The Spatial Determinants of Sustainable Dialysis

Supplementary Information

S1. Baseline Scenario Extended Methods

S1.1. System Boundaries

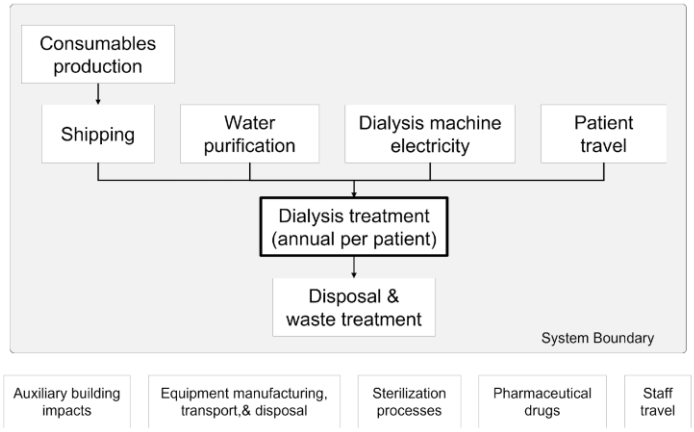

Figure S1. General system boundaries used for all scenarios (ICHD, home APD, and home CAPD) in baseline LCA.

The system boundary (Fig. S1), which was followed for all scenarios (ICHD, home APD, and home CAPD) in the baseline LCA and for all sensitivity analyses, included the production and shipping of consumables, water purification, dialysis machine electricity (ICHD, home APD), patient travel, and disposal and waste treatment processes. Figures S2-S4 show the detailed process trees used for the ICHD, home APD, and home CAPD assessments, and Figure S5 shows the detailed process tree used for the water purification sub-process. Reasoning for the processes excluded from the system boundaries were as follows:

- Auxiliary building impacts: To make results comparable to previously published dialysis LCAs (see Table 1), the majority of which exclude building energy use (e.g., lighting, HVAC) from their analysis, we excluded auxiliary building impacts.
- Equipment manufacturing, transport, and disposal: Based on the material composition of an HD machine from Bonnet et al.[1] and a conservative estimate of a 10-year lifespan and 4 patient capacity for an HD machine, we estimated that the HD machine contributes <1% of the annual per-patient ICHD CFP. APD machines and water purification systems were assumed to have similarly low contributions to the overall dialysis CFP. Therefore, equipment contributions were deemed negligible.
- Sterilization processes for consumables: Sterilization processes have been excluded from previously published LCAs. We also estimated that terminal steam sterilization of packaged PD fluid would contribute to <2% of the total home PD CFP, based on autoclave use data[2], making sterilization contributions negligible. Because non-fluid consumables (dialyzer, tubing, cassette) have lower total masses than fluid and because these consumables are typically irradiation or electron-beam sterilized, which are more energy efficient than steam sterilization, we assumed that the CFP contributions from sterilization of these consumables would be lower than for fluid sterilization.
- Pharmaceutical drugs: The solutes and concentrates used to mix the standard HD and PD fluids were included in the analysis. Additional pharmaceutical drugs (e.g., anticoagulants, cardiovascular drugs, dietary supplements) dialysis patients may take

orally or intravenously were excluded from our analysis. Pharmaceuticals have generally been excluded from previous dialysis LCAs but are known to have significant environmental impacts. Lim et al.[3] found that pharmaceuticals contributed 36% of the total ICHD CFP. However, because of the complexity of drug supply chains and the significant patient-to-patient variation in prescriptions, pharmaceuticals were considered outside the scope of our analysis. While exact prescriptions are patient-specific, on average, HD patients are prescribed more pharmaceutical drugs than PD patients[1], which would be expected to increase the environmental impacts of HD relative to PD.

- Staff travel: Previous dialysis LCAs have differed on whether staff travel is included in the analysis. For ICHD, Lim et al.[3] and Connor et al.[4] found that staff travel contributed 4.6% and 3%, respectively, of the total ICHD CFP. Connor et al.[4] also found that staff travel contributed <2.5% of the total home HD CFP, and home PD would be expected to require similar or less staff travel than home HD. Given the estimated <5% contribution to CFP, we excluded staff travel from the LCA boundary.

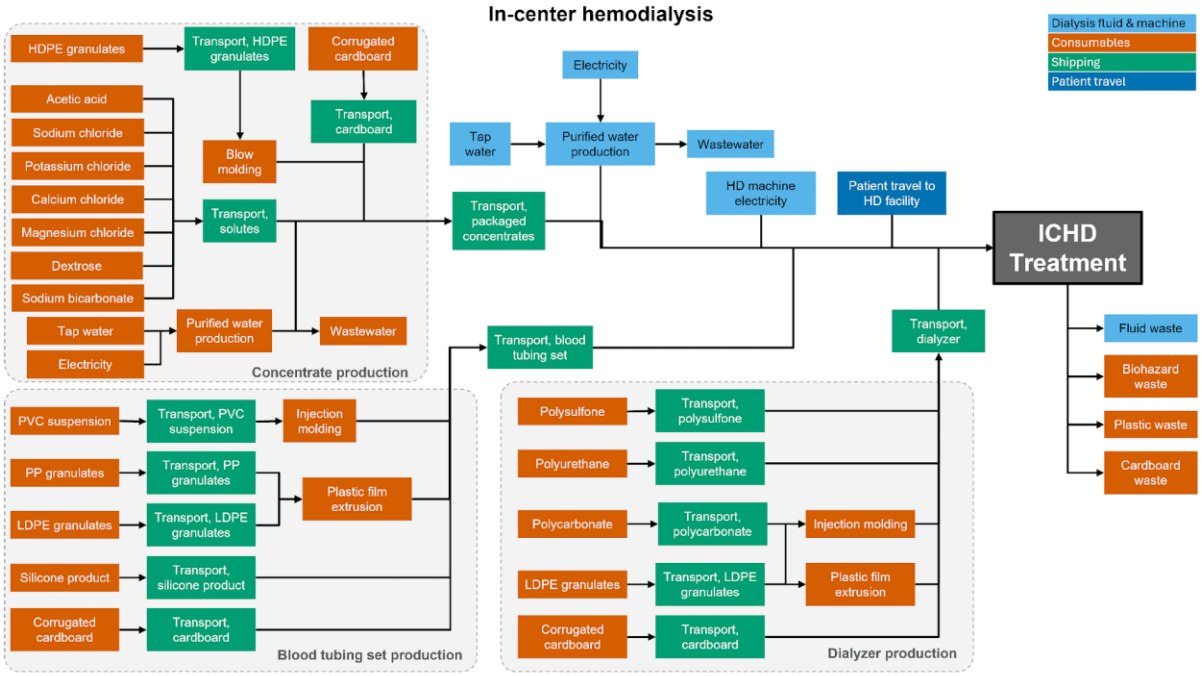

Figure S2. Process tree for in-center hemodialysis (ICHD) treatment. Concentrate, blood tubing set, and dialyzer production occur at their respective manufacturing facilities before shipping to the dialysis center. Water is purified on site to produce HD fluid. The HD machine uses electricity during treatment to control blood and fluid flow. The patient travels three times weekly to the dialysis center for treatment. Waste fluid, plastic (including biohazardous materials that have been in contact with patient blood), and cardboard are all disposed of following treatment.

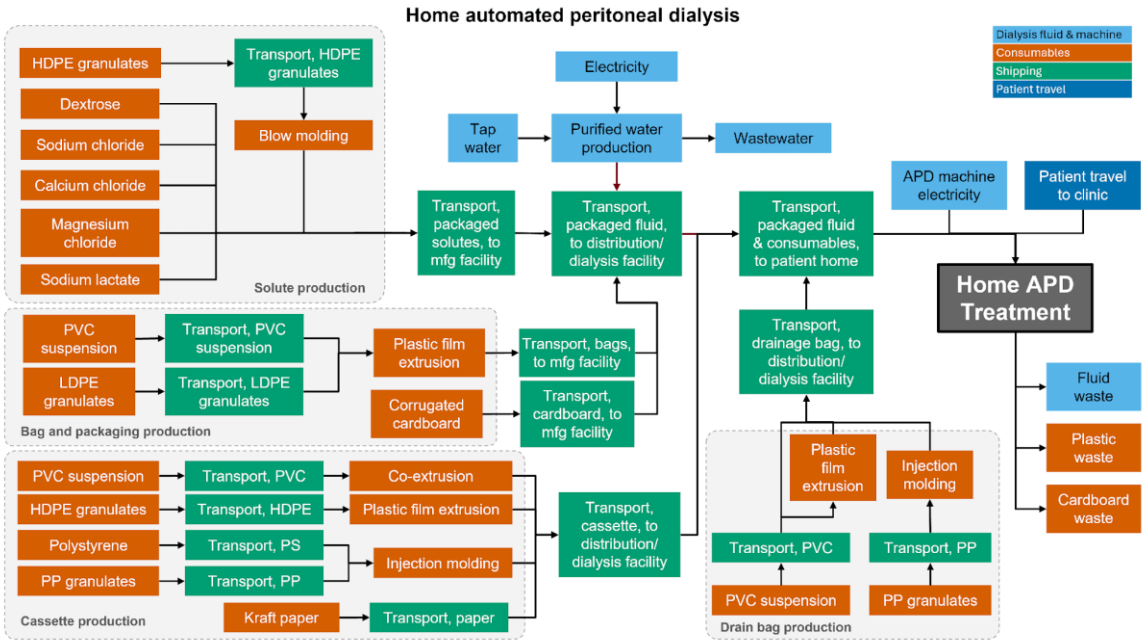

Figure S3. Process tree for home automated peritoneal dialysis (APD) treatment. Solute and bag production occur at their respective manufacturing facilities before shipping to the PD fluid manufacturing facility, where water purification, mixing, and packaging occur. The packaged fluid is then shipped to a distribution center or dialysis center. Cassette and drain bag production occur at their respective manufacturing facilities before shipping to a distribution center or dialysis center. Packaged fluid, cassettes, and drain bags are then transported to the patient's home. The APD machine uses electricity during treatment to control fluid inflow and outflow. The patient travels one time monthly to the dialysis center for clinical visits. Waste fluid, plastic, and cardboard are all disposed of following treatment.

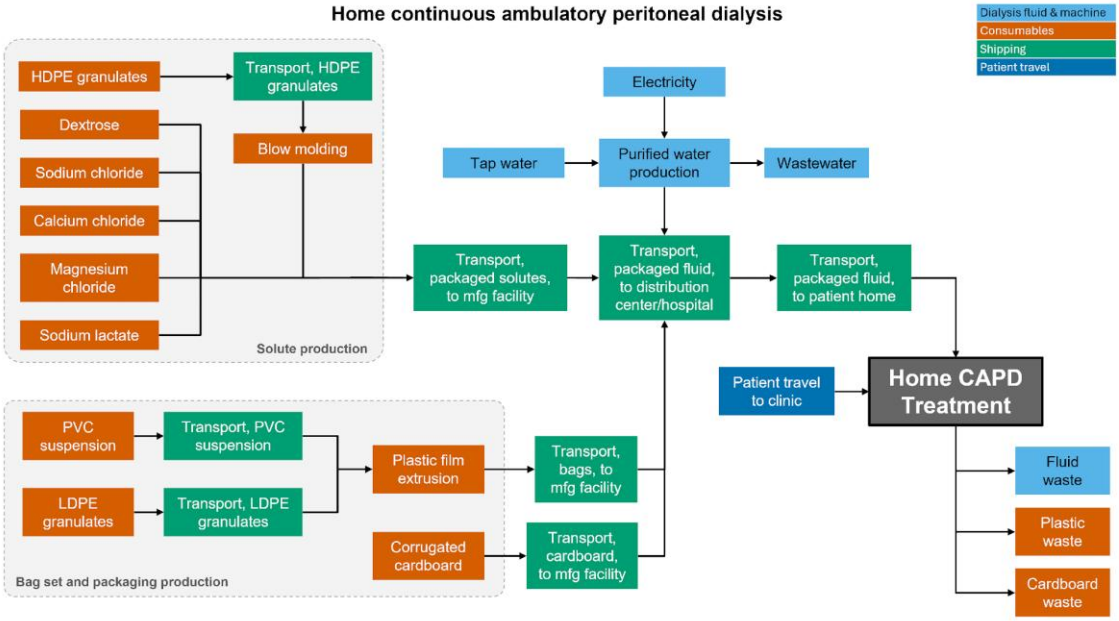

Figure S4. Process tree for home continuous ambulatory peritoneal dialysis (CAPD) treatment. Solute and bag set (including attached drain bag) production occur at their respective manufacturing facilities before shipping to the PD fluid manufacturing facility, where water purification, mixing, and packaging occur. The packaged fluid is then shipped to a distribution center or dialysis center, and then to the patient's home. The patient travels one time monthly to the dialysis center for clinical visits. Waste fluid, plastic, and cardboard are all disposed of following treatment.

