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Peritoneal Dialysis Training and Educational Interventions: A Narrative Review

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Abstract:	Background Peritoneal dialysis (PD) training and education for patients and their caregivers, provided by PD nurses, are crucial for effective PD programs. The goal is to impart sufficient knowledge, skills, training, and support to minimize complications. However, the evidence regarding effective educational interventions during training has been unclear and inconsistent. The review question was: How do PD training methods and educational interventions impact on PD outcomes in adult patients? Methods A narrative review was undertaken with defined inclusion and exclusion criteria of articles published in the last 10 years. Databases were searched, followed by a selection process conducted with the project team. Quality appraisal and a final selection were uploaded to Excel, and data was extracted. A narrative description of the results was then completed. Results A total of 982 articles followed the selection process of these 21 studies, including mixed methods research design, but all met the inclusion criteria. The results were described under headings of training methods, educational interventions, patient characteristics, retraining, and outcomes reported.

	Conclusion The narrative review highlights gaps in robust evidence for educational interventions during training. However, some evidence supports adapting PD training methods to incorporate more individualised approaches, appropriate pre-training assessments, and consistent outcome measures.

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INTRODUCTION

Patients (with their carers) opting for home PD must first learn the procedure. This essential PD training, provided by PD nurses, forms the foundation for successful home-based PD programs. However, there is a significant lack of standardization and structured training programs worldwide, leading to considerable variation in the delivery and approaches to PD patient training (1). Preventing PD-related complications, such as peritonitis and exit-site infections, is crucial. Peritonitis is the leading cause of PD discontinuation PD (2) and persists as a significant challenge in achieving widespread success in PD adoption. Consequently, efforts to enhance training programs and implement targeted educational interventions during training have been the subject of numerous reviews and commentaries (1). A previous International Society for PD (ISPD) training curriculum has been published to provide guidance and best practice recommendations (3). The guidelines identified core components to successful training; including skills of the trainer, time dedicated to training, methods and protocols, assessment of learning styles, individual needs and flexible approaches required, home visits and retraining (3). However, this training curriculum was published eight years ago and provided a review of published literature available at the time. ISPD peritonitis guidelines emphasise the importance of patient training in peritonitis prevention and, in particular, reassessments and retraining (4). A review of educational interventions published in 2015 included studies published before 2013, and eighteen articles were reviewed (5). This review highlighted the limited progress in establishing evidence for the most effective educational interventions in PD training (5). A more recent review published on nursing educational interventions focused specifically on self-management interventions and included 11 studies, of which only two were specific to PD training (6). All these publications and guidelines recognise the lack of evidence for key educational interventions, strategies and core components required for PD training.

Therefore, the purpose of this **narrative review** was to further update and identify relevant evidence to recommend best practice guidelines for teaching PD to patients and their caregivers.

Methods

A narrative review was undertaken, incorporating elements of a systematic review process (7, 8). A team of seven nurses was convened as part of the ISPD nursing working group of training guidelines (HH, AF, JC, GB, JN, DPM, MT). The team had expertise in conducting literature reviews and were all involved in the review process. **We report our methods and findings in accordance with the recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals (9)** . The protocol was not registered. The research question was developed using standard population, intervention, comparator and outcome (PICO) described to enhance research and review questions, with clear inclusion and exclusion criteria (10).

Review Question: How do PD training methods and educational interventions impact on PD outcomes in adult patients?

Review Aims:

1. Identify educational and training interventions that demonstrate improvement in PD-related outcomes for patients on PD.
2. What is the evidence for retraining on improving PD-related outcomes?
3. What PD patient outcomes are reported for PD training?

4. What gaps in knowledge remain for future research?

PICO Question Table 1 Representing the Inclusion Criteria

Participants	Adult patients > 18 years receiving PD
Intervention	Any studies of interventions of PD patient training, education, retraining, experience, knowledge assessment and skills acquired. All types of study methodology
Comparator	Any comparators versus standard practice or experience of intervention
Outcome	Impact on PD therapy outcome patient survival and technique survival (PD-infections, catheter dysfunction, mortality, technique survival, life participation, hospitalization)

Exclusion Criteria

- Paediatric studies
- Educational interventions that did not relate to patient training or relevant outcomes as above.

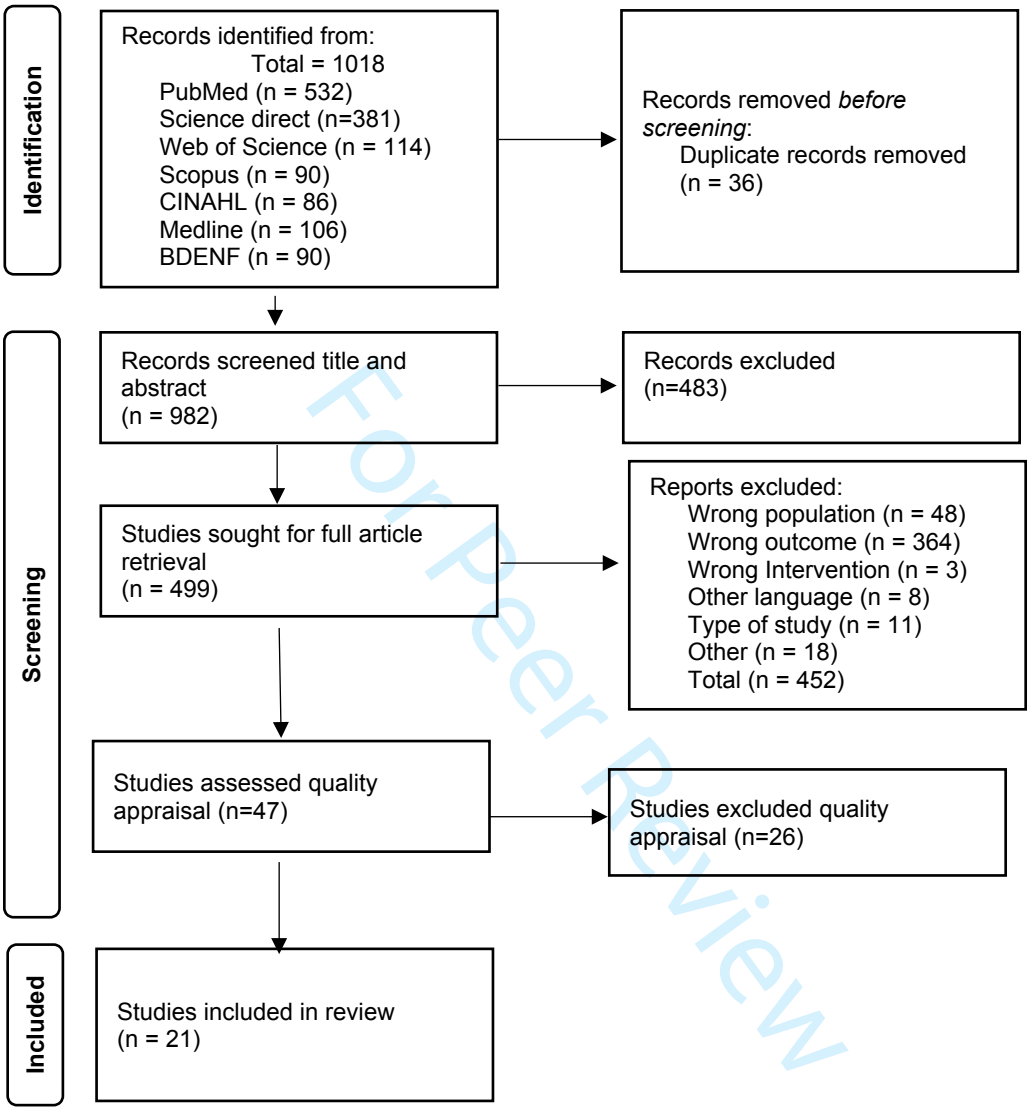
Search Strategy

A systematic search for relevant articles was performed by two independent researchers in 2023. To obtain greater coverage of possible articles, the search was executed in multiple databases**.The databases searched were PubMed, Web of Science, Scopus, CINAHL, Medline and BDENF**. Based on relevant studies in this field, this combination should cover more than 90% of all relevant references (11, 12). **A range of subject headings (MESH) and subheadings, key terms and key words were identified covering the individual elements of PICO. These were translated into the appropriate terminology covering the intervention and a range of potential outcomes and adapted for each search interface and database.** The range of year of publication was between 2013 and 2023. Supplement 1 has a full list of terms and strategies

Selecting Studies

All studies were uploaded to Endnote and then to Rayyan systematic review software to support the screening process of the whole team. Duplicate records in the search results were removed using Rayyan. Two stages of selection occurred. First, the title and abstract were independently screened for eligibility by all seven members; any conflict was resolved with further discussion to ensure that the selected articles met all the inclusion criteria. The second stage involved a full-text review; selected members of the group were paired to agree to the total list of included articles and those to be excluded. Publications in English, Portuguese, and Spanish were included as two reviewers were proficient in translation and able to do so.

