

National Green Renal Programme

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Opportunity for Change: Introducing Incremental Peritoneal Dialysis

September 2026

An opportunity to save across NHS Scotland:



1.14 tonnes of
CO₂e per
patient in their
incident year



£7,400 per
patient year

1. Description of action

1.1 To implement a protocol of personalised, incremental peritoneal dialysis, adapted to local parameters.

2. Background, and opportunity for change

2.1 Peritoneal dialysis (PD) is a treatment option for patients with kidney disease. It uses the inner lining of abdomen (peritoneum) as a natural filter. During PD, dialysis fluid enters the abdomen through a catheter, absorbs waste and excess fluid, and is then drained.

2.2 Incremental PD (iPD) is a personalised approach to initiating dialysis in patients accounting for residual kidney function (RKF) (Blake, Dong, and Davies, 2020). Instead of a standard number of daily exchanges for Continuous Ambulatory PD (CAPD) or Automated PD (APD), iPD starts with a less frequent, lower volume or strength dialysate bags. The treatment offers more a patient-centred and sustainable approach, facilitated by inherent adaptability of PD regimens (Reddy and Mendu, 2020). See How-To Guide in Appendix 2 for detail.

2.3 'Dialysis-free time' is important to patients (Evangelidis et al, 2017), however, standardised, inflexible dialysis prescribing can lead to overtreatment, additional glucose exposure, accelerated loss of RKF through membrane changes, and unnecessary financial and environmental impact (Tangvoraphonkchai and Davenport, 2017). By initiating a reduced dose of PD, we may delay the need for full-dose treatment, mitigating resource and emissions burden of dialysis (Reddy and Mendu, 2020).

2.4 A body of evidence supports iPD; it features in prescribing guidelines for PD e.g. from the [International Society for Peritoneal Dialysis](#), and is also included in PD Academy training. Uptake varies between countries but is increasing, with data from a census by the Italian Society of Nephrology indicating that use among PD patients in their first year (incident patients) increased steadily from 11.9% in 2005 to 40.2% in 2024 (Neri et al, 2024). Similarly, units in England and Spain reported that the majority of incident PD patients and 50% of PD patients in their subsequent years (prevalent patients) are on incremental schedules (Centre for Sustainable Healthcare (CfSD), 2025).

2.5 While the operational definitions of iPD vary, the strategy is best understood as an individualised treatment approach (Blake, Dong, and Davies, 2020), incorporating RKF (Guest et al, 2017). In practice, PD starts at a lower dose. As

remaining kidney function (RKF) gradually decreases, or the patient's clinical needs change, the dialysis treatment can be increased. This may mean increasing the number of daily exchanges, the amount of fluid used in each exchange, or using stronger dialysis fluid. See the How to Guide (Appendix 2).

2.6 Practical examples of iPD regimens (Sandrini et al, 2016; Nardelli et al, 2022; Agar and Sloand, 2018) are provided in the How to Guide. However, guidelines do not specify regimens, reflecting the emphasis on individualising care and the adaptable nature of PD along several parameters such as fewer daily exchanges, dialysate volumes of less than 2L, or treatment delivered fewer than 7 days per week (Malik et al, 2018). Although traditional adequacy metrics such as a weekly Kt/V of 1.7 or creatinine clearance of 50 L/week are often referenced, the objective of iPD is to preserve clinical wellbeing through managing uremic symptoms, fluid status, nutritional health, and quality of life (Brown et al, 2020; Glavinovic et al, 2020).

3. Who needs to be involved in this change locally?

3.1 It is recommended that the following groups should be consulted and involved:

- Patients: have patient information leaflet or video of the principals of iPD ready for discussion with potential patients.
- Unit nurses: ensure dialysis unit nurses are confident in the concepts and options for initiating iPD and in incrementing dialysis prescription as indicated.
- Engage the team: present clinical and sustainability evidence, align with patient goals, invite feedback and discussion.

