Focus on peritoneal dialysis training: working to decrease peritonitis rates

Lei Zhang1,2, Carmel M. Hawley1,3 and David W. Johnson1,3

1Department of Nephrology, Princess Alexandra Hospital, Brisbane, Australia, 2Department of Nephrology, Guangdong Provincial Hospital of Chinese Medicine, Guangzhou, China and 3Centre for Kidney Disease Research, Translational Research Institute, Brisbane, Australia

Correspondence and offprint requests to: David Johnson; E-mail: david.johnson2@health.qld.gov.au

ABSTRACT

Patient training has widely been considered to be one of the most critical factors for achieving optimal peritoneal dialysis clinical outcomes, including avoidance of peritonitis. However, research in this important area has been remarkably scant to date. This article will critically review the clinical evidence underpinning PD patient training and will specifically focus on four key areas: who should provide training and how, when and where should it be performed to obtain the best results. Evidence gaps and future research directions will also be discussed.

Keywords: peritoneal dialysis, peritonitis, training

INTRODUCTION

Peritoneal dialysis (PD)-related peritonitis is one of the most serious complications of PD and acts as an appreciable obstacle to PD development. It contributes to ~20% of PD technique failures [1], results in an overall mortality rate of 2–6% [2, 3] and is a major barrier to the selection of PD as a renal replacement therapy modality by patients with end-stage kidney disease (ESKD). Single-centre studies in Korea [4], Brazil [5], Portugal [6] and Taiwan [7] have reported decreasing peritonitis rates over time. This pleasing trend has been ascribed primarily to improvements in PD connectology [8] and exit site care [9] as these innovations have resulted in decreased risks of touch contamination, intra-luminal entry of organisms or exit site colonization or infection leading to reduced peri-luminal entry of organisms. However, there is wide variation in global PD peritonitis rates [10] ranging from 0.06 episodes/year in Taiwan [11] to 1.66 episodes/year in Israel [12] (Figure 1). Even in the same country, peritonitis rates vary substantially among units, independent of centre size. Data relating to peritonitis rates among units from the Australian and New Zealand Dialysis and Transplant Registry (ANZDATA) reported a 10-fold variation in 2003–08 [13] and a 3-fold variation in 2011 [1]. Similar findings were reported from multi-centre analyses in the UK (7-fold variation) [14], Scotland (5-fold variation) [15] and Austria (20-fold variation) [16]. It is likely that such substantial variations in PD peritonitis are at least partly related to variable attention paid by centres to potentially modifiable peritonitis risk factors [17], including patient training [10].

Although patient training has widely been considered to be one of the most critical factors for achieving optimal PD clinical outcomes, including avoidance of peritonitis, research in this important area has been remarkably scant to date. This article will critically review the clinical evidence underpinning PD patient training and will specifically focus on four key areas: who should provide training and how, when and where should it be performed to obtain the best results. Evidence gaps and future research directions will also be discussed.

PD TRAINING RECOMMENDATIONS

As PD is a home-based therapy, patients or their carers generally need to execute all exchange procedures without the assistance of clinical staff. Individual patient exchange technique has been shown to be strongly associated with the risk of peritonitis [18, 19]. One multi-centre observational study including 353 patients from 11 centres in Italy reported that the relative risk of peritonitis comparing patients who were non-compliant with the dialysis protocol with those who were compliant was 1.6 (95% CI 1.1–2.4) [20]. Another single-centre observational study including 110 patients in Beijing reported that patients with poor bag exchange technique had an over 5-fold increased risk of peritonitis [21]. Therefore, adequate training of patients in proper PD technique [22, 23] is an important and necessary strategy to decrease peritonitis rates. However, an international survey of PD training programmes
involving 317 nurses from USA, Canada, South America, the Netherlands and Hong Kong, showed that only 31% of respondents had a formal adult education background and 53% did not know their unit’s peritonitis rates [24]. Moreover, total training time per patient varied enormously, with a range of 6–96 h.

There are two International Society of Peritoneal Dialysis (ISPD) guidelines relating to PD training [10, 25]. According to the ISPD PD Patient Training Guideline [25], published in 2006, a number of factors are thought to have an influence on training outcomes, including trainer-to-patient ratio, trainer’s experience and knowledge updates, training methods and protocols, training time and frequency and training environment and place. Moreover, a 1:1 trainer-to-patient ratio, experienced trainers, flexible and individual training methods, home training and home visits and retraining are recommended for better outcomes (Table 1).