Figure 1 the PRISMA flow chart review identification and selection process.



Quality Assessment

All included studies were then reviewed for quality assessment as there were a variety of methods reported, and tools were selected from the Joanna Briggs Institute (13). Two researchers independently conducted quality appraisal using a designed qualitative extraction tool, and 26 studies were excluded at this stage. Whilst this number is large at the quality appraisal stage, studies lacked detail, were not specific about patient training and poor quality**.** It provided a further robust procedure**.** The three RCTs had an additional risk of bias assessment with the overall quality fair (14-16).

Data Extraction

A process of data extraction of all included studies was conducted with author, country, methods, intervention, and outcomes incorporated (Supplement 2).

Results

A total of 21 studies were included in the full **narrative** review. By countries Australia (n=1), Brazil (n=1), China (n=1), Denmark (n=1), France (n=1), Italy (n=1), Israel (n=1), Korea (n=1), Spain (n=3), Sudan (n=1), Turkey (n=1), USA (N=3), Uruguay (n=2) and international multicentre (n=3).
The methods' descriptors varied: five observational retrospective studies, four cross-sectional surveys, three randomised controlled trials (RCTs), three observational prospective studies, two cohort studies, two qualitative studies, one mixed method, and one quality improvement study.
The full table of included studies is in Supplement 2.

Study Populations

All studies included details of the population of incident and prevalent PD patients as the learner in training, with demographic details included. Some studies included carers or third-party trainers and some included nurses as the learner. Studies varied in size, as to be expected, with mixed study design being included. Two published studies were from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS), and both were conducted differently, Perl et al. (2) included prevalent and incident patients, and the primary outcome was peritonitis rates, whereas the Cheetham et al study only included incident patients (on PD < 3 months) with primary outcome as time to first peritonitis (17).

Study Outcomes

In the included studies where training methods, educational interventions or characteristics were used, the primary outcome used was peritonitis and/or exit site infection rates, with some including time to first infection or infection-free time (15-23). Other outcomes that can be included as all-cause technique survival were not necessarily reported; the PDOPPS studies, whilst collecting multiple data sources at the patient and centre level, focused on the primary outcome for training on infection risk (2, 17). Only two studies included hospitalisation as an outcome (14, 24), with only one including quality of life (QOL) (14).

Analysis

Due to the small number of RCTs and the mixed methods used, a meta-analysis was not possible. This analysis, therefore, is a narrative review of the evidence in line with the review question and aims.

Main Findings

This narrative literature review aimed to identify educational interventions that demonstrate improvement in PD patient outcomes. Studies evaluating these components will be discussed separately to acknowledge the difference between education and training for the purposes of the analysis. The results are therefore presented as:

1. Training methods

2. Educational interventions
3. Patient characteristics and assessments
4. Retraining
5. Outcome reported in studies.

1. Training Methods

1.1 Training Duration

Training times are referenced in several studies to try and elicit if and how they impact on PD related outcomes (a summary is provided in table 2). The most significant large-scale studies to examine the relationship of training time to peritonitis include two large prospective cohort studies. A study from Brazil, which included 2,243 incidence patients, examined training characteristics associated with peritonitis; cumulative training of >15 h had a significantly lower incidence of peritonitis compared with <15 h (0.26 per year at risk versus 0.32 per year at risk, P = 0.01) (21). The analysis of PDOPPS by Cheetham et al., of 1,346 newly started patients on PD across 120 facilities, unlike the Brazilian study, found training duration and timing were not significantly associated with peritonitis risk (17). The authors of this large study highlighted the strengths compared to the Brazilian study as being able to adjust for a larger number of patient, facility and training characteristics (17). Similarly to the Brazilian study, the PDOPPS study first publication by Perl et al. of incident and prevalent (7,051) patients across 209 facilities, did find a correlation with training time with facilities reporting an initial period of patient training that was six days or longer had lower risk for peritonitis as compared with facilities that had an initial period of six or fewer days (2). Consideration of many confounding factors has led to recommending individualised approaches as the length of training time may be influenced by patient characteristics such as health literacy or disability challenges. Smaller studies have attempted to address this with differing results. One study of 40 participants with a range of disabilities with mean age of 53.8 ± 11 years showed median training time as 7 ± 0.13 hours. This study focused on one-day specific APD training using a cycler with audio, visual and animation, there was no follow up. Training time did not differ significantly by sex, disability, computer or technical experience, or education level (25). Whereas a retrospective study from Spain of 135 patients reported days rather than hours, with patients requiring a median of 10 (IQR 8–13) sessions to acquire enough skills to perform the PD technique with a median of 19 days (IQR 14–28) (23). 31 patients (23%) needed more than 13 sessions and were considered to have a prolonged training time. Prolonged training time patients were older and had more comorbidities, with a significantly higher predictive risk of developing peritonitis demonstrated by the higher rates of peritonitis in this group, although there was no difference in time to first peritonitis episode in each group (23). Similarly, a further cross-sectional observational study of 112 patients trained in APD and CAPD examined the learning time and risk of first peritonitis in older and younger patients (18). On average older patients (>70 years) required more training time (an average 4 hours more) and developed first episode of peritonitis earlier than the younger cohort (18).

1.2 Training Location

Other than training time, the place of training has been examined, for example, either a hospital setting or a patient's home, often dependent on country and unit variations as demonstrated in PDOPPs (17). There was no strong evidence of PD modality or location on peritonitis risk (17). One retrospective study from Italy reviewed CAPD and APD home training (n=17) versus video training (n=21) with only small numbers of patients (26). The video training was used for both CAPD and APD and replaced a home visit. The outcomes including time for training, number of home visits, number of procedures to complete training and clinical outcomes. The video training group needed fewer home visits, and the home training group had more episodes of peritonitis and higher dropout; no episodes of peritonitis were reported in the video training group (26).

1.3 Person Training

The association of who does the training on outcomes was not reported in detail across many studies. Often terms such as 'experienced PD nurse' were highlighted; the PDOPP's study described a reduction of peritonitis risk when third-party trainers delivered the training, but this was only in the UK with small numbers. Within this study, when carers were trained, there was also a lower risk of peritonitis (17). Patient-to-nurse ratio and individual versus group training found no correlation to peritonitis risk (17).