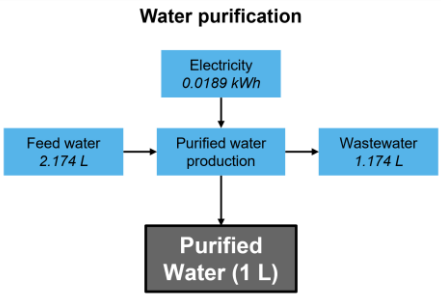

Figure S5. Process tree for water purification. This process is used for all water purification steps across all modeled scenarios (HD concentrate production, APD fluid manufacturing, CAPD fluid manufacturing, on-site HD fluid production). The electricity, feed water, and wastewater input process vary based on water purification location. Water and wastewater volumes and electricity consumption are based on the Essendon Fields reverse osmosis plant water and power consumption data from Barraclough et al.5

S1.2. Material & Energy Inventories

Table S1. Baseline ICHD material and energy inventory.

Item & Components	Quantity per FU	ecoinvent process	Quantity basis/reference
Purified water (rinsing/priming)	7020 L	water purification | US-WECC*	45 L/session[6]
Dialysate	18,720 L		500 mL/min, 4 hour sessions[6]
Purified water	17,589 L	water purification | US-WECC*	45X mix ratio[7]
Acid concentrate	416 L		Fresenius NaturaLyte Liquid Acid, 45X mix ratio[7]
HDPE granulates	9.27 kg	polyethylene production, high density, granulate | polyethylene, high density, granulate | RoW	
Blow molding	9.27 kg	blow moulding | blow moulding | RER	
Acetic acid	4.49 kg	acetic acid production, from n-butane oxidation | acetic acid | RER	
Sodium chloride	109.3 kg	sodium chloride production, powder | sodium chloride, powder | RER	
Potassium chloride	2.79 kg	potassium chloride production | potassium chloride | RER	
Calcium chloride	2.59 kg	market for calcium chloride | calcium chloride | RER	
Magnesium chloride	0.89 kg	magnesium sulfate production | magnesium sulfate | RER	$MgSO_4$ used as proxy for $MgCl_2$ following Sehgal et al.[8]
Dextrose	18.7 kg	glucose production | glucose | RER	
Purified water	416 L	water purification | DE*	
Corrugated cardboard	15.3 kg	corrugated board box production | corrugated board box | RER	
Bicarb concentrate	715 L		Fresenius Liquid Sodium Bicarbonate Concentrate, 45X mix ratio[9]

HDPE granulates	14.5 kg	polyethylene production, high density, granulate | polyethylene, high density, granulate | RoW	
Blow molding	14.5 kg	blow moulding | blow moulding | RER	
Sodium bicarbonate	58.1 kg	market for sodium bicarbonate | sodium bicarbonate | RER	
Purified water	715 L	water purification | DE*	
Corrugated cardboard	23.8 kg	corrugated board box production | corrugated board box | RER	
Blood tubing set	156 sets		Blood tubing set A from Sehgal et al.[8]
Polyvinyl chloride	35.8 kg	polyvinyl chloride production, suspension polymerisation | polyvinyl chloride, suspension polymerised | CN	
Polypropylene	6.85 kg	polypropylene production, granulate | polypropylene, granulate | CN	
LDPE granulates	0.91 kg	polyethylene production, low density, granulate | polyethylene, low density, granulate | RoW	
Silicone product	1.79 kg	silicone product production | silicone product | RER	
Injection molding	35.8 kg	injection moulding | injection moulding | RER	
Plastic film extrusion	7.76 kg	extrusion, plastic film | extrusion, plastic film | RER	
Corrugated cardboard	1.42 kg	corrugated board box production | corrugated board box | RER	
Dialyzer	156 dialyzers		Dialyzer A from Sehgal et al.[8]
Polysulfone	3.22 kg	polysulfone production, for membrane filtration production | polysulfone | GLO	
Polyurethane	0.73 kg	polyurethane production, flexible foam, MDI-based | polyurethane, flexible foam | RoW	
Polycarbonate	26.4 kg	polycarbonate production | polycarbonate | CN	
LDPE granulates	2.89 kg	polyethylene production, low density, granulate | polyethylene, low density, granulate | RoW	
Injection molding	22.5 kg	injection moulding | injection moulding | RER	
Plastic film extrusion	1.68 kg	extrusion, plastic film | extrusion, plastic film | RER	
Corrugated cardboard	1.85 kg	corrugated board box production | corrugated board box | RER	
HD machine electricity	343 kWh	market for electricity, low voltage | electricity, low voltage | US-WECC	2.2 kWh/session from Essendon Fields average session power in Barraclough et al.[5]
Dialysate and water waste	25,740 L	market for wastewater, average | wastewater, average | RoW	
Blood tubing set and dialyzer biohazard waste	78.6 kg	market for hazardous waste, for incineration | hazardous waste, for incineration | RoW	
Concentrate bottle plastic waste	23.8 kg	market for waste plastic, mixture | waste plastic, mixture | RoW	
Corrugated cardboard waste	42.4 kg	market for waste paperboard | waste paperboard | RoW	

*water purification process details in Table S4

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S2. Baseline home APD material and energy inventory.

Item & Components	Quantity per FU	ecoinvent process	Quantity basis/reference
Packaged APD fluid	730 bags		2X-6L fluid bags daily, Baxter Dianeal PD-2 with 2.5% Dextrose[10]
Purified water	4,380 L	water purification | US-SERC*	
Packaged solutes	171 kg		
HDPE granulates	4.22 kg	polyethylene production, high density, granulate | polyethylene, high density, granulate | RoW	
Blow molding	4.22 kg	blow moulding | blow moulding | RoW	
Dextrose	110 kg	glucose production | glucose | RoW	
Sodium chloride	23.6 kg	sodium chloride production, powder | sodium chloride, powder | RoW	
Sodium lactate	32.7 kg	lactic acid production | lactic acid | RoW	Lactic acid used as proxy for sodium lactate following McAlister et al. and Barraclough et al.[11,12]
Calcium chloride	1.13 kg	market for calcium chloride | calcium chloride | RoW	
Magnesium chloride	0.22 kg	magnesium sulfate production | magnesium sulfate | RoW	$MgSO_4$ used as proxy for $MgCl_2$ following Sehgal et al.[8]
Empty fluid bags	730 bags		measured
Polyvinyl chloride	70.5 kg	polyvinyl chloride production, suspension polymerisation | polyvinyl chloride, suspension polymerised | CN	
LDPE granulates	21.5 kg	polyethylene production, low density, granulate | polyethylene, low density, granulate | RoW	
Plastic film extrusion	92 kg	extrusion, plastic film | extrusion, plastic film | RoW	
Corrugated cardboard	230 kg	corrugated board box production | corrugated board box | US	
4-prong cassette	365 cassettes		HomeChoice Automated PD set[11]
Polyvinyl chloride	59.1 kg	polyvinyl chloride production, suspension polymerisation | polyvinyl chloride, suspension polymerised | CN	
PP granulates	32.7 kg	polypropylene production, granulate | polypropylene, granulate | CN	
HDPE granulates	2.85 kg	polyethylene production, high density, granulate | polyethylene, high density, granulate | RoW	
Kraft paper	2.41 kg	kraft paper production | kraft paper | RoW	
Polystyrene	3.94 kg	polystyrene production, general purpose | polystyrene, general purpose | RoW	
Plastic film extrusion	2.85 kg	extrusion, plastic film | extrusion, plastic film | RoW	
Co-extrusion	59.1 kg	extrusion, co-extrusion of plastic sheets | extrusion, co-extrusion | RoW	
Injection molding	36.6 kg	injection moulding | injection moulding | RoW	

Cycler Drainage Bag	365 bags		C15L Cycler drainage bag[11]
Polyvinyl chloride	139.8 kg	polyvinyl chloride production, suspension polymerisation | polyvinyl chloride, suspension polymerised | CN	
PP granulates	8.76 kg	polypropylene production, granulate | polypropylene, granulate | CN	
Plastic film extrusion	74.1 kg	extrusion, co-extrusion of plastic sheets | extrusion, co-extrusion | RoW	
Injection molding	8.76 kg	injection moulding | injection moulding | RoW	
APD machine electricity	329 kWh	market for electricity, low voltage | electricity, low voltage | US-WECC	HomeChoice APD system, 100W average power consumption, 9 hours per night[13]
Dialysis fluid waste	4,547 L	market for wastewater, average | wastewater, average | RoW	
Plastic waste	343 kg	market for waste plastic, mixture | waste plastic, mixture | RoW	
Corrugated cardboard waste	233 kg	market for waste paperboard | waste paperboard | RoW	

*water purification process details in Table S4

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S3. Baseline home CAPD material and energy inventory.

Item & Components	**Quantity per FU**	**ecoinvent process**	**Quantity basis/reference**
Packaged CAPD fluid	1,460 bags		4X-2L fluid bags daily, Baxter Dianeal PD-2 with 2.5% Dextrose[10]
Purified water	2,920 L	water purification | US-SERC*	
Packaged solutes	114.2 kg		
HDPE granulates	2.8 kg	polyethylene production, high density, granulate | polyethylene, high density, granulate | RoW	
Blow molding	2.8 kg	blow moulding | blow moulding | RoW	
Dextrose	73 kg	glucose production | glucose | RoW	
Sodium chloride	15.7 kg	sodium chloride production, powder | sodium chloride, powder | RoW	
Sodium lactate	21.8 kg	lactic acid production | lactic acid | RoW	Lactic acid used as proxy for sodium lactate following McAlister et al. and Barra[11,12]
Calcium chloride	0.75 kg	market for calcium chloride | calcium chloride | RoW	
Magnesium chloride	0.15 kg	magnesium sulfate production | magnesium sulfate | RoW	$MgSO_4$ used as proxy for $MgCl_2$ following Sehgal et al.[8]
Empty bag sets (including drain bags)	1,460 bags		Measured

Polyvinyl chloride	181.7 kg	polyvinyl chloride production, suspension polymerisation | polyvinyl chloride, suspension polymerised | CN
LDPE granulates	46.4 kg	polyethylene production, low density, granulate | polyethylene, low density, granulate | RoW
Plastic film extrusion	228 kg	extrusion, plastic film | extrusion, plastic film | RoW
Corrugated cardboard	254 kg	corrugated board box production | corrugated board box | US
Dialysis fluid waste	3,031 L	market for wastewater, average | wastewater, average | RoW
Plastic waste	231 kg	market for waste plastic, mixture | waste plastic, mixture | RoW
Corrugated cardboard waste	253 kg	market for waste paperboard | waste paperboard | RoW

*water purification process details in Table S4

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S4. Water purification sub-process material and energy inventories for baseline locations. Feed water and wastewater volumes and electricity consumption are based on the Essendon Fields reverse osmosis plant water and power consumption data from Barraclough et al.[5]

Item & Components	Quantity per 1 L purified water	ecoinvent process
Water purification | US-WECC		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-WECC
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | DE		
Feed water	2.174 L	market for tap water | tap water | RER without CH
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | DE
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RER without CH
Water purification | US-SERC		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-SERC
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

S1.3. Location & Transportation Data

Figure S6 shows the location assumptions for all the material sourcing, manufacturing, and treatment process for the baseline assessment. The transportation distances and ecoinvent transport processes used for each transportation step are included in Tables S5 (ICHD) and S6 (home APD and CAPD). In general, land shipping was assumed to use a 16-32 metric ton truck at all stages, except for the final transportation of PD consumables from the distribution center to the patient home, which was assumed to use a 3.5-7.5 metric ton truck. All ocean shipping used container ship transport. Where data was available, geography-specific vehicles were used (e.g., Europe [RER]). In all other cases, rest-of-world (RoW) or global (GLO) values were used. All road transport distances were obtained from Google Maps, and all ocean transport distances were obtained from sea-distances.org.

