ENVIRONMENTAL IMPACT OF CARE FOR PATIENTS WITH DIALYSIS-DEPENDENT KIDNEY FAILURE

Frances Mortimer, 25 April 2025

Disclosures

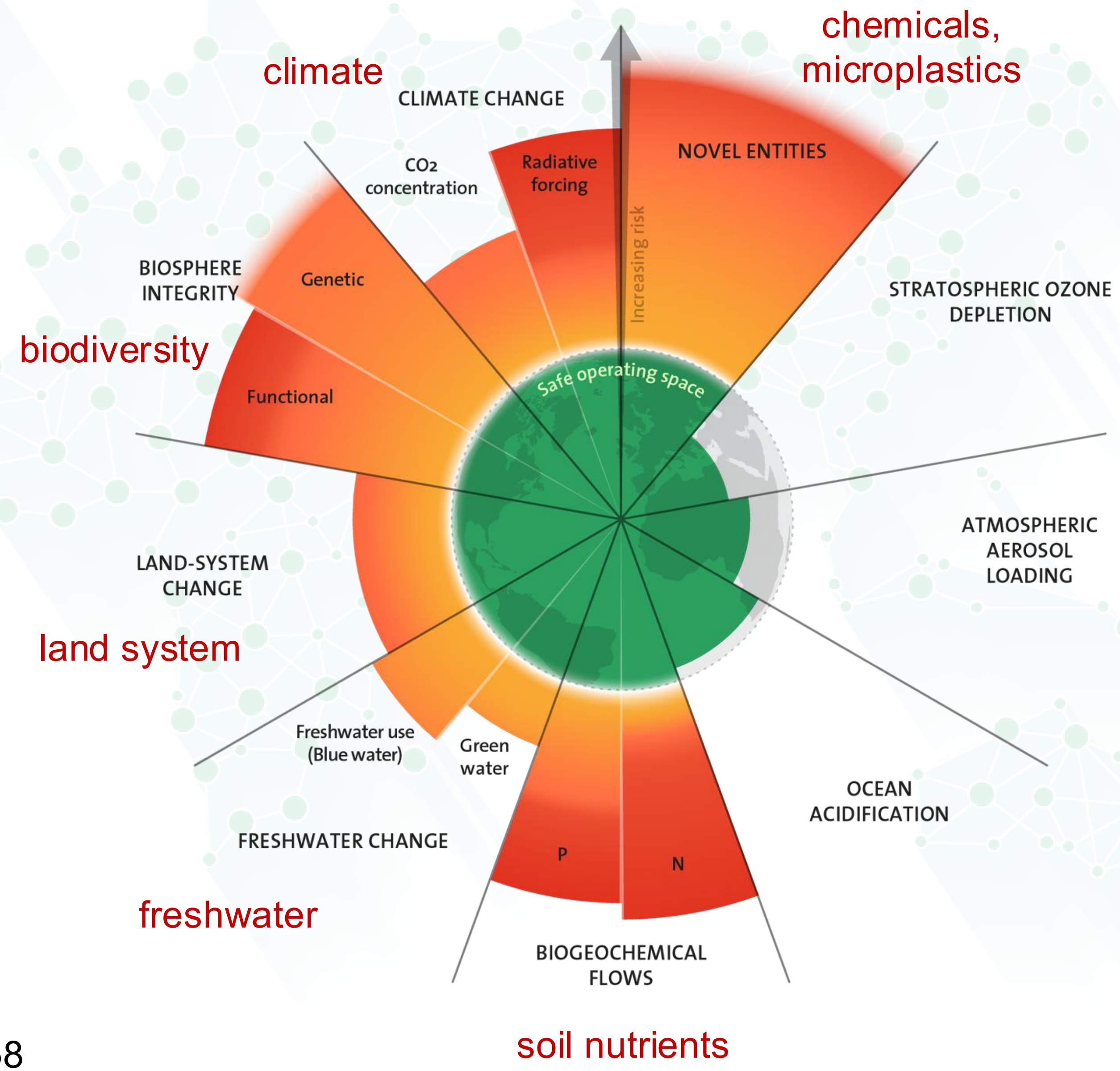
- KitNewCare – 4-year project funded by Horizon Europe / UKRI
- Implementing Sustainable Kidney Care – project funding from NHS England in 2024-5

Context

- Increasing CKD prevalence and increasing dialysis populations – estimated 3 million globally, predicted could double by 2030
- Unequal but increasing access to kidney replacement therapy in LMICs

Context

- Six out of nine planetary boundaries crossed in 2023
- Earth self-regulation disrupted