4. Boundaries

4.1 The table below identifies the boundaries for this action:

In scope	Out of scope
• Consumables • Manufacture of Consumables • Transport of consumables, if reduced frequency • Waste generated • APD machine energy use	• End of life of dialysis equipment • Equipment manufacture • Digital technology • Travel (staff and patient clinic visits)

5. What are the patient benefits of this change?

5.1

- Quality of life - an incremental start can also be an easier psychological and logistical transition onto dialysis for patients and carers through reduced time and resource burden (fewer exchanges, dialysis-free days, smaller stock requirements etc.) Quality of life may also be improved through the additional retention of dialysis-free time.
- Infection risk - most PD-related infections occur within the first 12 months, highlighting this period as the most vulnerable due to inexperience with PD technique. Starting with fewer exchanges may mitigate this early risk through reduced catheter manipulations. Studies have supported this trend, though not all achieving statistical significance. (Yan et al, 2017; Huang et al, 2022; Nardelli et al, 2024). An infection episode lead to treatment failure, increase resource use, and affect patient morbidity.

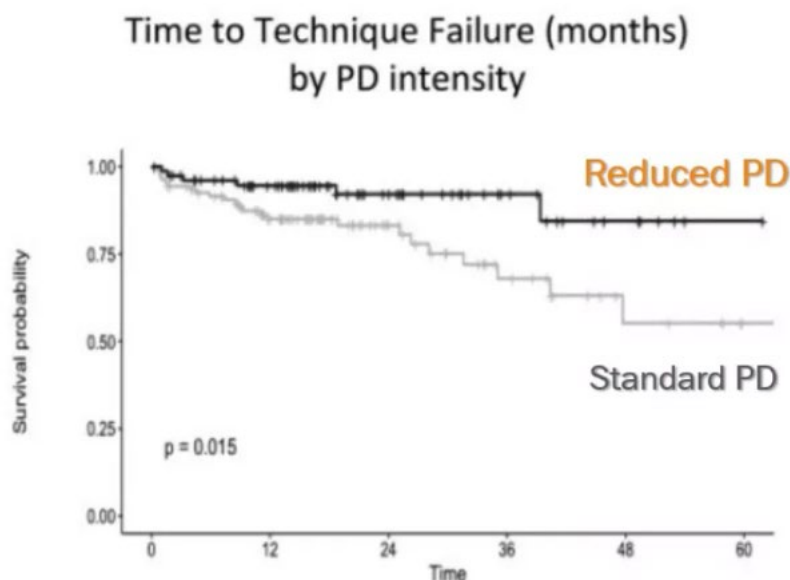


Figure 1. The risk of PD peritonitis may be lower on iPD (Navaratnarajah et al, 2021).

Although Lee et al (2019) reported similar rates of technique failure and hospitalisations between incremental and standard PD groups; Figure 1 demonstrates lower rates of technique failure on reduced intensity PD (Navaratnarajah et al, 2021). This may potentially lead to a longer stay on PD and less requirement to switch to haemodialysis.

- Peritoneal membrane preservation and metabolic effects: Decreased glucose exposure can help mitigate systemic metabolic effects (weight gain, high blood sugar (hyperglycemia) and dyslipidemia) (Lambie et al, 2016) and slow the progression of peritoneal fibrosis, potentially extending technique survival (Lee et al, 2004; Davies et al, 2001).

- Potential benefits of preserving RKF. For the above reasons, and through avoiding overly aggressive dialysis early in the treatment journey, iPD may preserve RKF, see Figure 2.