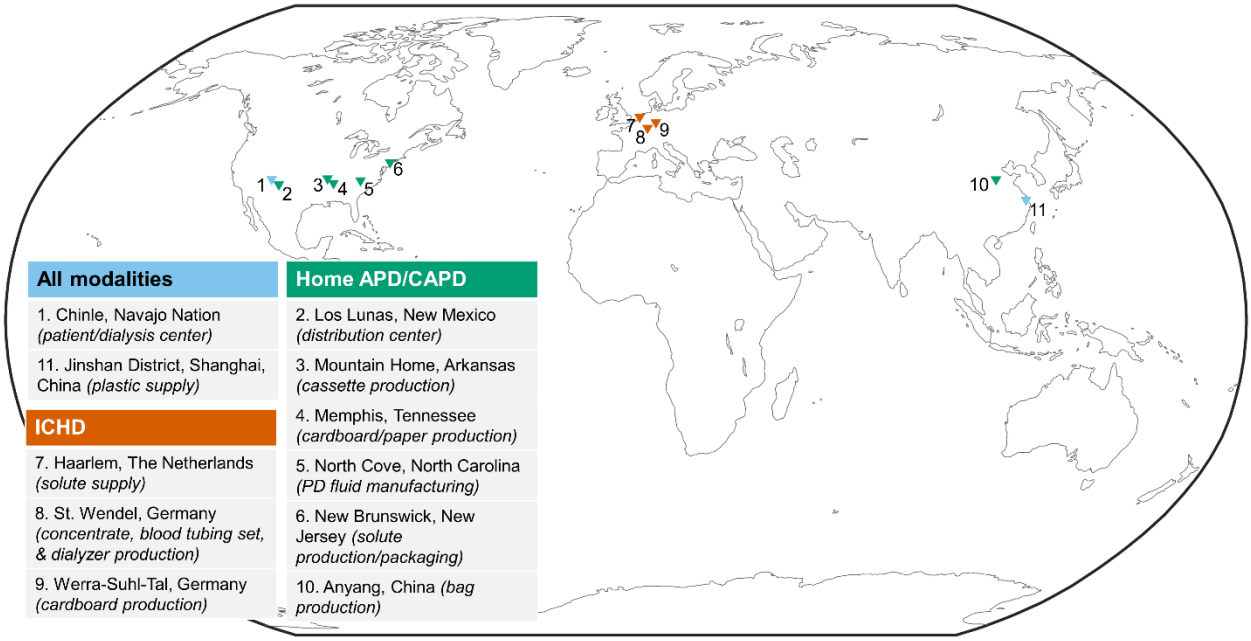

Figure S6. Map showing the location assumptions for all process steps in the baseline LCA for ICHD, home APD, and home CAPD.

Table S5. ICHD transportation details

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Plastic to concentrate/ blood tubing set/dialyzer production	Jinshan District, Shanghai, China	St. Wendel, Germany	125	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			19,872	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
Solutes to concentrate production	Haarlem, The Netherlands	St. Wendel, Germany	465	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
Cardboard to concentrate/ blood tubing set/dialyzer production	Werra-Suhl-Tal, Germany	St. Wendel, Germany	350	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
Packaged concentrates/ blood tubing sets/dialyzers to dialysis center	St. Wendel, Germany	Chinle, Navajo Nation	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			7,434	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			3,095	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Patient home to dialysis center	near Chinle, Navajo Nation	Chinle, Navajo Nation	10	transport, passenger, car, petrol, medium size, EURO 5 | transport, passenger, car, petrol, medium size, EURO 5 | RoW

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S6. Home APD and CAPD transportation details

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Plastic to bag production	Jinshan District, Shanghai, China	Anyang, China	1,091	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Bags to fluid manufacturing	Anyang, China	North Cove, NC	4,443	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
HDPE to solute production	Jinshan District, Shanghai, China	New Brunswick, NJ	175	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			19,598	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
Solutes to fluid manufacturing	New Brunswick, NJ	North Cove, NC	1,065	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Cardboard to fluid manufacturing	Memphis, TN	North Cove, NC	882	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Fluid to distribution center	North Cove, NC	Los Lunas, NM	2,539	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Plastic to cassette production*	Jinshan District, Shanghai, China	Mountain Home, AR	2,822	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,571	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
Paper to cassette production*	Memphis, TN	Mountain Home, AR	314	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Cassettes to distribution center*	Mountain Home, AR	Los Lunas, NM	1,443	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Drain bags to distribution center*	Anyang, China	Los Lunas, NM	1,946	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
Distribution center to patient home	Los Lunas, NM	Chinle, Navajo Nation	372	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | RoW
Patient home to dialysis center	near Chinle, Navajo Nation	Chinle, Navajo Nation	10	transport, passenger, car, petrol, medium size, EURO 5 | transport, passenger, car, petrol, medium size, EURO 5 | RoW

*Home APD only

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

S2. End-of-Life Sensitivity Analysis

S2.1. End-of-Life Sensitivity Analysis Methods

For all end-of-life processes (wastewater, hazardous waste incineration, waste plastic, waste paperboard) in the baseline analysis, we used RoW geography market processes. Because the environmental impacts of different waste treatment processes can vary, we conducted a sensitivity analysis. The baseline LCAs for all three dialysis modalities were modified to vary the market geographies for waste plastic and waste paperboard. The five geographies (South Africa, India, Germany, United Kingdom, Greece) we selected represent the full range of emissions factors from the available data. These market processes use an average mix of waste treatment processes (e.g., incineration, landfill, open burning). Details about the ecoinvent processes used for the sensitivity analysis are included in Table S7.

Table S7. End of life sensitivity process details

Item	Quantity per FU	ecoinvent process
ICHD		
Dialysate and water waste	25,740 L	market for wastewater, average | wastewater, average | RoW (Rest-of-World, baseline)
Blood tubing set and dialyzer biohazard waste	78.6 kg	market for hazardous waste, for incineration | hazardous waste, for incineration | RoW (Rest-of-World, baseline)
Concentrate bottle plastic waste	23.8 kg	market for waste plastic, mixture | waste plastic, mixture | RoW (Rest-of-World, baseline)
		market for waste plastic, mixture | waste plastic, mixture | ZA (South Africa)
		market for waste plastic, mixture | waste plastic, mixture | IN (India)
		market for waste plastic, mixture | waste plastic, mixture | DE (Germany)
		market for waste plastic, mixture | waste plastic, mixture | GB (United Kingdom)
		market for waste plastic, mixture | waste plastic, mixture | GR (Greece)
Corrugated cardboard waste	42.4 kg	market for waste paperboard | waste paperboard | RoW (Rest-of-World, baseline)
		market for waste paperboard | waste paperboard | ZA (South Africa)
		market for waste paperboard | waste paperboard | IN (India)
		market for waste paperboard | waste paperboard | DE (Germany)
		market for waste paperboard | waste paperboard | GB (United Kingdom)
		market for waste paperboard | waste paperboard | GR (Greece)
Home APD		
Dialysis fluid waste	4,547 L	market for wastewater, average | wastewater, average | RoW (Rest-of-World, baseline)
Plastic waste	343 kg	market for waste plastic, mixture | waste plastic, mixture | RoW (Rest-of-World, baseline)
		market for waste plastic, mixture | waste plastic, mixture | ZA (South Africa)
		market for waste plastic, mixture | waste plastic, mixture | IN (India)
		market for waste plastic, mixture | waste plastic, mixture | DE (Germany)
		market for waste plastic, mixture | waste plastic, mixture | GB (United Kingdom)
		market for waste plastic, mixture | waste plastic, mixture | GR (Greece)

Corrugated cardboard waste	233 kg	market for waste paperboard | waste paperboard | RoW (Rest-of-World, baseline)
		market for waste paperboard | waste paperboard | ZA (South Africa)
		market for waste paperboard | waste paperboard | IN (India)
		market for waste paperboard | waste paperboard | DE (Germany)
		market for waste paperboard | waste paperboard | GB (United Kingdom)
		market for waste paperboard | waste paperboard | GR (Greece)
Home CAPD		
Dialysis fluid waste	4,547 L	market for wastewater, average | wastewater, average | RoW (Rest-of-World, baseline)
Plastic waste	343 kg	market for waste plastic, mixture | waste plastic, mixture | RoW (Rest-of-World, baseline)
		market for waste plastic, mixture | waste plastic, mixture | ZA (South Africa)
		market for waste plastic, mixture | waste plastic, mixture | IN (India)
		market for waste plastic, mixture | waste plastic, mixture | DE (Germany)
		market for waste plastic, mixture | waste plastic, mixture | GB (United Kingdom)
		market for waste plastic, mixture | waste plastic, mixture | GR (Greece)
Corrugated cardboard waste	233 kg	market for waste paperboard | waste paperboard | RoW (Rest-of-World, baseline)
		market for waste paperboard | waste paperboard | ZA (South Africa)
		market for waste paperboard | waste paperboard | IN (India)
		market for waste paperboard | waste paperboard | DE (Germany)
		market for waste paperboard | waste paperboard | GB (United Kingdom)
		market for waste paperboard | waste paperboard | GR (Greece)

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

S2.1. End-of-Life Sensitivity Analysis Results

Figures S7 and S8 show the water demand and CFP results for the end-of-life sensitivity analysis. End-of-life processes contributed to <2% of the overall water demand for all modalities and all scenarios (Fig. S7). The total ICHD CFP only varied 3% (Fig. S8a). This was because biohazardous waste (which did not vary in this sensitivity because additional geography data was not available for hazardous waste) dominated the end-of-life CFP of HD. Home APD and home CAPD showed more variation in end-of-life CFP (Figs. S8b-c), but impact on the overall treatment CFP was still minor (<15%). Consumables manufacturing and shipping remained the dominant contributors to PD CFP. For the remaining sensitivity analyses, the baseline RoW end-of-life processes were used.

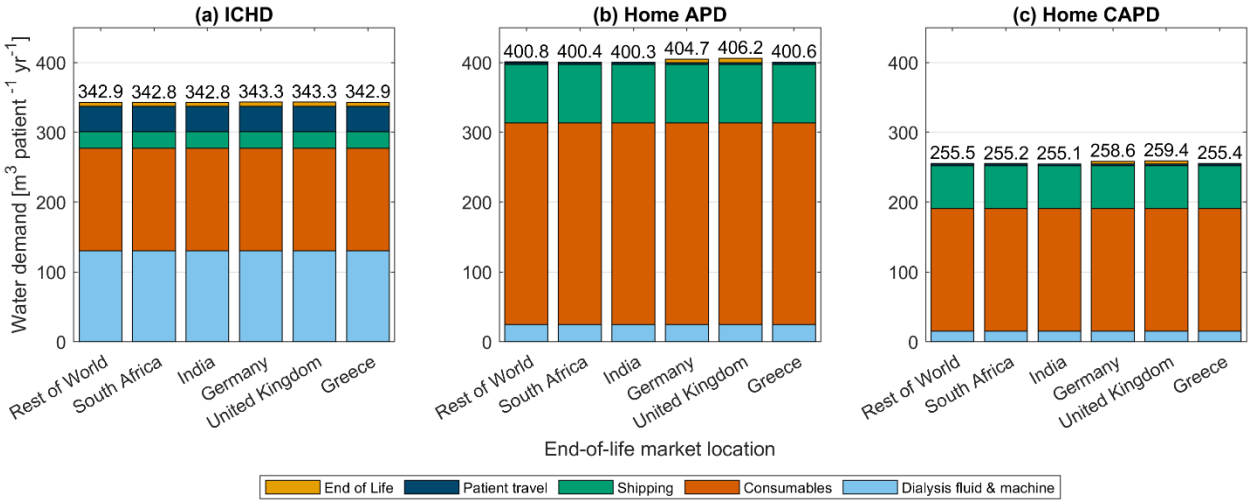

Figure S7. Annual per-patient water demand of (a) ICHD, (b) home APD, and (c) home CAPD, using different end-of-life market processes for plastic and paper waste. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, patient travel, and all end-of-life processes. Home CAPD has the lowest water demand, and APD has the highest water demand regardless of end-of-life process. End-of-life processes contribute to <2% of overall water demand in all scenarios.

