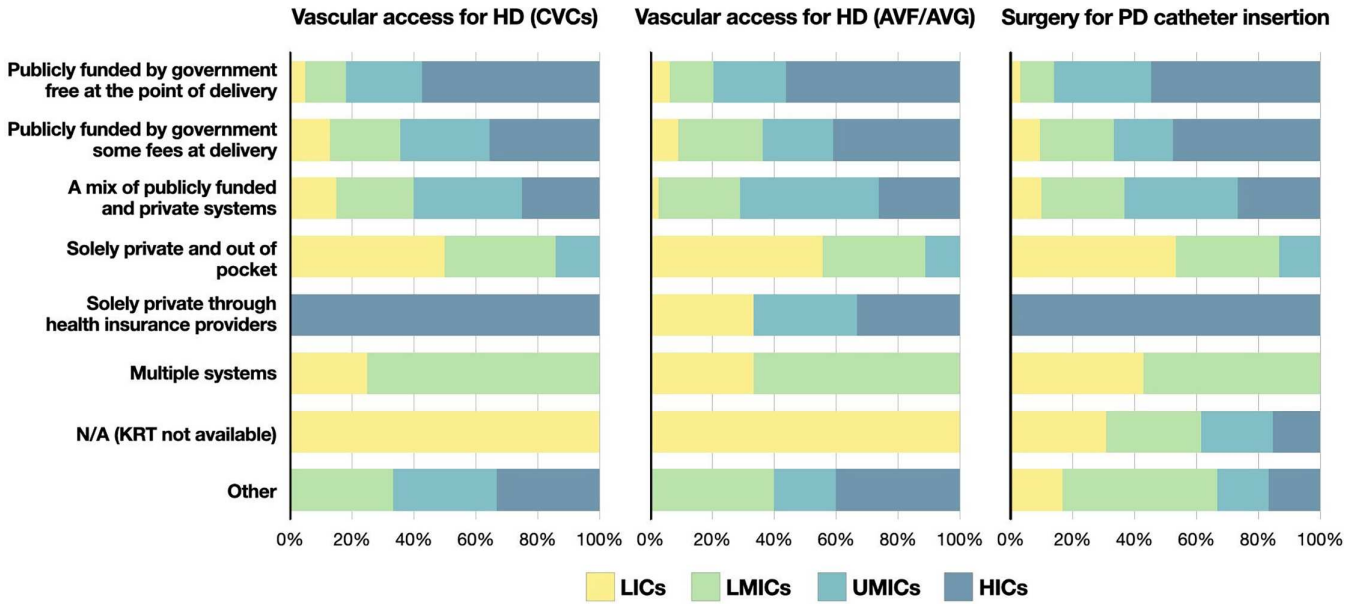

FIGURE 4 Funding models for peritoneal or vascular access by country income levels. AVF, arteriovenous fistula; AVG, arteriovenous grafts; CVCs, central venous catheters; HD, haemodialysis; HICS, higher-income countries; KRT, kidney replacement therapies; LICs, low-income countries; LMICs, lower middle-income countries; N/A, not available; PD, peritoneal dialysis; UMICs, upper middle-income countries.

TABLE 1 Reported shortages of health workforce for dialysis access creation by ISN Regions and World Bank Income Groups.

	Transplant surgeons	Surgeons (HD access)	Surgeons (PD access)	Interventional radiologists (HD access)	Interventional radiologists (PD access)	*n*
Overall	102 (65)	101 (65)	79 (51)	103 (66)	83 (53)	156
ISN regions:						
Africa	34 (83)	35 (85)	34 (83)	36 (88)	31 (76)	41
Eastern & Central Europe	10 (53)	13 (68)	6 (32)	6 (32)	5 (26)	19
Latin America	13 (72)	13 (72)	9 (50)	15 (83)	11 (61)	18
Middle East	7 (64)	3 (27)	2 (18)	9 (82)	9 (82)	11
NIS & Russia	5 (63)	2 (25)	2 (25)	5 (63)	4 (50)	8
North America and the Caribbean	7 (78)	5 (56)	3 (33)	5 (56)	4 (44)	9
North & East Asia	5 (71)	4 (57)	3 (43)	5 (71)	2 (29)	7
Oceania & South East Asia	10 (67)	11 (73)	10 (67)	11 (73)	9 (60)	15
South Asia	7 (100)	7 (100)	6 (86)	7 (100)	7 (100)	7
Western Europe	4 (19)	8 (38)	4 (19)	4 (19)	1 (5)	21
World Bank Groups:						
Low income	21 (95)	20 (91)	21 (95)	21 (95)	20 (91)	22
Lower-middle income	28 (78)	27 (75)	22 (61)	29 (81)	26 (72)	36
Upper-middle income	31 (76)	28 (68)	21 (51)	33 (80)	25 (61)	41
High income	22 (39)	26 (46)	15 (26)	20 (35)	12 (21)	57