The subsequent ISPD Position Statement on Peritonitis Prevention [10], published in 2011, recommended that training programmes should be based on three core components: nurse, PD centre and PD patients. Training, retraining and home visits are three necessary steps to guarantee training efficacy. Nurse trainers should have the specific theoretical and clinical skills (including familiarity with the principles of adult education), which need to be enhanced by subsequent continuing education. Senior PD nurses are responsible for training and monitoring new PD nurses. PD centres should have a well-planned PD training curriculum, training and retraining protocols, and home visit protocols. Patients should successfully complete the testing at the end of training to ensure that they can safely perform all procedures and have the ability to recognize contamination and respond appropriately.

While these guidelines collectively provide useful recommendations for the undertaking and evaluation of PD patient training, there is no robust evidence that instituting these interventions will lead to reduced peritonitis rates [26]. There has also been no formal evaluation of how well these guidelines have been implemented in clinical practice or whether they have contributed to improvements in clinical outcomes in PD centres.

**WHO SHOULD PROVIDE PD TRAINING?**

Although it is generally accepted that nurse trainers should be used whenever possible [27], there have been no studies comparing nurse trainers with non-nurse trainers. One-on-one training has been recommended by the ISPD training guideline [10] to enable nurses to allow enough training time and facilitate scheduling of retraining. However, an analysis of dialysis training, including 67 centres in USA and 11 centres in Canada [28], showed that the nurse-to-patient ratio varied from 1:1 to 1: 80,
with an overall ratio of 1:6.7 in USA and 1:35 in Canada. Only one centre in USA utilized one-on-one training. The data from 10 renal units in Scotland [15] showed that the nurse-to-patient ratio ranged from 1:7.1 to 1:29.8 and was not associated with peritonitis rates. Although these results suggest that the individual clinical workloads of nursing staff who provide training, retraining and general support to PD patients is not a dominant factor in determining peritonitis rates, other important considerations in relation to nurse trainers may include clinical experience [29], educational levels [30] and the proportion of specialist nurses within a PD unit [31].

Theoretically, more experienced nurse trainers should provide more efficient training with good communication and counselling skills, and demonstrate greater sensitivity to patients’ physiological and psychological challenges. This tenet is supported by a single-centre, Chinese observational cohort study of 305 incident PD patients [32] (Table 2), which found that patients trained by nurses with more than 15 years of general medical experience had a lower risk of Gram-positive peritonitis compared with patients trained by nurses with between 10 and 15 years’ experience [adjusted hazard ratio (HR) 2.69, 95% CI: 1.03–6.98; P = 0.04] or less than 10 years’ experience (HR 3.16, 95% CI: 1.20–8.30; P = 0.02). In contrast, another single-centre retrospective study by Chow et al. [33] in Hong Kong (Table 2), including 200 PD patients, reported an inverse association between the duration of a PD trainer’s experience and peritonitis rates. Indeed, training conducted by nurses with less than 3 years of PD experience was paradoxically associated with a lower risk of Gram-positive peritonitis compared with those with 3 or more years of PD experience (HR 0.24, 95% CI: 1.14–4.41; P = 0.02). The apparent disparity in findings between the two studies may be partly explained by the fact that nurse trainers selected the patients they trained in the Hong Kong study but not in the Chinese study, such that there may have been an imbalance in the peritonitis risk factor status of patients trained by junior and senior nursing staff in the Hong Kong study. For example, it is conceivable that the more challenging patients may have been assigned to the more experienced nurses, thereby confounding the association between nurse experience and peritonitis rates. Chow et al. alternatively proposed that more experienced nurses may have stale knowledge without continuing education and be more resistant to protocols developed according to adult learning principles. They further suggested that active continual learning [41–43] and applying principles of adult learning in training, particularly relating to protocol adherence, are likely to be important principles in trying to reduce peritonitis rates. Another key difference between the two single-centre studies was the definition of the trainer’s experience. The study by Yang et al. in Beijing defined trainer’s experience as the number of years a nurse had been in practice in general medicine, whereas Chow et al. considered only experience in specialist dialysis units. As suggested in the ISPD guideline [25], PD nurse trainers should have experience in both general medicine and specialist PD practice. However, there are no studies evaluating the impact of a trainer’s general medical experience compared with their specialist PD experience on peritonitis rates.