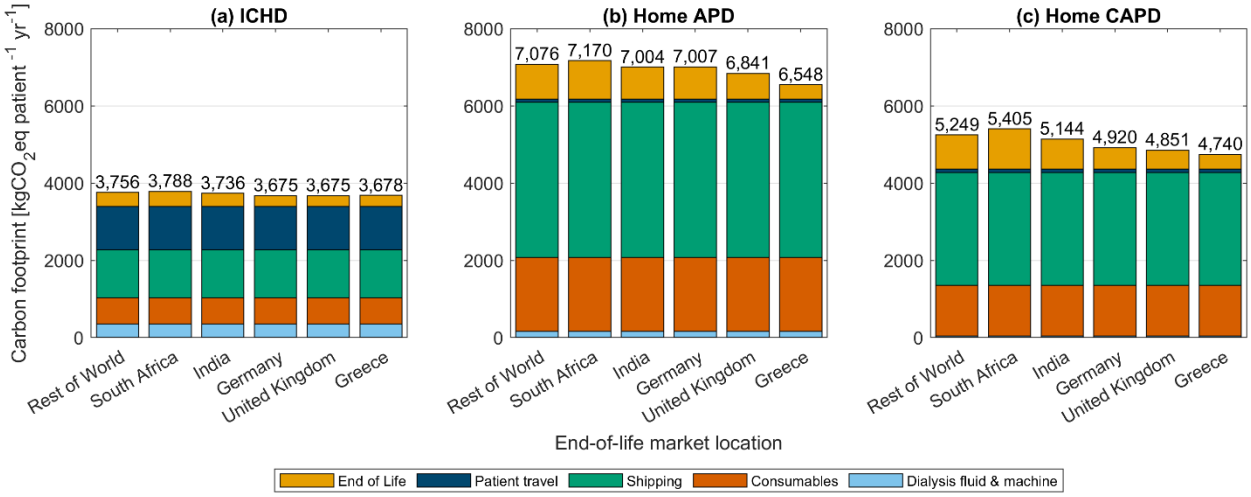

Figure S8. Annual per-patient CFP of (a) ICHD, (b) home APD, and (c) home CAPD, using different end-of-life market processes for plastic and paper waste. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, patient travel, and all end-of-life processes. ICHD has the lowest CFP, and APD has the highest CFP regardless of end-of-life process. ICHD shows the least variation, as biohazardous waste dominates end-of-life CFP (and does not vary in this LCA setup), and contributes to only 3% variation in overall ICHD CFP. Home APD and home CAPD show more variation in end-of-life CFP, but impact on the overall treatment CFP is still minor (<15%).

S3. Patient Location and Travel Sensitivity Analysis

S3.1. Navajo Nation Patient Travel Water Demand Results

Figure S9 shows the water demand results of the patient travel sensitivity for ICHD and home CAPD for the Navajo Nation patient scenario. Much like the CFP (see Figures 3a-b), the water demand of ICHD increased significantly with increasing patient distance due to the embodied water demand of passenger cars and frequency of travel for ICHD. However, the relative contribution of patient travel to water demand was slightly lower than the contribution to CFP (70% and 90%, respectively, for a patient living 200 km from the dialysis center). The water demand of home CAPD increased only moderately (21%) for a very rural patient compared to an urban patient.

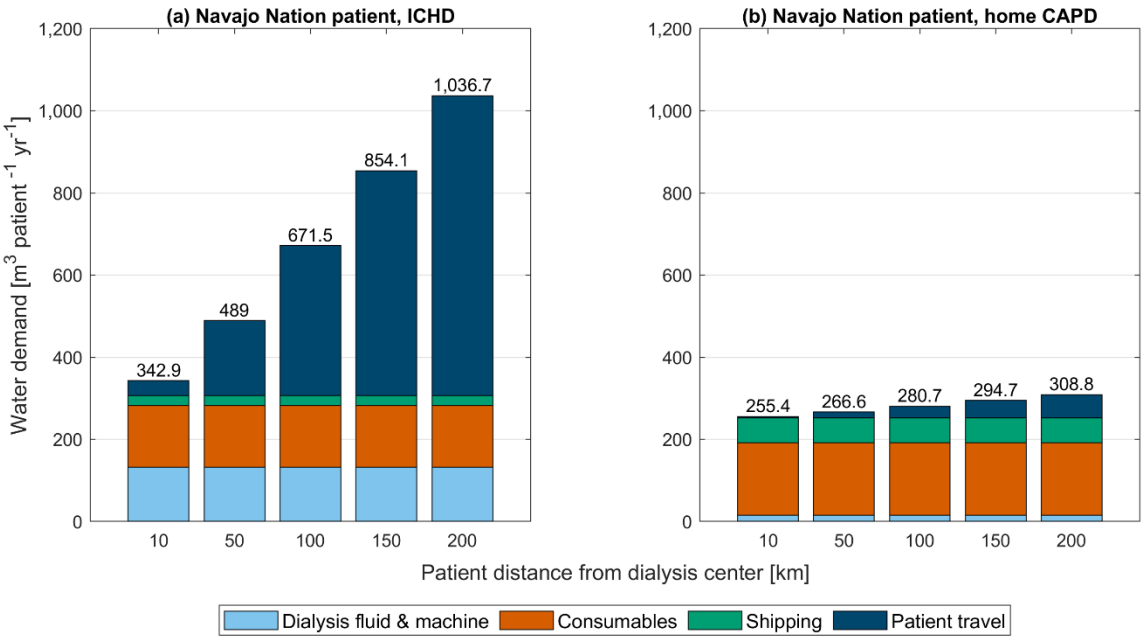

Figure S9. Annual per-patient water demand of (a) ICHD and (b) home CAPD for a patient living between 10 and 200 km from a dialysis center in Chinle, Navajo Nation. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. ICHD has higher water demand than home CAPD in all cases, and ICHD water demand increases drastically with increasing patient distance from the dialysis center due to the embodied water use of passenger car travel.

S3.2. Patient Geography Sensitivity Analysis Methods

To explore patient geography sensitivity, the initial baseline LCAs for ICHD and home CAPD were modified for eight additional patient locations in the U.S. and sub-Saharan Africa (Fig. S10). These locations were selected to represent a broad geographic range across these two regions and to include examples of places where home dialysis both is and is not currently available.

For ICHD, water is purified on-site in the dialysis center, and electricity is used for HD machine operation. The water purification sub-processes and HD machine electricity processes

used for the different patient locations analyzed are detailed in Tables S8 and S9. All other material and energy processes were identical to the baseline LCA (Tables S1-S3).

The transportation distances and ecoinvent transport processes used for each transportation step in the patient geography sensitivity analysis are included in Tables S10 (ICHD) and S11 (home CAPD). For the U.S. patient scenarios, we assumed that PD fluid was shipped from the manufacturer to a regional distribution center before delivery to the patient. For the sub-Saharan Africa patient scenarios, we assumed that PD fluid was shipped from the manufacturer to the local dialysis center before final delivery to the patient. Like the baseline LCA, land shipping was assumed to use a 16-32 metric ton truck at all stages, except for the final transportation of PD consumables from the distribution center or dialysis center to the patient home, which was assumed to use a 3.5-7.5 metric ton truck. All ocean shipping used container ship transport. Europe (RER) geography processes were used for all transport in Europe, and South Africa (ZA) geography processes were used for all transport in sub-Saharan Africa. In cases where geography-specific data was unavailable, RoW or GLO values were used. Like the Navajo Nation patient travel sensitivity, the distance between the patient and the dialysis center was varied from 10 km to 200 km for all eight patient location scenarios. For the four sub-Saharan Africa patient scenarios, the ICHD analysis was also conducted for motor scooter and minibus travel in addition to passenger car travel due to the high use of these transit options across sub-Saharan Africa[14].

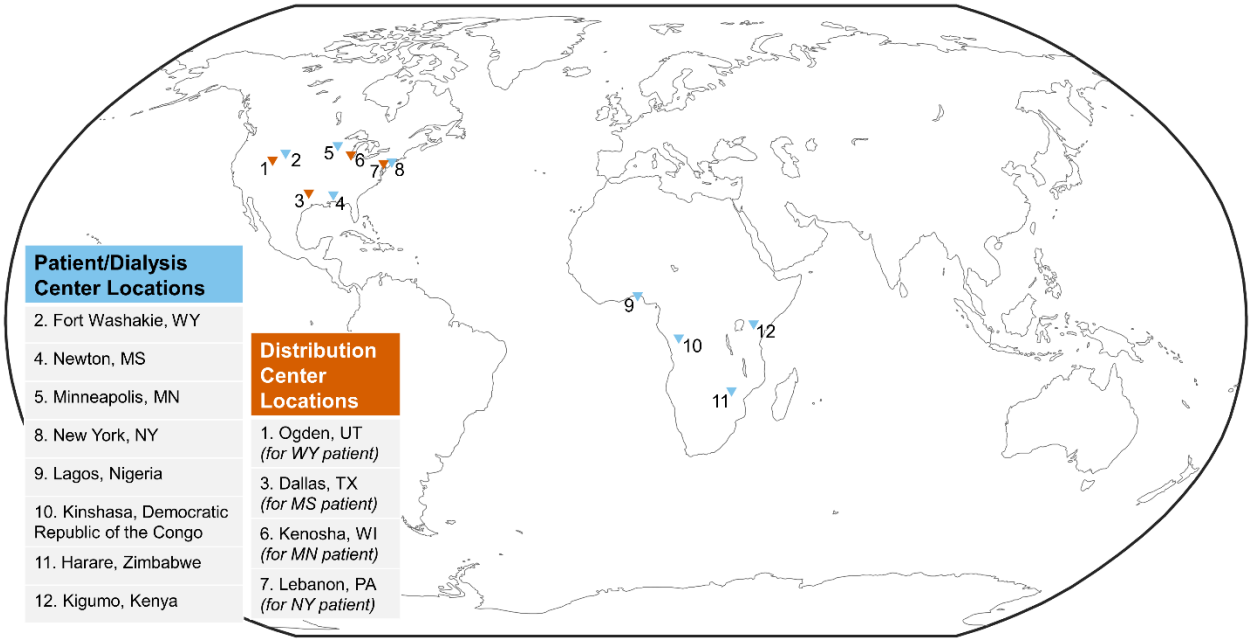

Figure S10. Map showing the patient/dialysis center and distribution center locations for the patient location and travel sensitivity analysis for ICHD and home CAPD. Distribution center locations are based on Fresenius/TruBlue Logistics distribution locations[15].

Table S8. Water purification sub-process material and energy inventories for ICHD for various patient/dialysis center location scenarios. Feed water and wastewater volumes and electricity consumption data from Barraclough et al.[5]

Item & Components	Quantity per 1 L purified water	ecoinvent process
Water purification | US-WECC (Fort Washakie, WY)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-WECC
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | US-SERC (Newton, MS)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-SERC
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | US-MRO (Minneapolis, MN)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-MRO
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | US-NPCC (New York, NY)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-NPCC
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | NG (Lagos, Nigeria)		
Feed water	2.174 L	market for tap water | tap water | ZA
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | NG
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | CD (Kinshasa, DRC)		
Feed water	2.174 L	market for tap water | tap water | ZA
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | CD
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | ZW (Harare, Zimbabwe)		
Feed water	2.174 L	market for tap water | tap water | ZA
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | ZW
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | KE (Kigumo, Kenya)		
Feed water	2.174 L	market for tap water | tap water | ZA
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | KE
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S9. HD machine electricity inventory for ICHD for various patient/dialysis center location scenarios.

Patient/dialysis center location	ecoinvent process for HD machine electricity
Fort Washakie, WY	market for electricity, low voltage | electricity, low voltage | US-WECC
Newton, MS	market for electricity, low voltage | electricity, low voltage | US-SERC
Minneapolis, MN	market for electricity, low voltage | electricity, low voltage | US-MRO
New York, NY	market for electricity, low voltage | electricity, low voltage | US-NPCC
Lagos, Nigeria	market for electricity, low voltage | electricity, low voltage | NG
Kinshasa, DRC	market for electricity, low voltage | electricity, low voltage | CD
Harare, Zimbabwe	market for electricity, low voltage | electricity, low voltage | ZW
Kigumo, Kenya	market for electricity, low voltage | electricity, low voltage | KE

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S10. ICHD transportation details for various patient/dialysis center location scenarios. All other transportation processes not listed here are identical to the baseline ICHD scenario (Table S5).