Table 2 Duration of Training

Author	Training Duration	Participants	Outcome
Aguilera-Flórez et al 2020 (18)	Training duration-hours	112 incident patients trained on either on APD or CAPD-single centre	Patients over 70 years needed 18.13±7.93 hours for training; those patients under 70 years needed only 12.73±4.27 hours, (p=0.004) for training. Time to first episode of peritonitis was earlier in the longer training group - but this difference was not significant
Bernardini J et al 2014 (25)	Training duration-hours	40 APD patients	Median training time was 7 ± 0.13 hours, with a range of 5 - 8.25 hours. We found no correlation between the number of hours needed for successful training and age (r = 0.30). Training time did not differ significantly by sex, disability, computer or technical experience, or education level. The required training time was less for participants with previous PD experience (6.5 ± 0.7 hours) than for those naive to dialysis (7 ± 0.8 h), but at p = 0.056, the difference just missed being statistically significant.
Cheetham et al. (2022) (17)	Training duration-days	1376 incident PD patients-multicentre	Variability of training duration UK (2–3 days in 51% patients) and longest in Japan (>7 days in 68% patients). However, the maximum training hours per day was shortest in Japan (mean 3.03 h/training day), contributing to high variability in total training hours across countries. Duration of training and training location were not significantly associated with peritonitis risk
Figueiredo AE et al 2013 (21)	Training duration-hours	2243 incident patients-multicentre	Patients who received a cumulative training of >15 h had significantly lower incidence of peritonitis compared with <15 h (0.26 per year at risk versus 0.32 per year at risk, P = 0.01). Time to 1st peritonitis, months±SD (range)24.2±27.8 (0.1–122.9)

Perl J et al 2019 (2)	Training duration-days	7,051 adult PD patients-incident and prevalent-multi centre	Lower peritonitis rate ratio-RR in facilities using a training duration of 6 or more days (RR vs <6 days [Australia/New Zealand, Canada, Japan, Thailand, and United States only; contrast not estimable for the United Kingdom], 0.81; 95% CI, 0.68-0.96).
Sosa Barrios RA et al 2021 (23)	Training duration-sessions	135 PD patient training episodes-single centre	The number of training sessions required increased with age (Spearman Rho 0.404; p = 0.000001), diabetic status (p = 0.001), unemployment status (p = 0.046) and CCI (Spearman Rho 0.369; p = 0.00001). Longer training (> 13 sessions) was a significant risk factor for higher peritonitis risk, but extended training was not related to a shorter technique survival

2. Educational Interventions

Educational interventions were predominantly aimed at patients and carers, with some studies including nurses as the learners. Table 3 outlines the educational interventions and outcomes across the studies.

Table 3 Educational Interventions

Author	Type of Intervention	Follow-up +/_ frequency	Outcome
Chow JS et al (27)	Evaluate acceptability and usability of the TEACH- PD training curricula developed for PD trainers and patients in a real clinical setting. Standardised education training curricula for PD trainers and patients: PD nurses had to complete all assessments demonstrating nursing-level understanding of all clinical content.	30 days	Refinement of TEACH-PD curricula satisfaction with training modules materials; PD trainers pre-post interview of the online module; PD patients rates of PD related complications; PD units review of existing PD training curriculum
Firanek CA et al (28)	A 13-point survey, which focused on training tools, topics covered, methods used, and level of support at home, was administered during group face-to-face interviews with the PD training nurses	None	Infections, loss to in centre HD, and improved retention of patients on PD

Larsen T. (29)	Error-elicitation as instructional practice	90:25h of video recording	Performance of the APD procedure
Bonnal H et al (19)	Educational practices considered: training before catheter placement, availability of specialist nurse, using written and audio support and simultaneous practical and theoretical training	2012-2015	Proportion of peritonitis according to the different educational practice
Gadola L et al. (30)	Evaluation of the tool used to assess patient skills (Objective Structured Assessment-OSA) and the impact on peritonitis rates of a new Peritoneal dialysis education program (PDEP)	2 years	Peritonitis rates
Gadola L et al (22)	Evaluate peritonitis risk factors and its prevention with the New Peritoneal Education Program (NPEP) using a OSA for proficiency	1999-2016	Peritonitis rates and risk factors
Radmore NMT, Hyrkäs K. (31)	Semi structured qualitative interviews	None	Explore the teaching–learning partnership between nurses and patients

Various methods, interventions and outcomes were used, including a pilot project, TEACH-PD, focused on a curriculum for patients and nurses; the results of the larger study are yet to be published (32). The survey by Firanek et al. (2013) of training practices that likely contribute to successful training outcomes in APD focused on six centres in the USA of successful PD programs with excellent clinical outcomes (28). The clinics provided ongoing education, reinforcement, and retraining of concepts and skills through discussion, quizzes, and topic-specific monthly training sessions (28). Although retrospective, the study from the French Registry by Bonnal et al. (2020) analysed 1,035 patients (19). The authors conducted multiple covariate analyses to elucidate the impact of different educational approaches on the impact of developing peritonitis. The use of written support during PD learning and starting PD learning with hands-on training alone was associated with a lower survival free time of peritonitis, whereas the use of audio support and starting PD learning with hands-on training in combination with theory were associated with a lower risk of presenting further episodes of peritonitis after a first episode (19). It is important to note only 4% of centres used audio support.
Two studies from Uruguay evaluated a multidisciplinary educational training program. The results indicated a reduction in peritonitis episodes and time to first infection following the introduction of a new training program (22, 30).

3. Patient Characteristics and Assessments

Many studies included in this review examined specific patient characteristics to assess the risk of developing peritonitis. The French registry study used multivariate analysis to evaluate these characteristics and risks. One group, with higher risk were individuals with a learning disability (HR 1.43, 95% CI 1.05-1.95). Conversely, another group with a hearing impairment had a lower risk of developing peritonitis. (HR 0.35, 95%CI 0.16–0.75) (19). The study reported from Uruguay did not find any differences in patient characteristics associated with peritonitis risk (22). The PDOPPS data also didn't identify any significant risk factors for peritonitis, except for instances where a carer or third-party person (usually a nurse in a different location) conducted the training (17). In contrast, a large study from Brazil found lower educational levels and literacy to be independently associated with peritonitis incidence (21).
Studies have retrospectively assessed knowledge of patients undergoing training to explore correlations to peritonitis risk. A small survey study from Sudan assessed knowledge and literacy in 50

prevalent patients (young cohort mean age 42 years). Compared with patients in the middle and lower quartiles, patients in the upper quartile of knowledge score had lower rates of peritonitis, exit-site infection, and hospitalization (24).

4. Retraining

One important question to understand is how retraining or programmes focused on retraining improve education or PD-related outcomes. Six of the included studies focused on retraining efforts and are all characterised in supplement 3, with only three being prospective RCTs (14-16, 20, 33, 34). No two studies were the same in design and the heterogeneity makes comparisons difficult. The intervention of retraining was different; for example, in one study, the focus was on reassessments and then deciding if retraining was required (15), whereas in other studies, delivering enhanced programmes of care/retraining was the intervention (14, 20, 34). All the interventions differed in content from just additional home visits (14) to observed practices (20), theory and practical (15), theory test only (34), comparison of practical versus oral education (16) to a self-efficacy training program (33). In all the studies routine training at the start of PD treatment was delivered but different on start and follow up of retraining programmes. Large dropout rates were noted with many cited factors including transplantation, transfer to HD and patients' reluctance to attend frequent retraining (15, 16).

Discussion

This comprehensive review provides an update on the evidence for training methods, educational interventions and retraining in patients receiving PD. Like previous reviews, there is still inconsistency and variable results, the largest studies being observational and the lack of RCTs. The ISPD guidelines for both peritonitis and training highlight specific areas related to PD training to improve outcomes, such as peritonitis and exit-site infections (3, 4). Both acknowledge the lack of strong evidence to support many recommendations.

The training methods within this review and, more specifically, the time needed to train patients and caregivers adequately remain unclear, with differing results across the large observational studies (2, 17, 21). However, there is some consistency in training times being adapted according to the different needs of the population, with older patients requiring longer periods (18, 23) and people with low health literacy being at higher risk of peritonitis (19, 21). This emphasises the need to assess patients before training to understand their differing needs and thus adopt different approaches to training. This was recommended in the ISPD training curriculum with specific emphasis on adult learning styles (3).

There is a lack of evidence of appropriate methods to assess health literacy in PD studies or self-management programmes (6, 35). No studies in this review provided strong evidence for self-efficacy programs with only one small study on hand hygiene practices (33). For patients and carers undertaking PD, success is not solely based on technical skills but also on the ability to make decisions, manage risks, and adjust to the burden of the treatment. Peritonitis stigma and underreporting has been highlighted in previous studies, recommending supportive approaches into education about peritonitis (36).

Starting training before catheter insertion or planned training seems to be relevant but not always clear in studies; the PDOPP's data reported the majority of the training was carried out after catheter insertion (2), whereas the French data training commenced one month prior to catheter insertion (19). Education before the commencement of PD has been reported in a larger study by Hsu et al. (2018), showing an improvement in peritonitis outcome (37), similar to the Brazilian cohort (21). Providing

support and assessments has also been described as beneficial before the commencement of PD training (38). This would align with opportunities to assess patients beforehand, as described earlier and recommended in previous guidelines (3).