**HOW IS TRAINING BEST PROVIDED?**

**PD training curriculum**

A well-developed PD training curriculum based on adult learning theory has been recommended by the ISPD guidelines [10]. Adult learning theory is one technique which has been reported to produce considerable increase in recall [44]. However, there have been very few studies evaluating the effect of introducing training programmes based on adult learning theory. One adult learning theory-based PD training curriculum reported by Hall et al. [35] (Table 2) in a North American, multi-centre, non-randomized, cluster training study involving 620 patients from 36 Gambro Healthcare PD centres engaged the principle of cognitive domain and psychomotor domain of adult learning theory. This curriculum was structured by learning levels including memory, concept, principle, judgement/decision, problem solving and demonstration, from low to high (Figure 2). The PD patients were trained to gather supplies needed for an exchange in the memory level, differentiate between sterile and unsterile items in the concept level, recognize and state the principles in the principle learning level, recognize situations that may lead to peritonitis and state the appropriate action to take in the judgement/decision learning level and then recognize contamination and demonstrate the action to take in problem solving learning level. Finally, patients were then required to demonstrate safe connection to the dialysis system. The intervention centres were selected by ‘expressed interest by PD nurses after viewing a demonstration of teaching techniques,’ while the control centres were identified by their ‘willingness to collect data.’ Compared with patients trained by conventional training programmes (n = 374), patients trained by an adult learning theory-based curriculum (n = 246) exhibited lower peritonitis rates (28.2 versus 36.7 per 1000 patient-months, P = 0.09873), and the interval between peritonitis episodes lengthened (34.4 versus 26.3 months, P = 0.09873) over a 24-month follow-up period. However, these results were not statistically significant and the appropriateness of the statistical analyses is questionable. Furthermore, the non-random selection of centres by ‘interested’ nurses raises the possibility of selection (ascertainment), observer and performance biases. The conventional PD training curriculum was not described such that the generalizability of these results is uncertain. It should also be noted that there was a significant imbalance in the average interval between peritonitis episodes between patients from the intervention centres and those from the control centres prior to study inception (20.0 versus 33.2 months, respectively) providing further evidence of ascertainment bias. Only basic baseline patient characteristic information pertaining to age and gender was provided for patients in the two groups, together with a vague general statement that race and diabetes were ‘equally distributed between the two groups.’ Consequently, it is entirely possible that the observed non-significant difference in peritonitis rates between the two groups may have related to differing patient, centre and nurse factors associated with peritonitis rather than due to the training protocol per se. The adult learning-based PD training protocol also took longer to complete than the conventional training protocol (29.0 versus 22.6 h, P < 0.001). Consequently,
<table>
<thead>
<tr>
<th>Who</th>
<th>Study</th>
<th>Design</th>
<th>Patient Number</th>
<th>Results</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1 trainer-to-patient ratio</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No trial comparing one-on-one training with alternative ratio</td>
</tr>
<tr>
<td>Trainers with long-time training experience</td>
<td>Yang et al., 2012 [32]</td>
<td>Observational cohort study</td>
<td>305</td>
<td>Longer experience was associated with lower peritonitis rate</td>
<td>Still controversial. The role of general medical experience should be evaluated.</td>
</tr>
<tr>
<td>Continuous education of trainers</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No detailed continuous education programme report and no related trial</td>
</tr>
<tr>
<td>Multidisciplinary team involvement</td>
<td>Gadola et al., 2013 [34]</td>
<td>Retrospective study</td>
<td>31</td>
<td>No related trial about its specific effectiveness</td>
<td></td>
</tr>
<tr>
<td>How</td>
<td>Training programme based on adult learning principles</td>
<td>Hall et al., 2004 [35]</td>
<td>Multi-centre, non-randomized control study</td>
<td>620</td>
<td>Reduced peritonitis rates (P = 0.098)</td>
</tr>
<tr>
<td></td>
<td>Gadola et al., 2013 [34]</td>
<td>Retrospective study</td>
<td>31</td>
<td>Reduced peritonitis rates (P &lt; 0.05)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chow et al., 2007 [36]</td>
<td>Retrospective study</td>
<td>159</td>
<td>Late arrival of the training sessions was associated with increased peritonitis (P = 0.04)</td>
<td></td>
</tr>
<tr>
<td>Training programme with training schedule</td>
<td>Bernadini et al., 2014 [37]</td>
<td>Non-control</td>
<td>40</td>
<td>No correlation between the training time and degrees of disability</td>
<td></td>
</tr>
<tr>
<td>Duration of training</td>
<td>Neville et al., 2005 [38]</td>
<td>Pilot study</td>
<td>10</td>
<td>Peritonitis rates reduced (P-value not reported)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bernadini et al., 2006 [24]</td>
<td>Survey</td>
<td>317</td>
<td>No correlation between training time and peritonitis rates (P = 0.38)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Holloway et al., 2001 [19]</td>
<td>Survey</td>
<td>597</td>
<td>Decreased peritonitis rate with longer training time (P = 0.001)</td>
<td></td>
</tr>
<tr>
<td>Assessment of patients skill and knowledge at the end of training</td>
<td>Chen et al., 2008 [11]</td>
<td>Cohort observation study</td>
<td>100</td>
<td>Post training test score was not related to peritonitis rates. (P = 0.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gadola et al., 2013 [34]</td>
<td>Retrospective study</td>
<td>25</td>
<td>OSA score correlated with prior years’ peritonitis rates. (P &lt; 0.05)</td>
<td></td>
</tr>
<tr>
<td>Where</td>
<td>Re-training of patients important</td>
<td>Russo et al., 2006 [20]</td>
<td>Multi-centre observational study</td>
<td>353</td>
<td>Patients with younger age, lower education degree and in the early or late phase of PD had greater need for retraining</td>
</tr>
<tr>
<td>Home training</td>
<td>Castro et al., 2002 [39]</td>
<td>Retrospective study</td>
<td>84</td>
<td>Peritonitis rates declined after home training (P-value not reported)</td>
<td></td>
</tr>
<tr>
<td>Home visits</td>
<td>Ellis et al., 2012 [40]</td>
<td>Retrospective study</td>
<td>22</td>
<td>Peritonitis rates declined after home visit. (P = 0.25)</td>
<td></td>
</tr>
</tbody>
</table>
given that this study represents the strongest evidence underpinning the ISPD guideline recommendations for training, it is clear that more clinical and research effort is required in this area before firm recommendations can be made.