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Packaged concentrates/ blood tubing sets/dialyzers to dialysis center (U.S. patient scenarios)	St. Wendel, Germany	Fort Washakie, WY	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			6,636	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			3,251	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	St. Wendel, Germany	Newton, MS	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			7,434	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			993	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	St. Wendel, Germany	Minneapolis, MN	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			6,636	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			1,941	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	St. Wendel, Germany	New York, NY	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			6,636	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			32.2	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Packaged concentrates/ blood tubing sets/dialyzers to dialysis center (sub-Saharan Africa patient scenarios)	St. Wendel, Germany	Lagos, Nigeria	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			8,104	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			10.3	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	St. Wendel, Germany	Kinshasa, DRC	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			9,366	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	St. Wendel, Germany	Harare, Zimbabwe	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			10,649	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			2,281	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	St. Wendel, Germany	Kigumo, Kenya	620	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			11,979	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO

			569	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
Patient home to dialysis center (U.S. patient scenarios)	near Fort Washakie, WY; Newton, MS; Minneapolis, MN; New York, NY	Fort Washakie, WY; Newton, MS; Minneapolis, MN; New York, NY	10, 50, 100, 150, OR 200	transport, passenger, car, petrol, medium size, EURO 5 | transport, passenger, car, petrol, medium size, EURO 5 | RoW
Patient home to dialysis center (sub-Saharan Africa patient scenarios)	near Lagos, Nigeria; Kinshasa, DRC; Harare, Zimbabwe; Kigumo, Kenya	Lagos, Nigeria; Kinshasa, DRC; Harare, Zimbabwe; Kigumo, Kenya	10, 50, 100, 150, OR 200	transport, passenger, car, petrol, medium size, EURO 5 | transport, passenger, car, petrol, medium size, EURO 5 | RoW OR transport, passenger, motor scooter, fleet average | transport, passenger, motor scooter, fleet average | RoW OR transport, gasoline minibus jitney *(emissions factor based on average value of modeled 2020 low and high scenarios from Prozzi et al.*[16]*)*

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S11. Home CAPD transportation details for various patient/dialysis center location scenarios. All other transportation processes not listed here are identical to the baseline CAPD scenario (Table S6).

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Fluid to distribution center (U.S. patient scenarios)	North Cove, NC	Ogden, UT	3,146	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	North Cove, NC	Dallas, TX	1,609	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	North Cove, NC	Kenosha, WI	1,173	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	North Cove, NC	Lebanon, PA	882	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Fluid to patient home (U.S. patient scenarios)	Ogden, UT	Fort Washakie, WY	460	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | RoW
	Dallas, TX	Newton, MS	747	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | RoW
	Kenosha, WI	Minneapolis, MN	599	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | RoW
	Lebanon, PA	New York, NY	240	transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | transport, freight, lorry, 3.5-7.5 metric ton, diesel, EURO 6 | RoW
Fluid to dialysis center (sub-Saharan Africa patient scenarios)	North Cove, NC	Lagos, Nigeria	505	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			9,247	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			10.3	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	North Cove, NC	Kinshasa, DRC	505	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,497	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO

			580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	North Cove, NC	Harare, Zimbabwe	505	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,677	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			2,281	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	North Cove, NC	Kigumo, Kenya	505	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			15,649	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			569	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
Fluid to patient home (sub-Saharan Africa patient scenarios)	Lagos, Nigeria; Kinshasa, DRC; Harare, Zimbabwe; Kigumo, Kenya	near Lagos, Nigeria; Kinshasa, DRC; Harare, Zimbabwe; Kigumo, Kenya	10, 50, 100, 150, OR 200	transport, freight, lorry, 3.5-7.5 metric ton, diesel, unregulated | transport, freight, lorry, 3.5-7.5 metric ton, diesel, unregulated | ZA
Patient home to dialysis center (U.S. patient scenarios)	near Fort Washakie, WY; Newton, MS; Minneapolis, MN; New York, NY	Fort Washakie, WY; Newton, MS; Minneapolis, MN; New York, NY	10, 50, 100, 150, OR 200	transport, passenger, car, petrol, medium size, EURO 5 | transport, passenger, car, petrol, medium size, EURO 5 | RoW
Patient home to dialysis center (sub-Saharan Africa patient scenarios)	near Lagos, Nigeria; Kinshasa, DRC; Harare, Zimbabwe; Kigumo, Kenya	Lagos, Nigeria; Kinshasa, DRC; Harare, Zimbabwe; Kigumo, Kenya	10, 50, 100, 150, OR 200	transport, passenger, car, petrol, medium size, EURO 5 | transport, passenger, car, petrol, medium size, EURO 5 | RoW OR transport, passenger, motor scooter, fleet average | transport, passenger, motor scooter, fleet average | RoW OR transport, gasoline minibus jitney *(emissions factor based on average value of modeled 2020 low and high scenarios from Prozzi et al.*[16]*)*

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

S3.3. Patient Geography Sensitivity Analysis Results

The results for all patient location scenarios are shown in Figures S11-S18. The cutoff distance at which CAPD becomes less carbon intensive than ICHD with car transport varied from 19 km for the DRC and Kenya patients (Figs. S16 and S18) to 31 km for the Mississippi patient (Fig. S12). For the sub-Saharan Africa scenarios, motor scooter transport reduced the CFP of patient travel compared to car transport by ~60%. In this case, the cutoff distance at which CAPD becomes less carbon intensive than ICHD varied from 40 km for the Nigeria patient (Fig. S15) to 64 km for the Zimbabwe patient (Fig. S17). Public transport options, like minibuses, drastically reduced ICHD CFP, so it was less than CAPD for all patient distances. However, it should be noted that while the environmental benefits of public transport are

theoretically highest for very rural patients, these patients often have lease access to public transport options, and actual per-person emissions would increase with fewer individuals sharing a route.

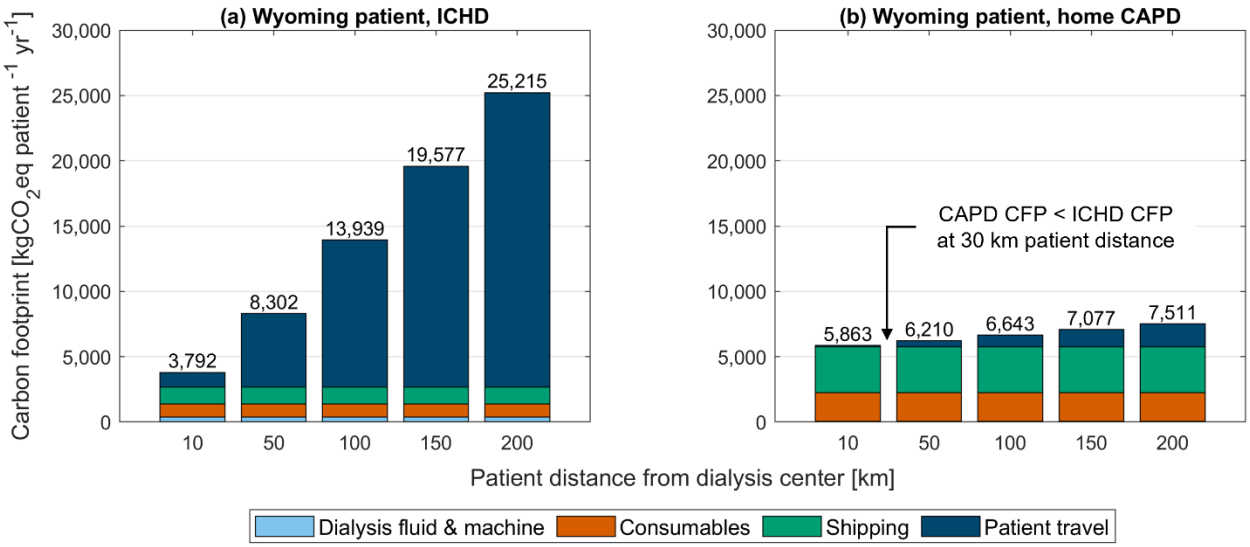

Figure S11. Annual per-patient CFP of (a) ICHD and (b) home CAPD for a patient living between 10 and 200 km from a dialysis center in Fort Washakie, Wyoming. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP is less than ICHD for any patient travel distance above 30 km.

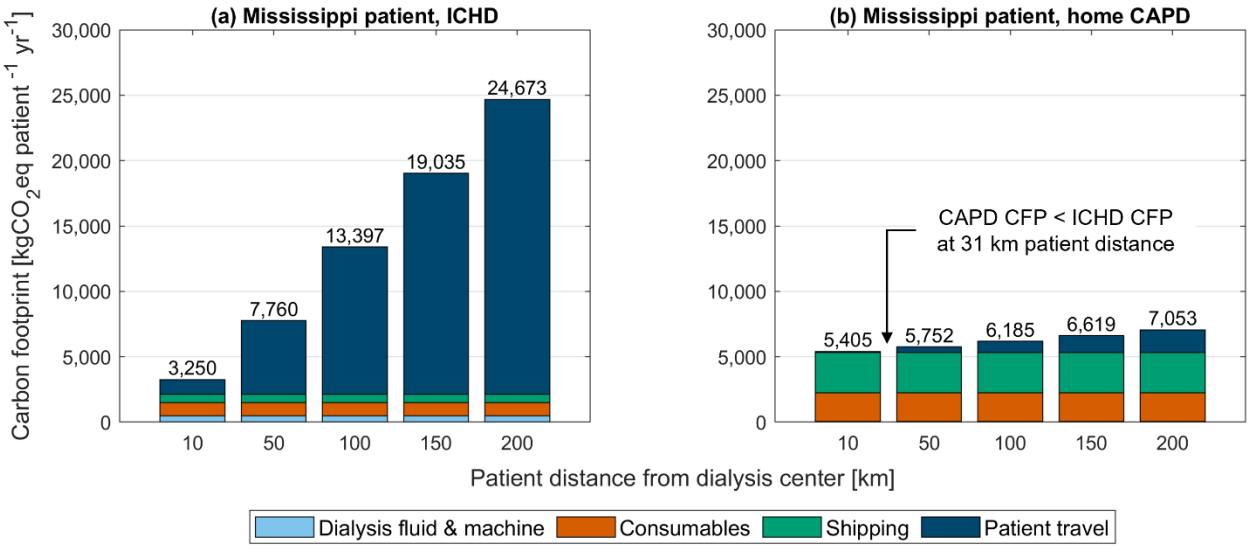

Figure S12. Annual per-patient CFP of (a) ICHD and (b) home CAPD for a patient living between 10 and 200 km from a dialysis center in Newton, Mississippi. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP is less than ICHD for any patient travel distance above 31 km.

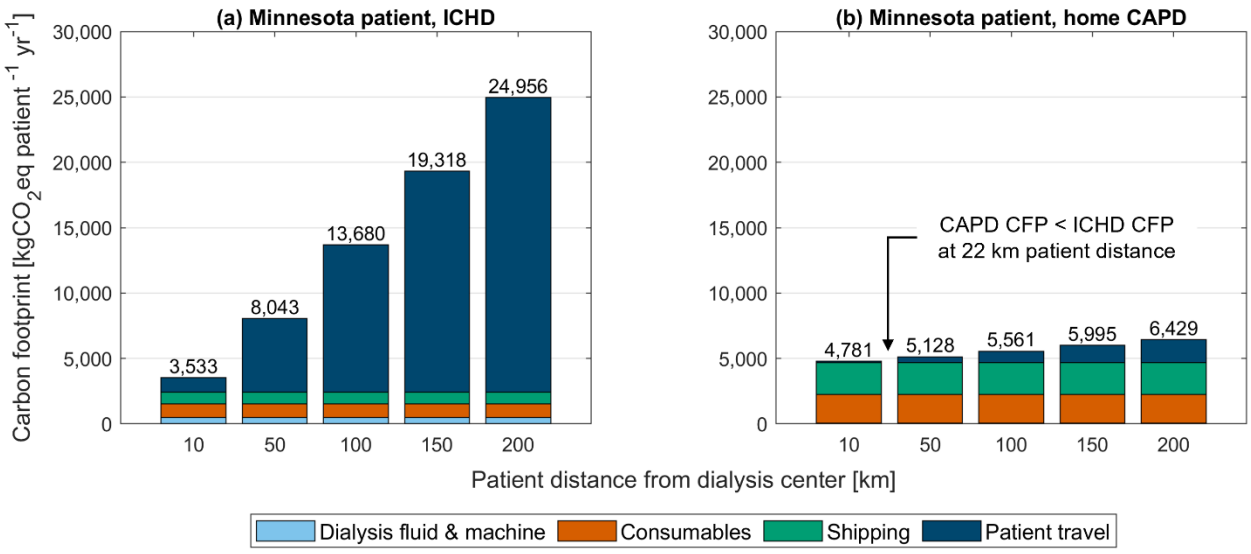

Figure S13. Annual per-patient CFP of (a) ICHD and (b) home CAPD for a patient living between 10 and 200 km from a dialysis center in Minneapolis, Minnesota. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP is less than ICHD for any patient travel distance above 22 km.