Richardson et al. 2023. DOI:10.1126/sciadv.adh2458

Carbon footprint of haemodialysis

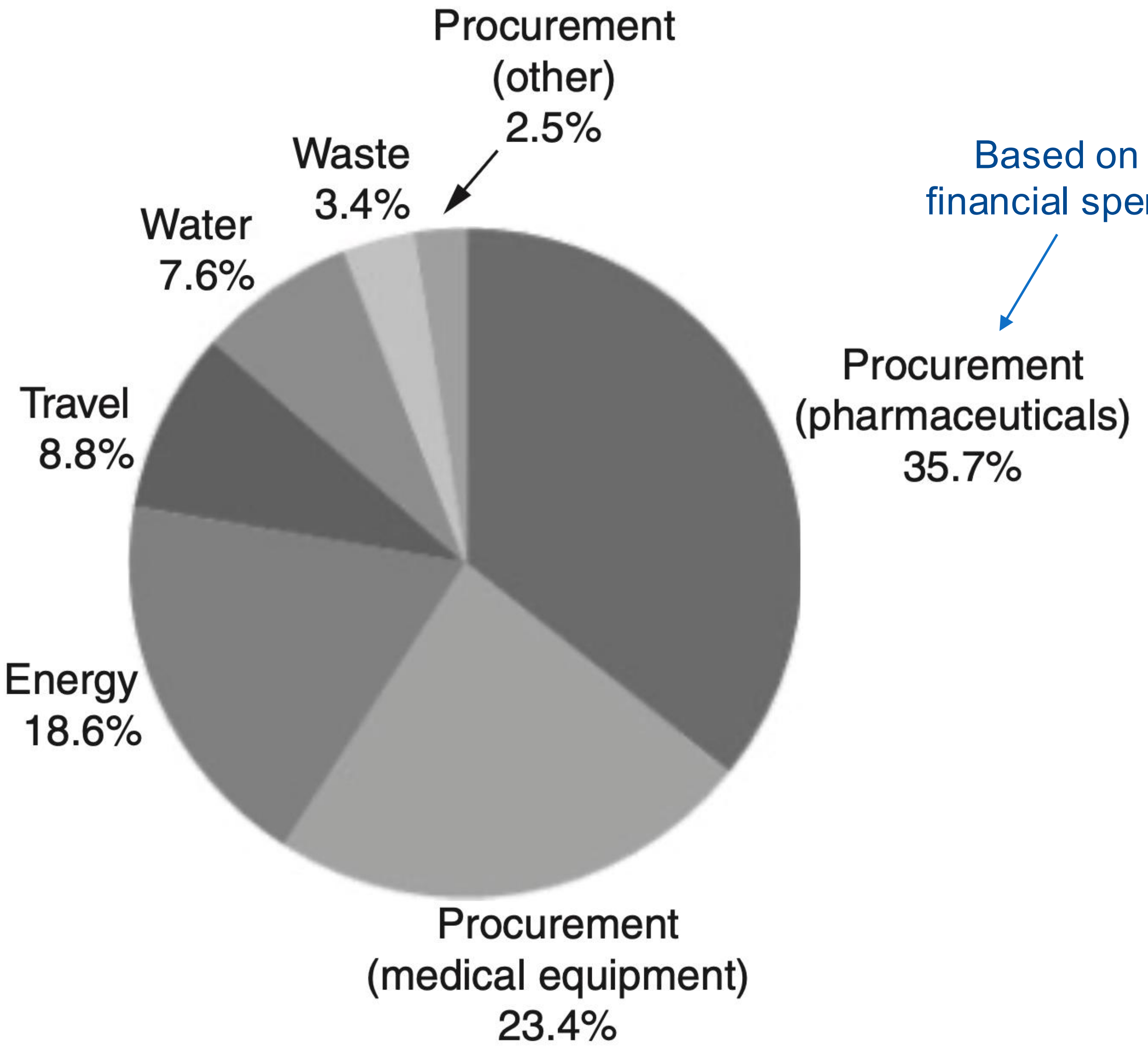
The annual per-patient carbon footprint of conventional HD (i.e. 3 x 4-h sessions/week) has been estimated at **3.8-10.3 tCO_2e**

Study / Country	Carbon emissions (tCO_2e per patient per year)
Barraclough et al. (2025) Australia	4.8
Hernández et al. (2023) Mexico	10.3
Sehgal et al. (2022) United States	9.2
Mtioui et al. (2020) Morocco	5.1
Lim et al. (2013) Australia	10.2
Connor et al. (2011) United Kingdom	3.8

- Equivalent to driving 22,000-62,000 km in an average (UK) car
  (Source: UK Government)

- Global average total annual emissions per person = 4.7 tCO_2e
  (Source: World Bank)

