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NEPHROLOGY - ORIGINAL PAPER

Study of early complications associated with peritoneal dialysis catheters: an analysis of the New Zealand Peritoneal Dialysis Registry data

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Abstract

Introduction Early peritoneal dialysis catheter (PDC)-related complications are frequent and make an important contribution to long-term PD survival. We aimed to analyse the incidence and specific causes of early PDC-related complications.

Methods This study was conducted from January 2001 to December 2012, utilising the New Zealand PD Registry (NZPDR) data. The objectives of this study were to analyse the incidence and causes of PDC-related complications within 4 weeks and 3 months of insertion. A logistic regression analysis was conducted to analyse any demographic or clinical risk factors of early PDC-related complications.

Results Of the 2573 PDC insertions during this period, majority 88% were surgically inserted. The number of complication within 4 weeks ranged from minimum of 20% to a maximum of 34% annually, with infections and flow dysfunctions leading the causes. There has been a minor drop in the infection rates from 19 to 16% ($p=0.21$), and flow dysfunction from 12 to 9% ($p=0.16$), from 2001 to 2012. A reduced odds of early complication was noted in elderly individuals above 60 years age, with odds ratio of (OR) of 0.73 (95% CI 0.53–0.99), while as higher odds of early complications were recorded in female gender, OR 1.41 (95% CI 1.06–1.88). Of the 10% of patients who failed to initiate PD within 90 days, flow dysfunction contributed to 32%, followed by infectious and surgical causes in 16% and 15%, respectively. The median time from insertion of PDC to initiation of PD was 17 days (interquartile range of 14–24 days)

Conclusions Improvements in PDC insertion techniques and reduction in infection rates may result in improvements in long-term PD technique survival.

Keywords Peritoneal dialysis · Technique failure

Introduction

Peritoneal dialysis (PD) became a reality after Henry Tenckhoff developed an indwelling peritoneal dialysis catheter (PDC) in 1968 [1]. Subsequently, innovations in PD catheter design focused on modifications in the length, shape and the cuff numbers intending to extend PDC survival and to improve outcomes [2]. Over this period, developments in PDC insertion techniques also evolved from an open surgical procedure to minimally invasive laparoscopic and Seldinger wire approach [3]. A well-functioning PDC enabling an uninterrupted flow of PD fluid in and out of peritoneal cavity is pivotal to successful PD therapy. Despite advances in PDC insertion techniques and connectology, infectious and technical complications still remain the major causes of temporary or permanent transfer on to hemodialysis (HD) [4].

Early PD failure is frequent and negatively impacts overall PD survival. One-third of all PD failures and 40% of all technique failures have been reported to occur within the first 6 months of PDC insertion. This is a particularly vulnerable period, resulting in highest rates of transfers to HD [5–8]. The majority (80%) of these patients commence

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HD using a temporary central venous line (CVL) [9], further compounding the risk of adverse events and associated hospital costs [10].

Identification and risk assessment of the causes of early PD failure is an important step in improving long-term PD outcomes. Such an assessment may lead to refining of catheter implantation techniques, and help in provision of psychosocial support for at-risk individuals/groups [11]. This study is aimed to analyze the early complications associated with PDC's in New Zealand (NZ), utilizing the New Zealand Peritoneal Dialysis Registry (NZPDR) data.

Materials and methods

This is a retrospective analysis of prospectively collected data within the NZPDR. The NZPDR collects comprehensive data on all patients on PD in the contributing NZ Renal Services and has ethical approval to collect and analyse the data. This study was conducted over 12 years from 1st January 2001 to 31st December 2012, across five NZ centres who agreed to participate in this study. De-identified data were collected after formal research approval from the NZPDR steering committee. Basic data include gender, weight, height, ethnicity, smoking status (current, former, or never smoked), type of PD catheter inserted (swan neck, coiled catheter, or embedded catheter), causes of end-stage kidney disease (ESKD), creatine clearance, and operator (surgeon, nephrologist or interventional radiologist) inserting the PDC. All complications occurring within 4 weeks and 3 months of PDC insertion were recorded. Body mass index (BMI) was divided into quartiles: underweight BMI (less than 18.5 kg/m^2), normal BMI (18.5–24.9 kg/m^2), overweight BMI (25–29.9 kg/m^2), and obese BMI above 30 kg/m^2 based on the WHO classification.

