The relationships between clinical, socio-demographic and self-management: factors and complications in Thai peritoneal dialysis patients

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Abstract

Background: Peritoneal dialysis (PD) complications are known to be substantial during treatment. Complications may lead to PD failure. One way to reduce complications is to identify patients at risk early.

Objective: The study sought to describe complications and investigate the independent associations among the number of complications and age, distance, comorbidity, level of activity in daily living, and PD self-management.

Design, participants and setting: A cross-sectional descriptive study was conducted in 364 patients recruited from June to December 2010 who had undergone PD for at least one year.

Methods: Data were collected through self-reported questionnaires and reviewing medical records. Multiple regression analysis was used to identify the independent associations among a number of complications and independent variables.

Results: A high prevalence of complications was observed in each of three categories: PD inadequacy — electrolyte imbalance (90.7%); PD-related complications — dyslipidaemia (63.8%); and end-stage renal disease-related complications — mineral and bone disorder (90.7%), anaemia (89.3%), and malnutrition (81%). In multiple regression analysis, comorbidity, PD self-management, level of activity in daily living, and age were independently associated with the number of complications (R^2 = .231, p<.001) ($F_{(4,358)}$ = 26.816, p<.001). Comorbidity was the strongest factor in predicting complications.

Conclusion: There was a high prevalence of PD complications occurring in one year period before recruiting to the study in this sample. Patients with higher comorbidity, lower self-management, lower level of activity in daily living, and younger age were more likely to have higher a number of complications. These factors should be specified for PD suitability. Promoting self-management will help them to undertake PD safely.

Keywords

Complications, peritoneal dialysis, relationships, self-management, socio-demographic.

Introduction

In 2008, the *Peritoneal Dialysis First* policy was launched to address the needs of end-stage kidney disease (ESKD) patients in Thailand in the context of dialysis resource constraints especially for health care staff. Because it uses fewer health care resources than haemodialysis (HD), peritoneal dialysis (PD) has become the treatment first given to patients with universal coverage who require renal replacement therapy (Disease Management Institute [DMI], 2009). Although PD has been associated with decreased mortality (Hemmelgarn *et al.*, 2006), reduced overall health care cost, and increased access to health care for ESKD patients (Kasemsup *et al.*, 2005), the long-term effectiveness of PD is limited by complications. In Thailand, nearly 13% of patients experienced complications in the first year of PD (DMI,

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2009). The higher the number of complications presented, the greater the risk for failure of PD treatment. In a prospective study of 262 patients receiving PD, it was found that 37% of patients switched to HD because of infection. Fluid overload (18.5%), abdominal surgery (12.3%) and malnutrition (10.8%) were other leading causes of PD failure in the study (Jaar *et al.*, 2009). Moreover, a study by Fried *et al.* (2008) investigating inadequate dialysis outcomes in 1,432 patients receiving PD who having anuria also proved that PD inadequacy was associated with early hospitalisation and mortality after multivariate adjustment.

Although a wide range of complications have been reported, most studies examining PD outcomes have focused on very specific complications such as peritonitis, exit site infection, and malnutrition (Russo *et al.*, 2006; Sirivongs *et al.*, 2006). The treatment goals can be attained not only when patients are safe from the disease and treatment-related complications, but also when they have achieved the desired levels of dialysis clearance and fluid removal. Efforts to promote optimal PD services must take many other common complications into consideration.

Patient factors were previously found to be related to PD complications (Oakes & Rossi, 2003; Sirivongs *et al.*, 2006; Su *et al.*, 2009; Wang *et al.*, 2003; Ward, 2008; Wong *et al.*, 2009). Since most Thai ESKD patients lived in remote areas far from PD centres, had low incomes, lower level of education, were of advanced age, had poor physical function, and had multiple comorbid conditions (Sirivongs *et al.*, 2006; Supaporn, 2006), the determinants which indicate risks of failure to prevent complications during PD maintenance have become substantial. Though observational studies have suggested an improved rate of complications in PD (Guo & Mujais, 2003; Mujais & Story, 2006), these studies are limited to the factors of patients who preferred the modality and lived in economically developed countries, and may not be applicable to less developed countries.

