A Randomized Controlled Trial Comparing Mupirocin and Polysporin Triple Ointments in Peritoneal Dialysis Patients: The MP^3 Study

Rory F. McQuillan, Ernest Chiu,* Sharon Nessim,† Charmaine E. Lok,* Janet M. Roscoe,‡ Paul Tam,‡ and Sarbjit Vanita Jassal**

Summary

Background and objectives Infectious complications remain a significant cause of peritoneal dialysis (PD) technique failure. Topical ointments seem to reduce peritonitis; however, concerns over resistance have led to a quest for alternative agents. This study examined the effectiveness of applying topical Polysporin Triple ointment (P^3) against mupirocin in a multi-centered, double-blind, randomized controlled trial.

Design, setting, participants, & measurements PD patients routinely applied either P^3 or mupirocin ointment to their exit site. Patients were followed for 18 months or until death or catheter removal. The primary study outcome was a composite endpoint of exit-site infection (ESI), tunnel infection, or peritonitis.

Results Seventy-five of 201 randomized patients experienced a primary outcome event (51 peritonitis episodes, 24 ESIs). No difference was seen in the time to first event for P^3 (13.2 months; 95% confidence interval, 11.9–14.5) and mupirocin (14.0 months; 95% confidence interval, 12.7–15.4) (P=0.41). Twice as many patients reported redness at the exit site in the P^3 group (14 versus 6, P=0.10). Over the complete study period, a higher rate per year of fungal ESIs was seen in patients using P^3 (0.07 versus 0.01; P=0.02) with a corresponding increase in fungal peritonitis (0.04 versus 0.00, respectively; $P<0.05$).

Conclusions This study shows that P^3 is not superior to mupirocin in the prophylaxis of PD-related infections. Colonization of the exit site with fungal organisms is of concern and warrants further study. As such, the use of P^3 over mupirocin is not advocated in the prophylaxis of PD-related infections.

Clin J Am Soc Nephrol 7: 297–303, 2012. doi: 10.2215/CJN.07970811

*Division of Nephrology, University Health Network, Toronto, Canada; †Division of Nephrology, Jewish General Hospital, McGill University, Montreal, Canada; and ‡Division of Nephrology, Scarborough General Hospital, Toronto, Canada

Correspondence: Dr. Sarbjit Vanita Jassal, University Health Network, 200 Elizabeth St, 8N-857, Toronto, Ontario M5G 2C4, Canada. Email: vanita.jassal@uhn.ca

Introduction

Peritonitis is the most significant complication associated with peritoneal dialysis (PD). It is a cause of considerable morbidity and may lead to technique failure and lengthy hospitalization. Furthermore, recent data suggest that peritonitis may be a contributing factor in 15% of PD deaths and that each episode of peritonitis carries a 4%–8% risk of mortality (1,2).

Historically, PD catheter-related infections have been predominantly caused by organisms found on skin surfaces, such as *Staphylococcus epidermis* and *Staphylococcus aureus*. However, in recent years, there is an increasing proportion of exit-site infection and catheter-related peritonitis caused by *Pseudomonas aeruginosa* and other Gram-negative organisms. On the basis of current evidence, current clinical practice guidelines (3) suggest the routine use of a topical agent at the PD catheter exit site and two agents, mupirocin and gentamicin, are recommended. Mupirocin has been, and currently remains, widely used globally. It is a topical antibiotic cream or ointment that has excellent activity against Gram-positive organisms but has little or no effect against *Pseudomonas* or other Gram-negative bacteria. Several studies comparing mupirocin with placebo have shown a reduction in exit-site infection and peritonitis with the topical application of nasal or exit-site mupirocin, largely driven by a decrease in *S. aureus* infection (4–12). Gentamicin is an aminoglycoside antibiotic that may either be used topically as a prophylactic agent or systemically as a treatment for documented infection. It has excellent antibacterial activity against Gram-negative organisms like *P. aeruginosa* and also against some Gram-positive organisms, including *S. aureus*. In a randomized controlled trial comparing gentamicin to mupirocin in prevalent PD patients, a reduction in Gram-negative peritonitis was seen without an increase in Gram-positive infections (13). Two subsequent, nonrandomized studies failed to confirm the superiority of gentamicin over mupirocin (14,15). Despite the robust, randomized, controlled nature of the data, the inclusion of multiple interim analyses for safety reasons increased the risk of a false positive result to 34% (16). This observation, coupled with concerns that widespread use of topical gentamicin may lead to bacterial resistance, has led to a continued search for new agents.