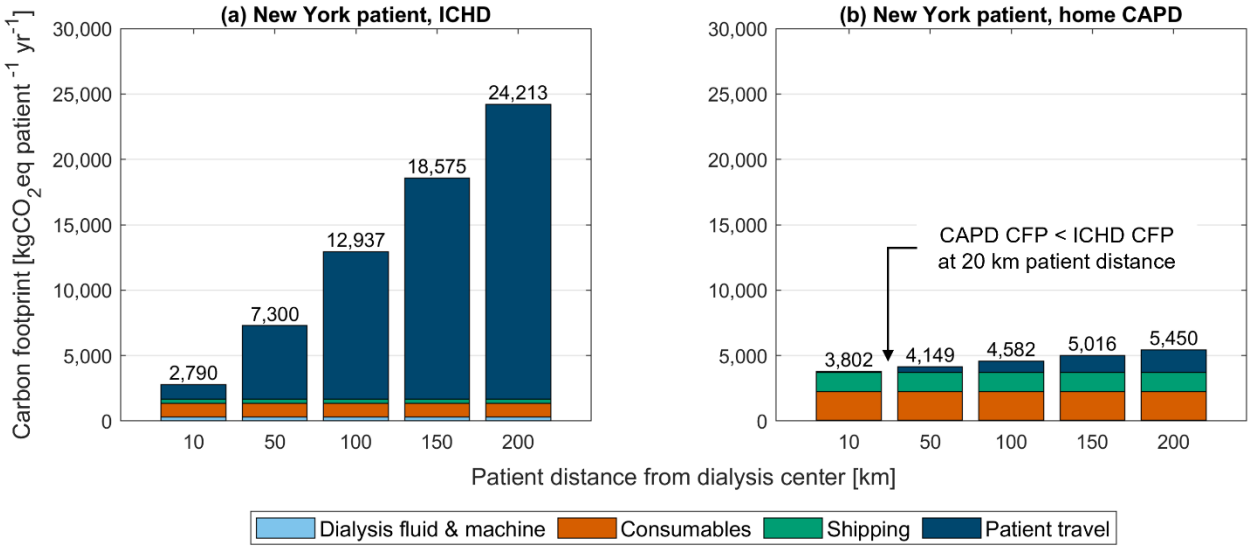

Figure S14. Annual per-patient CFP of (a) ICHD and (b) home CAPD for a patient living between 10 and 200 km from a dialysis center in New York, New York. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP is less than ICHD for any patient travel distance above 20 km.

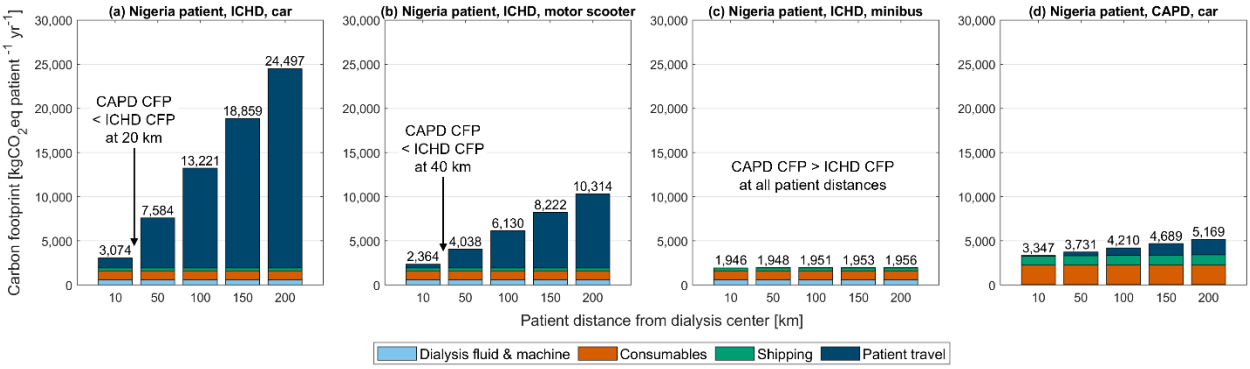

Figure S15. Annual per-patient CFP of (a) ICHD using personal car transport, (b) ICHD using personal motor scooter transport, (c) ICHD using public minibus transport, and (d) home CAPD using personal car transport for a patient living between 10 and 200 km from a dialysis center in Lagos, Nigeria. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP using a personal car is less than the ICHD CFP using a personal car or motor scooter for any patient travel distance above 20 km or 40 km, respectively. The ICHD CFP using public minibus transport is less than the home CAPD CFP at all patient distances.

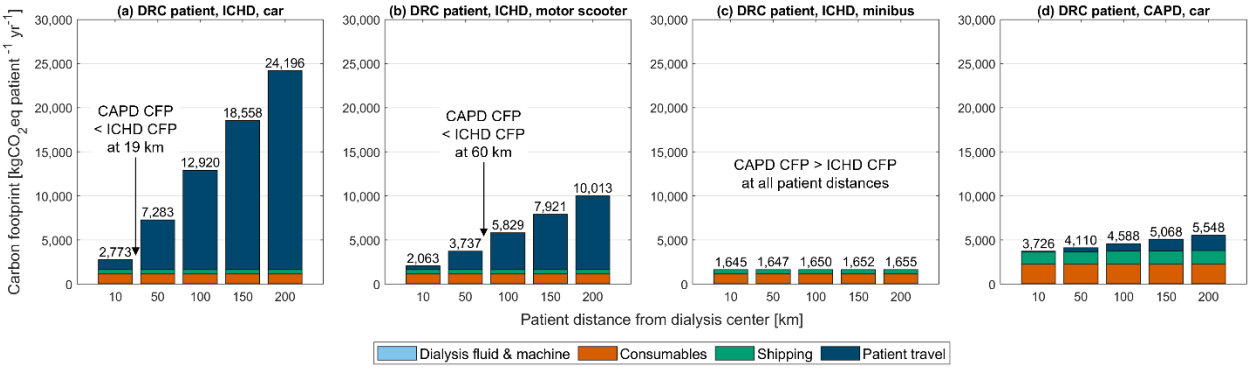

Figure S16. Annual per-patient CFP of (a) ICHD using personal car transport, (b) ICHD using personal motor scooter transport, (c) ICHD using public minibus transport, and (d) home CAPD using personal car transport for a patient living between 10 and 200 km from a dialysis center in Kinshasa, DRC. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP using a personal car is less than the ICHD CFP using a personal car or motor scooter for any patient travel distance above 19 km or 60 km, respectively. The ICHD CFP using public minibus transport is less than the home CAPD CFP at all patient distances.

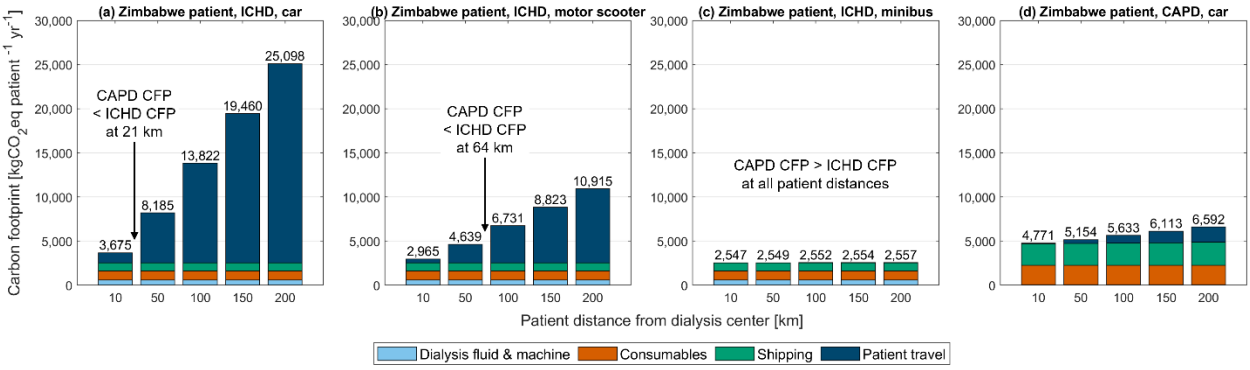

Figure S17. Annual per-patient CFP of (a) ICHD using personal car transport, (b) ICHD using personal motor scooter transport, (c) ICHD using public minibus transport, and (d) home CAPD using personal car transport for a patient living between 10 and 200 km from a dialysis center in Harare, Zimbabwe. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP using a personal car is less than the ICHD CFP using a personal car or motor scooter for any patient travel distance above 21 km or 64 km, respectively. The ICHD CFP using public minibus transport is less than the home CAPD CFP at all patient distances.

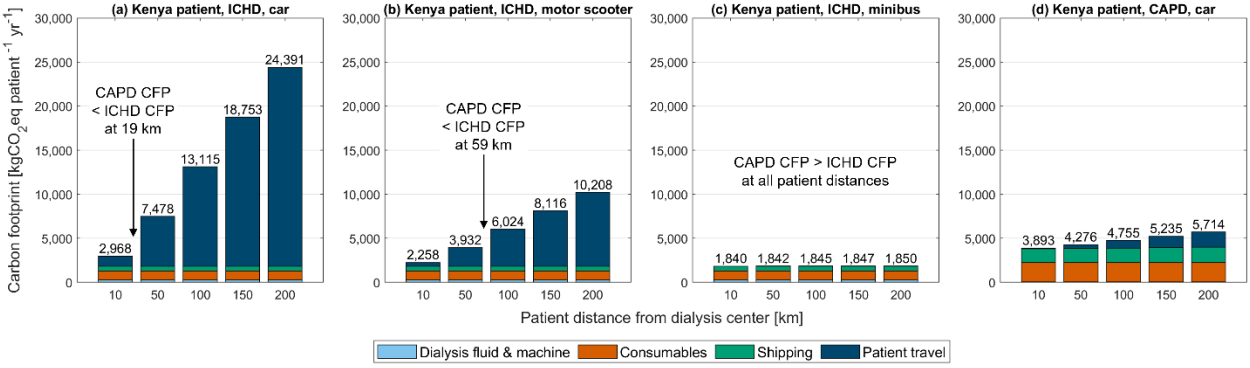

Figure S18. Annual per-patient CFP of (a) ICHD using personal car transport, (b) ICHD using personal motor scooter transport, (c) ICHD using public minibus transport, and (d) home CAPD using personal car transport for a patient living between 10 and 200 km from a dialysis center in Kigumo, Kenya. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The home CAPD CFP using a personal car is less than the ICHD CFP using a personal car or motor scooter for any patient travel distance above 19 km or 59 km, respectively. The ICHD CFP using public minibus transport is less than the home CAPD CFP at all patient distances.

S4. PD Fluid Manufacturing Location Sensitivity Analysis

S4.1. Manufacturing Location Sensitivity Analysis Methods

Because of the significant, yet variable, contribution of shipping to the home CAPD CFP a sensitivity analysis of PD fluid manufacturing location was conducted. For each of the nine patient locations, a CAPD LCA was conducted for six different centralized PD fluid manufacturing locations, selected as a globally distributed sample of current manufacturing facility locations. The manufacturing locations of the PD fluid inputs (solutes, cardboard packaging) were also varied with the fluid manufacturing scenarios. All locations are shown in Figure S19. The material and energy inventory were identical to the initial home CAPD baseline (Table S3), except for a few changes to the ecoinvent processes used:

- The water purification sub-process varied with manufacturing location (Table S12).
- The Friedberg, Germany, manufacturing scenario used RER material inputs for packaged solutes (blow molding, dextrose, sodium chloride, sodium lactate, calcium chloride, magnesium chloride). All other manufacturing scenarios used RoW inputs (same as baseline, Table S3).
- For corrugated cardboard, US geography processes were used in the North Cove, North Carolina, and Bloomington, Indiana, manufacturing scenarios (same as baseline, Table S3). RER geography processes were used in the Friedberg, Germany, manufacturing scenario. All other manufacturing scenarios used RoW geography processes.