Recently, Gadola et al. [34] (Table 2) introduced a new PD education programme (PDEP) based on adult learning theory, with the training content focusing on chronic kidney disease (CKD) and renal replacement therapy modalities, basic mechanisms of PD, concepts of clean and sterile, hand washing, peritoneal solutions and supplies, bag exchanges, PD adequacy and schedule, troubleshooting, nutrition and diet and CKD complications and pharmacological treatment. After 2 years, peritonitis rates declined significantly from 0.55 to 0.28 episodes/patient-year, before and after the application of PDEP, respectively (P < 0.05). Unfortunately, this study was limited by its retrospective design leading to the possibility of recall bias and its use of historical controls leading to the possibilities of performance (co-intervention) bias and Hawthorn effect. Peritonitis rates also appeared to be falling prior to the introduction of the PDEP.

Although the PD training programmes in the studies by Hall et al. [35] and Gadola et al. [34] were based on adult training theory, their contents and curricula were different. The former study focused on introducing the structure of their training programme without any detailed description about differences in content between the developed and the conventional programme. In contrast, Gadola et al. [34] provided more emphasis on content and did not describe structural learning progress.

Besides content and structure based on adult learning theory, training schedule has also been considered to be an essential element in the training programme [45]. It consists of not only specific components of the training programme, but also target dates for their completion, which could help to motivate patients. The retrospective study by Chow et al. [36] (Table 2) reported that patients who arrived late for scheduled training had an increased risk of peritonitis, with an adjusted risk ratio of 1.56 (P = 0.04). Unfortunately, there have been no trials comparing different training schedules covering the same content and curriculum.