Carbon footprint of haemodialysis - breakdown



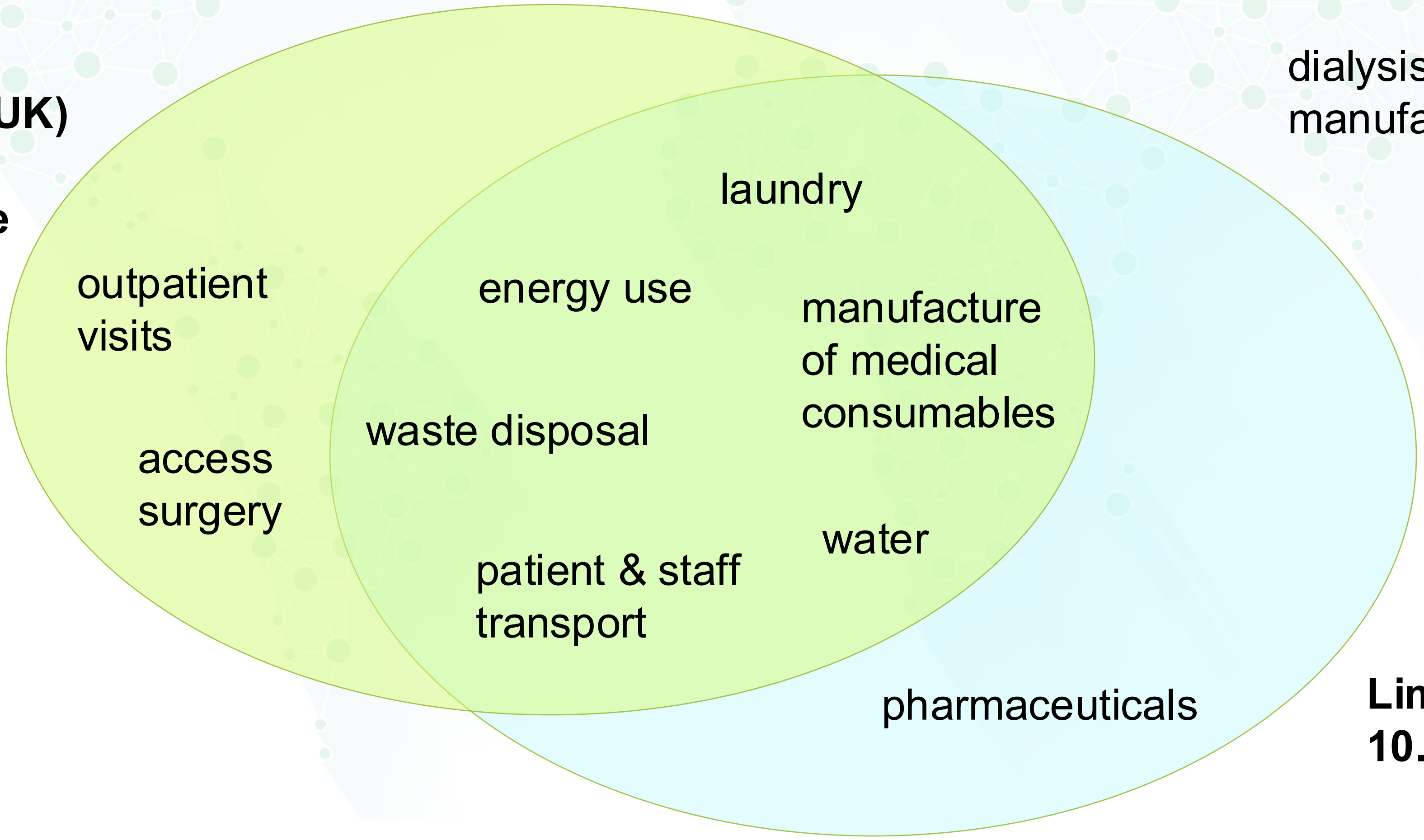
Based on financial spend

Sector and procurement subsector breakdown of the greenhouse gas emissions of the Victorian suburban satellite dialysis unit.

Lim et al, 2013. DOI:10.1071/AH13022

Carbon footprint of haemodialysis

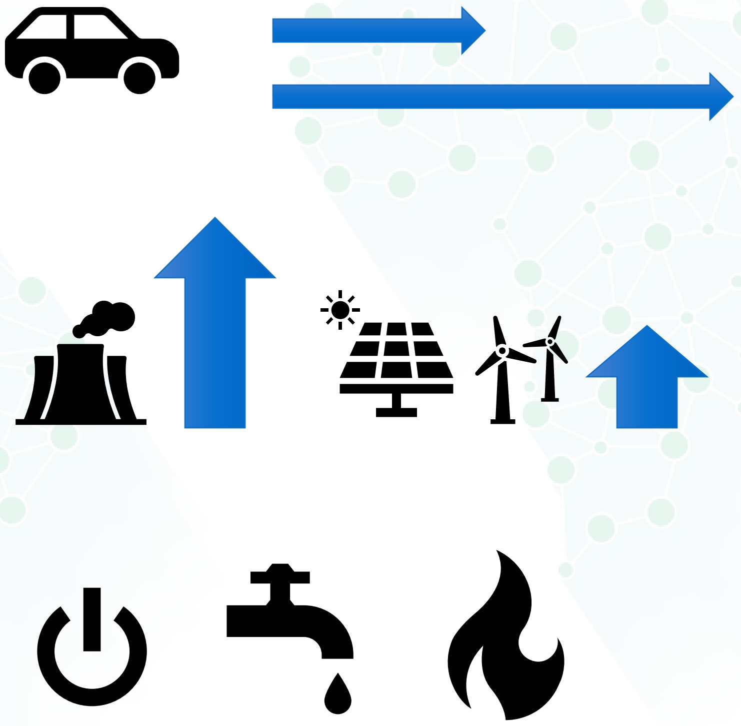
Study variation: scope



Carbon footprint of haemodialysis

Sources of variation

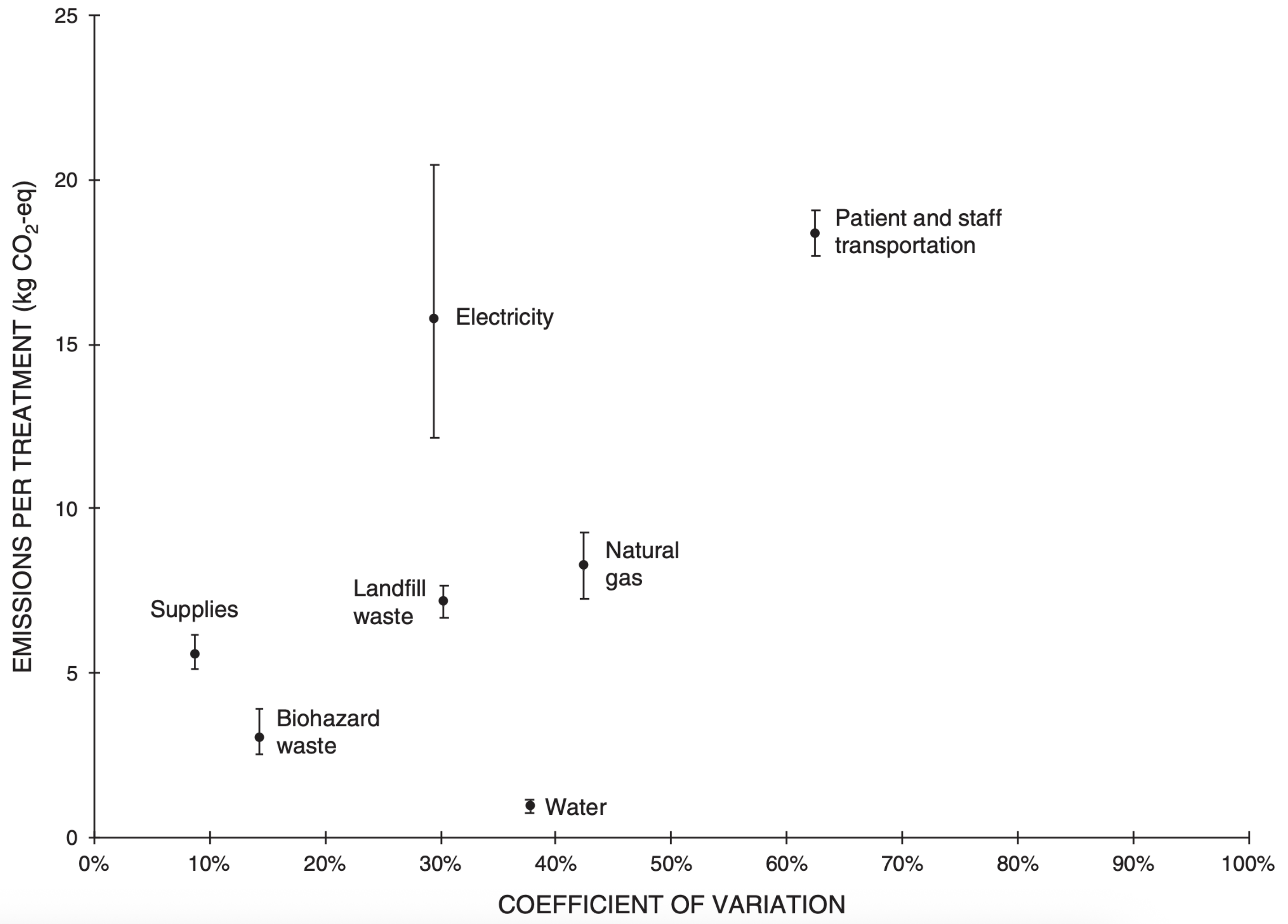
- patient travel distances
- energy mix
- resource use