The transportation distances and ecoinvent transport processes used for each transportation step in the manufacturing geography sensitivity analysis are included in Tables S13-S17. For the Navajo Nation and U.S. patient scenarios, we assumed that PD fluid was shipped from the manufacturer to a regional distribution center before delivery to the patient. For the sub-Saharan Africa patient scenarios, we assumed that PD fluid was shipped from the manufacturer to the local dialysis center before final delivery to the patient. Like the baseline LCA and patient travel sensitivity, land shipping was assumed to use a 16-32 metric ton truck at all stages, except for the final transportation of PD consumables from the distribution center or dialysis center to the patient home, which was assumed to use a 3.5-7.5 metric ton truck. All ocean shipping used container ship transport. RER geography processes were used for all transport in Europe, and ZA South Africa geography processes were used for all transport in sub-Saharan Africa. In all other cases, RoW or GLO processes were used. The distance between the patient and the dialysis center was held constant at 10 km, and patient travel was assumed to be via personal car. Because the long-distance land transport of packaged fluid dominates, differences in patient distance were determined to lead to only minor variation in the home CAPD CFP. Holding patient distance constant was therefore deemed a reasonable assumption.

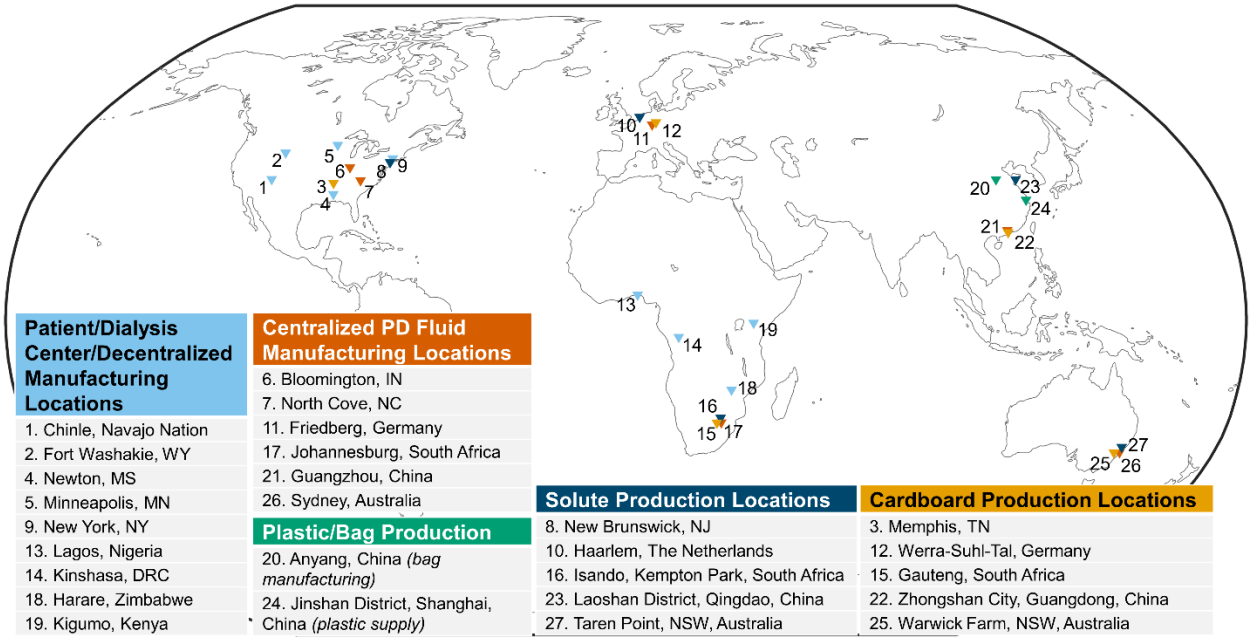

Figure S19. Map showing the locations of the patient/dialysis center/decentralized manufacturing, centralized manufacturing, and other manufacturing steps (plastic, bag, solute, and cardboard production) for the manufacturing location sensitivity analysis for home CAPD.

Table S12. Water purification subprocess material and energy inventories for PD fluid manufacturing for various centralized manufacturing location scenarios. Feed water and wastewater volumes and electricity consumption are based on the Essendon Fields reverse osmosis plant water and power consumption data from Barraclough et al.[5]

Item & Components	Quantity per 1 L purified water	ecoinvent process
Water purification | US-SERC (North Cove, NC)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-SERC
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | US-RFC (Indianapolis, IN)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | US-RFC
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | DE (Friedberg, Germany)		
Feed water	2.174 L	market for tap water | tap water | RER without CH
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | DE
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RER without CH
Water purification | CN-S (Guangzhou, China)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | CN-S-grid
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | AU (Sydney, Australia)		
Feed water	2.174 L	market for tap water | tap water | RoW
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | AU
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW
Water purification | ZA (Johannesburg, South Africa)		

Feed water	2.174 L	market for tap water | tap water | ZA
Electricity	0.0189 kWh	market for electricity, low voltage | electricity, low voltage | ZA
Wastewater	1.174 L	market for wastewater, average | wastewater, average | RoW

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S13. Transportation details for home CAPD with centralized PD fluid manufacturing in Bloomington, Indiana.

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Plastic to bag production	Jinshan District, Shanghai, China	Anyang, China	1,091	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Bags to fluid manufacturing	Anyang, China	Bloomington, IN	3,978	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
HDPE to solute production	Jinshan District, Shanghai, China	New Brunswick, NJ	175	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			19,598	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
Solutes to fluid manufacturing	New Brunswick, NJ	Bloomington, IN	1,204	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Cardboard to fluid manufacturing	Memphis, TN	Bloomington, IN	652	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Fluid to distribution center/dialysis center	Bloomington, IN	Los Lunas, NM	2,217	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Ogden, UT	2,415	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Dallas, TX	1,398	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Kenosha, WI	484	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Lebanon, PA	1,002	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Lagos, Nigeria	1,012	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			9,351	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			10.3	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Kinshasa, DRC	1,012	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,608	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Harare, Zimbabwe	1,012	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,825	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO

		2,281	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	Kigumo, Kenya	1,012	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		15,533	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		569	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S14. Transportation details for home CAPD with centralized PD fluid manufacturing in Friedberg, Germany.

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Plastic to bag production	Jinshan District, Shanghai, China	Anyang, China	1,091	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Bags to fluid manufacturing	Anyang, China	Friedberg, Germany	651	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			20,291	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
HDPE to solute production	Jinshan District, Shanghai, China	Haarlem, The Netherlands	125	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			19,544	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			17	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
Solutes to fluid manufacturing	Haarlem, The Netherlands	Friedberg, Germany	455	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
Cardboard to fluid manufacturing	Werra-Suhl-Tal, Germany	Friedberg, Germany	146	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
Fluid to distribution center/dialysis center	Friedberg, Germany	Los Lunas, NM	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			7,434	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			2,774	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Ogden, UT	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			6,636	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			3,483	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Dallas, TX	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
			7,434	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO

		1,749	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	Kenosha, WI	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
		6,636	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		1,395	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	Lebanon, PA	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
		6,636	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		233	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
	Lagos, Nigeria	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
		8,104	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		10.3	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	Kinshasa, DRC	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
		9,366	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	Harare, Zimbabwe	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
		10,649	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		2,281	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	Kigumo, Kenya	494	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RER
		11,979	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		569	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S15. Transportation details for home CAPD with centralized PD fluid manufacturing in Guangzhou, China.

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Plastic to bag production	Jinshan District, Shanghai, China	Anyang, China	1,091	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Bags to fluid manufacturing	Anyang, China	Liwan District, Guangzhou, China	1,627	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW

HDPE to solute production	Jinshan District, Shanghai, China	Laoshan District, Qingdao, China	764	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Solutes to fluid manufacturing	Laoshan District, Qingdao, China	Liwan District, Guangzhou, China	1,907	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Cardboard to fluid manufacturing	Zhongshan City, Guangdong, China	Liwan District, Guangzhou, China	85.6	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Fluid to distribution center/dialysis center	Liwan District, Guangzhou, China	Los Lunas, NM	1,332	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,938	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Ogden, UT	1.227	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,938	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Dallas, TX	2,367	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,938	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Kenosha, WI	3,366	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,938	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Lebanon, PA	4,310	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,938	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Lagos, Nigeria	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			16,867	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			10.3	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Kinshasa, DRC	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			15,385	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Harare, Zimbabwe	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,314	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			1,662	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Kigumo, Kenya	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW

		12,047	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		569	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S16. Transportation details for home CAPD with centralized PD fluid manufacturing in Sydney, Australia.

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Plastic to bag production	Jinshan District, Shanghai, China	Anyang, China	1,091	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Bags to fluid manufacturing	Anyang, China	Sydney, Australia	687	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			9,010	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
HDPE to solute production	Jinshan District, Shanghai, China	Taren Point, NSW, Australia	157	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			8,578	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
Solutes to fluid manufacturing	Taren Point, NSW, Australia	Sydney, Australia	44	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Cardboard to fluid manufacturing	Warwick Farm, NSW, Australia	Sydney, Australia	18	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Fluid to distribution center/dialysis center	Sydney, Australia	Los Lunas, NM	1,332	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			12,057	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Ogden, UT	1,227	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			12,057	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Dallas, TX	2,366	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			12,057	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Kenosha, WI	3,365	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			12,057	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Lebanon, PA	4,310	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			12,057	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Lagos, Nigeria	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			16,887	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO

		10.3	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	Kinshasa, DRC	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		15,385	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	Harare, Zimbabwe	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		11,314	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		1,662	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
	Kigumo, Kenya	36.4	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		12,047	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		569	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

Table S17. Transportation details for home CAPD with centralized PD fluid manufacturing in Johannesburg, South Africa.

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
Plastic to bag production	Jinshan District, Shanghai, China	Anyang, China	1,091	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Bags to fluid manufacturing	Anyang, China	Johannesburg, South Africa	651	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,314	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
HDPE to solute production	Jinshan District, Shanghai, China	Isando, Kempton Park, South Africa	125	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			12,992	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			577	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
Solutes to fluid manufacturing	Isando, Kempton Park, South Africa	Johannesburg, South Africa	33.8	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
Cardboard to fluid manufacturing	Gauteng, South Africa	Johannesburg, South Africa	21.6	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA

Fluid to distribution center/dialysis center	Johannesburg, South Africa	Los Lunas, NM	1,390	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			12,649	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			2,774	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Ogden, UT	1,390	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			12,573	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			3,483	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Dallas, TX	1,390	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			12,649	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			1,479	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Kenosha, WI	1,390	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			12,573	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			1,395	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Lebanon, PA	1,390	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			12,573	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			233	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Lagos, Nigeria	1,400	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			4752	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Kinshasa, DRC	1,970	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			3,251	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Harare, Zimbabwe	1,129	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Kigumo, Kenya	1,149	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			3,184	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

S4.2. Decentralized Manufacturing Scenario Methods

For all nine patient locations, we also conducted an LCA of CAPD using decentralized PD fluid manufacturing in a local dialysis center. In this scenario, solutes and empty bags are shipped to the dialysis center, water is purified on-site, and PD fluid is prepared and packaged before distribution to patient homes. The general process tree for decentralized manufacturing is shown in Figure S20. The material and energy inventory data for decentralized manufacturing were identical to the baseline CAPD scenario (Table S3), except for two changes to the ecoinvent processes:

- The water purification sub-processes varied with patient/dialysis center location and were the same as those used for the ICHD patient location sensitivity (Table S8).
- For corrugated cardboard, US geography processes were used in the Navajo Nation and U.S. patient scenarios while RoW geography processes were used for the sub-Saharan Africa patient scenarios.

Details about the transportation distances and ecoinvent transport processes used are included in Table S18.