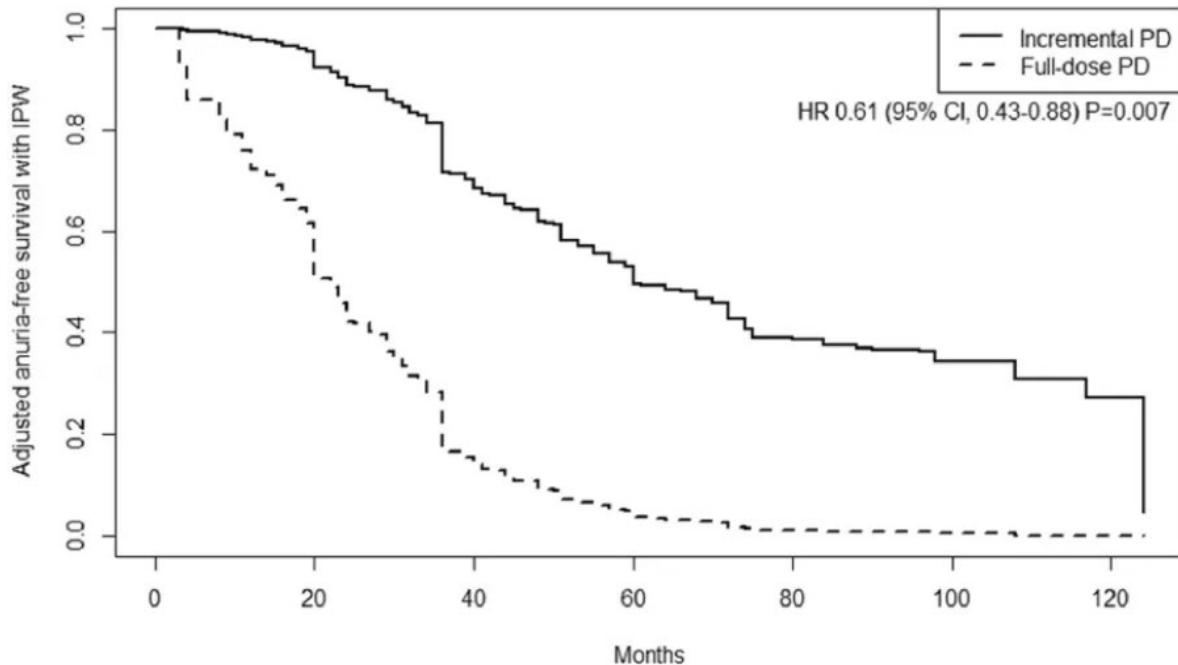


Figure 2: Incremental PD can help preserve that RKF (Lee et al, 2019).

Lee et al (2019) studied 347 incident PD patients, 176 incremental and 171 full-dose PD. After inverse probability weighting adjustment, the incremental group had a lower risk of anuria (hazard ratio 0.61, 95% CI 0.43–0.88). Patient survival, technique survival, and peritonitis-free survival were all similar between groups ($P > 0.05$). Similarly, meta-analysis by Garofalo et al (2019) of 5,292 patients (but only 115 on iPD) showed a lower mean RKF loss (-0.58 ml/min per month, 95% CI 0.16 to 1.01, $P=0.007$). RKF contributes to volume control, potassium and phosphate clearance, and erythropoietin and vitamin D production, and is associated with patient survival (cardiovascular risk in particular) (Okazaki et al, 2023). However, other studies have reported no significant differences in either Glomerular Filtration Rate (GFR) decline or urine output/anuria-free survival after 24 months (Yan et al, 2017; Nardelli et al, 2024).

- 5.2 Additional co-benefits may also be realised; an incremental approach can increase access for individuals with limited storage capacity, particularly if PD is anticipated to be short-term, such as a bridge to living donor transplantation. The option to initiate PD using an incremental approach may also enhance treatment acceptability, supporting higher PD prevalence.

6. Potential environmental and financial benefits

6.1 Incremental PD offers savings on consumables, waste generation, and energy use (Vilar et al, 2022).

Outcome	Potential benefits
Carbon reduction	Incremental PD reduces water usage, plastic waste, and carbon emissions by as much as 30–45% per patient compared to full-dose PD. (Nardelli et al, 2025) Estimated average 0.391 kgCO ₂ e per Litre per year. Scaled up this could be as much as 62.8 tCO ₂ e per year across NHS Scotland.
Cost savings	Estimates ranging from AUD 4,080 (~£2,130) (Nicdao et al, 2026) to €8,700 (~ £7,500) saved annually per patient (Nardelli et al, 2025)
Patient experience	Better quality of life, fewer infections, less glucose exposure and potential preservation of RKF. (Nardelli et al, 2025)

6.2 Estimation of carbon savings

Through reduced consumables, transport, and plastic waste, carbon emissions can be reduced by as much as 30–45% for incremental PD prescriptions compared to full-dose PD (Nardelli et al, 2025). Based on 2025 Scottish PD prevalent use of 182 patients (121 on APD, 61 on CAPD), and the assumption that all incident and 30% prevalent patients could be considered suitable for iPD, 160,000 fewer litres would be required. This would be in addition to savings on transportation and waste and we calculated a cost savings of up to £7,500 annually per patient, based on evidence as above, and local data as below.