Because PD provision has been mandated under an effort to control PD service quality, understanding the observed complications will help targeting for nursing interventions. Moreover, another way to improve PD effectiveness is to better select ESKD patients for the treatment; therefore possible qualifications need to be clarified. We hypothesised that after PD commencement, age, distance from centres, comorbidity, level of activity in daily living, and PD self-management factors would be independently associated with the number of complications among the patients.

Participants and methods

Study design

This study is a cross-sectional descriptive study aiming to describe characteristics of complications of patients receiving PD, and explore the independent associations among the number of complications and independent variables of age, distance from centres, comorbidity, level of activity in daily living, and PD self-management among patients undertaking home-based PD.

Participants

Three hundred and sixty-four study participants (n=364) were recruited into the study from June to December 2010 through simple random sampling method from 17 PD centres located in the central and north-eastern regions of Thailand. These were prevalent patients, who had been on home-based PD for a minimum of 12 months. Individuals were excluded if they had had a period of HD treatment prior to enrolment in this study.

Measurements and data collection

The study participants were approached individually by the researcher on the follow-up day while attending a PD clinic. The objectives and procedures of the study were described to them and written informed consent to participation in the study was obtained. If the participants agreed to participate, then data were collected using four self-reported questionnaires and clinical data were reviewed and recorded by the researcher thereafter. The study instruments were as follows.

The Charlson Comorbidity Index (CCI) was used to assess the incidence of 17 comorbid diseases abstracted from medical records by the researcher. A weighted scale ranged from 1 to 6 so the possible score ranged from 1 to 34 and a higher score indicated greater severity of comorbid diseases. It had a good inter-rater reliability (Charlson *et al.*, 1987).

The Katz Index (KI) of activity in daily living, a 10-item self-administered questionnaire, was used to determine the level of physical functioning (Katz *et al.*, 1963). The score ranged from fully dependent (0) to fully independent (3) in all activities, yielding a total score of 0–30. A higher score meant a lower level of dependency. It had a good internal consistency (Reijneveld *et al.*, 2007).

The PD Self-Management Scale (PDSMS) was developed by the research team and modified from The Self-Management Capacity Scale (Lui *et al.*, 2006). It is a 24-item self-administered questionnaire used in determining the PD self-management capability of the patients (Table 1). It consisted of five subscales: 10 items of PD procedure performance; four items pertaining to diet and fluid modification; three items relating to medication taking compliance; four items on self-assessment; and three items on the management of complication conditions, ranging from poorly performing (1) to well performing (4). Summation of scores yielded a total score of between 24 and 96. A higher score meant a higher level of PD self-management capability. Cronbach's alpha for this population was 0.92 and its content validity index was evaluated for content validity by a panel of five experts.

The Thai Patient Health Questionnaire-9 (Thai PHQ-9) is a 9-item self-reported scale assessing depressive symptoms experienced by the patients. It was developed by Lotrakul *et al.* (2008). Items were ranged from never (0) to always (3), yielding a total score between 0 and 27. The total score ≥9 was interpreted as indicating depression and the occurrence of psychological complications. A score was then provided for complications. The internal consistency with Cronbach's alpha was 0.79 (Lotrakul *et al.*, 2008).

The Peritoneal Dialysis Complication Record is a standardised data extraction tool (Table 2) based on the PD clinical practice guidelines. It was used to assess the number of complications occurring during a period of one year before recruitment into the study. The 25 complications acquired after commencing PD and recorded in medical records were grouped under three headings: *PD inadequacy,* a set of clinical data indicating body fluid imbalance, serum electrolyte imbalance, urea clearance, and ultra-filtration (UF) clearance; *PD-related complications,* a group of conditions acquired from performing PD treatment such as catheter malposition, exit site infection, peritonitis, hyperglycaemia, and so on; and *ESKD-related complications,* a set of clinical data indicating cardiovascular symptoms, mineral and bone disorders, anaemia, malnutrition, and depressive symptoms. Related laboratory and investigation results and patient health assessment throughout one-year follow-ups were retrospectively reviewed by the researcher. A dichotomous score came from 'no' (0) for no occurrence and 'yes' (1) for at least one occurrence at any point in a past year of each type of complication. The PD clinical practice guideline provided by the Thai National Health Security Office (Thai NHSO) was used as the criterion in interpreting the investigating results and clinical data of the patients.