Polysporin Triple (P^3; bacitracin 500 U/g, gramicidin 0.25 mg/g, and polymyxin B 10,000 U/g) is an alternative topical ointment that has been used with success for some years in the hemodialysis (HD) population (17). Compared with placebo ointment, P^3 applied to the exit site of HD patients dialyzed with a tunnelled temporary or semi-permanent dialysis catheter reduced infections (18). In addition to being inexpensive and easily available, P^3 is attractive because it has bacteriostatic activity against a wide range of both skin flora and other organisms, including Gram-negative bacteria (19).

The aim of this study was to ascertain whether the application of P^3 ointment was superior to mupirocin when routinely applied at the PD catheter exit site in the prevention of PD-related infections.

Materials and Methods

A detailed account of the methods used in this study was previously published (20). This was a multi-center, double-blind, randomized controlled trial of two active treatments. Ointments were prepared and dispensed by a central clinical trials pharmacy, and were similar in color, odor, and consistency. PD patients from each of the three participating sites were eligible for inclusion if they were aged ≥18 years and were medically stable as defined by their nephrologist. Both prevalent and incident patients were included. Informed consent was obtained. Exclusion criteria included patients with ARF; catheter-related infection at the time of recruitment or in the previous 3 months; use of an oral, intravenous, or intraperitoneal antibiotic at the time of randomization or in the past 1 week; a known allergy to any component of P^3 or mupirocin; or a scheduled date for living donor transplant surgery within 6 months of the study completion date. Centrally allocated permuted block randomization was used to assign patients to either mupirocin or P^3 ointment. Stratification groups were based on the center, whether an incident or prevalent patient, and the use of a cycler. Patients were instructed to apply the ointment to the exit site using a cotton-tipped applicator with each dressing change, and were specifically advised not to use any other exit-site applications outside the protocol. All other aspects of medical care, including the management of PD-related infections, were left to the discretion of the patient's primary nephrologist.

Patients were followed in person and by telephone at monthly intervals. To determine whether patients had additional hospitalizations and intercurrent illnesses, we screened daily hospital admission logs and reviewed the minutes from the weekly clinical meetings in which patients with ongoing PD-related issues were reviewed. The primary end point was the time to first PD-related infection. This was a composite end point that included one or more of the following: exit-site infection, tunnel infection, or PD peritonitis, as defined by International Society of Peritoneal Dialysis guidelines. Secondary end points included the removal of the catheter for refractory infection, hospitalization due to PD-related infection, death due to PD-related infection, all-cause mortality, and transfer to HD. This study was approved by the hospital research ethics board at each of the participating sites. The data safety monitoring board recommended continued follow-up even after the first PD-related infection for subsequent safety data analysis. As such, follow-up was continued in all patients until death, transfer to another unit, transplantation, or the end of the 18-month follow-up period. Patients electively switching to HD were advised to continue routine exit-site care, and were followed for infections until PD catheter removal.

Statistical Analyses

The sample size was estimated at 100 participants in each arm, on the basis of an accrual period of 6 months and a follow-up period of 18 months, and an instantaneous hazard ratio of 0.045 for the standard treatment group versus 0.023 for the P^3 group to achieve a power of 81%, with an α of 0.05 (20).

Descriptive data were reported as mean ± SD or as median ± quartiles. The composite end point was compared using a Kaplan–Meier curve and log rank comparisons. Peritonitis and exit-site rates were calculated for each individual based on their follow-up time. Rates were calculated as the number of events occurring divided by the total follow-up days. *Post hoc* comparisons between groups for hospitalization, mortality, and infection rates were done using Kaplan–Meier curves and log rank comparisons, and Poisson regression as appropriate. All statistical analyses were performed using PASW software (version 17.2; SPSS Inc, Chicago, IL).