Area	Carbon calculations
Carbon footprint	Larkin et al, 2025 Daily prescription of 2 x 5L 2.7% creates 1515.2 kgCO ₂ e annually (2 bags x 365 days = 730 bags) $1515.2 / 730 = 2.076 \text{ kgCO}_2\text{e per 5L bag}$ $2.076 / 5 = 0.415 \text{ kgCO}_2\text{e per Litre}$ Daily prescription of 2L 2.7% creates 457 kgCO ₂ e annually $457 / 365 = 1.252 \text{ kgCO}_2\text{e per 2L bag}$ $1.252 / 2 = 0.626 \text{ kgCO}_2\text{e per Litre}$

MacAlister et al, 2024

Daily prescription of 2 x 6L 2.5% creates 656 kgCO₂e annually
 $656 / 365 = 1.797 \text{ kgCO}_2\text{e per 12L}$
 $1.797 / 12 \text{ Litres} = 0.150 \text{ kgCO}_2\text{e per Litre}$

Daily prescription of 3 x 2L 2.5% creates 818 kgCO₂e annually
 $818 / 365 = 2.241 \text{ kgCO}_2\text{e 6L}$
 $2.241 / 6 = 0.373 \text{ kgCO}_2\text{e per Litre}$

Taking these 4 figures, the average carbon footprint of dialysate is 0.391 kgCO₂e per Litre.

If 30% of Scotland's prevalent patients (approximately 55 patients) were eligible for the lowest dose of 4 Litre instead of a more standard 8-12L, then up to 8L saving per day would translate to:

$55 \text{ patients} \times 8\text{L} = 440 \text{ Litres per day}$
 $440 \text{ Litres} \times 365 = 160,600 \text{ Litres per year}$
 $160,600 \times 0.391 \text{ kgCO}_2\text{e} = 62,794.6 \text{ kgCO}_2\text{e} (62.8 \text{ tCO}_2\text{e}) \text{ per year}$

Financial cost

Based on figures provided by NHS Ayrshire and Arran, peritoneal dialysate fluids cost:

	GBP per item	GBP per Litre
Extraneal 2L	14.77	7.39
Extraneal 2L	12.31	6.16
Physioneal 1.36% 5L	13.56	2.71
Physioneal 2.27% 2L	6.51	3.26
Physioneal 2.27% 2.5L	6.80	2.72
Physioneal 2.27% 5L	13.56	2.71
Average GBP		4.16

If 30% of Scotland's prevalent patients (approximately 55 patients) were eligible for the lowest dose of 4L instead of the standard 8-12L, that potential 8L saving would mean up to the following financial savings may be achievable:

$55 \text{ patients} \times 8\text{L} = 440 \text{ Litres per day}$
 $440 \text{ Litres} \times 365 = 160,600 \text{ Litres per year}$
 $160,600 \times \text{£}4.16 = \text{£}668,096 \text{ per year}$

Total saving	Up to 62.8 tonnes CO2 emissions per year and £668,096
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7. Risks and issues

- 7.1 Incremental PD requires regular monitoring of the patient's RKF, waste clearances, fluid balance, and symptomatology to adapt PD prescription according to clinical assessment. If adequate monitoring and adjustments are not made, then there is a risk of under-dialysing and patient harm. However, monitoring is an inherent part of all PD protocols. More important to delivery is staff confidence in assessing and adjusting prescription. Considerations must also be given to the patient's ability cope with an eventual increase in PD time and/or frequency as RKF declines, both psychologically, and in terms of storage space.