Ethical consideration and human rights

The study was approved by the ethics committee from the Mahidol University Institutional Review Board. The protections of participants' rights in the study began at preparation and continued until data collection procedures were completed. Informed consent was obtained from the participants before they entered the study.

Data analysis

Data were analysed by using descriptive statistics including frequency, percentage, means, and standard deviations to describe socio-demographic data. Multiple linear regression analysis (MRA) was used to estimate the independent association among the number of complications and independent variables of age, distance from centres, comorbidity, level of activity in daily living, and PD self-management. Block entry method of variable selection was used. Statistical analyses were performed using SPSS Statistics 17 (SPSS Inc., 2008).

Results

Socio-demographics

Study participants (n=364) had a mean age of 50.5 years (SD 13.8) (range, 18 to 86 years) and lived a mean distance of 43 (SD 44.6) kilometres (range, 1 to 324 kilometres) from the PD centres. Approximately half (51%) were male and most were married (76%) and had a primary-level education (70%). About half of the participants were self-employed (42%) or otherwise employed (13%) while 45% were unemployed. Most had an income lower than 5,000 Baht (79%) and used the universal coverage scheme as their health insurance (92%). One hundred and seventy-three (48%) performed the PD bag exchange procedure by themselves and 113 (31%) had it performed by a caregiver (Table 1).

Table 1: Baseline socio-demographic characteristics (n=364)

Variables	n (%)	
Gender		
Male	185	(50.8)
Female	179	(49.2)
Marital status		
Married	277	(76.1)
Single	55	(15.1)
Widowed/divorced	32	(8.8)
Highest education level		
None	20	(5.5)
Primary	253	(69.5)
Secondary	81	(22.3)
Bachelor/higher	10	(2.7)
Occupation		
Unemployed	164	(45.1)
Employed	47	(12.9)
Self-employed	153	(42.0)
Monthly income (Baht)		
<5000	288	(79.1)
5001–15000	62	(17.0)
>15000	14	(3.9)
Type of health insurance	336	(92.3)
Universal coverage scheme	28	(7.7)
Others		
Bag exchange performer		
Patients	173	(47.5)
Patients and caregivers	78	(21.4)
Caregivers	113	(31.1)

Causes of ESKD included hypertension (29%), both diabetes and hypertension (26%). The cause was unknown for 23%. For most, PD catheters were implanted by a surgeon (76%) and in the operating room (86%) (Table 2). The average time in PD treatment was 19.7 months (SD 11.3) (range, 12 to 142).

PD complications

A high prevalence of complication was observed in each of the three categories: ESKD-related complications (99.5%), PD inadequacy (96.2%), and PD-related complications (94.2%). For individual complications, the four most common were electrolyte imbalance (90.7%), mineral and bone disorder (90.7%), anaemia (89.3%), and malnutrition (81%), while the four least common were bowel perforation (0.0%), membrane change (0.0%), hydrothorax (0.3%), and catheter tunnel infection (1.1%) (Figure 1).

Table 2: Clinical characteristics (n=364)

Variables	n (%)
Cause of ERSD	
Unknown	82 (22.5)
Diabetes	48 (13.2)
Hypertension	104 (28.6)
Diabetes and hypertension	95 (26.1)
Urinary system	42 (11.5)
Others	21 (5.8)
Catheter implantation by	
Surgeon	278 (76.4)
Nephrologists/medical physician	86 (23.6)
Place of catheter implantation	
Bedside	52 (14.3)
Operating room	312 (85.7)

ERSD = End Stage Kidney Disease

Associations among clinical, socio-demographic, and self-management factors and number of complications

In a multiple linear regression analysis, comorbidity, PD self-management, level of activity in daily living, and age were independently associated with the number of complications (R^2 = .23, p<.001) ($F_{(4,358)}$ = 26.82, p<.001). The coefficient of determination (R^2 = .23) was small, indicating that the linear regression model predictability was low. Comorbidity had the largest effect on the number of complications. As comorbidity score increased by 1 point, the number of complications increased by 0.40. As PD self-management score increased by 1 point, the number of complications decreased by 0.04. As level of activity in daily living increased by 1 point, the number of complications decreased by 0.06. As age increased by 1 year, the number of complications decreased by 0.02 (Table 3).