Body mass index (BMI) was calculated by standard formula, weight in kilograms divided by height in meter squared. The BMI was divided into quartiles: underweight BMI (less than 18.5 kg/m^2), normal BMI (18.5–24.9 kg/m^2), overweight BMI (25–29.9 kg/m^2), and obese BMI above 30 kg/m^2 on the basis of the WHO classification of the BMI. The combined creatinine clearance sum of residual renal and peritoneal clearance was divided into two groups, below and above 50 liters/week.

Statistical methods

Patient and centre level characteristics are presented as frequencies (percentages) for categorical variables, mean with a standard deviation (SD) for continuous normally distributed variables and median (with interquartile range) for continuous non-normally distributed variables.

Pie chart was constructed to show percentages and Student's *t* test was used for testing difference between sample means. Logistic regression analysis was carried out to analyse any demographic and clinical risk factors contributing to early PDC-related complications. The variables analysed were age at PDC insertion, gender, BMI, primary disease causing ESKD, creatinine clearance, operator type and type of PDC.

For all statistical calculations, p value of < 0.05 was considered as statistically significant and all confidence intervals (CI) were reported at the 95% level. All data were analysed using the STATA (version 15.0; STATA Corp LD, College station, TX, 7845, USA).

Outcomes

The PDC-related early complications within 4 weeks of catheter insertion were categorized as infectious: (including surgical site infection, peritonitis, exit-site infection and tunnel infection, non-infectious (including flow dysfunctions and flow pain) and surgical (including hemoperitoneum, leaks, and unrelated abdominal surgeries). The flow dysfunction was defined as poor dialysate rate (less than 500 mL flow in 5 min during the infusion and/or draining of dialysate solution) not resolved with conservative management [12]. Dialysate leak was defined as dialysate fluid draining from the exit site or central wound. The early PDC-related complications are classified according to the International Society of Peritoneal dialysis (ISPD) guidelines 2019 [13].

Results

Of 2573 PDC's inserted during the study period, 88% were inserted by surgeons, 7% by radiologists, and 5% by nephrologists. The baseline demographic characteristics of the patients are presented in Table 1. The specific complications within 4 weeks of PDC insertion are illustrated in Fig. 1, with infections predominating throughout the study period. There were only minor differences in the peritonitis or catheter flow dysfunction rates between 2001 and 2012. The number of early complications within 4 weeks of PDC insertion ranged from 20 to 34% over the years of the study as shown in Fig. 2. The logistic regression analysis is shown in Table 2, which reveals reduced odds of early complication in elderly individuals above 60 years age, with odds ratio, (OR) of 0.73 (95% CI 0.53–0.99), while as there were higher odds of early complications in female gender, OR 1.41 (95% CI 1.06–1.88).

The number of patients initiating PD within 90 days of PDC insertion is shown in Fig. 3, with 88% initiating PD within 90 days in 2001, compared to 93% in 2012 ($p = 0.9$), with an overall average of 90%. The causes of non-initiation

Table 1 Demographic characteristics (descriptive statistics)

Variables	
N	2573
Age, mean, years ± SD[a]	57.82 ± 14.15
< 60 years	1382 (53.8)
≥ 60 years	1186 (46.1)
Sex, *n* (%)	
Male	1418 (55.1)
Weight, *n*, Mean kilograms, ± SD	74.2 ± 15.8
Body mass index (BMI), Mean ± SD	26.20 ± 5.11
BMI categeory, *n* (%)	
≤ 18.5	32 (3.6)
18.5–24.9	333 (38.1)
25–29.9	327 (37.4)
≥ 30	182 (20.8)
Ethnic groups, *n* (%)	
European Pakeha[b]	848 (33)
Maori	982 (38.2)
Pacifica	315 (12.2)
Asian	94 (3.6)
Others	334 (13)
Smoking status, *n* (%)	
Smoker	458 (19)
Former	906 (37.7)
Never smoked	1040 (43.3)
Coiled catheter, *n* (%)	1050 (36.6)
Buried catheter	117 (4.6)
Primary disease, *n* (%)	
Glomerulonephritis	529 (23.1)
Renovascular disease and hypertension	255 (11.2)
ADPKD	119 (4.3)
Diabetes mellitus	94 (4.1)
Others	1243 (54.4)
Operator type, *n* (%)	
Surgeon	2117 (87.9)
Renal physician	90 (5)
Interventional radiologist	262 (6.9)
Creatinine clearance (Crcl), *n*	2250
Mean Crcl L/Week (95% CI)	80.5 (78.6–82.4)
Creatinine clearance, *n* (%)	
< 50 L/week	260 (11.5)
≥ 50 L/week	2011 (88.5)

[a]Age at PD catheter insertion

[b]Pakeha describes any person of non-Maori or non-Polynesian heritage

of PD within 90 days are shown in Fig. 4. Of the 10% of patients who failed to initiate PD within 90 days, flow dysfunction contributed to 32%, followed by infectious and surgical causes in 16% and 15%, respectively. In the remainder of 37% of instances, no cause was recorded. The median time from insertion of PDC to initiation of PD was 17 days (interquartile range of 14–24 days). PD initiation was counted from the first day of PD training.