Results

A total of 387 patients were assessed for eligibility (Figure 1). We recruited 204 patients from 3 sites. However, because of unforeseen difficulties, recruitment from one of the sites was discontinued and the data were excluded (n=3). The remaining 201 patients from two centers were randomly assigned to either mupirocin (n=100) or P^3 (n=101) using stratified block randomization as per protocol. The baseline characteristics of these 201 patients are shown in Table 1. There were no differences in terms of age, sex, comorbidities, methicillin-resistant *S. aureus* carriage, PD modality, or time on dialysis between the two groups.

Patients were followed for a total of 2742 patient-months (median 18 months; range, 0.1–18 months). Eighty-seven patients (45%) were followed for <18 months due to death, premature study withdrawal, or PD catheter removal (Figure 1). No statistical difference was found for the time to first PD-related infection (P=0.41) (Figure 2). In total, 75 patients had a PD-related infection, including 36 patients from the mupirocin group and 39 from the P^3 group (Table 2). Fifty-one study events were due to episodes of peritonitis, of which 23 occurred in the P^3 group and 28 occurred in the mupirocin group. There were twice as many exit-site infections in the group assigned to receive P^3, although this did not reach statistical significance (P=0.09). No tunnel infections occurred during the study period. To note, patients in the P^3 group were at increased risk of reaching the primary endpoint because of fungal infection compared with those randomized to mupirocin (7 versus 0; P=0.01). This finding was largely driven by fungal exit-site infection. There was no difference in the number of infections seen by center, PD modality, or incident versus prevalent patient groups. Secondary outcomes are shown in Table 3. Hospitalization rates were similar in both groups.