country / region

facility

Sources of variation – resource use



Sehgal et al, 2022.

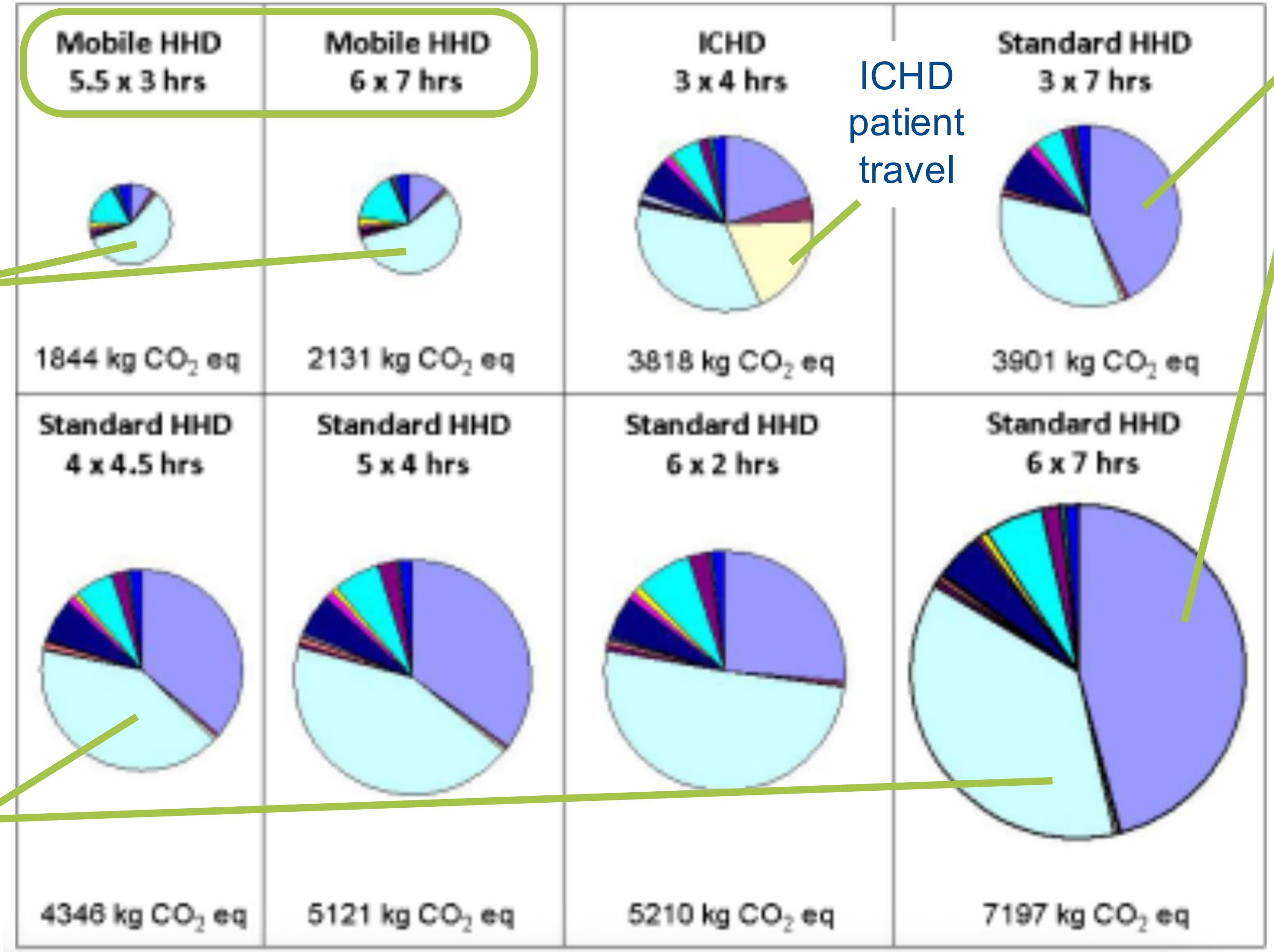
DOI: 10.1681/ASN.2022010086

Figure 1. Contributors to carbon footprint of hemodialysis (n=15 facilities) - in Ohio

Carbon footprint of home HD

energy use
∝ **(frequency x duration)**

NxStage machine **frequency** (consumables) **> duration** (energy)



consumables
∝ **frequency**

- Building Energy Use
- Staff Travel
- Patient Travel
- Medical Equipment: Consumables
- Medical Equipment: Packaging
- Water Consumption
- Paper Consumption
- Laundry
- Construction: Installation
- Construction: Maintenance
- Sanitation
- Waste Management: Clinical Waste
- Waste Management: Recycled Domestic Waste
- Waste Management: Domestic Waste to Landfill
- Dialysis Access Surgery
- Outpatient Appointments