Table 3: Multiple linear regression analysis of the number of complications (n=364)

Independent variables	β	SE	Beta	t	p
(Constant)	11.822	0.918		12.881	<.001
1. Comorbidity	0.399	0.064	0.373	6.192	<.001
2. Level of activity in daily living	–0.064	0.018	–0.174	–3.479	.001
3. PD self-management	–0.035	0.009	–0.181	–3.744	<.001
4. Age	–0.017	0.008	–0.119	–2.022	<.05

Dependent variable: Number of complications
R = .48, R^2 = .23, Overall $F_{(5,357)}$ = 21.52, p<.001
PD = Peritoneal dialysis

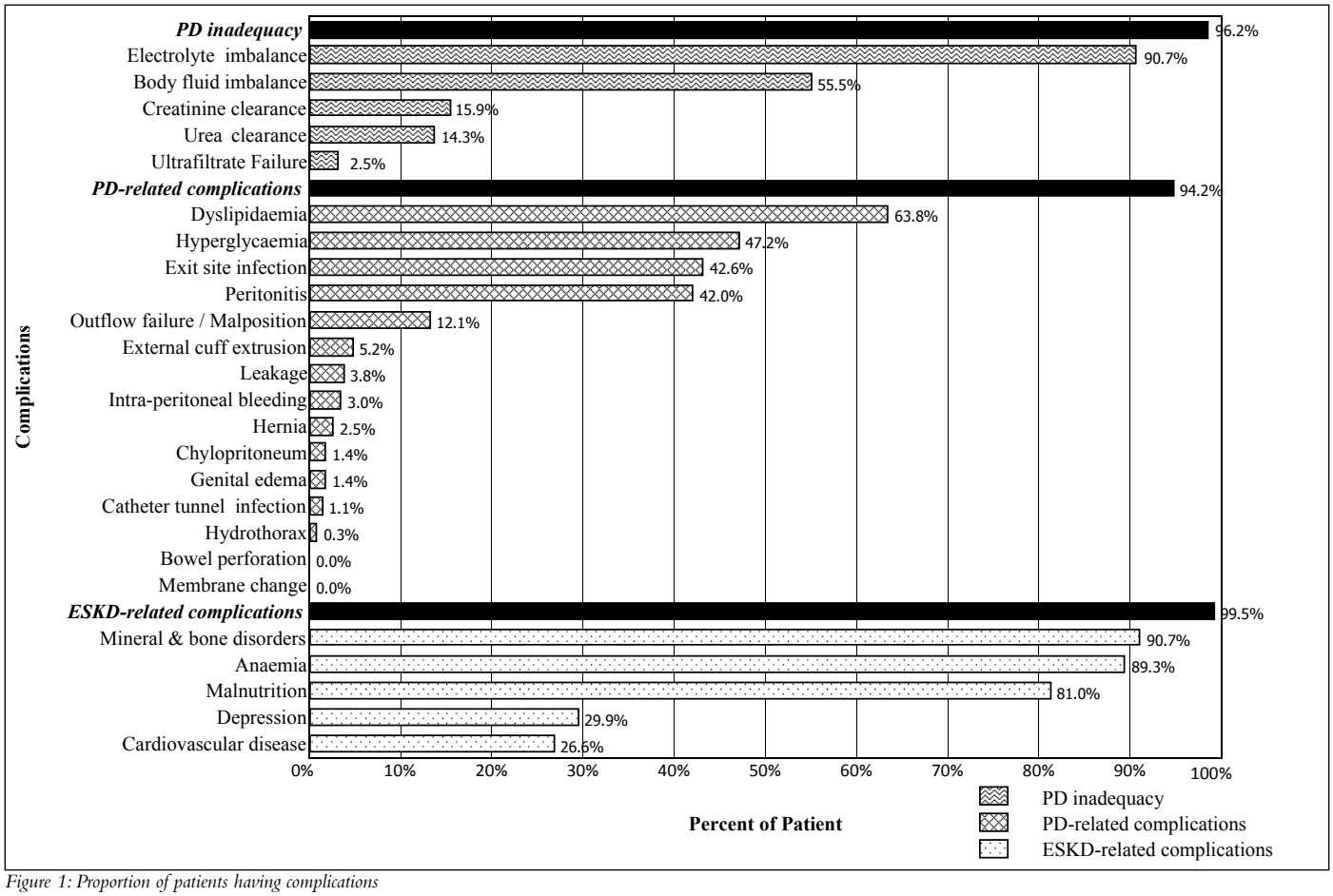

Figure 1: Proportion of patients having complications

Discussion

The study results showed the most common complications in each of three groups: PD inadequacy — electrolyte imbalance (91%); PD-related complications — dyslipidaemia (64%); and ESKD-related complications — mineral and bone disorder (90%), anaemia (89%), and malnutrition (81%). In this study the high prevalence of complications may be partly due to system-related factors. At the early phase of PD provision, a low number of patients in a centre would lead to insufficient experience in PD care in the health care providers. Additionally, the development of PD care training programs for providers was so primitive that their skills were not advanced enough and led to a small number of PD nurses and nephrologists.

As to PD inadequacy, health conditions mostly depended on PD prescription. Therefore, the high prevalence of electrolyte imbalance in terms of hyponatraemia and hypokalaemia measured in this cohort was likely to have resulted from both the patient factor of poor nutritional intake and the service factor of failure to modify the prescription. We found 81% of our cohort had malnutrition. Poor nutritional status is associated with intracellular potassium depletion, which can lead to flux of extracellular sodium and potassium into the cells, resulting in hyponatraemia and hypokalaemia. A previous survey of Asian patients receiving PD confirmed an association between hypokalaemia and poor nutritional status (Szeto *et al.*, 2005). Besides poor oral intake, the intracellular potassium deficit may be due to inappropriate PD prescription. A study of Newman and colleagues (2000) in a centre reported an increasing prevalence of hypokalaemia that was associated with increasing PD doses for adequacy targets. Moreover, the stimulation of insulin secretion by absorption of glucose in the dialysis fluid can drive potassium into cells, leading to hypokalaemia.