Discussion

To our knowledge, this is the largest study analyzing early PDC-related complications, previous studies on PDC-related complications are limited by conflicting results and small sample sizes [14–16]. The Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS) is expected to systematically delineate early and long-term risk predictors of PD technique failure [17].

This study observed at least 20% of all PDC insertion developed one complication within 4 weeks of insertion annually, up to a peak 34%. The odds of early complications were noted to be lower in the elderly individuals and higher in female gender with no clear justification. A previous study by Tiong et al. analysed several factors related to catheter dysfunction and found that patients with a background of diabetes, glomerulonephritis, or previous abdominal surgery had a higher risk (OR: 3.24; 6.52; 3.42, respectively) of early complications (within 30 days after catheter placement) [18].

Infections were the major cause of early complications accounting for 19% in 2001, with a minor drop to 16% towards the end of the study. This drop-in early infectious complication was likely due to the implementation of ISPD protocols for prophylaxis and treatment of infectious and other technical complications associated with PD. ISPD catheter-related infection; 2017 update recommends prophylactic antibiotic administration before catheter placement, treatment of contamination, exit-site care, training of staff in catheter placement, prevention of procedure-related complications and aggressive patient training [19]. The guidelines also recommend thorough auditing of every episode of infection and technical complication to determine the cause of the event and to mitigate their recurrence to establish a successful PD program [19–22].

The early PDC infection rates noted in this NZ study are still above the ISPD targets of less than 10%, highlighting that more needed to be done. Individual centres need to audit their PDC insertion practices, accounting for the evolving advances in this field, to continuously improve outcomes. Reducing early PD-related complications is highly dependent on the expertise of the PD staff [23].

Overall, 10% of PD patients failed to initiate PD within 3 months, with flow dysfunction and infectious complications being the major culprits. Early PD-related complications particularly flow dysfunction and exit-site leaks, are common and can be discouraging for the patients. Such discouragements bring with it an ominous unwillingness to continue with therapy. [8] To avoid such early catheter-related