Description of risk or issue	Solution or mitigation	Clinical practice implementation
Under dialysing, potassium, middle molecules	Patient selection, medicines/lifestyle optimisation	Symptom and biochemistry monitoring, patient-triggered review as well as routine to prevent delays in prescription change
Fluid overload / pulmonary oedema	Patient review including symptoms, trends in weight and fluid status, blood results, etc.	Digital technologies and tele-medicine can facilitate regular review without increasing travel or inconvenience to patient
Reluctance to increase prescription when clinically indicated	Use of patient information leaflet or upfront discussion to highlight integral treatment escalation	
Lack of storage space as prescription increases	Make plans early for additional storage where may be required	
Limited staff confidence in initiating iPD	Educational opportunities	At Scottish Renal Association (SRA), or attending PD academy; or

		CPD time spent in experienced centres
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8. Implementation guidance

8.1 The opportunity for change highlights the importance of implementing this action. This modification will help sites and NHS Scotland achieve net-zero emissions by 2040 as stated in NHS Scotland's Climate Emergency and Sustainability Strategy 2022-2026.

8.2 Below is guidance on how this change can be implemented within each area. For further information or guidance, please contact the National Green Renal Programme team via: cfsdgghs@nhs.scot.

Local Sustainability or Green Theatre Group	
1.	Review opportunity for change and validate what this means locally.
2.	Provide National Green Renal Programme Team with validated information/local targets.
3.	Convene a discussion with the staff who need to implement it and those who are impacted by the action.
4.	Understand what the opportunity is for implementing the action locally: work already undertaken and challenges
5.	Agree a local implementation plan.
6.	Implement local plan.
7.	Provide data as per measurement plan.
8.	Monitor implementation of action.

9. Measurement plan

Name of Measure (carbon, cost, staff experience and patient outcome)	Type of measure (Outcome, Process, Balancing)	Concept being measured?	Where is the data available from?	Who is collecting the data?	Frequency of collection
Carbon	Calculated based on prescribed litres of	Uptake of iPD, with cost factor applied	Annual Scottish renal	Scottish Renal Registry	Annually

	dialysate per week		registry report PD local data	Local PD teams	
Cost	Calculated based on prescribed litres of dialysate per week	Uptake of iPD, with carbon emission factor applied	Annual Scottish renal registry report Local PD data	Scottish Renal Registry Local PD teams	Annually
Patient experience	Patient reported experience +/- Local surveys*	Satisfaction QoL	UK Kidney Association +/- local units	UK Kidney Association +/- local units	Annually As indicated locally

*Example survey available by contacting Green Renal Team - cfsdghs@nhs.scot

10. Appendices

Appendix 1 - Overview of carbon cost and financial cost of peritoneal dialysis items		
	kgCO ₂ e per annum *	Cost per item in GBP ^
Tork blue roll advanced 1 carton=2 each	172	1.12
Merpore 9x10cm low exudate 1 carton = 50	4.5	0.40
Physioneal 2.27% 2L CAPD, 1 carton = 5 each	457	6.51
Physioneal 2.27% 2.5L APD, 1 carton = 4 each	272	6.80
Physioneal 2.27% 5L APD, 1 carton = 2 each	757	13.56
Physioneal 1.36% 5L APD, 1 carton = 2 each	541	13.56
Extraneal 2L CAPD, 1 carton = 5 each	331	12.30
Connection shield, 1 carton = 60	3	0.46
Minicap for patient line, 1 carton = 60	3	0.46
Hand sanitising gel with pump 500ml, 1 each	29.9	6.39
Black bag 200g 16x25x39, 1carton = 20 each	100	0.23
Blue clamp for PD bags, 1 carton = 12	~4	2.27
Flexicap disconnect cap, 1 carton = 30	11	1.96
Micropore tape 2.5cm x 9.1m, 1 carton = 12 each	2	0.55
Homechoice drainage lines, 1 carton 30 each	511	1.68
Homechoice 4 prong-cassette, 1 carton = 30	245.25	13.23
Extension set 3.65m, 1 carton = 30 (to allow patient to go to toilet without disconnecting)	186.1	3.75
APD machine	151.7	
Cycler drainage bag (15L, 1 carton = 30)	285.9	4.15
Homechoice Y connector for drainage bag, 1 carton = 30	3	2.00

*Larkin et al, 2025; McAlister et al, 2024

^costs provided by NHS Ayshire & Arran

Appendix 2 - NGRP how to guide: Incremental peritoneal dialysis (iPD)

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Date: 26.01.2026

Review input from M. Petrie, A. Jones, T. Cameron.