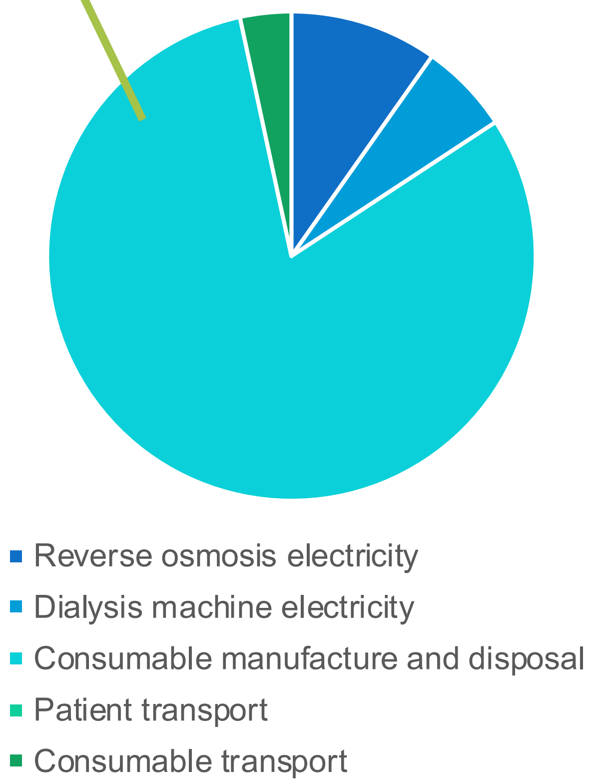
Connor et al, 2011. DOI:10.1111/j.1542-4758.2010.00523.x

Carbon footprint of home HD

Scenario	Annual kg CO_2e	Additional kg CO_2e (% change compared with 'standard')
'Standard' – 3 times per week for 4 hours, Qd 500 ml/min	2,835	-
3 times per week for 6 hours, Qd 300 ml/min	2,903	68 (2)
Alternate days for 4 hours, Qd 500 ml/min	3,317	482 (17%)
Alternate days for 8 hours, Qd 300 ml/min	3,513	678 (24%)
6 nights per week for 8 hours, Qd 300 ml/min	6,006	3,171 (112%)

Longer treatment times can be achieved with relatively small carbon increase

consumables
∝ frequency



Barraclough et al, 2025. In press.

Carbon footprint of peritoneal dialysis in Australia

Table 5. Annual greenhouse gas impacts per patient of the provision of automated peritoneal dialysis and continuous ambulatory peritoneal dialysis by state

State	APD (kg CO_2e Emissions)	CAPD (kg CO_2e Emissions)
New South Wales	2350	1455
Victoria	2729	1677
Queensland	4099	2479
South Australia	3065	1874
Tasmania	3186	1944
Northern Territory	4503	2716

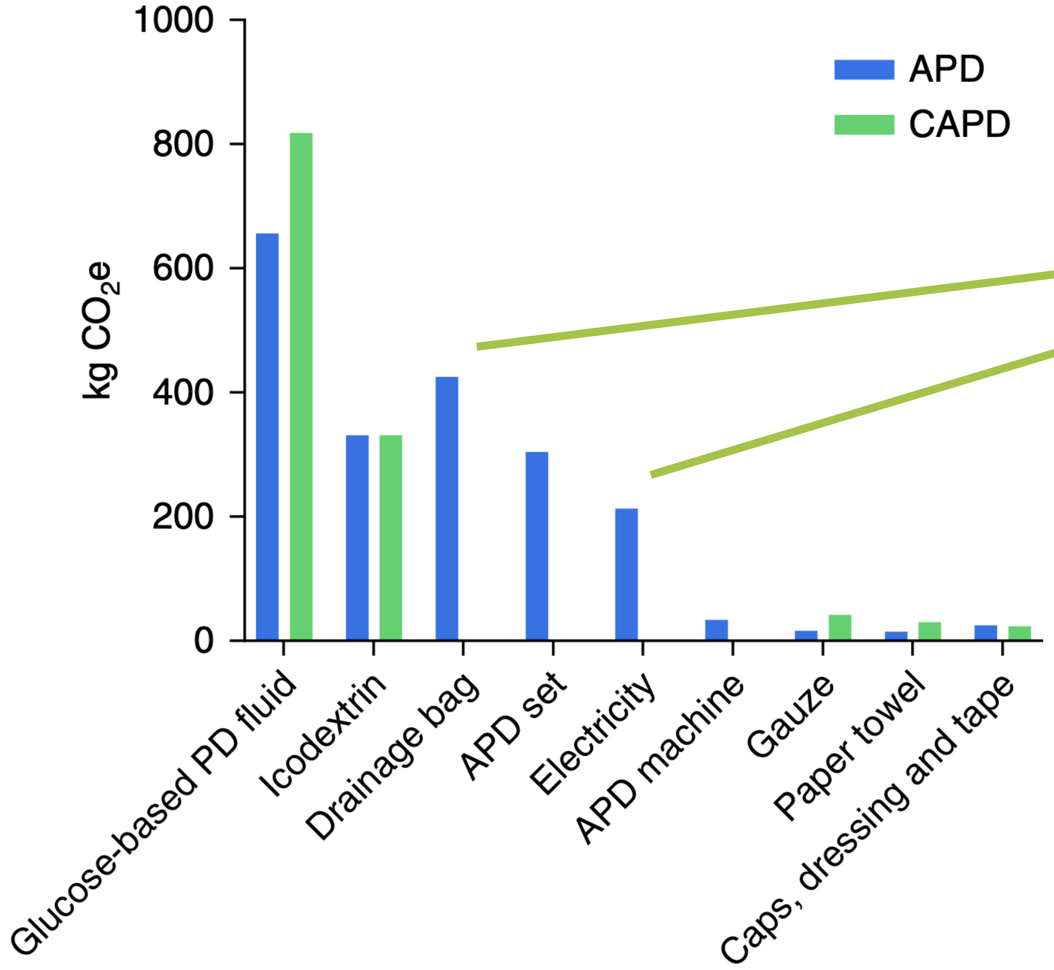
APD, automated peritoneal dialysis; CAPD, continuous ambulatory peritoneal dialysis; CO_2e, carbon dioxide equivalent.