Other training methods included in this narrative review were video training (26). This is not a new concept, as many centres during COVID had to look at more remote ways to provide training. The advancement of virtual reality-assisted training is now of interest and may provide alternative approaches to PD training (39).

The only RCTs included in this review were those that examined retraining, the ISPD peritonitis guidelines recommends retraining as part of any PD program (4). The design of the studies varied hence inconsistent results. In the context of PD programmes, many factors should be considered, which are often not described in full within studies. For example, in routine care, how is support at home provided, i.e. routine home visits, telephone support, or follow-up/access to teams if peritonitis or other problems occur? Many programs likely deliver retraining in a more informal capacity or when a problem has occurred rather than in a preventive way.

The training and expertise of nurses delivering training are often referenced as important. Even from this review some of the smaller qualitative studies referenced how skilled nurses adapt different methods and develop relationships which can all help and support patients in training (29, 31). The standardisation and competencies required by nurses undertaking PD training are not well understood; often, references to experience are described with conflicting results (21). The TEACH-PD study may offer some insights into what should be included in a curriculum for nurses. One study in this review did describe nurses following principles of adult learning but details were lacking on what this entailed (22).

Outcomes reported in the included studies were mainly infection-related. The overall improvement in peritonitis rates has been studied over 30 years with multiple factors contributing (40). Before 2000, advancements in technology and technique likely contributed to improvements. In more recent years, these improvements are less obvious but may be attributed to better adherence to guidelines for peritonitis prevention and increased standardisation (40). In addition, factors that are specific to the training and education of patients and families/carers are less obvious but may be contributing, although this review lacks consistency. Furthermore, there was a lack of patient-reported outcomes within the included studies. The Standardised Outcomes in Nephrology PD (SONG-PD) initiative reported inconsistencies in infection outcomes and emphasised that standardized outcomes for PD trials are required to improve efficiency and relevance (41). Whilst infection and technique survival were the most important core outcomes, life participation was also included (42). SONG-PD further identifies outcomes relevant to patient and caregiver burden, emphasising developing strategies to adapt and build resilience to prevent or minimize burnout (43). Future studies for training and education interventions should standardise reporting of infections and include other reported outcomes such as those described by SONG-PD.

Strengths and Limitations

The strengths of this narrative review were the search strategy which followed a systematic and robust methodology. A team approach reduced bias of included studies. The limitations of this review need to be acknowledged. **The review protocol was not registered as is, therefore, a limitation**. **As the lack of high certainty evidence, a systematic review methodology process could not be truly applied** which usually only include RCTs and follow strict adherence to quality appraisal, risk of bias and statistical meta-analysis. A decision was made to include all study d**esigns and produce an integrated narrative** review to allow for a broader review to examine the evidence base following an initial scoping exercise where few RCTs were identified. **A further limitation is the number of articles excluded at the quality appraisal stage, but the authors acknowledge they should have been**

excluded at the screening stage; however, the quality appraisal process provided additional robustness to ensure all eligibility criteria were followed.

Implication for practice and research

- This review will underpin future guidelines for training and education of peritoneal dialysis patients and caregivers.
- The need for robust research to establish evidence to guide best practice on training methods and educational interventions.
- Consideration of assessments prior to training to individualise training programs and methods.
- The use of novel techniques, technology, videos and virtual training needs expanding.

Conclusion

In conclusion this updated review highlights inconsistencies in approaches to training and education, however some encouraging recommendations of adapted methods in training with individualised approaches, appropriate assessments before training and the need for consistent outcomes across future studies including QOL and life participation.

Conflict of Interest Statement

All authors confirmed there were no conflicts of interest to declare.

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Supplement 1 Search Strategy and Terms

Mesh	Mesh definition	Key Terms[a]	Key words[b]
Peritoneal dialysis Mesh Unique ID: D010530	Dialysis fluid being introduced into and removed from the peritoneal cavity as either a continuous or an intermittent procedure.	Dialyses, Peritoneal Dialysis, Peritoneal Peritoneal Dialyses	-
Patient education as topic Mesh Unique ID: D010353	The teaching or training of patients concerning their own health needs.	Education, Patient Patient Education Education of Patients	-
education [Subheading] Mesh Unique ID: Q000193	Used for education, training programs, and courses in various fields and disciplines, and for training groups of persons.		Teaching Training Curriculum
Infections Mesh Unique ID: D007239	Invasion of the host organism by microorganisms or their toxins or by parasites that can cause pathological conditions or diseases.	Infection and Infestation Infestation and Infection Infections and Infestations Infestations and Infections Infection I would remove infestation	Exit site infection Tunnelitis Tunnel infection Catheter infection
Peritonitis Mesh Unique ID: D010538	Inflammation of the peritoneum lining the abdominal cavity as the result of infections, autoimmune, or chemical processes. Primary peritonitis is due to infection of the peritoneal cavity via hematogenous or lymphatic spread and without intra-abdominal source. Secondary peritonitis arises from the abdominal cavity itself through rupture or abscess of intra-abdominal organs.	Secondary Peritonitis Peritonitis, Secondary Primary Peritonitis Peritonitis, Primary	-
Mortality MeSH Unique ID: D009026	All deaths reported in a given population.	–	–
Quality of Life MeSH Unique ID: D011788	A generic concept reflecting concern with the modification and enhancement of life attributes, e.g., physical, political, moral, social environment as well as health and disease.	Life Quality Health-Related Quality Of Life Health Related Quality Of Life HRQOL	Life participation Fatigue Burnout
–	–	–	Technique survival Technique failure
Catheter obstruction MeSH Unique ID: D061807	A hindrance to the passage of fluids through a CATHETER.		Fluid overload Catheter dysfunction FLUID BALANCE
Hospitalization MeSH Unique ID: D006760	The confinement of a patient in a hospital.		

a. terms that are included in the mesh
b. terms not found in mesh, but return results

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	c. Search strategy (SS)
	SS A= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training
A	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields])) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter])) **WOS** ((((((TI=(education)) OR TI=(patient education as topic)) OR TI=(teaching)) OR TI=(training)) OR TI=(curriculum)) AND TI=(peritoneal dialysis)) and 2017 or 2013 or 2014 or 2015 or 2016 or 2018 or 2019 or 2020 or 2021 or 2022 (Publication Years) and Article or Review Article or Letter or Early Access (Document Types) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI ("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") **BDENF** (ti:("peritoneal dialysis")) AND (ti:("education" OR "patient education" OR "teaching" OR "training" OR "curriculum"))
	SS B= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training AND outcome
B	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields]) AND "outcome"[All Fields]) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter])) **WOS** (((((((TI=(Education)) OR TI=(patient education as topic)) OR TI=(teaching)) OR TI=(training)) OR TI=(curriculum))) AND TI=(peritoneal dialysis)) AND ALL=(outcome) and 2013 or 2014 or 2016 or 2017 or 2018 or 2019 or 2020 or 2021 or 2022 (Publication Years) and Article or Review Article or Early Access (Document Types) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND TITLE-ABS-KEY (outcome) AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI ("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND TX outcomes **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") AND title(outcomes) **BDENF** (ti:("peritoneal dialysis")) AND (ti:(("education" OR "patient education" OR "teaching" OR "training" OR "curriculum"))) AND (tw:(outcomes))
	SS C= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training AND infections OR peritonitis OR Tunnelitis OR Tunnel infection
C	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields]) AND ("infections"[MeSH Terms] OR