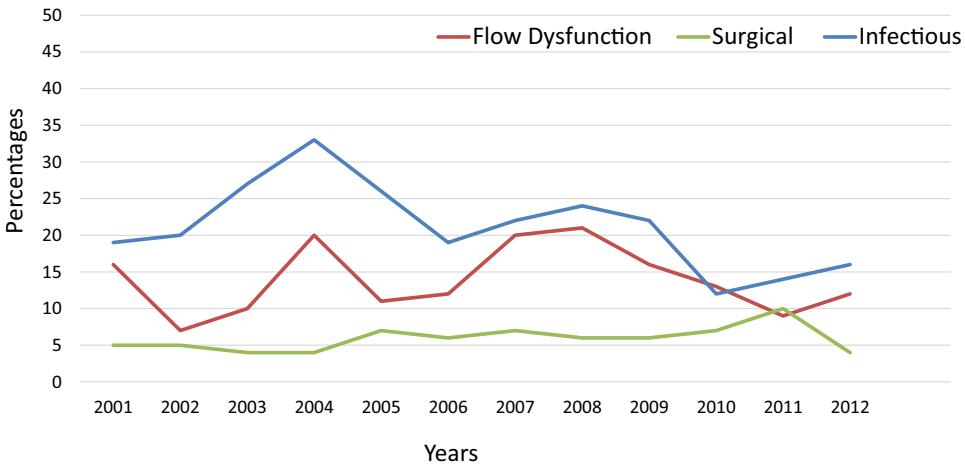

Fig. 1 PDC complications within 4 weeks of insertion

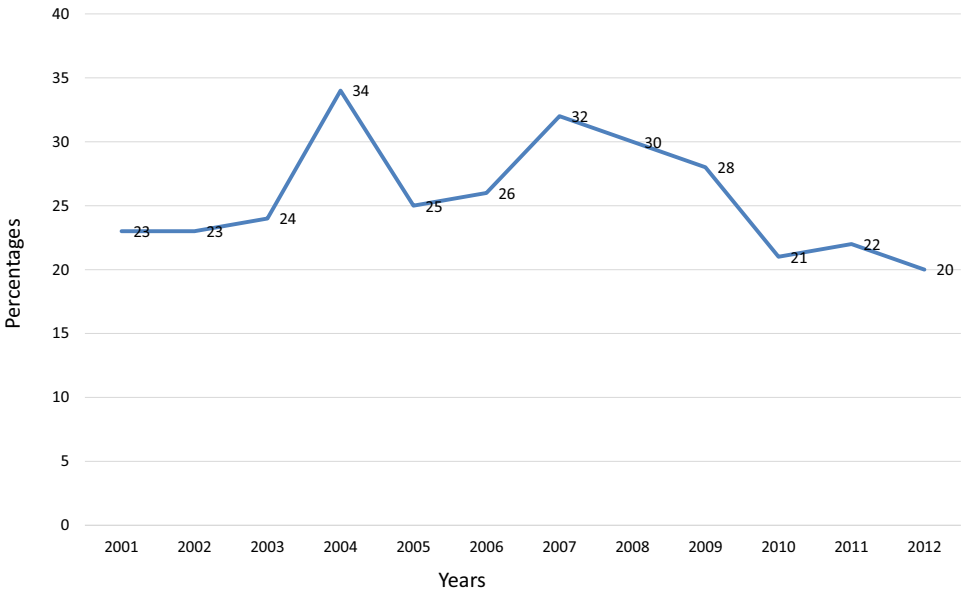

Fig. 2 Percentage of patients with one or more complications within 4 weeks of insertion

complications, we must adhere to the basic principles of planning, selecting the appropriate catheter design, marking the optimum position of the PD exit site, and following up to date pre and post-insertion ISPD guidelines [23].

Open communication and collaboration between the nephrology and surgical or radiology teams inserting the PDC are important because decisions that are made before and during the insertion of the PDC have implications for catheter functioning. The insertion of catheters by unsupervised trainees is an unacceptable practice. The liberal use of laxatives before and during PD training is an underappreciated strategy to promote good catheter function. Constipation is associated with poor catheter performance due to catheter migration and compression of the catheter lumen by the bowel [23].

The strengths of this analysis are that it is a multi-centre, with prospectively collected data on early complications in a large patient group, conducted over a longer period. The limitations include missing observations, relatively older data, and the possibility of inaccuracy in the data entry due to a lack of verification procedures. We acknowledge that the cohort of the patients receiving subsequent PDC may not have been the same as the cohort receiving the first catheter, and so the comparison is difficult. We also acknowledge that only 5 of 13 (38%) of NZ centres offering PD participated in the study, and so the analysis may not represent the PD practice patterns in the whole of the NZ.

Table 2 Logistic regression analysis of risk of ∝ early PDC-related complications

Variables	Odds ratio	95% CI
Age[a]		
≥ 60 years	0.73	0.53–0.99
Sex		
Female	1.41	1.06–1.88
BMI		
18.5–24.9	0.97	0.42–2.27
25–29.9	1.01	0.43–2.38
≥ 30	1.39	0.58–3.28
Creatinine clearance		
Creatinine clearance ≥ 50 L/week	0.82	0.55–1,21
Ethnicity		
Maori	1.13	0.75–1.70
Pacifica	1.12	0.68–1.85
Asian	1.08	0.52–2.26
Others	1.19	0.72–1.98
Operator type		
Renal physician	1.54	0.91–2.61
Interventional radiologist	1.12	0.70–1.78
Coiled catheter	1.27	0.91–1.77
Buried catheter	1.37	0.68–2.74
Primary disease		
Renovascular dis and HTN	0.63	0.34–1.17
ADPKD	1.25	0.64–2.43
Diabetes	0.75	0.52–1.08
Others	0.69	0.38–1.22

[a]Age at catheter insertion ∝ within 4 weeks

Conclusions

There is a significant early complication rate after PDC insertion which includes both technical and infective causes with complication rates lower and higher in elderly individuals and female gender, respectively. A small percentage of patients did not initiate PD within 90 days during the study period. Infection remains the major cause of early PDC-related complications. Reduction in infection-related complications and improvements in PD catheter insertion techniques may result in improvements in PD technique survival.