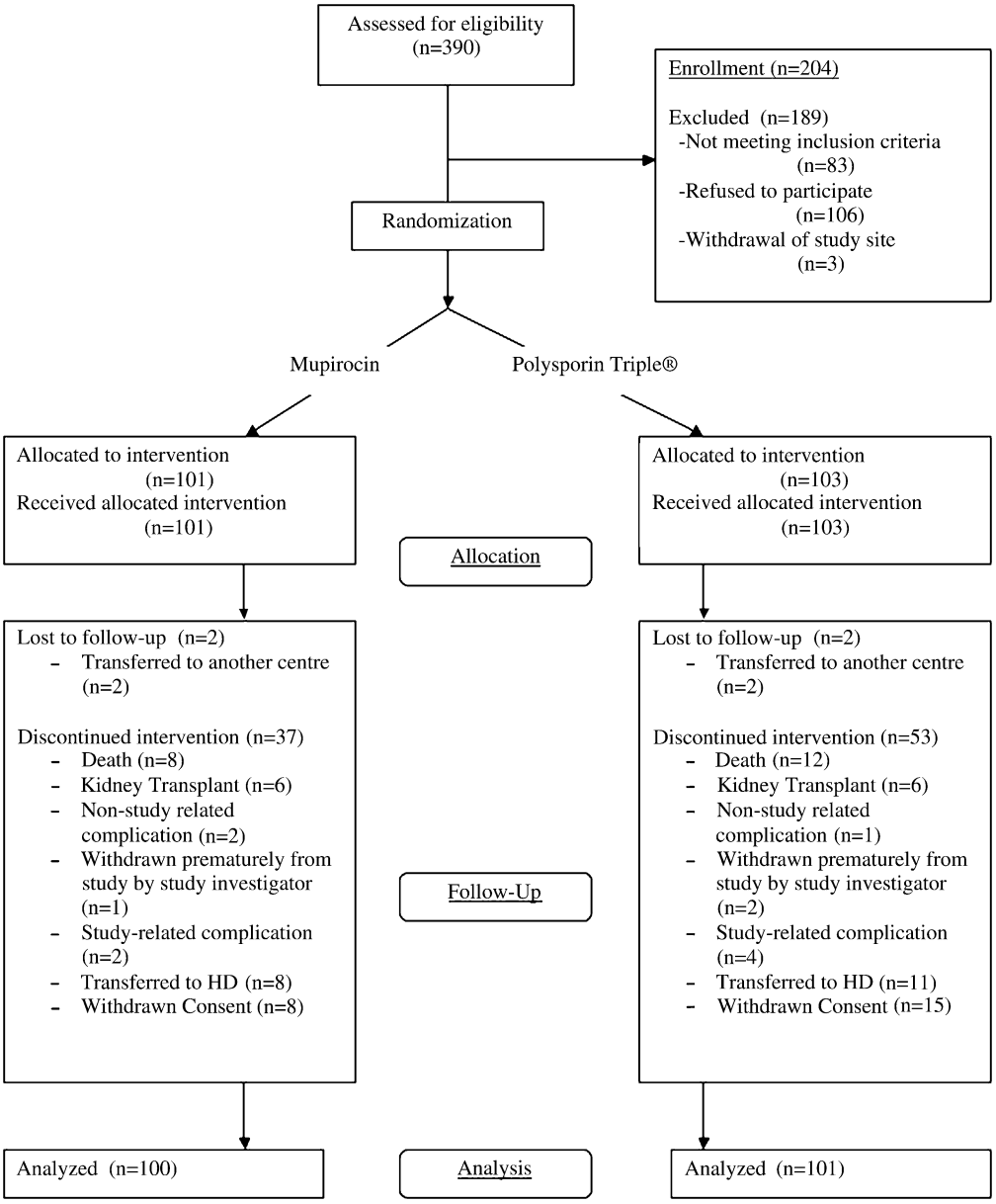


Figure 1. | **Flow diagram showing patient recruitment and follow-up.** HD, hemodialysis.

Data collected over the duration of the study (total follow-up time of 120.2 and 108.2 patient-years for mupirocin and P^3, respectively) showed an overall PD-related infection rate of 0.59 per patient-year (1 in 17 patient-months). The overall peritonitis rate in study participants was 0.39 per patient-year (1 in 26 patient-months) with no statistical difference between those randomized to mupirocin or P^3 (0.40 versus 0.37, respectively). The observed exit-site infection rate was 0.19 per patient-year with significantly higher rates in those randomized to the P^3 group than in the mupirocin group (0.28 versus 0.12, respectively; P=0.02). There was a highly significant increase in the rate of fungal infections, both exit-site infections (0.07 versus 0.01 episodes per patient-year) and episodes of peritonitis (0.04 versus 0.00 episodes per patient-year), seen in association with P^3 (Table 4). None of the patients with fungal infection had exposure to oral or systemic antibiotics in the previous 3 months.

Rash was a common side effect reported by patients, particularly in those randomized to P^3 (14 versus 6 for P^3 and mupirocin, respectively). There were two protocol violations (one in each of the two study groups). In both cases, the patients presented to an emergency department, and had a dressing change performed using mupirocin on one occasion before resuming their normal study drug.

Discussion

In this study, application of P^3 to the PD catheter exit site was not shown to be superior to exit-site mupirocin in the prevention of PD-related infections. Patients randomized to mupirocin seemed to have fewer exit-site infections

Table 1. Baseline demographic and clinical information of participants

Characteristic	Mupirocin	P^3
Participants (*n*)	100	101
Age (yr)	61.02±13.66	59.36±15.04
Sex (% male)	66	62
Median time on PD in months of prevalent patients (1st–3rd quartile)	17.1 (9.1–38.5)	20.3 (9.1–38.8)
CAPD		
incident	16	16
prevalent	31	32
APD		
incident	17	14
prevalent	36	39
Etiology		
GN	15	25
renal vascular disease	24	22
diabetes mellitus	36	33
other	18	14
unknown	7	7
Comorbidities		
diabetes	42	46
on immunosuppressant	11	10
previous PD peritonitis	36	25
previous hemodialysis	34	28
Baseline MRSA status		
positive/number checked (% positive)	4/93 (4.3)	3/94 (3.2)
Previous mupirocin use (%)	51 (51%)	56 (55%)
Ethnicity		
Asian	20	25
black	14	16
Middle Eastern/Indian	12	13
Caucasian	43	38
other	11	9