Introduction:

Incremental Peritoneal Dialysis (iPD) is a patient-centred approach where prescribed PD dose is adjusted according to personalised requirements, considering Residual Kidney Function (RKF) and other patient factors. 1 As kidney

function gradually declines the dose is increased to maintain a minimum total weekly Kt/V of 1.7 whilst limiting burden of treatment, reducing glucose exposure, and lowering environmental impact (30–45% less waste/water) - see Background section below.

We do not endorse a formal protocol for incremental PD as there are so many ways this can be approached, and with no clear evidence for one over another, it would be very challenging to capture this in a protocol/guideline. The basic concepts are to start with smaller volumes, fewer exchanges, reduced hours or days of dialysis, and to build up as dictated by adequacy measures, clinical parameters and staff assessment.

Summary:

- **Clinical goal:** To postpone full-dose therapy, preserving quality of life (and peritoneal membrane) while ensuring adequate solute clearance.
- **Patient selection:** Ideal for incident patients with RKF (urine output >500 mL/day* or glomerular filtration rate > 5 mL/min/1.73m²) (Baxter 2019; Sandrini et al, 2016).
 - * Optimise diuretic doses to maintain adequate urine output.
- **Initiation protocol:** Given the intention of fully individualising the PD prescription according to the patients' requirements, no standard protocol is offered (other than for Lothian staff, who do have a protocol, 2026 version Appendix 1), but examples of how iPD is commenced and general principals to apply are provided:
 - **CAPD (Manual):** During training, start with one 1-1.5L exchange once a day, usually 1.36% or icodextrin (Extraneal). This can then be increased to 2L and / or two exchanges per day (e.g. and 1.36% and an icodextrin as required (instead of the standard 4).
Nb. Leaving a few 100ml in can help avoid retention of fluid. Beyond this increase to 3 then 4 exchanges per day, +/- increase volume.
 - **APD (Cycler):** The APD machine can be started as alternate days and / or for fewer hours e.g. 4 hours in the evening rather than overnight if preferred whilst gaining confidence or if poor sleep; lower volumes and no daytime dwells are also options.
Nb: Generally it can help to start at 50% tidal volume before increasing to 85% over a week or so to minimise alarms initially and build technique confidence.
- **Monitoring and adjustment:**
 - **Target:** The combination of residual kidney and peritoneal clearance should meet target goals (Combined StKt/V)
 - **Assessments:** Perform regular 24-hour urine collections and blood tests monthly whilst changes to prescriptions are being made, then 3

monthly when prescription is unchanged to monitor RKF and adequacy (Kt/V) (Sandrini et al, 2016)

- **Dose Escalation:** Increase the number of exchanges or fill volumes when clinical symptoms (e.g., volume overload, fatigue) or laboratory results indicate a decline in total clearance.
- **Remote monitoring** offers better care delivery with lower environmental impact; this can include remote program changes e.g. Claria Sharesource.

Practical examples of iPD regimens:

(1) CAPD with fewer than 4 daily exchanges, dialysate volumes of less than 2 L, or treatment delivered fewer than seven days per week, often just 4-6 days; regimens are even described with a single daily icodextrin (extraneal) dwell for 8-16 hours
(2) APD performed less than 7 days weekly, with smaller volumes (1.5 L) and total daily volumes under 10 L and/or without a long dwell.

The decision to start PD remains the same irrespective of the dosing schedule i.e. based on clinical indications of symptoms and CKD complications; there is no benefit to commencing PD early (GFR 10-14ml/min/1.73 m²) above starting GFR 5-7 (Ethier et al, 2020).