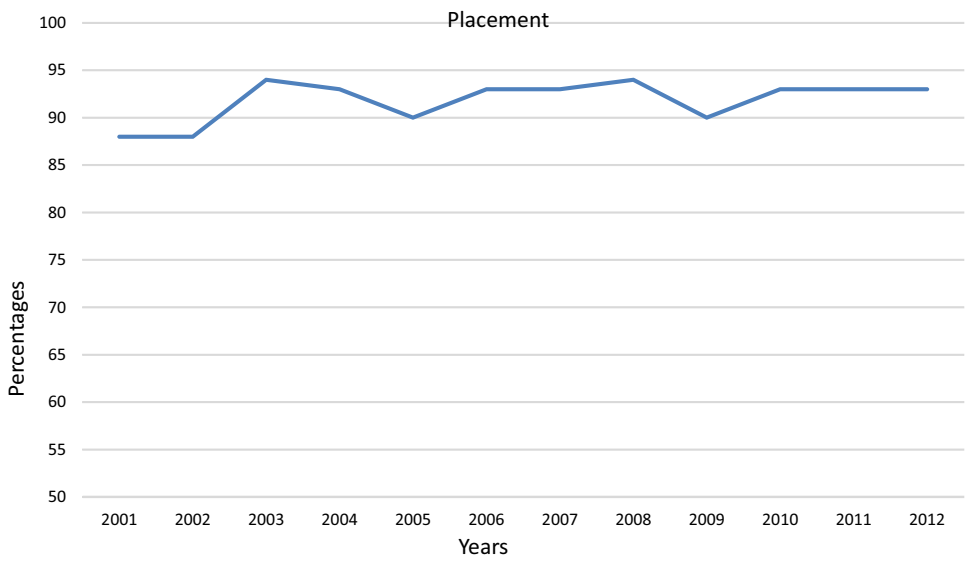

Fig. 3 Percentage of patients established on PD within 90 days of catheter placement

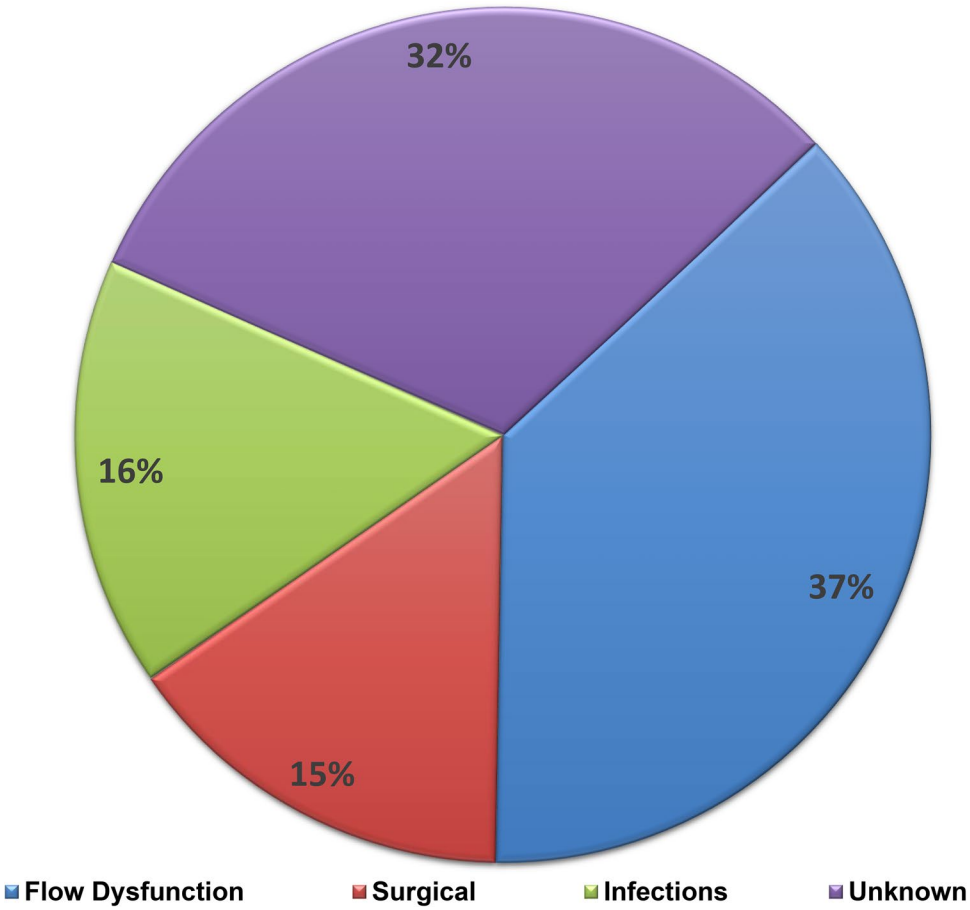

Fig. 4 Causes of non-initiating PD within 90 days

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Compliance with ethical standards

Conflict of interest Walaa Saweirs has received Honoria from Baxter New Zealand as a speaker. Nothing to disclose for all other authors.

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