APD > CAPD

(both are lower than ICHD)

McAlister et al, 2024. DOI: 10.1681/ASN.0000000000000361

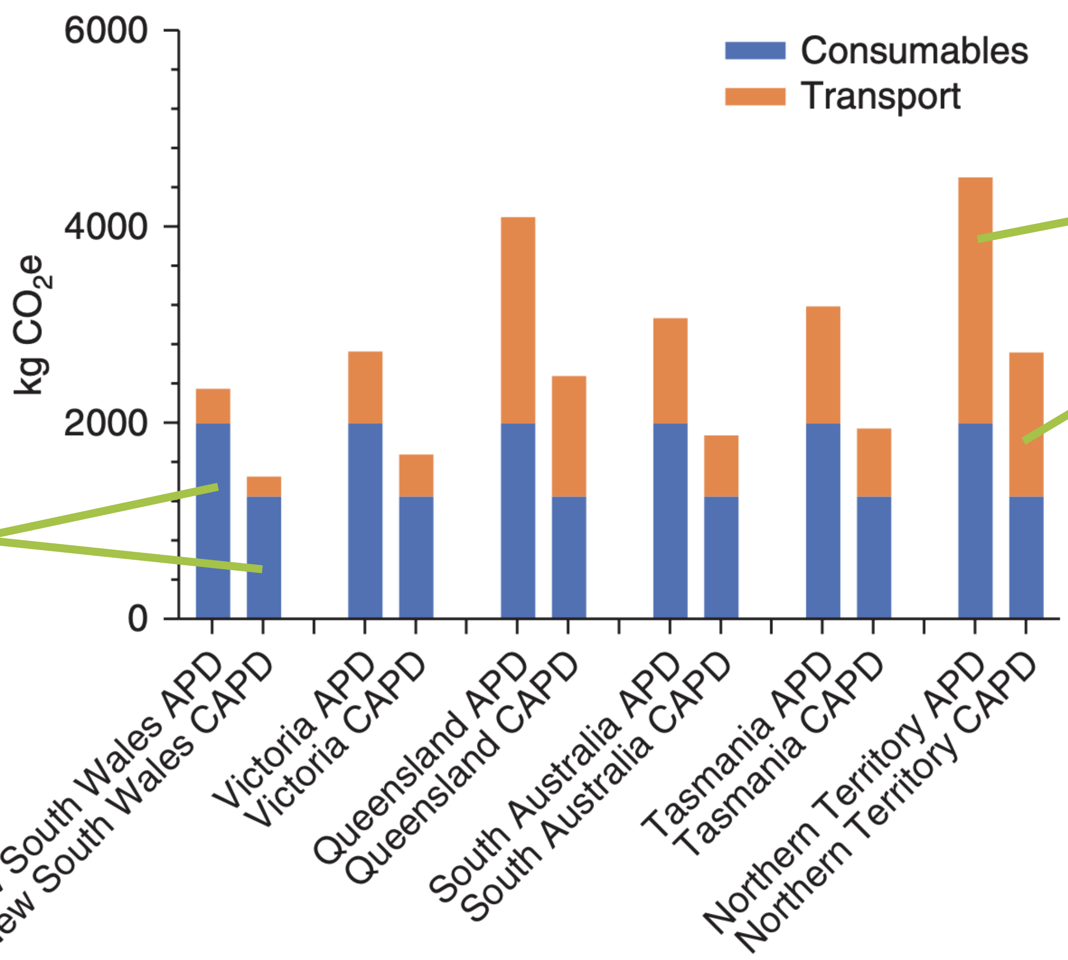
Carbon footprint of peritoneal dialysis in Australia



Higher carbon footprint of APD driven by 15L drainage bag, APD cassette, and electricity for APD machine

