RISK FACTORS AND OUTCOME OF CONTAMINATION IN PATIENTS ON PERITONEAL DIALYSIS—A SINGLE-CENTER EXPERIENCE OF 15 YEARS

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♦ **Objective:** Contamination is an important risk factor for peritoneal dialysis (PD)–related peritonitis. The present study outlines the clinical characteristics and outcomes of PD patients experiencing touch contamination.

♦ **Methods:** We reviewed the case records of PD patients from 1995 to 2010. Patients who experienced contamination of their PD system were identified and stratified into “dry” and “wet” contamination groups. Risk factors, microbiology, and clinical outcomes were compared.

♦ **Results:** Of 548 episodes of touch contamination, 246 involved dry contamination, and 302, wet contamination. After contamination, 17 episodes of peritonitis (3.1%) developed; all episodes occurred in the wet contamination group ($p < 0.001$). The incidence of peritonitis after wet contamination was 5.63%. Prophylactic antibiotics significantly reduced the risk of peritonitis (1 of 182 episodes, $p < 0.001$). Half the patients experiencing peritonitis had either culture-negative or staphylococcal episodes, and most of those episodes responded to intraperitoneal antibiotics. In 2 patients, peritonitis was attributable to *Pseudomonas*, and in 3, to *Acinetobacter*. In these latter patients, outcomes were less favorable, with catheter removal being required in 4 of the 5 episodes.

♦ **Conclusions:** The overall rate of peritonitis was low after contamination. Wet contamination was associated with a much higher risk of peritonitis. Prophylactic antibiotics after wet contamination were effective in preventing peritonitis.

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Peritonitis is a common and serious complication in peritoneal dialysis (PD) patients and a significant cause of peritoneal failure and mortality (1–3). Touch contamination of the PD system is a frequently

encountered problem in patients on PD and an important risk factor for peritonitis. However, few publications have adequately addressed this common clinical occurrence. Current knowledge about, and management of, contamination stems from anecdotal experience, and several areas remain obscure. First, data on the clinical features of and the reasons for contamination are limited. Second, optimal management of patients experiencing contamination is still undefined. Third, data on the microbiology and outcomes of contamination-related peritonitis are lacking. In the present study, we aimed to highlight the aforementioned clinical aspects in our patients who experienced contamination of their PD system.

METHODS

This retrospective study was conducted at Tung Wah Hospital, University of Hong Kong. Since 1995, we have kept records of all reported or documented contamination cases. We reviewed the case records of patients who, from January 1995 to September 2010, experienced contamination of their PD system.

At our center, patients with contamination are identified in two ways. First, self-reports of contamination by patients are clearly documented in the case records. Second, all patients who present with peritonitis are routinely given questionnaires by the medical personnel to identify potential causes of the peritonitis. Cases experiencing touch contamination were identified through those processes, and their records were reviewed.

For each documented episode of contamination, data were also collected on baseline demographics, medical comorbidities, duration of dialysis, reason for and type of contamination (“dry” or “wet”), and management of the contamination. We use the term “dry contamination” to describe contamination outside a closed PD system—for example, leak or disconnection distal to a closed clamp. “Wet contamination” describes contamination with an open system—for example, leaks from dialysate bags, tubing, or connections during instillation or drainage of

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PD fluid (PDF); leaks or breaks in tubing proximal to the tubing clamp; or touch contamination of the connection during a PD exchange.

Patients were asked to return to the unit when contamination was noticed. The transfer set was then changed, and prophylactic antibiotics (levofloxacin 250 – 300 mg daily for 3 days) were prescribed to patients with wet contamination. Patients with delayed presentation were not offered prophylactic antibiotics.

The primary study outcome was peritonitis within 72 hours of contamination, defined as cloudy PD effluent with a white cell count in excess of 100/ μ L (>50% neutrophils) and with abdominal pain and positive PDF culture within that period. A secondary outcome was the response of peritonitis to treatment, including primary response and secondary response to intraperitoneal antibiotics and need for Tenckhoff catheter removal. Primary response was defined as a clinical response, with a PD effluent total cell count of less than 100/ μ L at day 3. Secondary response was defined as non-resolution of total cell count to less than 100/ μ L at day 3, but response to second-line antibiotics. At our center, the first-line treatment for PD peritonitis was intraperitoneal cefazolin plus an aminoglycoside (in the absence of an allergy). The transfer set was changed in all patients who developed peritonitis. Patients who did not respond to this regime were switched to second-line agents according to susceptibility and culture results.

STATISTICAL ANALYSIS

Data are expressed as mean $\pm$ standard deviation for continuous variables and as frequency counts and percentages for categorical variables. Continuous variables were compared using an independent two-sample t-test or a Mann-Whitney test. The chi-square test was used to compare differences in proportions for categorical data. All statistical analyses were performed using the SPSS software application (version 15: SPSS, Chicago, IL, USA); all *p* values are two-sided.

RESULTS

From January 1995 to December 2010, 548 episodes of contamination occurred in 296 patients (total patient-months during the period: 36 283; incidence: 1 contamination episode in 66.2 patient-months). Table 1 shows the baseline characteristics of the patient cohort.