Monitoring:

Although traditional adequacy metrics such as a weekly Kt/V of 1.7 or creatinine clearance of 50 L/week are often referenced, the true objective of iPD is to preserve clinical well-being, focusing on control of uremic symptoms, fluid status, nutritional health, and quality of life (Brown et al, 2020).

Decremental:

While both provide a reduced dialysis dose, they pursue fundamentally different objectives. In frail older patients with multiple comorbidities, decremental, or palliative PD may be employed, where the aim is not arbitrary clearance adequacy but prioritises symptom relief, comfort, and quality of life (Brown and Hurst, 2020).

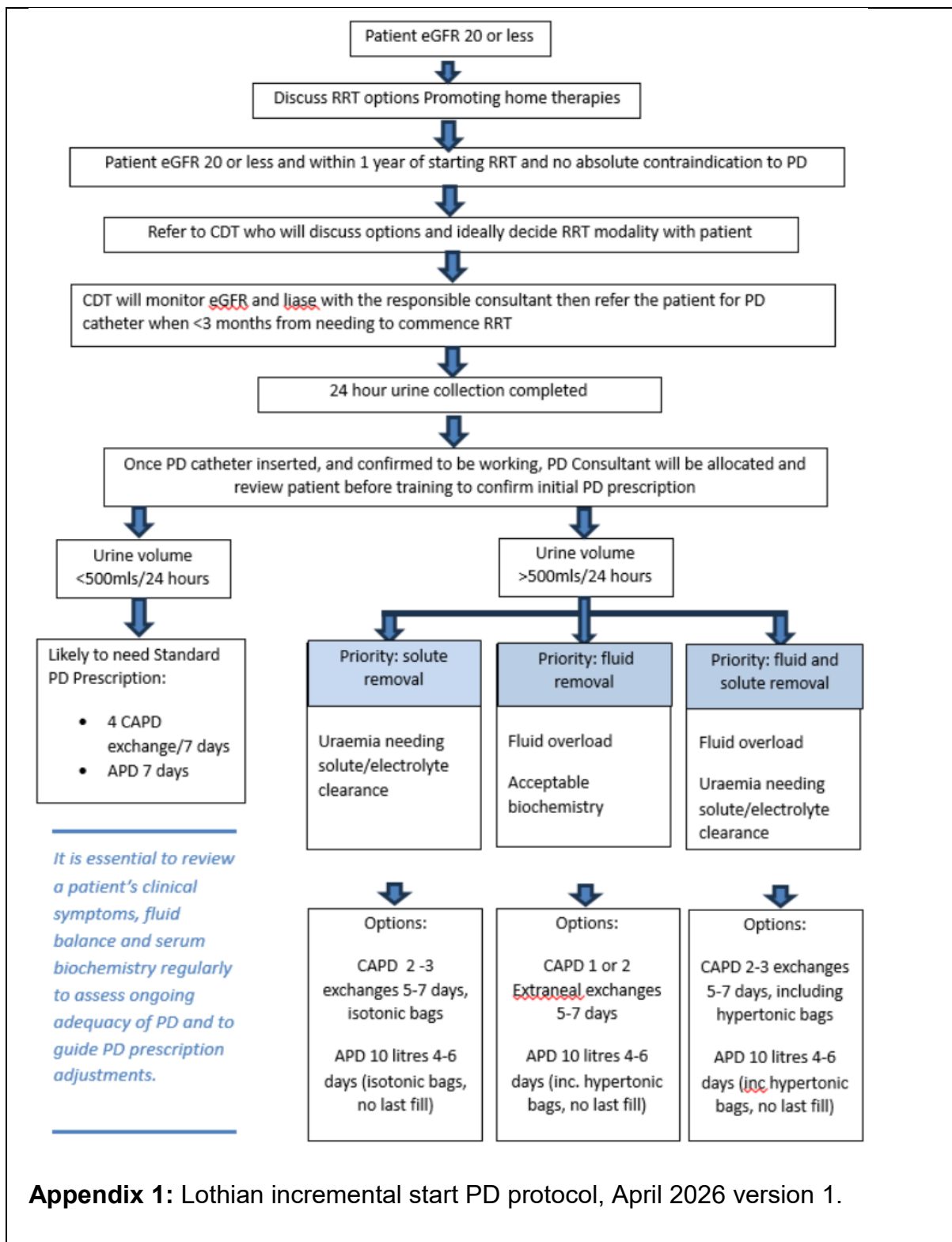


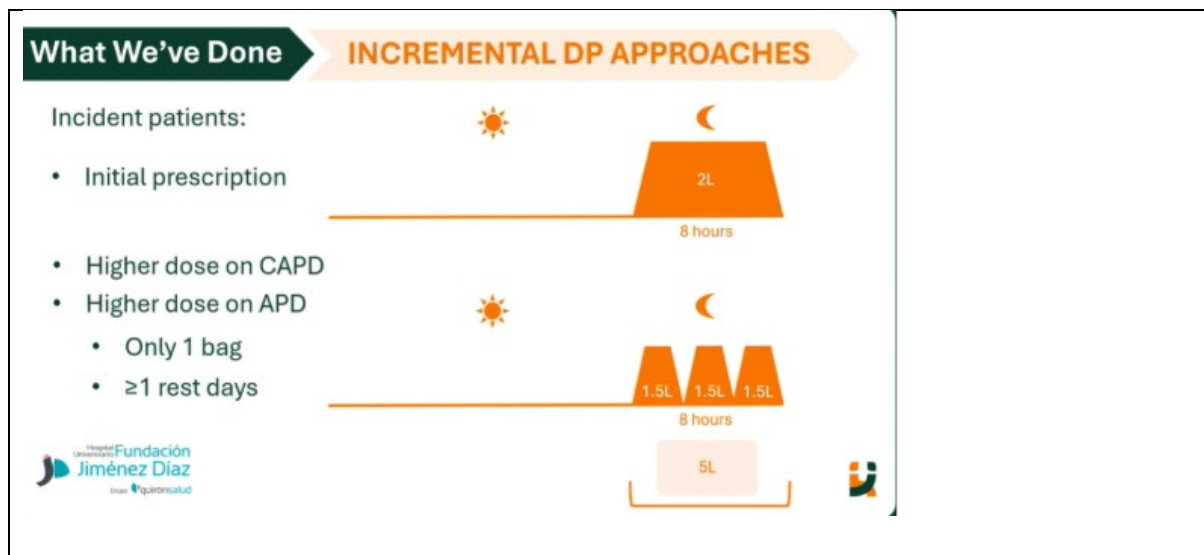
Figure 3

Barriers	Solutions	Clinical practice implementations
Patient reluctance to escalate the dialysis dose	Timely anticipation of treatment strategy	Implementation of numerous pre-treatment visits
Risk of fluid overload and inadequate clearance	Close clinical surveillance	Closer monitoring of weight, Kt/V, diuresis volume and residual kidney function
	Implementation of tele-health medicine	Exploitation of digital PD platforms to enhance distance monitoring
Limited provider familiarity with the dialytic approach	Proposal of educational opportunities	Allow health-care staff to spend periods in highly experienced center
	Enhancement of clinical tools	Elaboration of guiding PD protocols
Unfavourable reimbursement policy	Payment modalities reform	Concrete incentives for units with high percentage of patients on iPD

PD, peritoneal dialysis; iPD, incremental peritoneal dialysis.

Table 1. Potential barriers and solutions. Duplicated from: [Incremental PD: less is more](#) (Nardelli et al, 2025)





11. Acknowledgements

Audrey Jones, Peritoneal Dialysis Lead Nurse Specialist – NHS Ayrshire & Arran

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13. Version control

Version	Date (YYYY MM DD)	Amendment	Author
0.1	2026 06 10	First draft	DZ
0.2	2026 06 29	Expand and rewrite	EM
0.5	2026 07 17	Add references and finalise calculations	DZ
0.6	2026 08 18	Finalise text	EM

Role	Initials	Date
Author	DZ	2026 08 18
Reviewer	RM	2026 08 19
Reviewer	CC	2026 08 19
Approver	EM	2026 08 20