McAlister et al, 2024. DOI: 10.1681/ASN.0000000000000361

Carbon footprint of peritoneal dialysis in Australia



transport emissions are impacted ++ by distance

higher carbon of APD driven by higher use of consumables

McAlister et al, 2024. DOI: 10.1681/ASN.0000000000000361

Carbon footprint of peritoneal dialysis in Australia

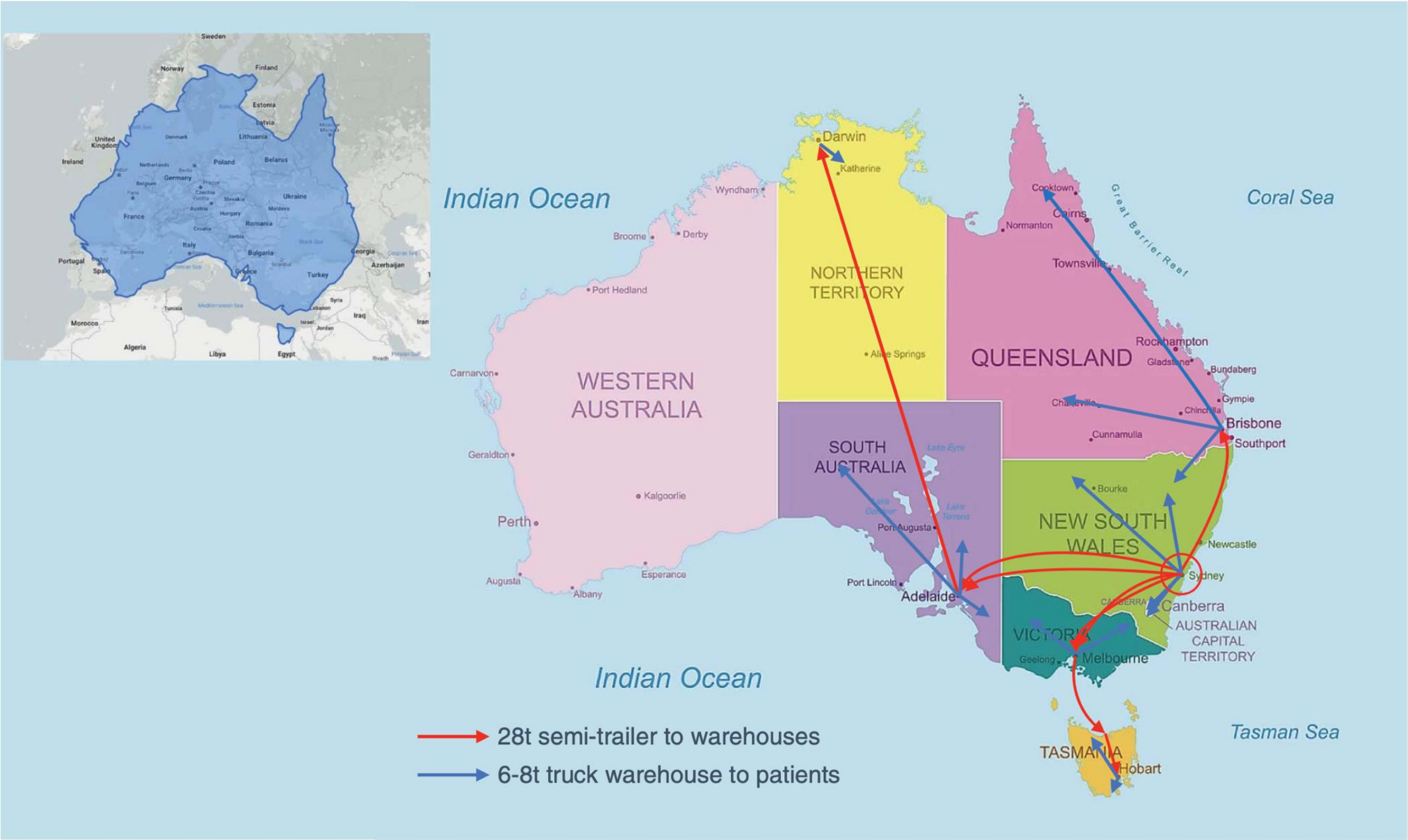
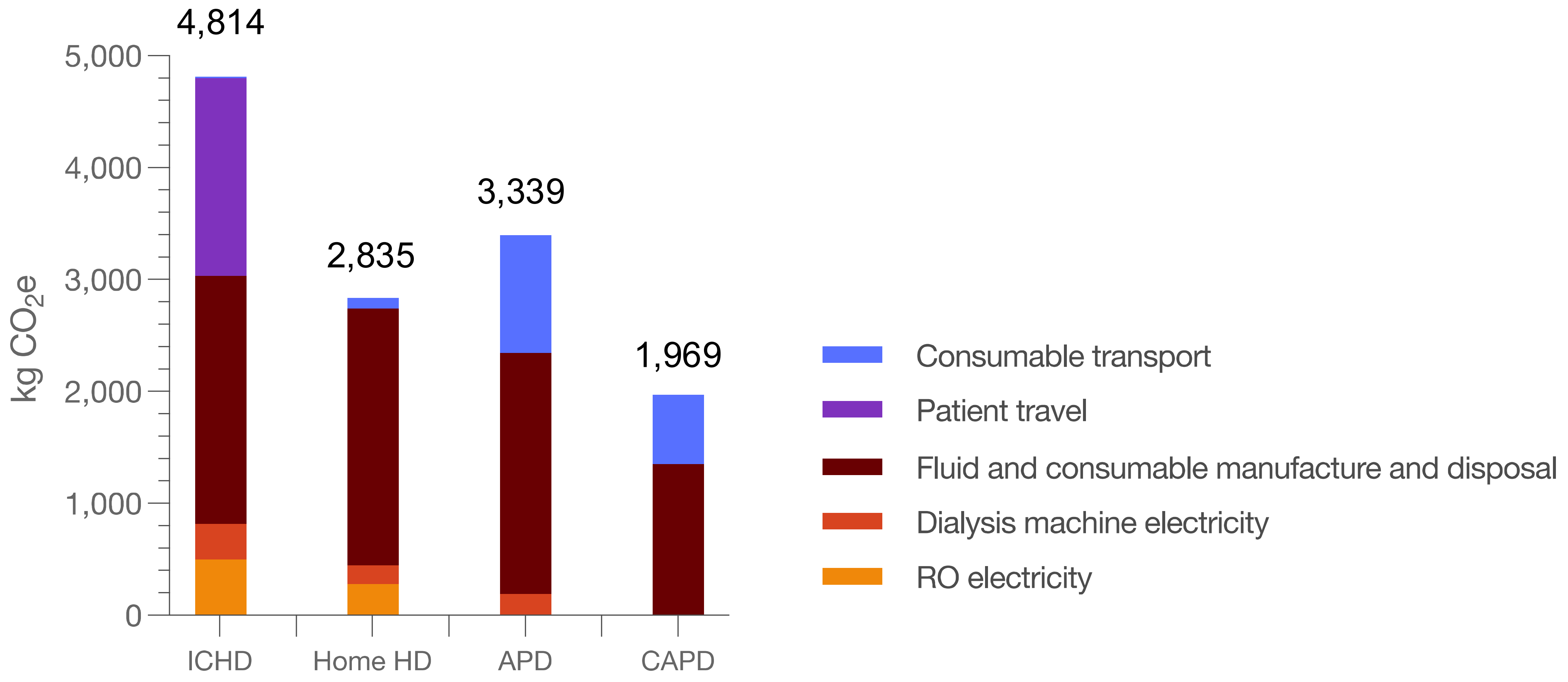