**Duration of PD training**

There are no randomized studies comparing outcomes between different durations of training. The length of the PD training time is variable around the world [24, 28] (Table 2) and depends mostly on individual patient characteristics. Clearly, patients with learning disabilities or physical handicaps will take more time to learn than the average patient. The study by Gadola et al. [34] also reported that patients who needed a longer training time due to older age or lower education level did not have higher peritonitis rates than other PD patients. Similarly, neither the hours per day training nor the number of days

**FIGURE 2:** Adult learning-based PD training programme [35]. Reprinted from Hall et al. [35] with permission of the American Nephrology Nurses’ Association. Web site: www.anna.org; For a sample copy of the journal, please contact the publisher.
trained correlated with peritonitis rates in the ISPD survey on PD training [24, 46]. However, a survey of paediatric patients in 2001 [19] (Table 2) observed a significant association between longer training time and lower peritonitis rate (P < 0.01).

**PD training methods**

As the learning ability of patients varies, flexible and individual training methods are needed, especially for patients with mental handicaps [47], low levels of literacy, poor visual acuity, cultural diversity, different language [48] and elderly or paediatric patients [49]. Since Kennedy et al. [50] applied a doll as an aid for PD training in 1985, various methods, such as animation, visual images, audiotape and online courses, have been developed to enhance training experiences. The use of pictorial tools and more symbols rather than written words for training in one pilot study including 10 disabled patients by Neville et al. [38] (Table 2) resulted in reduced peritonitis rates (0 episodes in 26.5 patient-months), compared with traditional training methods (1 in 12 patient-months). However, this was an extremely small study. The study by Bernardini et al. [37] (Table 2) used a training programme with audio, visual and animated instructions in 40 participants, most of whom had various degrees of disabilities. All the participants met the training objectives. However, there were no correlations found between the training time and disability, experience with computers or technology, or education level. The lack of a control group for comparison and the lack of an outcome report of peritonitis rates limited the application of this study.

**Training assessment tools**

As it is still not clear whether any of the aforementioned interventions (curriculum, longer training time or individualized teaching method) would result in improvement in peritonitis rates, the assessment of a patient’s skill and theory at the end of training has been suggested as a reasonable strategy. There are two published scoring systems involved in the evaluation of PD patients after training. One is the Objective Structured Assessment (OSA) applied by Gadola et al. [34] in Uruguay (Table 2), and the other is post-training test scores reported by Chen et al. [11] in Taiwan (Table 2).

The OSA score, based on Objective Structured Clinical Assessment, was first introduced for the evaluation of medical students in 1975. It consists of 6 ‘stations’ and 15 ‘key’ steps. The purpose of Station 1 is to evaluate a patient’s compliance with the complete bag exchange protocol, including room preparation, bag checking and warming, facial mask and washing hands and bag exchange procedure. The roles of Stations 2–6 are to evaluate a patient’s behaviour with respect to contamination, bag leakage and cloudy effluent and minor exit-site infection. Gadola et al. [34] applied the OSA scores to evaluate skills in 25 patients who had been on PD for at least 1 month. Those who passed the OSA had lower peritonitis rates (0.24 episodes per patient-year) in the preceding years than did those who failed the OSA (0.67 episodes per patient-year, P < 0.05). It should be noted that the number of patients who failed the OSA was small (n = 3) and the duration of follow-up was relatively short, such that there was considerable imprecision regarding the estimate of effect of the predictive value of this assessment tool. The single-centre design also limited the generalizability of the study’s findings.

The post-training test score reported by Chen et al. [11] consisted of 10 parts, including anatomy and physiology, overview of CKD, overview of PD, the complications of peritonitis and exit-site infections, diet control, cardiovascular complications, PD skills and procedures, aseptic techniques, management of peritonitis and routine tasks. From 2001 to 2007, 100 new patients were included in the study using the post-training test score. However, the risk for peritonitis was not related to the post-training scores (P = 0.8). The different outcomes between the two reports may have been due to the fact that the post-training test was only testing theoretical knowledge rather than performance ability. People with higher educational levels scored better but did not necessarily do better. The instruments or the scoring systems evaluating the patients’ skills at the end of training still need to be further developed.

Interestingly, after the post-training test in the study by Chen et al. [11], nurses retrained patients again and even patients with the lowest test score before were able to perform PD accurately. This observation suggests that retraining may be crucial for peritonitis prevention.