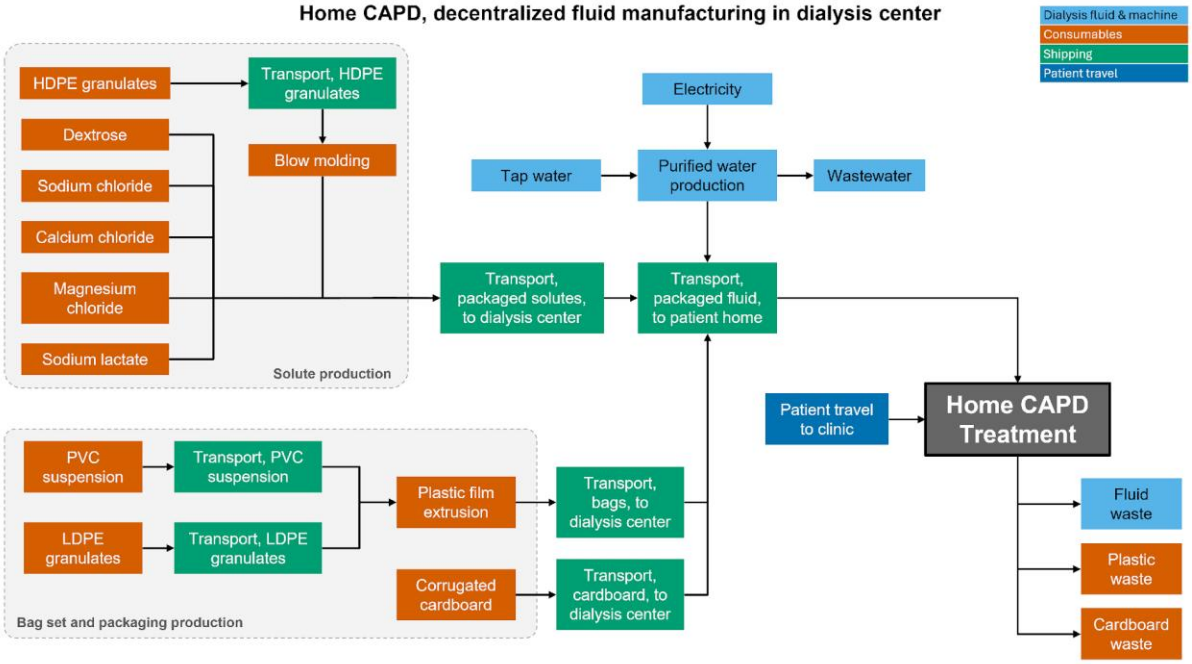

Figure S20. Process tree for home CAPD treatment using decentralized fluid manufacturing in a local dialysis center. Solute and bag set (including attached drain bag) production occur at their respective manufacturing facilities before shipping to the dialysis center, where water purification, mixing, and packaging occur. The packaged fluid is then shipped to the patient's home. The patient travels one time monthly to the dialysis center for clinical visits. Waste fluid, plastic, and cardboard are all disposed of following treatment.

Table S18. Transportation details for home CAPD with decentralized PD fluid manufacturing in various local dialysis centers.

Transport process	Starting location	Ending location	Distance (km)	ecoinvent process
All scenarios				
Plastic to bag production	Jinshan District, Shanghai, China	Anyang, China	1,091	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Navajo Nation/U.S. patient/decentralized fluid manufacturing scenarios				
Bags to dialysis center	Anyang, China	Chinle, Navajo Nation	3,978	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Fort Washakie, WY	2,247	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Newton, MS	3,729	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Minneapolis, MN	3,779	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		New York, NY	5,150	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			10,568	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
HDPE to solute production	Jinshan District, Shanghai, China	New Brunswick, NJ	175	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			19,598	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
Solutes to dialysis center	New Brunswick, NJ	Chinle, Navajo Nation	3,551	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Fort Washakie, WY	3,253	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Newton, MS	1,791	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Minneapolis, MN	1,942	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		New York, NY	58	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Cardboard to dialysis center	Memphis, TN	Chinle, Navajo Nation	1,987	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Fort Washakie, WY	2,212	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		Newton, MS	360	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW

		Minneapolis, MN	1,332	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
		New York, NY	1,780	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
Sub-Saharan Africa patient/decentralized fluid manufacturing scenarios				
Bags to dialysis center	Anyang, China	Lagos, Nigeria	651	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			19,415	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			10.3	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Kinshasa, DRC	651	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			17,913	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			580	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Harare, Zimbabwe	651	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,314	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			1,662	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Kigumo, Kenya	651	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			11,942	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			569	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
HDPE to solute production	Jinshan District, Shanghai, China	Isando, Kempton Park, South Africa	125	transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | RoW
			12,992	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
			577	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
Solutes to dialysis center	Isando, Kempton Park, South Africa	Lagos, Nigeria	1,431	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			4,752	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Kinshasa, DRC	2,001	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			3,250	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Harare, Zimbabwe	1,110	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA

		Kigumo, Kenya	1,146	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			3,184	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
Cardboard to dialysis center	Gauteng, South Africa	Lagos, Nigeria	1,409	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			4,752	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Kinshasa, DRC	1,979	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			3,250	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO
		Harare, Zimbabwe	1,128	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
		Kigumo, Kenya	1,126	transport, freight, lorry, 16-32 metric ton, diesel, unregulated | transport, freight, lorry, 16-32 metric ton, diesel, unregulated | ZA
			3,184	transport, freight, sea, container ship, heavy fuel oil | transport, freight, sea, container ship, heavy fuel oil | GLO

Note: all ecoinvent processes are allocation at the point of substitution, system (APOS, S)

S4.2. Manufacturing Location Sensitivity Analysis Results

The results for all patient and manufacturing location combinations (Fig. S21) show that geography is a significant determinant of the CAPD CFP. For conventional centralized manufacturing, the total CFP varied from 3,123 $kgCO_2eq$ for the Nigeria patient/Australia manufacturing scenario (Fig. S21f) to 7,247 $kgCO2_2eq$ for the Wyoming patient/South Africa manufacturing scenario (Fig. S21b), with shipping contributing 23-66%. Because it minimizes the distance over which heavy packaged fluid must be shipped, decentralized fluid manufacturing in a dialysis center led to a lower CFP than centralized fluid manufacturing in all cases: 2,604-2,738 $kgCO_2eq$. Furthermore, decentralizing manufacturing made the total home CAPD CFP largely independent of patient geography (~5% variation across all geographies).

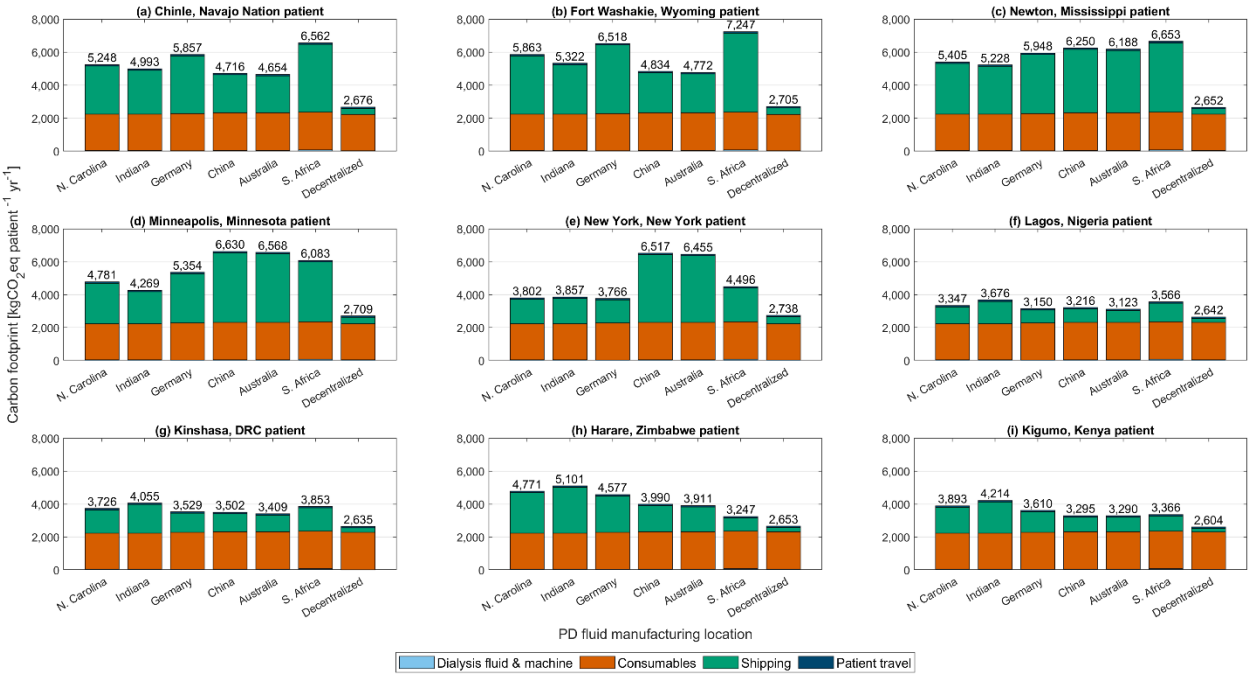

Figure S21. Annual per-patient CFP of home CAPD using PD fluid manufactured in various centralized locations or decentralized in a local dialysis center for a patient living in (a) Chinle, Navajo Nation; (b) Fort Washakie, Wyoming; (c) Newton, Mississippi; (d) Minneapolis, Minnesota; (e) New York, New York; (f) Lagos, Nigeria; (g) Kinshasa, DRC; (h) Harare, Zimbabwe; and (i) Kigumo, Kenya. Stacked bars show contributions from dialysis fluid and machine operation, consumables, shipping, and patient travel. The CFP using centralized fluid manufacturing varies significantly with patient and manufacturing location. Decentralized fluid manufacturing leads to a lower CFP than centralized fluid manufacturing in all cases by minimizing the distance over which heavy packaged fluid must be shipped.

S5. CFP Reduction Metric Assumptions

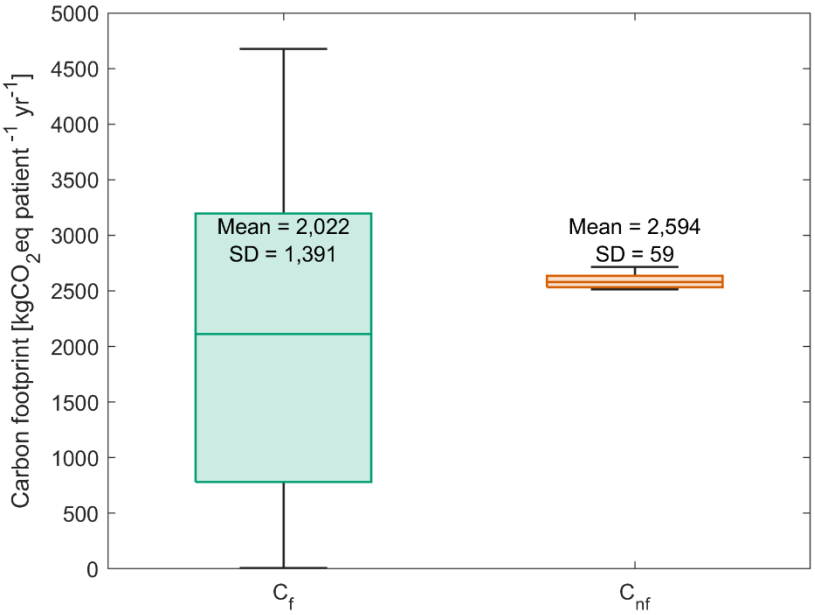

Figure S22. Distributions of the annual per-patient CFP of home CAPD from shipping of packaged PD fluid (C_{fluid} = C_f) and from all other processes ($C_{not\ fluid}$ = C_{nf}) are shown for the 63 previously analyzed scenarios (x54 centralized scenarios, x9 decentralized scenarios). While C_{nf} does vary slightly with geography (SD = 59 kgCO2eq), the most significant variation in CFP comes from shipping of packaged PD fluid, C_f (SD = 1,391 kgCO2eq). Therefore, to enable application of the CFP reduction metric to any location scenario, we assumed C_{nf} was constant in the CFP reduction metric and used the mean value of 2,594 kgCO2eq (see Equation 5).

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