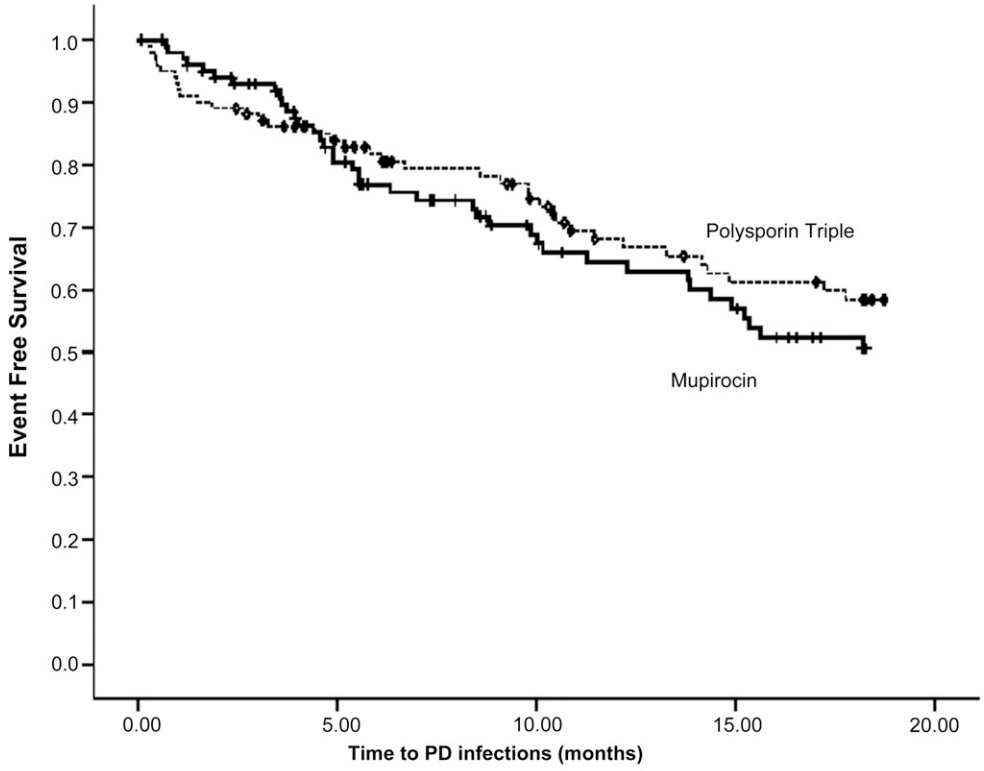
PD, peritoneal dialysis; P^3, Polysporin Triple ointment; CAPD, continuous ambulatory peritoneal dialysis; APD, ambulatory peritoneal dialysis; MRSA, methicillin-resistant *Staphylococcus aureus*.

and a higher risk of Gram-negative peritonitis. However, the total number of catheter-related infections and the time to these infections were similar in both groups. Furthermore, over the full follow-up period, there was a higher frequency of fungal exit-site infection and fungal peritonitis among patients receiving P^3.

The major reasons for the lack of superiority of P^3 over mupirocin likely relate to the frequency and type of infections that occurred in this study. Specifically, although the P^3 group had fewer Gram-negative peritonitis episodes than the mupirocin group, the total number of episodes of Gram-negative peritonitis and exit-site infection were low, limiting the potential benefit of P^3 over mupirocin. In addition, any small signal toward benefit in the P^3 group resulting from better Gram-negative coverage was negated by the increased frequency of fungal infection.

The finding of an increased risk of fungal infections with P^3 is consistent with one report in the HD literature of an increased incidence of exit-site infection with P^3 (21). In larger series in which P^3 was used for several years for exit-site prophylaxis at the central venous catheter site, no increase in fungal infection was seen (17). However, it is known that broad-spectrum antibacterial agents can alter local flora and lead to overgrowth of fungal organisms. One example of this is the increased risk of fungal peritonitis among PD patients who have received antibiotics in the prior few months (22–25). Interestingly, in the randomized trial by Bernardini *et al.* (13) comparing topical mupirocin with gentamicin, there was a signal toward a greater number of fungal exit-site infections among patients who received gentamicin (without an increase in fungal peritonitis) together with a lower Gram-negative peritonitis rate similar to that demonstrated in our study. The likelihood of fungal colonization and potential infection may relate to the extent to which the patient's endogenous skin flora is altered. The three agents in P^3 collectively offer comparatively more broad-spectrum coverage than gentamicin alone; however, gentamicin has wider coverage than mupirocin. If interpreted together with the observations that P^3 has more fungal colonization than gentamicin and that gentamicin has more colonization than mupirocin, we propose that there is a trade-off between the benefits of broad-spectrum activity against many potential pathogens and the risk of fungal colonization and infection.