For PD-related complications, prevalence of dyslipidaemia in this study appeared to be similar to Pennell *et al.* (2004) who found 84% of patients undergoing PD for at least six months had hyperlipidaemia. The high prevalence may be caused by a metabolic and dietary adaptation to the continuous absorption of glucose from dialysis fluid. According to Boeschoten (2000), patients receiving PD have highly atherogenic triglyceride-rich lipoprotein abnormalities contributed to by several mechanisms. Firstly, the continuous absorption of glucose may increase triglyceride synthesis, which can result in a further increase in the concentration of triglyceride-rich lipoproteins. Secondly, loss of lipoproteins in the dialysate can result in low concentrations of serum high density lipoprotein (HDL) cholesterol. Finally, reduced activities of lipolytic enzymes can be responsible for lipoprotein abnormalities.

For ESKD-related complications, the conditions of mineral and bone disorder, anaemia, and malnutrition systematically involved in the disease itself were found in most participants. Unlike in this study, hyperphosphataemia used to indicate bone disorder was found in 28–40% of patients undergoing PD (Badve & McCormick, 2008; Dong *et al.*, 2007; Noordzij *et al.*, 2006). However, findings similar to those of this study on the other two categories of complications have been reported. Soffritti *et al.* (2009) noted that only 4.3% of PD patients in Italy could maintain the targeted haemoglobin level over time. Moreover, Prasad and colleagues (2008) found that the prevalence of malnutrition in PD patients was 75% assessed by the subjective global nutrition assessment (SGA) criteria and 64% assessed by serum albumin level. The high rates of disease-related complications in this cohort were possibly associated with several interrelated effects of comorbidities, social characteristics, and dietary intake patterns of the patients. The finding is almost certainly reflective of the clinical difficulty involved in achieving a good control level of these co-conditions because some of them had their origins early in the onset of renal impairment.

Independent associations of the factors and number of complications

From the results of multiple linear regression analysis, 23% of the variation in the number of complications can be explained by comorbidity, PD self-management capability, ability to undertake activities in daily living, and younger age. Comorbidity was most strongly associated with the number of complications. It is the group of additional health conditions of the patients that substantially contributed to the rates of complications. In previous studies, diabetes mellitus, the presence of peripheral vascular disease, and cardiovascular disease have been found to predict infection rates (Chow *et al.*, 2005; Han *et al.*, 2007; Prasad *et al.*, 2007; Sirivongs *et al.*, 2006; Wang *et al.*, 2003). Chow *et al.* (2005) found that diabetes was associated with a hazard ratio of 1.5, 95% CI of 1.1–2.4 ($p=0.03$) to develop an initial peritonitis. Thus, the results suggested an adverse effect of comorbidity that impedes the effectiveness of PD treatment.