**WHEN SHOULD PD PATIENTS BE RETRAINED?**

In a single-centre, prospective, observational study of 130 incident urban PD patients, Dong et al. [21] reported that, after 6 months of PD, nearly half of the patients did not wash their hands, or check the bag for expiry date or leaks and 10% did not wear their cap or face mask. Not wearing a cap or mask was an independent risk factor for first peritonitis episode (HR 7.26, 95% CI 2.6–20.1, P < 0.001). This study was significantly limited by its small sample size, exclusion of a large number (n = 180) of potentially eligible patients, short follow-up period, single-centre design and single observation of a bag exchange.

An Italian study by Russo et al. [20] (Table 2) demonstrated that, after a mean of 33 months on PD, retraining was needed for 47% of patients on PD, based on incorrect answering of questions about PD infection or failure to follow standard exchange procedures. Variables predicting the need for retraining included younger patients (less than 55 years old), lower education status and being in the early (<18 months) or late (>36 months) phase of PD therapy.

The reasons for non-compliance with dialysis exchanges in PD patients are uncertain. One psychological mechanism referred to as ‘false memory’ was discovered in PD patients at Bergamo hospital in 1999 [20]. Patients who made mistakes in performing PD exchanges were not aware of their mistakes and said that they were behaving just as the nurse taught them in training due to poor memory recall. Another mechanism is ‘fluke mind’. After long-term compliance with the exchange protocol as taught, patients may consider themselves secure and expert in the exchange procedure, and begin to take shortcuts or simply deviate from the standard steps which they were taught initially. Therefore, retraining patients
to help impose a renewed adherence to the connection procedure is necessary.

Unfortunately, there is no evidence about how often and how soon retraining should be done after initial training. The 2011 ISPD Peritonitis Prevention Guidelines suggest that retraining should be performed after hospitalization, peritonitis or catheter infection, change in dexterity, vision, or mental acuity, and 3 months after initial training and routinely thereafter (once yearly at minimum). Further studies of the frequency of retraining are needed.

In addition to retraining in exchange technique, the 2011 ISPD Peritonitis Prevention Guidelines also recommend retraining in the recognition of peritonitis and the proper response to it. Individual special reinforcement in retraining may be a more effective method. It is therefore important to develop strategies to identify the emergence of individual problems during long-term follow-up of patients on PD.

WHERE IS THE IDEAL PLACE TO PROVIDE PD TRAINING?

Home training

Home training is intuitively attractive as a patient’s home is the place where they will actually perform their PD. It is different from the dialysis unit because not only is it generally a more comfortable environment, but it also differs because of the involvement of family members. Patients may also potentially experience problems transitioning from the dialysis unit to the home environment, even though they were well trained in the hospital. Training at home has been considered to offer many benefits, such as higher patient satisfaction and acceptance, improved home assessment, individualized education, effective interaction and active family involvement [51]. The study reported by Castro et al. [39] (Table 2) showed that peritonitis rates decreased from 1 episode per 24.5 patient-months (0.49 episodes per patient-year) to 1 episode per 44.4 patient-months (0.27 episodes per patient-year) after application of home-based training for 84 new PD patients. Unfortunately, no P-value of the comparison was reported and the study may have been potentially confounded by co-intervention bias. Further studies comparing the outcomes between home-based training and centre-based training are required.

Home visits

Home visits are an efficient way for the PD nurse trainers to detect the problems patients may encounter during follow-up and are an ideal way to assess the actual implementation of techniques by PD patients, which cannot readily be detected during regular outpatient visits [53, 54]. The first study of home visits in home dialysis patients reported in 1993 by Ponferrada et al. [55] recommended a single home visit for each new PD patient after evaluating the effectiveness of 18 months’ regular home visits in 36 patients. The authors further recommended that additional visits only be performed if significant problems were identified. At least one home visit was made to their patients by 525 (78.4%) of the 670 centres in USA in 1998 [53]. Bernardini et al. [52] recommended a home visit during the first 6 months of PD as a reliable way to predict further compliance with exchange procedures. Patients who were compliant in this first visit had an 88% probability of compliance on future visits. The authors concluded that those found to be compliant on their first home visit did not require further home visits, while non-adherent patients should be re-evaluated within in a few months. Consecutive home visits in Turkey [56, 57] identified personal hygiene as the weakest point of PD practice, and included it in the retraining programme. The multi-centre study in Italy by Russo et al. [20] applied home visits to investigate non-compliant behaviour in PD patients, and to determine what should be reinforced in retraining.