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	"peritonitis"[MeSH Terms] OR "Tunnelitis"[All Fields] OR "Tunnel infection"[All Fields])) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter])) **WOS** ((TI=(peritoneal dialysis)) AND TI=(education OR patient education OR teaching OR training OR curriculum)) AND TI=(peritonitis OR exit site infection OR tunnel infection OR catheter related infection OR tunnelitis) and 2013 or 2015 or 2016 or 2017 or 2018 or 2019 or 2020 or 2021 or 2022 (Publication Years) and Article or Early Access (Document Types) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND TITLE-ABS-KEY (peritonitis OR "exit site infection" OR "tunnel infection" OR "catheter related infection" OR tunnelitis) AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI ("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND TI ("peritonitis" OR "infections" OR "exit site infection" OR "tunnelitis" OR "tunnel infection" OR "catheter related infection") **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") AND title("peritonitis" OR "exit site infection" OR "tunnel infection" OR "catheter related infection" OR "tunnelitis") **BDENF** tw:((ti:("peritoneal dialysis")) AND (ti:("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND (ti:("peritonitis" OR "exit site infection" OR "tunnel infection" OR "catheter related infection" OR "tunnelitis"))) AND (collection_enfermeria:"BDENF" OR collection_enfermeria:"MEDLINE" OR collection_enfermeria:"LILACS" OR collection_enfermeria:"colecionaSUS" OR collection_enfermeria:"SOF-ENFERMERIA")
SS D= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training AND mortality	
D	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields]) AND "mortality"[MeSH Terms]) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter])) **WOS** ((TI=(peritoneal dialysis)) AND TI=(education OR patient education OR training OR teaching OR curriculum)) AND ALL=(mortality) and 2013 or 2014 or 2022 or 2020 or 2018 or 2017 or 2016 or 2014 or 2013 (Publication Years) and Review Article or Early Access or Article (Document Types) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND TITLE-ABS-KEY (mortality) AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI ("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND TI mortality **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") AND title(mortality) **BDENF** (ti:("peritoneal dialysis")) AND (ti:("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND (ti:(mortality))
SS E= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training AND quality of life OR life participation OR burnout OR fatigue	
E	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields]) AND ("quality of life"[MeSH Terms] OR

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	"life participation"[All Fields] OR "burnout"[All Fields] OR "fatigue"[All Fields])) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter])) **WOS** ((TI=(peritoneal dialysis)) AND TI=(education OR patient education OR training OR teaching OR curriculum)) AND ALL=(quality of life OR life participation OR burnout OR fatigue) and 2015 or 2016 or 2019 or 2021 or 2022 (Publication Years) and Article (Document Types) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND TITLE-ABS-KEY ("quality of life" OR "life participation" OR burnout OR fatigue) AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI ("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND TI (“quality of life” OR “life participation” OR “fatigue” OR “burnout”) **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") AND title("quality of life" OR "life participation" OR burnout OR fatigue) **BDENF** (ti:("peritoneal dialysis")) AND (ti:("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND (ti:("quality of life" OR "life participation" OR burnout OR fatigue))
SS F= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training AND technique failure OR technique survival	
F	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields]) AND ("technique failure"[All Fields] OR "technique survival"[All Fields])) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter])) **WOS** ((TI=(peritoneal dialysis)) AND TI=(education OR patient education OR training OR teaching OR curriculum)) AND ALL=(technique failure OR technique survival) and 2022 or 2021 or 2020 or 2018 or 2017 or 2016 or 2014 or 2013 (Publication Years) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND TITLE-ABS-KEY ("technique failure" OR "technique survival") AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI ("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND TI ("technique failure" OR "technique survival") **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") AND title("technique failure" OR "technique survival") **BDENF** (ti:("peritoneal dialysis")) AND (ti:("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND (ti:("technique failure" OR "technique survival"))
SS G= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training AND catheter obstruction OR catheter dysfunction	
G	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields]) AND ("catheter obstruction"[MeSH Terms] OR "catheter dysfunction"[All Fields])) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter]))

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	WOS ((TI=(peritoneal dialysis)) AND TI=(education OR patient education OR training OR teaching OR curriculum)) AND ALL=(catheter obstruction OR catheter blockages OR catheter dysfunction) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND TITLE-ABS-KEY ("catheter obstruction" OR "catheter dysfunction" OR "catheter blockage") AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI ("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND TI ("catheter obstruction" OR "catheter dysfunction") **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") AND title("catheter obstruction" OR "catheter dysfunction" OR "catheter blockage") **BDENF** (ti:("peritoneal dialysis")) AND (ti:("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND (ti:("catheter obstruction" OR "catheter dysfunction" OR "catheter blockage"))
SS H= Peritoneal Dialysis AND education OR Patient Education OR teaching OR Curriculum OR training AND hospitalization	
H	**PM** ("Peritoneal Dialysis"[MeSH Terms] AND ("education"[MeSH Subheading] OR "Patient Education as Topic"[MeSH Terms] OR "teaching"[MeSH Terms] OR "Curriculum"[MeSH Terms] OR "training"[All Fields]) AND "hospitalization"[All Fields]) AND ((2013/3/19:2023/3/19[pdat]) AND (english[Filter] OR portuguese[Filter] OR spanish[Filter])) **WOS** ((TI=(peritoneal dialysis)) AND TI=(education OR patient education OR training OR teaching OR curriculum)) AND ALL=(hospitalization) **SCOPUS** (TITLE-ABS-KEY ("peritoneal dialysis") AND TITLE-ABS-KEY (education OR "patient education as topic" OR training OR teaching OR curriculum) AND TITLE-ABS-KEY (hospitalization) AND NOT TITLE-ABS-KEY (hemodialysis)) AND PUBYEAR > 2012 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA , "NURS") OR LIMIT-TO (SUBJAREA , "MULT")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish") OR LIMIT-TO (LANGUAGE , "Portuguese")) **CINAHL** TI (TI peritoneal dialysis AND TI (“education” OR “patient education” OR “teaching” OR “training” OR “curriculum”)) AND TI hospitalization **MEDLINE** title(Peritoneal dialysis) AND title("education" OR "patient education" OR "teaching" OR "training" OR "curriculum") AND title(hospitalization) **BDENF** (ti:("peritoneal dialysis")) AND (ti:("education" OR "patient education" OR "teaching" OR "training" OR "curriculum")) AND (ti:(hospitalization))

PM: PubMed
WOS: Web of Science
BDENF: Biblioteca Virtual en Salud Enfermería

Filters	
Language	English, Spanish and Portuguese
Publication rate	10 years (2023-03-19 to 2013-03-19)

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Information Sources: number of articles found in specialized databases							
SS	**Pubmed**	**Web of Science**	**Scopus**	**CINAHL**	**MEDLINE**	**BDENF**	**Total**
A	**278**	**46**	**36**	**42**	**76**	**61**	**539**
B	**73**	**26**	**14**	**10**	**5**	**11**	**139**
C	**76**	**12**	**16**	**31**	**16**	**10**	**161**
D	**21**	**11**	**8**	**0**	**0**	**0**	**40**
E	**28**	**5**	**9**	**2**	**6**	**7**	**57**
F	**25**	**12**	**4**	**0**	**0**	**0**	**41**
G	**8**	**1**	**1**	**1**	**3**	**1**	**15**
H	**23**	**1**	**2**	**0**	**0**	**0**	**26**
Total	**532**	**114**	**90**	**86**	**106**	**90**	**1018**

Supplement 2 Table of Included Studies

Author, Year, Country	Title of Study	Study Design	Population	Interventions	Key Findings	Limitations
Aguilera-Flórez et al. (2020). Spain (1)	Análisis del tiempo de entrenamiento y su relación con los episodios de peritonitis	Retrospective, observational, cross-sectional study. Single centre	112 incident patients trained either on APD or CAPD	No intervention	Patients over 70 years needed 18.13±7.93 hours for training; those patients under 70 years needed only 12.73±4.27 hours, (p=0.004) for training. Time to first episode of peritonitis was earlier in the longer training group - but this difference was not significant. The authors suggest that older patients need more time to complete their training.	The authors noted that they did not take into account the learning time needed for a patient to learn a new modality (from CAPD to APD), which could be a shorter number of days of training needed for this group, compared to patients learning CAPD or APD for the first time.
Bernardini and Davis (2014). USA (2)	Evaluation of a computer-guided curriculum using animation, visual images, and voice cues to train patients for peritoneal dialysis.	Observational, cross-sectional study. Patients were from one city in the US.	40 patients on PD, included both incident and prevalent patients. Patients with visual, hearing, or touch impairments were purposely included to reflect the disabilities common to the general APD population	Scripted training procedure, 4-8 hours of training on one day. This one-day training program had experienced PD training nurses to teach patients, including many with disabilities, one on one, to learn APD using a computer-guided curriculum using animation, visual images and voice cues. - the pace of training was adjusted to meet individual abilities and needs - patients were evaluated by the training nurse at	There was no correlation between the number of hours needed for successful training and age(r=0.30). - training time did not differ significantly by sex, disability, computer or technical experience, or education level. - the required training time was less for participants with previous PD experience (6.5 ± 0.7 hours) than for those naive to dialysis (7 ± 0.8 h), but this difference was not significant. The findings of this study suggested that a one-day training program using a cycler for APD that provided automated instruction using audio, video, and animation, and those features, combined with a qualified training nurse using a standardized script, appeared to be both efficient and effective for teaching PD patients how to use this cycler.	The study design was limited in that it lacked a comparison group to allow for an evaluation of differences with current training methods. The sample size of 40 participants was small. The training capabilities of the training nurses, which were not assessed, may have varied. Most participants had a relatively high education level. Thus, these results may not be generalizable to the general PD population.