Fig 2. Transport of fluid to patients

McAlister et al, 2024. DOI: 10.1681/ASN.0000000000000361

Comparative carbon footprint of dialysis modalities



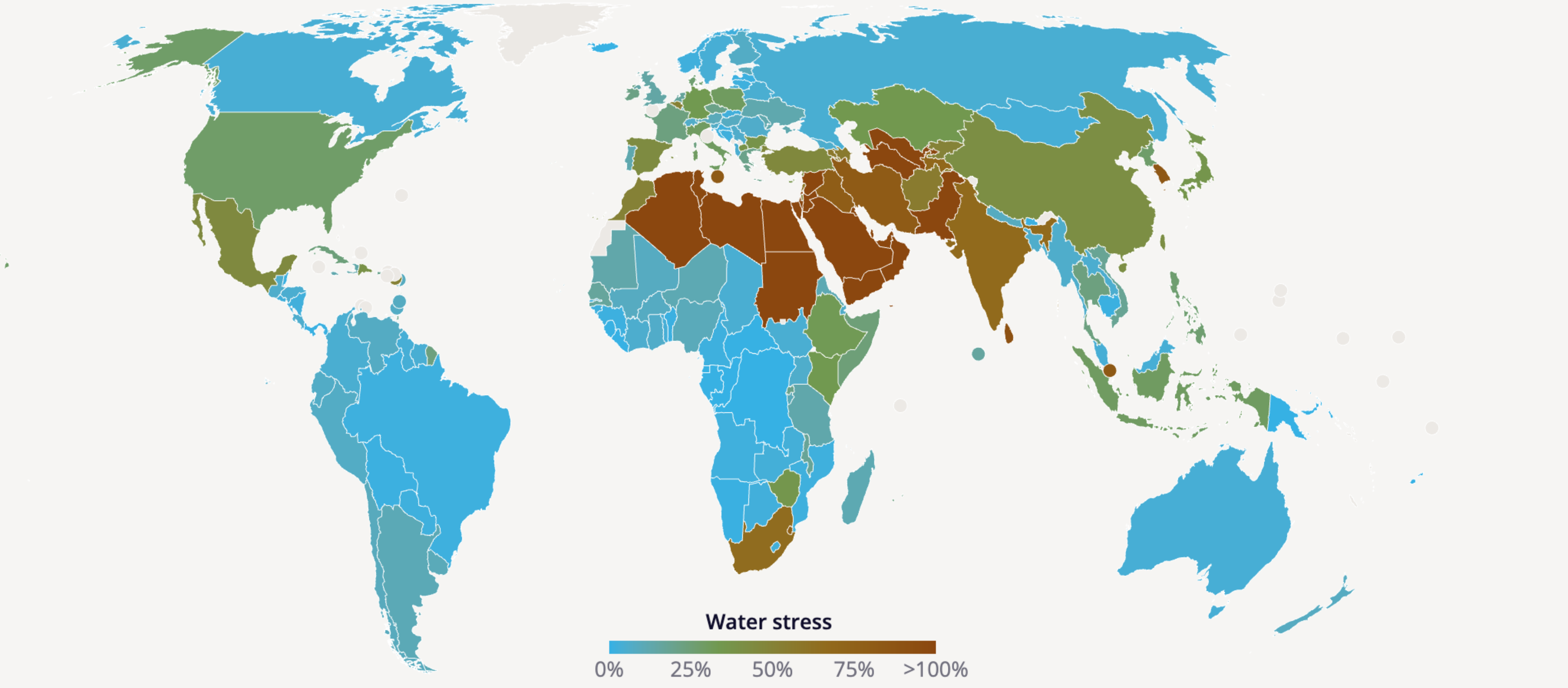
Barraclough et al, 2025. In press.

Other environmental impacts of dialysis

- Water
- Waste
- Ecological toxicity of pharmaceuticals

Water stress around the world

World Bank SDG Atlas 2023



Impact of dialysis on water consumption

- In ICHD, 400L tap water commonly used per dialysis session (dialysate volume 500ml/min x 4 hours = 120 L – if not regenerated)

  > 30-station dialysis unit x 3 shifts x 312 days x 400 L = **11 million L / year**

- Mobile HD systems use much less – e.g. 30 L per session

- Water use in supply chain

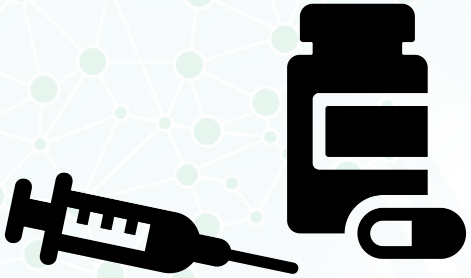
Environmental impact of dialysis waste

- Amount of waste produced: 1.5-8kg per HD session*
  - Dialysis system used
    - dialyser, blood lines, bicarbonate cartridge
    - drainage of residual fluids
- Transport distance
- Disposal method
  - Hazardous waste - incineration (dioxins from PVC, particulate pollution)
  - Non-hazardous – landfill / recycling (limited by mixed materials)
- Escape into environment - microplastics

*Piccoli et al 2015, doi: 10.1093/ndt/gfv031

Ecological toxicity of pharmaceuticals

- Ecological impact of a pharmaceutical agent is a product of:
  - Consumption levels > concentrations released
  - Persistence / mobility in the environment
  - Bioaccumulation
  - Toxicological potency



- Known ecotoxic effects of, e.g.
  - Beta-blockers (metoprolol, propranolol) – toxic to aquatic organisms (algae, water flea)[1]
  - Prednisolone – developmental effects in fish[2]
  - Antibiotics

- The European Medicines Agency requires environmental risk assessment on new medicines – data available?

1. Cleuvers M, 2005. DOI: 10.1016/j.chemosphere.2004.11.090
2. Wang et al 2023. Doi: 10.1021/acs.est.3c02658

The case for global change

- A planet in crisis
- Equity, growing demand

“We have no future if we destroy the very environment that sustains us.”

“We have to hear both the cry of the earth and the cry of the poor.”

Pope Francis

Targets for improvement

There are significant opportunities – to date, dialysis systems have not been designed with the environment in mind

- Improve water purification – to save both energy and water
- Reduce transport distances – local production
- Redesign/reuse of consumables
- Renewable energy generation, efficient buildings

Thank you!