With this in mind, the clinical significance of fungal exit-site infection in PD patients remains unclear. On the basis of our data, no patients with fungal exit-site infection went



No. of Patients	At Start	6months	12months	18months
Mup	101	86	69	62
P[3]	100	75	60	52

Figure 2. | **Kaplan–Meier graph showing time to primary end point (catheter-related infection).** Solid line indicates mupirocin; dashed line, P[3] ointment. PD, peritoneal dialysis; Mup, mupirocin; P[3], Polysporin Triple.

on to develop fungal peritonitis over the duration of follow-up. However, there were also four fungal peritonitis episodes in the P[3] group over the 18-month follow-up period, and these could not be attributed to systemic use of antibiotics in the prior few months. Although the number of fungal peritonitis episodes in the P[3] is small, the potential for morbidity and mortality as a result of a fungal peritonitis episode is high.

This study, as with all studies, has both strengths and limitations. The strengths include conformation to the original study protocol, sufficient events to meet predicted study power, and maintenance of blinding. The observed event and drop-out rates were similar to those predicted in the sample size calculation, suggesting that the study is adequately powered to have shown a benefit with P[3] had one been present. Thus, the negative findings of this study strongly suggest a lack of superiority of P[3] over mupirocin. In both centers, the compliance with randomization and outcome event reporting was high and the overall peritonitis rate was consistent with city-wide trends both before

Table 2. Characteristics of first catheter-related infections (*n*=75)

Catheter-Related Infection, Organism	Mupirocin	P[3]	*P* Value
Peritonitis			
total	28	23	0.48
Gram-positive	15	13	0.71
Gram-negative	6	2	0.16
fungal	0	1	0.31
culture negative	7	7	1.00
Exit-site infection			
total	8	16	0.10
Gram-positive	5	7	0.56
Gram-negative	2	1	0.56
fungal	0	6	0.01
culture negative	1	2	0.56

P[3], Polysporin Triple ointment.

Table 3. Death and/or hospitalization events in those randomized to mupirocin and P[3] ointment

Outcome	Mupirocin	P[3]	*P* Value
Mortality			0.30
all-cause	8	12	
catheter-related infection	2	3	
Hospitalizations			
all-cause	64	66	0.47
peritonitis-related	15	10	
Catheter removal for infection	4	9	0.54
Transfer to hemodialysis	9	13	0.38

P[3], Polysporin Triple ointment.

and after this study. The two protocol violations were short and consequently unlikely to have affected the study outcome. This study is limited by the high number of patients randomized to P[3] who requested to be withdrawn from the study because of a rash or irritation associated with the use of the ointment; however, the attrition rate is not higher than that predicted initially. Rash is a recognized side effect of P[3]. However, in our HD experience, rash is found to resolve if application with the ointment is continued. We were struck by the high incidence of both exit-site infection and irritation with P[3], and hypothesized that this combination may have been attributed to a misdiagnosis bias. We hypothesized that skin irritation might have prompted more frequent swabbing of the exit site in the P[3] group, and, if colonization was present, subsequently led to a misdiagnosis of infection. Presuming that skin irritation with P[3] would be more likely to occur within the first few weeks to months, we hypothesized that exit-site infections would be more commonly reported in the P[3] group within the first few months of the study. Using Kaplan–Meier survival analysis, we compared the time to first exit-site infection and found no early risk in the P[3] group (data not shown), arguing against misdiagnosis.

In conclusion, we do not recommend the use of P[3] ointment for prophylaxis against PD catheter-related infections. Despite its broad-spectrum coverage, P[3] does not seem to offer benefits as a prophylactic agent over those provided by mupirocin. Furthermore, concerns about fungal colonization and fungal peritonitis suggest that P[3] should be used with caution in the PD population.

Acknowledgments

We thank Maggie Chiu, Dorothy Burdzy, Fred Chan, and Judi Shea, without whom the rigorous collection of data would not have been possible; the patients and staff of the PD programs at Sunnybrook Health Sciences Centre, Scarborough General Hospital, and University Health Network who participated with full enthusiasm; and Drs. Joanne Bargman and Dimitrios Oreopoulos for their support throughout.

This study was funded by the Kidney Foundation of Canada.