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				the end of the training session for their proficiency in meeting the learning objectives.		
Bonnal et al. (2020). France (3)	Effects of educational practices on the peritonitis risk in peritoneal dialysis: A retrospective cohort study with data from the French Peritoneal Dialysis Registry (RDPLF)	Retrospective, observational, cohort study. Multicentre – 94 centres in France	1035 incident PD patients,	Compared different methods of training patients for PD.	This national study examined educational practices for patients new to PD and peritonitis risk. - 967 (93%) of patients received education from a specialized nurse. - written support was used for the PD learning in 907 (87%) patients, whereas audio support was used in 221 (21%) patients - use of a written support during PD learning and starting PD learning with hands-on training alone were associated with a lower survival free of peritonitis, whereas the use of an audio support and starting of PD learning with hands-on training in combination with theory were associated with a lower risk of presenting further episodes of peritonitis after a first episode. These findings suggest the various PD education modalities were associated with differences in the risk of peritonitis.	The study population may not be representative of the whole French PD population because some PD centres did not participate in the "nurses' practices" modules in which the educational covariates were collected. Furthermore, the authors noted that they did not know how the methods of education for PD learning were chosen for the different centres, which could have led to some selection bias.
Chang et al. (2018). Korea (4)	Frequent patient retraining at home reduces the risks of peritoneal dialysis-related infections: A randomised study	Prospective, randomised, controlled trial with parallel arms. Multicentre – 6 centres in Seoul, Korea	104 incident patients randomized to two groups: frequent retraining group (FG, n=51); or the conventional retraining group (CG, n=53)	The frequent retraining group (FG) received regular, repeated home visits by a PD nurse using a checklist every one to three months over the entire 2-year study period.	All patients received the same initial in-centre training during the break-in period. Over 24 months of follow up the event rates (ESI and any PD-related infections) for the FG were higher at an earlier period in the study, as compared to the CG. However, this difference is not significant since the p-value for the group difference was >0.05 for both ESI and any PD-related infections. In the generalised estimating equations (GEE) model the p-values for interactions between groups and time (interaction terms for group x time) were significant for both ESI and any PD-related infections, suggesting that the event rates of the two groups significantly changed over time. Overall, the exit site infection rates were 0.144 vs 0.168 episodes per year (p=0.09).	Seventy-eight subjects refused the study enrolment. Overall peritonitis rates were low. The patients in this study were relatively young with low comorbidity and high academic levels, and, thus, the study findings may not be generalizable to the general PD population.

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					Event rates for the FG decreased over time, and the event rates for the CG increased after month 12. In the FG of patients, only a sub-group of older patients (over 60 years) had a reduced risk of first episode of peritonitis, compared to the CG of patients. These findings suggest that elderly PD patients may benefit from frequent home visits for repeated retraining.	
Cheetham et al. (2022). Australia, Canada, Japan, New Zealand, Thailand, United Kingdom, United States (5)	International peritoneal dialysis training practices and the risk of peritonitis	Prospective, international, observational cohort study. Multicentre - 120 facilities.	1376 incident PD patients	No intervention.	In this study, data from adult patients on PD <3 months participating in the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS) were included: - training was most commonly performed at the facility (81%) - by facility-affiliated nurses (87%) - in a 1:1 setting (79%) From the findings of this large international study, the authors suggested that peritonitis risk was not associated with when, where, how or how long PD patients were trained. As such, training should be individualized to the patient's needs, but can be delivered in a manner that is convenient and in line with available local resources.	While this was a large international study, the authors noted that the observational design of this study only allowed for identification of associations and, therefore, not for causation. Also, there may have been some selection bias pertaining to the characteristics of individuals, as well as the centres, who agreed to participation in the PDOPPS.
Chow et al. (2019). Australia (6)	Targeted Education ApproaCH to improve Peritoneal Dialysis Outcomes (TEACH-PD): A feasibility study	Prospective, non-randomized, feasibility study. Two centres.	10 PD nurse trainers and 14 incident PD patients	TEACH-PD modules - standardised, evidence-based curriculum for PD trainers and patients.	In this feasibility study, all PD trainers completed the modules and passed competency assessments on their first attempt. - PD trainers found the modules to be practical and helpful particularly for those unfamiliar with adult learning principle-based training, but were time consuming to complete during work hours. - PD patients reported that the training modules were easy to follow, were comprehensive, prepared them adequately for competency assessments (100% pass rate on first attempt) and empowered them to start PD confidently at home. - none of the patients experienced peritonitis at 30 days follow-up. The outcomes of this feasibility study have informed the authors about refinement of the TEACH-PD modules prior to rigorous evaluation of its efficacy and cost-effectiveness in a large-scale study.	The authors suggest that this feasibility study was not designed to provide a justification for a change in clinical practice to use these training modules. Such a justification for change will need the outcomes of the planned larger scale randomized controlled trial.

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Einbinder et al. (2019). Israel (7)	ISPD guideline-driven retraining, exit-site care and decreased peritonitis: A single-centre experience in Israel	Prospective, pre and post interventional study. Single centre.	201 prevalent PD patients	The study period was divided into three intervals: Period 1, before the intervention; Period 2, an enhanced educational effort; and Period 3 in addition to the measures practiced in period 2, it was supplemented by strict adherence to exit-site care.	This educational interventional study was in 3 phases: - period 1 served as a baseline - in period 2, the intervention measures included assessing the techniques of the ongoing training program, retraining after each peritonitis episode, after hospitalizations longer than 2 weeks, and routinely every 3 months at the unit or at the patient's home: - the peritonitis rate decreased from 1.05 episodes per patient-year in period 1 to 0.85 episodes/patient-year in period 2. - in period 3, strict adherence to an exit-site care protocol, including twice weekly postoperative dressing changes performed by the dialysis unit nurse, and daily application of topical gentamycin or mupirocin ointment to the exit site was initiated the peritonitis rate in period 3 further decreased to 0.67 episodes/patient-year. The current study emphasizes the importance of retraining, as well as close attention to the exit-site care postoperatively, followed by daily application of topical antibacterial cream as per ISPD guidelines to prevent PD-related peritonitis.	Loss of some patients to follow-up during the different periods of this prospective study could have biased the outcomes.
Figueiredo et al. (2015). Brazil (8)	Impact of patient training patterns on peritonitis rates in a large national cohort study	Prospective cohort study. Multicentre – 122 PD centres in Brazil	2243 incident PD patients	No intervention.	This large, multi-centre study of PD training practices found: - patients who received a cumulative training of >15 hours had significantly lower incidence of peritonitis compared with <15 hours of training. - more experienced PD centres also had a significant reduction in incidence of peritonitis Fewer training hours, smaller centre size and training within 10 days of catheter implantation were all associated with worse peritonitis rates.	This was an observational study and, as such, all significant associations must be interpreted with caution. Moreover, the authors did not have detailed information regarding training methods on specific topics, such as curriculum of trainers, criteria for determining training success, expertise of nurses nor formal education for adult teaching.
Firanek et al. (2013). USA (9)	Training patients for Automated Peritoneal	Observational cross-sectional,	PD nurses at 6 large PD centres with	No intervention.	This review of training practices for APD at six PD centres - chosen for their excellent outcomes - found: - all used simple instructions and a hands-on approach - all initially trained patients on CAPD before APD.	A limitation of this study was that nurse training and experience were not investigated. Even