Limited studies of the correlation between home visits and peritonitis rates have been reported. Eileen et al. [40] (Table 2) in the USA retrospectively reviewed the change of peritonitis rates in 22 paediatric patients on PD after initiation of home visits for 6 months. Peritonitis rates decreased from 0.75 episodes per patient-year to 0.39 episodes per patient-year, without statistical significance (P = 0.25).

Although there are several advantages of home visits (listed in Table 3), the main disadvantages include its time consuming nature and the augmented need for staff, which in turn increases costs. In light of the uncertain balance of benefits versus costs and the dearth of quality investigations in this area, further studies evaluating the outcomes of home visits, such as peritonitis rate and cost effectiveness, are needed.

Assisted PD at home

Elderly patients have been shown to be at higher risk of peritonitis due to physiological changes related to ageing and a high prevalence of age-related health problems, such as dementia, leading to impaired vision, dexterity and cognitive functioning [59]. For such patients, training home-care nurses or family members to provide assistance with the performance of PD at home is an attractive option that is increasingly being explored [60, 61]. While the effect of assisted PD on clinical outcomes in elderly or functionally dependent patients has not been clearly established, several observational cohort studies have reported similar peritonitis-free survival rates between assisted PD patients and self-care PD patients [62–64]. There is also some evidence that patients assisted at home by private nurse/caregiver experience higher rates of peritonitis than those assisted by family members [65, 66]. Although this may be due to greater

| Table 3. Advantages and limitations of home visits |
|---|---|
| Advantages | Limitations |
| Assessment of home environment | Time consuming |
| Check of dialysis equipment/supplies usage and storage | Staffing required |
| Check of solutions expiry, and usage according to the latest prescription | Costly |
| Medication instruction, usage, storage, expiry | |
| Evaluation of patient compliance with exchange procedures | |
| Monitoring of potential hazards | |
| Ongoing education/instruction | |
| Psychosocial problems support | |
| Family interview | |
personal investment by family members, an analysis of the French Language Peritoneal Dialysis Registry (RDPLF) reported [66] no difference in peritonitis rates between these two groups when nurses from the training centre regularly conducted home visits, suggesting that training and retraining from an experienced PD nurse was more important than the type of assistant. Unfortunately, none of these studies reported the details regarding either the assistance or training programmes.

**FUTURE RESEARCH DIRECTIONS**

There are several research directions, listed in Table 4, which would be worthwhile pursuing in the future. A structured adult learning based PD training programme needs to be clearly described and evaluated. The comparison between different schedules covering the same curriculum and programme should be performed before recommending a particular schedule. More attention also needs to be paid to individualization among patients.

**CONCLUSIONS**

Although there is evidence that PD patient training methods are associated with peritonitis risk, the available studies are of poor methodological quality, often with retrospective designs, no control comparisons, small sample sizes, short follow-up durations, potential for co-intervention bias and, in some cases, a lack of statistical analysis or reporting of P-values (Table 2). High-level evidence guiding how, when and by whom PD training should be performed is lacking. Until high-quality evidence is generated, the ISPD PD training guidelines should be followed and evaluated against peritonitis outcomes. Further research in PD training methodology is clearly needed.

**CONFLICT OF INTEREST STATEMENT**

None declared.

---

**REFERENCES**


34. Gadola L, Poggi C, Poggio M et al. Using a multidisciplinary training program to reduce peritonitis in peritoneal dialysis patients. Perit Dial Int 2013; 33: 38–45
37. Bernardini J, Davis DJ. Evaluation of a computer-guided curriculum using animation, visual images, and voice cues to train patients for peritoneal dialysis. Perit Dial Int 2014; 34: 79–84
45. Kong I, Yip I, Mok G et al. Setting up a continuous ambulatory peritoneal dialysis training program. Perit Dial Int 2003; 23(Suppl. 2): S178–S182

Received for publication: 24.9.2014; Accepted in revised form: 2.12.2014