Abbreviations: HD, haemodialysis; PD, peritoneal dialysis; ISN, International Society of Nephrology; NIS, newly independent states.

insertion was free at the point of delivery, reimbursed through public funding in 38% of the surveyed countries. PD catheter insertion was free at the point of delivery, reimbursed through public funding in 41% of the countries (Supplementary Tables S1–S3). By region, CVC placement, through public funding, free at the point of delivery was highest in countries of the Middle East (82%). Solely private and out-of-pocket funding were highest in African countries (21%) and this method was not reported as being used in Eastern and Central Europe, the Middle East, South Asia, and Western Europe (Table S1). Similar relationships were noted between funding models and world regions for AVF/AVG creation (Table S2) and for surgical services for PD catheter insertion (Table S3). Publicly funded reimbursement models (either free at point of delivery or with some fees at point of delivery) were more prevalent in HICs than other income categories, while the solely private and out-of-pocket payment systems were more common in LICs and LMICs (Figure 4).

3.3 | Shortages of dialysis access providers by region and income levels

Overall, more than half of countries reported shortages in all categories of dialysis access providers: surgeons for HD access (65%), surgeons for PD catheters (51%), and interventional radiologists for HD access (66%), and PD access (53%) (Table 1). However, shortages across all categories of access providers were highest in South Asia, while shortages of interventional radiologists for HD and PD access were lowest in Western Europe (19% and 5%, respectively) (Table 1). Across countries by income levels, LICs reported the highest levels of shortages of dialysis access providers: transplant surgeons (95%), HD access surgeons (91%), PD access surgeons (95%), international radiologists for HD access (95%), and PD access (91%). These shortages were lowest in HICs (Table 1).

4 | DISCUSSION

To our knowledge, this is the first attempt at documenting the availability, patterns of use, funding models, and workforce for creation of vascular and peritoneal accesses for dialysis across all countries and regions of the world. This study demonstrates important global disparities with the capacity of nations in creating vascular or PD access for sustainable dialysis programs and adds to the literature on the organization, structures and funding for vascular and peritoneal access, an essential element for KRT.[4,12–14] Our work suggests that there was a greater shortage of surgeons and radiologists for both haemodialysis and peritoneal dialysis access placement in lower income regions. Consequently, a large proportion of patients in these regions initiated HD with a temporary CVC compared to permanent tunnelled catheters, AVF or AVG. Using temporary CVC is not optimal as described in various vascular access guidelines due to higher rates of complications.[6] Furthermore, this is concerning as the greatest proportional increase in the prevalence of kidney failure is projected to occur in low and middle income countries, and the use of temporary catheters impact the sustainability of dialysis program and patient outcomes.[15]

Central to our findings is the reported variability of public funding across regions and country income levels for placement of dialysis accesses. Among ISN regions, the prevailing funding model (public vs. private vs. mixed systems) varied between the regions. Across income levels, government/publicly funded systems that are free (or mostly free given minimal co-pay) at the point of delivery were more common in high-income countries compared to low-income countries. Low-income countries relied mostly on private or mixed public/private systems.

Our work has demonstrated the relationship between financial capacity and practice variation among countries.[1,2] A recent study of global availability and access to HD identified that publicly funded models were more frequently available in higher-income countries when compared to lower income countries and that there was greater accessibility of HD in high income countries.[1] Similarly, another study on PD use and practice patterns worldwide showed that higher-income countries followed a public model compared to lower income countries and that the availability of PD was higher in the HIC.[2]

Further, a well-documented major barrier to the development of sustainable chronic dialysis programs is the availability of qualified workforce with the skills necessary for dialysis access creation. A recent survey-based study by Ramachandran et al. analysed vascular access practices in South and Southeast Asia and found higher rates of non-tunnelled CVC, lower rates of AVF access, and also lower surveillance of vascular access in lower-income Asian countries.[16] This study also noted that due to a shortage of traditional interventionalists (such as interventional radiologists and vascular surgeons), there was an increase in interventional nephrologists involved with AVF creation and PD catheter insertions. They identified lack of training, lack of surgical back-up-support, and economic factors to be responsible for interventional nephrology growth in the low-resource countries. It is also possible however that a lack of surgical back-up support for managing procedural complications might prevent nephrologists from performing surgeries and procedures related to dialysis access creation. There is also a noted decreasing trend of nephrologists performing procedures in the developed countries, where surgeons and radiologists perform these procedures more frequently.[17]