Participants with a higher number of complications had lower self-management capability. It is possible that compliance in management of PD is difficult to achieve because patients have to make frequent daily decisions about fluid intake, nutrition, physical activity, management of symptoms, and coping with stress. These activities, if poorly managed, will lead the patients to face some degree of complication severity. Consistently, other studies have found that effective PD self-management has been proved to enhance complication control in areas such as PD adequacy, infection, malnutrition, cardiovascular disorder, and metabolic effects (Su *et al.*, 2009; Wang *et al.*, 2004; Wong *et al.*, 2009). Therefore, emerging evidence suggests that promoting self-management capability will be likely to lower complication rates.

Participants with a higher number of complications had a lower level of activity in daily living. This suggests a link between physical functioning and the development of complications. From the study, it can be said that reduced capability to engage in physical activity may contribute to a higher number of complications. Oliver *et al.* (2007) investigated the characteristics of PD patients who need home care assistance and found that nearly 80% of these patients had at least one condition of decreased strength in lifting a PD bag, decreased manual dexterity, decreased vision, and immobility. These acted as barriers to performing PD. However, given the cross-sectional

nature of this study, causality cannot be determined. It is not clear whether low levels of independence may contribute to complications, or whether, conversely, a higher number of complications may precipitate a decline in level of activity in daily living.

Other studies have confirmed an effect of advanced age on higher complications (Kotsanas *et al.*, 2007; McDonald *et al.*, 2004). Interestingly, a study conducted in a large cohort of 11,975 patients found a high risk of peritonitis in patients under the age of 44 (Oo *et al.*, 2005). In this study, younger age of patients was found to be related to a higher number of complications. This may be related to barriers to effective PD self-management in the younger group. In Thai society the middle-aged are supposed to be the key people responsible for taking care of their families. This means they may have less time to take care of themselves. As seen in Table 1, most of them were married and employed in labouring jobs.

The study findings indicate that the persistence of complications has important clinical implications and reinforces the challenging nature of providing clinical care and supporting self-management among patients. It seems imperative to foster early detection of complications. This might help reduce and prevent the highly prevalent complications. Avoidance or management of these complications depends not only on effective clinical management including PD prescriptions, medication administrations, mineral and blood component supplementations, and other essential services, but also on self-management enhancement so that patients can maintain proper dietary intake patterns and adhere to the PD regimen. The main finding of the study also suggests an opportunity to improve patient selection provided in the PD clinics through development of methods of risk assessment.

There are several limitations to this study. The study was conducted in the central and north-eastern regions of Thailand and therefore our ability to generalise to different geographical areas is limited. The study relied on self-reporting from ESKD patients who may have cognitive or other limitations affecting their recall. In addition, clinical variables were collected via retrospective medical record review and were therefore dependent on clinician documentation practices. Finally, a method for measuring the number and severity of complications was developed for this study. However, it is possible that accounting for the number of complications without a weighting system might lead to insufficient capturing of complication severity.

Conclusion and recommendations

The findings highlight the picture of complications and the importance of comorbidity, PD self-management, ability to undertake activity in daily living, and socio-demographic factors in delivering PD services for this sample. The high number of complications observed in the majority of the sample indicated that PD complications still persist while maintaining PD. Patients with a higher number of comorbid conditions, lower self-management capability, lower ability to undertake activity in daily living, and younger age were more likely to have a higher number of complications. As PD is the very first choice of treatment for Thai patients requiring RRT, patient selection criteria for PD should be clearly specified by policy makers. To achieve early identification of patients at risk, comprehensive counselling for PD initiation may be useful. Efforts to minimise the risk of complications should focus on management of comorbid conditions and promoting self-management capability through timely pre-dialysis education. Since PD nurses are the main providers of service for the patients, they are in the best position to not only prevent devastating conditions but also to detect the complications early. In emerging economies such as Thailand, strategies to develop these emerging nursing roles should be devised and implemented.