This study was presented in part as an oral presentation at the American Society of Nephrology Meeting in Denver, Colorado, in November 2010.

This paper is dedicated to the memory of Wolfgang Vogel and to those who provided support after his death.

Table 4. Infection rates over the full duration of the study

	Mupirocin (120 patient-years follow-up)		P[3] (108 patient-years follow-up)		*P* Value
	n	Rate	*n*	Rate	
Exit-site infections					
Gram positive	6	0.05	9	0.08	0.43
Staphylococcus aureus	3	0.025	3	0.035	
other Gram-positive	3	0.03	6	0.05	
Gram negative	5	0.04	10	0.09	0.20
Pseudomonas aeruginosa	3	0.02	2	0.02	
other Gram-negative	2	0.02	8	0.07	
fungal	1	0.01	8	0.07	0.02
sterile	2	0.02	3	0.03	0.65
total	14	0.12	30	0.28	0.02
Peritonitis					
Gram positive	25	0.21	24	0.22	0.88
Staphylococcus aureus	2	0.02	1	0.01	
other gram positive	23	0.19	23	0.21	
Gram negative	13	0.11	4	0.04	0.03
Pseudomonas aeruginosa	1	0.01	2	0.02	
other gram-negative	12	0.10	2	0.02	
fungal	0	0.00	4	0.04	0.05
sterile	10	0.08	8	0.07	0.64
total	48	0.40	40	0.37	0.39
Catheter-related infections	62	0.52	70	0.65	0.48

Rates are expressed as episodes per patient-year. P[3], Polysporin Triple ointment.

Disclosures

None.