Multiple other factors beyond economics could account for the differences in the types of dialysis accesses used for commencement of therapy. For instance, global differences in the utilization of PD may be influenced by governmental programs aiming to lower costs associated with KRT.[18–22] Conversely, some countries such as Israel have trended towards using less PD due to patient preference for in-center HD.[23] It is also important to note that PD was not universally available in all countries. Thus, there could be less interest in the training of interventionalists for PD access creation in these regions. This might have been reflected in our survey by respondents noting a perceived shortage in the workforce for peritoneal catheter insertion, when in fact it was due to the unavailability of the dialysis modality itself in that region. Further, some dialysis access modalities

(such as AVF) aren't amenable to placement based on clinical circumstances surrounding the urgency of dialysis initiation. The placement of this kind of accesses would therefore be impacted by late referrals to nephrology, insufficient patient education, or suboptimal estimation of CKD progression. Thus, it is important to consider that certain governmental policies, patient preferences, availability of dialysis modalities, and workforce limitations may ultimately influence how a country allocates resources for the creation of dialysis access.

Our data also provided additional context for interpreting the outcomes of Fistula First Breakthrough Initiative (FFBI) that was initially developed in 2003 in response to the extremely low use of AVF for HD in the United States.[24] In 1998, the prevalence of AVF was 26%.[25] However, after the FFBI was implemented in 2003 there was a significant increase from 33% in 2003 to 55% in 2006.[25] Most recently, in 2015, the AVF rate was noted at 63%.[25] This is confirmed by our findings showing 11%–50% of patients in the United States initiated dialysis with an AVF. Furthermore, the 2006 Kidney Disease Outcomes Quality Initiative (KDOQI) vascular access guidelines also set a target of CVC use to be less than 10%.[6] However, our data showed that in the United States, between 11% and 50% of patients received a tunnelled dialysis catheter, whereas 1%–10% of patients received a temporary catheter for dialysis access. This relatively higher use of catheters among patients in the United States might be attributed to newer guidelines which suggests that catheters might be preferable for HD patients who have limited life expectancy or for patients in whom AV access interferes with quality of life.

What are the implications for our findings? Various ISN initiatives have consistently advocated for increasing training capacity and programs in low-income regions[26,27] and the ISN has recently spearheaded interventional nephrology fellowship programs to help enhance the presence of procedurally trained nephrologists in low-income and lower-middle income regions.[15] Our data would suggest that training programs focused on training surgeons and interventionists might help address some of the gaps in kidney care in lower income countries. Limitations of implementing interventional nephrology training programs in low-resourced countries are of multifactorial nature, including a lack of formal training (due to the limited number of trained faculty), minimal back-up support, economic barriers, and consequent medico-legal issues with implementation of a procedure driven program.[15] Further, only a few centers in these regions may have the ability to train nephrologists in certain procedures. Our data can be used to inform policy recommendations on workforce, funding, and their roles towards optimal PD or vascular access for dialysis across regions and countries. This information is relevant for the ongoing initiatives of various professional organizations including the ISN and other national/regional professional nephrology societies as well as related organizations such as the American Society of Diagnostic and Interventional Nephrology (ASDIN).

There are some limitations to this study including social desirability bias, and information based on opinions. The inconsistencies in responses within individual countries were carefully followed up and resolved with the respondents and ISN leaders in various regions. Second, the use of median values to look at regional differences in this study where countries of different income levels participated in each region may have skewed the data thereby limiting generalizability of information to all countries in that region. For example, in the North America and Caribbean region, the median country was generally a lower income country in the Caribbean region, and its trend may not be generalizable to a HIC such as Canada or the USA. We tried to mitigate this concern by displaying maps that show variations based on countries to showcase the granularity of the data. Third, interventionists in different regions may have varying practices which may lead to discrepancies in the interpretation of the data. For example, some regions might have had surgeons and/or nephrologists who place tunnelled dialysis catheters compared to interventional radiologists which would affect responses related to shortages in the workforce. Lastly, we did not collect data on wait times for PD catheter insertion or access to surgical theatres in this study and so we cannot correlate these variables to the reported shortages of surgeons to place PD catheters. ISN-GKHA data regarding practice patterns and availability of PD has been reported elsewhere.[2]

In conclusion, our study highlights important variations in the availability of human and material resources for optimal vascular and PD access creation. We noted significant gaps in resources and patterns of access use in low-income countries compared to the HICs. Further work is needed on strategies to enhance uptake of optimal access for chronic dialysis via adequate resource allocation and support particularly in low resource settings.

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CONFLICT OF INTEREST STATEMENT

VJ reports grants from GlaxoSmithKline and Baxter Healthcare, provides scientific leadership to George Clinical, and consultancy fees for Biocon, Zudis Cadilla, and NephroPlus, all paid to his institution, outside the submitted work.

DATA AVAILABILITY STATEMENT

Data is available upon request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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