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Table 4: The Peritoneal Dialysis Self-Management Scale (PDSMS)

In your peritoneal dialysis treatment, what level do you perform the activities as follows? (Well/Quite well/Quite poorly/Poorly)

PD procedures element

Do you prepare PD appliances correctly?
Do you mask before hand washing regularly?
Do you wash your hands correctly?
Do you check a new bag before every usage?
Do you orderly exchange the bag correctly?
Do you record your intake/output correctly?
Do you perform daily dialysis as prescribed?
Do you store the appliances as recommended?
Do you perform exit site care correctly?
Do you perform exit site care regularly?

Diet and fluid element

Do you restrict salt intake as prescribed?
Do you restrict kinds of foods as prescribed?

Do you take amount of nutrient as prescribed?
Do you restrict your fluid intake according to the fluid removal?

Medications element

Do you take antihypertensive medicine as prescribed?
Do you take phosphate-combining medicine as prescribed?
Do you inject erythropoietin medicine as prescribed?

Self-monitoring element

Do you monitor your body weight every day?
Do you monitor your blood pressure regularly?
Do you check your abnormal signals regularly?
Do you recognise when abnormal signals happened to you?

Symptom managing element

Can you manage peritonitis correctly?
Can you manage exit site infection correctly?
Can you manage symptoms of fluid overload condition correctly?

Table 5: The Peritoneal Dialysis Complication Record

Complications	Interpretation	No	Yes
I. PD inadequacy 1. Body fluid imbalance	Pitting edema ≥1+, Dyspnoea, Breath sound crepitation, Pulmonary oedema		
2. Electrolyte imbalance	Serum Na<135 mmol/L, Serum K<3.5 mmol/L		
3. Urea clearance	Kt/V<1.7		
4. Creatinine clearance	Creatinine clearance<50 L/wk/1.73 m^2		
5. Ultrafiltrate (UF) failure	Yes or No		
II. PD-associated complications 6. Hernia	Yes or No		
7. Genital edema	Yes or No		
8. Leakage	Yes or No		
9. Outflow failure/malposition	Yes or No		
10. Hydrothorax	Yes or No		
11. Chylopritoneum	Yes or No		
12. External cuff extrusion	Yes or No		
13. Bowel perforation	Yes or No		
14. Intra-peritoneal bleeding	Yes or No		
15. Exit site infection	Yes or No		
16. Catheter tunnel infection	Yes or No		
17. Peritonitis	Yes or No		
18. Peritoneal membrane change	Yes or No		
19. Dyslipidaemia	Serum cholesterol >5.18 mmol/L, Triglyceride>2.26 mmol/L, LDL–C<2.59 mmol/L		
20. Hyperglycaemia	Fasting plasma glucose>6.1 mmol/L HbA_1C>0.075		
III. ESKD-associated complications 21. Cardiovascular disease	ECG shows ischaemic pattern, or anti-coagulant medicine or nitrate prescribed		
22. Mineral and bone disorders	Serum PO_4 >1.78 mmol/L		
23. Anaemia	Serum haemoglobin level<110 g/L		
24. Malnutrition	Serum albumin<35 g/L		
25. Depression	PHQ-9[1] score ≥9		

[1] PHQ-9 = Patient Health Questionnaire-9

Errata

Chenoweth, C. (2013). Reducing nursing needlestick injuries in haemodialysis clinics: a quality improvement program. *Renal Society of Australasia Journal*, 9(1), 22–26.

The RSAJ Chief Editor and Publisher would like to draw the attention to the following error in the *Renal Society of Australasia Journal* Volume 9 Issue 1. This correction should be attached to all reproductions of the published article: Chenoweth, C. (2013). Reducing nursing needlestick injuries in haemodialysis clinics: a quality improvement program. *Renal Society of Australasia Journal*, 9(1), 22-26.

The first two sentences of the discussion section on Page 25 are incorrect text.

The text: "Needle tip protrusion injuries have not been identified as a cause of NSIs in this review. Needle tip protrusion injuries has not been identified as a cause of NSIs in haemodialysis staff." SHOULD BE DELETED.

THE DELETED TEXT SHOULD BE REPLACED WITH: "Needle tip protrusion has been identified as a major cause of needlestick injuries in this review. To the best of our knowledge, needle tip protrusion injuries have not previously been described or identified as a cause of needlestick injuries in haemodialysis staff."

The RSAJ Chief Editor and the Publisher apologise for the above error.