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	Dialysis: A survey of practices in six successful centres in the United States	survey of training practices. Multicentre	successful clinical outcomes		- all provided ongoing education, reinforcement, and retraining of concepts and skills through discussion, quizzes, and topic-specific monthly training sessions. - all provided 24-hour support for patients. Adopting the best practices identified in this study has the potential to improve APD training.	though the survey was developed by individuals experienced in the delivery of PD training, it was not validated prior to its use.
Gadola et al. (2013). Uruguay (10)	Using a multidisciplinary training program to reduce peritonitis in peritoneal dialysis patients: A pilot study	Retrospective, cohort study. Single center	25 prevalent PD patients	A pilot multidisciplinary PD Education Program was introduced: - one-on-one teaching - number of sessions, duration, materials used are adapted to the personalities and cultural backgrounds of the patients and partners - sessions continue until participants complete the Objective Structured Assessment perfectly.	With the introduction of the new PD Education Program, annual overall peritonitis rates declined to 0.23 episodes/patient–year in 2010 from 0.58 episodes/patient–year in 2007.	Since this pilot study was a retrospective cohort study, it is not possible to establish cause and effect between the intervention and the outcomes. The Objective Structured Assessment (OSA) was developed by the authors and has not been validated in other PD programs.
Gadola et al. (2019). Uruguay (11)	Risk factors and prevention of peritoneal dialysis-related peritonitis	Retrospective, cohort study. Single centre	222 PD patients: 88 trained with the initial education program; 134 with the new training program.	The New Peritoneal Educational Program was expanded (2008 - 2016): - training remained focused on the patients' individual	With the introduction of this New Peritoneal Education Program, both peritonitis rates significantly improved and time to first peritonitis was significantly longer, compared to the time before the introduction of the new program.	As in the above preliminary study by the same authors, since this study was also a retrospective cohort study, it is not really possible to establish cause and effect between the intervention

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				characteristics, their styles of learning were considered - training duration remained tailored to their demands and the Objective Structured Assessment test results - twice yearly workshops and retraining sessions continued.		and the outcomes. The Objective Structured Assessment (OSA) was developed by the authors and has not been validated in other PD programs.
Karadag (2019). Turkey (12)	The effect of a self-management program on hand-washing/mask-wearing behaviours and self-efficacy level in peritoneal dialysis: A pilot study	Observational, pretest-posttest study. Single centre.	32 prevalent PD patients	Using a theory of self-efficacy and self-management, patients on PD and their relative caregivers: - were given instruction in small groups on hand washing and the wearing of mask. - these small group meetings were repeated over the next six months to reinforce the behavioural change and to monitor the skills of handwashing and mask-wearing. - at monthly clinic visits, education on recognizing the presence of	Six months after the first intervention, the number of patients who 'always' demonstrated hand-washing and mask-wearing behaviours increased along with knowledge of peritonitis, but the results did not reach statistical significance. A statistically significant difference was found between the pre-intervention and post-intervention on self-efficacy scale mean scores of patients (t:4,396, p<.001)	This study was initially planned as a randomised controlled trial; however, the insufficient number of patients in the clinic made it impossible to form a control group. A control group would have helped ensure that the observed results were not just random events.

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				peritonitis were emphasized.		
Larsen (2018). Denmark (13)	Nurses' elicitation of patient error as a practice in training end-stage renal patients in automated home peritoneal dialysis	Observational, qualitative, cross-sectional study. Single centre.	6 incident PD patients and 3 PD nurses	Error-elicitation as instructional practice.	This study examined how nurses teach patients with end-stage renal disease how to perform automated home peritoneal dialysis (APD) through analysis of video recordings: - analysis showed nurses' elicitation of errors to allow them to impart knowledge and skills onto patients, which patients would not get the opportunity to learn if nurses relied solely on errors that evolved on their own. The study suggests that rather than solely waiting for random errors to emerge, nurses on occasion steer patients towards specific errors to bring about particular instructional opportunities	This study had a small number of patients and nurses, it was also single centre. Seemingly, the study author received no feedback on her findings from either the patients or nurses involved in the study. The findings in this study may not be generalizable to the PD population or PD nurses.
Ljungman et al. (2020). Sweden, Denmark, Norway, Finland, Estonia, Latvia, the Netherlands, and UK (14)	Retraining for prevention of peritonitis in peritoneal dialysis patients: A randomized controlled trial	Prospective, randomized controlled study. Multi-country - 57 centres.	671 PD patients randomized to two groups: 331 incident PD patients - control group; 340 incident patients - retraining group	Each group received the same initial training delivered locally as per normal practice and following ISPD recommendations. Follow up visits in both groups at 1, 3 and 6 months and 6 monthly for 36 months, the group randomised to retraining at each visit had a 2-2.5 hour test theory and practical in the home or PD centre. If the patient did not meet the goals of both tests, further training was provided, either on the same	The authors of this study were unable to demonstrate that regular, targeted testing and retraining of new PD patients increased the time to first episode of peritonitis or reduced the rate of peritonitis.	The limitations of the study mainly concern its low power, as noted by the authors, low peritonitis rates. - 8% of the participants in the retraining group withdrew consent and half of those withdrawals occurred within the first 6 months. - 74% of the controls and 80% of the retraining patients discontinued the study. - also, the practical test and the questionnaire were not validated prior to the study.

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				day or scheduled later, until the goals were achieved. The control group continued as per normal routine practice.		
Peláez Requejo et al. (2013). Spain (15)	Evaluación de los conocimientos prácticos de los pacientes prevalentes en diálisis peritoneal	Observational, cross-sectional study. Single center.	62 prevalent PD patients	An assessment test with 23 items was designed, which reflected the steps of a manual exchange and intraperitoneal medication administration; the assessment was performed by an impartial observer during a routine patient check-up.	The average number of correct answers was 18±3, with no difference in relation to the variables analysed. The study authors believed that, in general, their PD patients were well-trained; however, the authors' opinion was that good training is not sufficient, and that regular, personalized retraining programs should be established, although they point out there is no consensus on when and how this retraining should take place.	This small, single centre study, was conducted at one point in time. Thus, these findings are not generalizable to the wider PD population.
Perl et al. (2019). Australia, Canada, Japan, Thailand, United Kingdom, United States (16)	Peritoneal dialysis–related infection rates and outcomes: Results from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS)	Prospective, observational study. Multi country - 209 facilities.	7,051 incident/prevalent PD patients	No intervention.	The large, multi-country study examined facility practices and their impact on peritonitis using data from PDOPPS. - facilities that reported an initial period of patient training of 6 days or longer had lower risk for peritonitis as compared with facilities that had an initial period of 6 or fewer days. - PD facility age and the patient-to-nurse ratio, two potential proxies for centre experience, were not associated with peritonitis risk. The authors suggest that longer duration of training may be a proxy for the quality, content, and comprehensiveness of aspects of patient training and procedures that may reduce peritonitis risk at a facility	The authors noted that, as in most observational studies, patients and facilities agreeing to participate in the PDOPPS may be different and could have somewhat higher performance on average than other facilities, which may explain the lower rates of peritonitis that were observed when compared with some of the national reports. The sample consisted of upper-middle-income and high-income countries and thus the results may

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						not generalize to other countries with fewer resources.
Radmore and Hyrkäs (2019). USA (17)	Teaching-learning partnership between nurses and long-term patients undergoing peritoneal dialysis: A qualitative study	Qualitative, exploratory, and descriptive design. Single centre.	4 PD patients and 3 PD nurses	No intervention.	This study explored the teaching–learning partnership between people receiving PD and PD nurses. - the findings of this study describe complex and evolving teaching–learning partnerships. The authors suggest that each patient/nurse partnership is unique and evolves over time. A successful partnership requires nurses to modify the educational content and teaching style to best meet the needs of people receiving PD and, most importantly, allow them to feel cared for and supported.	Small sample size with patients from a single centre. The authors sought to include another centre in this study; however, only one elected to participate. The authors note that it remains unknown what the findings would have been if they had collected data from more than one centre which may have represented a different culture in patient demographics and nursing care. Another limitation of the study was that there were no participants with a verified history of infection.
Sayed et al. (2013). Sudan (18)	Effect of the patient's knowledge on peritonitis rates in peritoneal dialysis	Observational, cross-sectional survey. Multi centre.	Convenience sample of 50 prevalent PD patients who had never received a home visit	No intervention.	Comprehensive checklists for the evaluation of PD-related procedures and the home environment developed in one centre with routine home visits, were used to evaluate PD patients in their homes from other centres in the country which did not have home visits. In these other centres: - only 38% of patients and caregivers demonstrated proper handwashing technique. - only 12% of patients reported adherence to daily exit-site care, - only one third of patients had suitable housing conditions, but housing had no clear association with infection rates. - overall patients in the upper quartile of knowledge score demonstrated better adherence to the recommended treatment protocols and lower peritonitis rates, exit-site infections and hospitalizations. The authors suggest that their evaluation form revealed	While this is an important study carried out in PD patients in a country ranked among the world's least developed countries, it would be interesting to see if the peritonitis rate among these PD patients could be improved with a targeted intervention of retraining in the home.