References

1. Mujais S: Microbiology and outcomes of peritonitis in North America. *Kidney Int Suppl* 103: S55–S62, 2006
2. Johnson DW, Dent H, Hawley CM, McDonald SP, Rosman JB, Brown FG, Bannister KM, Wiggins KJ: Associations of dialysis modality and infectious mortality in incident dialysis patients in Australia and New Zealand. *Am J Kidney Dis* 53: 290–297, 2009
3. Li PK, Szeto CC, Piraino B, Bernardini J, Figueiredo AE, Gupta A, Johnson DW, Kuijper EJ, Lye WC, Salzer W, Schaefer F, Struijk DG: Peritoneal dialysis-related infections recommendations: 2010 update. *Perit Dial Int* 30: 393–423, 2010
4. Al-Hilali NA, Ninan VT, Al-Humoud HA, Nampoory MR, Johny KV: Mupirocin once weekly reduces the incidence of catheter exit-site infection in peritoneal dialysis patients. *Perit Dial Int* 25: 91–92, 2005
5. Aykut S, Caner C, Ozkan G, Ali C, Tugba A, Zeynep G, Taner C: Mupirocin application at the exit site in peritoneal dialysis patients: Five years of experience. *Ren Fail* 32: 356–361, 2010
6. Chua AN, Goldstein SL, Bell D, Brewer ED: Topical mupirocin/sodium hypochlorite reduces peritonitis and exit-site infection rates in children. *Clin J Am Soc Nephrol* 4: 1939–1943, 2009
7. Lim CT, Wong KS, Foo MW: The impact of topical mupirocin on peritoneal dialysis infection in Singapore General Hospital. *Nephrol Dial Transplant* 20: 2202–2206, 2005
8. Mahajan S, Tiwari SC, Kalra V, Bhowmik DM, Agarwal SK, Dash SC, Kumar P: Effect of local mupirocin application on exit-site infection and peritonitis in an Indian peritoneal dialysis population. *Perit Dial Int* 25: 473–477, 2005
9. Thodis E, Bhaskaran S, Pasadakis P, Bargman JM, Vas SI, Oreopoulos DG: Decrease in Staphylococcus aureus exit-site infections and peritonitis in CAPD patients by local application of mupirocin ointment at the catheter exit site. *Perit Dial Int* 18: 261–270, 1998
10. Thodis E, Passadakis P, Panagoutsos S, Bacharaki D, Euthimiadou A, Vargemezis V: The effectiveness of mupirocin preventing Staphylococcus aureus in catheter-related infections in peritoneal dialysis. *Adv Perit Dial* 16: 257–261, 2000
11. Uttley L, Vardhan A, Mahajan S, Smart B, Hutchison A, Gokal R: Decrease in infections with the introduction of mupirocin cream at the peritoneal dialysis catheter exit site. *J Nephrol* 17: 242–245, 2004
12. Wong SS, Chu KH, Cheuk A, Tsang WK, Fung SK, Chan HW, Tong MK: Prophylaxis against gram-positive organisms causing exit-site infection and peritonitis in continuous ambulatory peritoneal dialysis patients by applying mupirocin ointment at the catheter exit site. *Perit Dial Int* 23[Suppl 2]: S153–S158, 2003
13. Bernardini J, Bender F, Florio T, Sloand J, Palmmontalbano L, Fried L, Piraino B: Randomized, double-blind trial of antibiotic exit site cream for prevention of exit site infection in peritoneal dialysis patients. *J Am Soc Nephrol* 16: 539–545, 2005
14. Chu KH, Choy WY, Cheung CC, Fung KS, Tang HL, Lee W, Cheuk A, Yim KF, Chan WH, Tong KL: A prospective study of the efficacy of local application of gentamicin versus mupirocin in the prevention of peritoneal dialysis catheter-related infections. *Perit Dial Int* 28: 505–508, 2008
15. Mahaldar A, Weisz M, Kathuria P: Comparison of gentamicin and mupirocin in the prevention of exit-site infection and peritonitis in peritoneal dialysis. *Adv Perit Dial* 25: 56–59, 2009
16. Zelem M: Interim analyses, multiple looks at data, and early stopping rules. In: *Cancer Medicine*, 6th Ed., edited by Kufe D, Pollock RE, Weichselbaum RR, et al, Hamilton, Ontario, BC Decker, 2003
17. Battistella M, Bhola C, Lok CE: Long-term follow-up of the Hemodialysis Infection Prevention with Polysporin Ointment (HIPPO) Study: A quality improvement report. *Am J Kidney Dis* 57: 432–441, 2011
18. Lok CE, Stanley KE, Hux JE, Richardson R, Tobe SW, Conly J: Hemodialysis infection prevention with polysporin ointment. *J Am Soc Nephrol* 14: 169–179, 2003
19. Fung S, O'Grady S, Kennedy C, Dedier H, Campbell I, Conly J: The utility of polysporin ointment in the eradication of methicillin-resistant Staphylococcus aureus colonization: A pilot study. *Infect Control Hosp Epidemiol* 21: 653–655, 2000
20. Jassal SV, Lok CE MP3 Study Group: A randomized controlled trial comparing mupirocin versus Polysporin Triple for the prevention of catheter-related infections in peritoneal dialysis patients (the MP3 study). *Perit Dial Int* 28: 67–72, 2008
21. Oliveira L, Graham J, Lok C, MacFarlane S, Zimmerman D: Risk factors for yeast superinfection in the treatment of suspected exit site infections: A case-control study. *J Vasc Access* 9: 35–38, 2008
22. Miles R, Hawley CM, McDonald SP, Brown FG, Rosman JB, Wiggins KJ, Bannister KM, Johnson DW: Predictors and outcomes of fungal peritonitis in peritoneal dialysis patients. *Kidney Int* 76: 622–628, 2009
23. Ram R, Swarnalatha G, Neela P, Murty KV: Fungal peritonitis in patients on continuous ambulatory peritoneal dialysis: A single-centre experience in India. *Nephron Clin Pract* 110: c207–c212, 2008
24. Indhumathi E, Chandrasekaran V, Jagadeswaran D, Varadarajan M, Abraham G, Soundararajan P: The risk factors and outcome of fungal peritonitis in continuous ambulatory peritoneal dialysis patients. *Indian J Med Microbiol* 27: 59–61, 2009
25. Prasad KN, Prasad N, Gupta A, Sharma RK, Verma AK, Ayyagari A: Fungal peritonitis in patients on continuous ambulatory peritoneal dialysis: A single centre Indian experience. *J Infect* 48: 96–101, 2004

Received: August 5, 2011 **Accepted:** October 18, 2011

R.F.M. and E.C. contributed equally to this work.

Published online ahead of print. Publication date available at www.cjasn.org.

Access to UpToDate on-line is available for additional clinical information at www.cjasn.org.