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					serious gaps in knowledge about PD among the patients and that the evaluation form is a valid and reliable assessment tool for the follow-up of CAPD patients in the home.	
Sosa Barrios et al. (2021). Spain (19)	Peritoneal dialysis (PD) technique training: what features influence learning time?	Retrospective, cross-sectional study. Single centre.	135 incident PD patients	No intervention.	This study identified and defined the characteristics influencing PD training duration, its relationship with the first peritonitis episode and permanence on PD. - the number of training sessions required increased with age, diabetic status, unemployment status, and median Charlson Comorbidity Index. - requiring longer training (> 13 sessions) was a significant risk factor for higher peritonitis risk, but extended training was not related to a shorter technique survival. The authors suggested that recognizing patients who need a longer duration of training would be useful in order to set up pre-emptive retraining, aiming to diminish peritonitis risk in this subset of patients.	Small sample size with PD patients from a single-centre. In the study period, 188 patients were trained but only 135 had all the data required for the study and were analysed – this may have led to biased results for the study.
Viglino et al. (2023). Italy (20)	Peritoneal dialysis training performed remotely: results and comparison with Home Training	Retrospective, observational, cohort study. Single centre.	38 incident PD patients non-randomized to two groups: 17 - training by PD nurse in the home; 21 - initial set up and demonstration in the home, then training via telemedicine/video training continued by PD nurse from the centre.	Remote Video Training for the PD patient in the home by PD nurse in the centre.	In this study, total duration, home visits, exchanges/procedures, peritonitis, technique survival were compared between Home Training (carried out in the patient's home) and Video Training. - in CAPD, Video Training significantly reduced the number of home visits by the nurse (− 69.6% vs Home Training). However, the total duration and the number of exchanges did not differ. - in APD , Video Training significantly reduced the number of home visits by the nurse (−57.2%) although the total duration and number of sessions required to complete the training were greater. - in the Home Training group, there were 5 episodes of peritonitis, while no cases of peritonitis were observed in the Video Training group. The authors of this study suggest that remote video training makes it possible to significantly reduce the number of patient/caregiver transfers, number of home visits while maintaining good patient outcomes.	Small, single centre, non-randomized, retrospective study. The authors observed that Video Training may be limited by patients having insufficient internet connectivity and by the refusal of the patient/caregiver to take part in video training. In this study, the usual place for PD patient training was in the patient's home; thus, these findings of reduced home visits with Video Training may not be generalizable to the wider PD population.
Xu et al. (2020). China (21)	Prevention of	Prospective,	150 incident PD patients	All participants received standard	The study was to explore the efficacy of 3 different retraining methods on the risk of PD-related peritonitis	As noted by the study authors:

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	peritoneal dialysis-related peritonitis by regular patient retraining via technique inspection or oral education: A randomized controlled trial	randomized controlled study. Single centre.	randomised to 3 groups	training delivered over three to seven sessions, with 3–4 h/session, depending on the education level and learning skills of the patient, randomisation at 1 month to receive either retraining via technique inspection (technique inspection group), retraining via oral education (oral education group) or no retraining (control group) by a research staff. Technique inspection required one-on-one supervision of the bag exchange procedure by a dedicated nurse; Oral education was delivered by asking the patient if he/she was adherent to each point of the questionnaire on bag exchange. Both kinds of retraining were delivered in a separate room	- time to first peritonitis was comparable between the groups - follow-up was on average for 2 years. The authors suggest that further research is needed to develop multifaceted retraining methods that will be well accepted by patients, while the optimal timing and frequency of retraining should also be determined.	- 194 patients were excluded, including 66 patients who declined to participate - did not want to attend repeated retraining during the follow-up period - only 43% of incident patients met the inclusion criteria. - there was a relatively high rate of withdrawals from the technique inspection group (14%) during first year, which indicates that this strategy may not be suitable for all subjects. - - the single-centre design limits the generalizability of the findings - a lack of blinding may have led to possible performance and observer bias.

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				under one-on-one supervision.		

APD = Automated Peritoneal Dialysis; CAPD = Continuous Ambulatory Peritoneal Dialysis; PD = Peritoneal Dialysis

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Supplement 3 Retraining

Author	Intervention	Follow up +/- Frequency of intervention	Outcome
Chang et al (1)	Details lacking what was involved in retraining other than extra home visits for the FG. Each group received the same initial in-house training.	24 months. Subjects in the FG received more frequent training visits (10.6±7.5 days vs 3.6±3.6 days; p<0.001). The total time spent on PD training was longer in the FG (20.3±9.4hours vs 11.7±6.7hours; p<0.001)	Primary outcome ESI, secondary outcome peritonitis, HRQOL (KDQOLSF), hospitalisation
Einbinder et al (2)	Three time periods: Period 1 before the intervention 72 months baseline; Period 2- 14 months involved an enhanced educational effort consisting of assessment of the ongoing training program by a nurse and correction of faults, as well as patients retraining every 3 months, after each peritonitis episode and after a period of prolonged hospitalization (>2 weeks). Period 3 consisted of 22 months, in addition it was supplemented by strict adherence to exit site care.	Only small numbers completed whole study period- Fourteen of 201 (7%) patients were included in all three study periods, 9 out of 142 (6.3%) were included in periods 1 and 2 and 13 of 96 (13.5%) were included in periods 2 and 3	Primary outcome peritonitis rates
Ljungman et al (3)	Each group received the same initial training delivered locally as per normal practice and following ISPD recommendations. Follow up visits in both groups at 1, 3 and 6 months and 6 monthly for 36 months, the group randomised to retraining at each visit had a 2-2.5-hour test theory and practical in the home or PD centre. If goals not met of both tests, further training was provided, either on the same day or scheduled later, until the goals were achieved. The control group continued as per normal routine practice.	Follow up was designed for 36 months. Only 86 in the control group and 67 in the retraining group completed the trial. High drop out and delays in data collection hindered the trial. Not all centres followed the protocol, 6% of patients attended less than 75% of the planned test.	Primary outcome was time to first peritonitis following randomisation. Secondary outcomes overall peritonitis incidence
Peláez Requejo et al (4)	An assessment test with 23 items was designed, which reflected the steps of a manual exchange and intraperitoneal medication administration; the assessment was performed by an	No specific follow up one off assessment	Scores on assessment

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	impartial observer during a routine patient check-up		
Xu et al (5)	All participants received standard training delivered over three to seven sessions, with 3–4 h/session, depending on the education level and learning skills of the patient, randomisation at 1 month to receive either retraining via technique inspection (technique inspection group), retraining via oral education (oral education group) or no retraining (control group) by a research staff	Patients in both intervention groups underwent retraining every 2 months over 2 years	Primary outcome first episode of peritonitis
Karadag et al (6)	The intervention was a 6 month self-efficacy program based on Bandura's self-efficacy domains. Delivered in hospital setting by an MDT. Once per month for 30 minutes patients questioned on potential complications and handwashing and mask-wearing behaviours. Follow up by telephone or home with reminders such as ‘wash your hands’, ‘put on a mask’ accompanied with visual materials.	6 month programme	Self-efficacy questionnaire

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