Of the 548 contamination episodes, 387 were self-reported, and 161 were discovered by retrospective questioning. There were 246 episodes of dry contamination and 302 episodes of wet contamination. Accidental

disconnection of the “mini-cap” or transfer set was the leading cause of contamination, followed by self-touch contamination and leakage of the PDF bag. Those reasons remained the leading causes regardless of whether they were self-reported or identified by retrospective questioning. Table 2 presents other reasons for contamination episodes.

In 17 contamination episodes (3.10%), peritonitis subsequently developed. All peritonitis episodes occurred in the wet contamination group ($p < 0.001$, Table 3). Regardless of the method of identification (self-report or retrospective questioning), wet contamination remained a significant risk factor for peritonitis. Among patients with wet contamination, the incidence of peritonitis was 5.63%. The use of oral prophylactic antibiotics resulted in a significantly lower risk of peritonitis in patients with wet contamination ($p < 0.001$). Among patients with wet contamination, 16 cases of peritonitis occurred in those who did not receive oral antibiotics for prophylaxis. Only 1 case of peritonitis occurred in a patient who received antibiotics for prophylaxis. That patient had methicillin-resistant coagulase-negative staphylococcal peritonitis (Table 4).

The organisms identified in the peritonitis episodes were: culture-negative ($n = 3$), methicillin-sensitive *Staphylococcus aureus* [MSSA ($n = 2$)], methicillin-sensitive coagulase-negative *Staphylococcus* [MSCNS ($n = 1$)], methicillin-resistant coagulase-negative *Staphylococcus* [MRCNS ($n = 3$)], *Pseudomonas aeruginosa* [PA ($n = 2$)],

TABLE 1
Baseline Characteristics of 296 Patients Who Experienced Contamination of Their Peritoneal Dialysis System

Characteristic	Value
Sex (<i>n</i> women/men)	147/149
Mean age (years)	63.9 $\pm$ 13.3
Mean duration of PD before contamination (months)	46.2 $\pm$ 44.8
Causes of renal failure [<i>n</i> (%)]	
Diabetic nephropathy	123 (41.6)
Unknown cause	74 (25.0)
Glomerulonephritis	57 (19.3)
Hypertensive nephropathy	23 (7.8)
Renal stone disease	8 (2.7)
Polycystic kidney disease	5 (1.7)
Renal tuberculosis	2 (0.7)
Obstructive uropathy	1 (0.3)
Pyelonephritis	1 (0.3)
Renal vascular disease	1 (0.3)
Drug-induced renal toxicity	1 (0.3)

TABLE 2
Causes of 548 Contamination Episodes

Cause	Episodes identified by		Total episodes
	Self-reporting	Retrospective questionnaire	
Accidental disconnection of mini-cap/transfer set	146	64	210
Touch contamination of transfer set	110	38	148
Leak in the solution bag	54	23	77
Cutting the transfer set or Tenckhoff catheter	38	18	56
Leak in transfer set	26	12	38
Leak in catheter	8	4	12
Other	5	2	7
TOTAL	387	161	548

TABLE 3
Incidence of Peritonitis in Patients with Dry and Wet Contamination^a

Patient group	Self-reporting	Wet Contamination episodes identified		Dry Contamination episodes identified		TOTAL
		Self-reporting	Retrospective questionnaire	Self-reporting	Retrospective questionnaire	
No peritonitis	211	74		164	82	531
Peritonitis	12	5		0	0	17
TOTAL		302			246	548

^a Statistically significant difference at $p < 0.001$.

TABLE 4
Incidence of Peritonitis in Patients Receiving or Not Receiving Prophylactic Antibiotics after Wet Contamination

Patient group	Antibiotic prophylaxis		TOTAL
	Yes	No	
No peritonitis	181	104	285
Peritonitis	1	16	17
TOTAL	182	120	302

^a Statistically significant difference at $p < 0.001$.

Acinetobacter baumannii ($n = 3$), and other organisms ($n = 3$). Patients with culture-negative or staphylococcal peritonitis had favorable clinical outcomes. Of 9 cases, 5 achieved a primary response, and 3 experienced a secondary response (all 3 cases were MRCNS, which responded to intraperitoneal vancomycin). A secondary fungal peritonitis that developed in 1 patient with MSSA required Tenckhoff removal. Patients with PA or *Acinetobacter* peritonitis generally had less favorable outcomes,

with a higher incidence of Tenckhoff removal (2 of 2 in the PA group and 2 of 3 in the *Acinetobacter* group).

DISCUSSION

Few reports have adequately addressed contamination of the PD system as a discrete entity. To our knowledge, the present work is the first to systematically examine clinical characteristics and outcomes of patients who experienced contamination of their PD system.

Our findings show that, for dry contamination, the risk of micro-organisms entering the peritoneal cavity is minimal. A change of transfer set is all that is needed. With such an approach, prophylactic use of antibiotics is unnecessary. However, wet contamination is associated with a significantly higher risk of peritonitis. Among 548 episodes of touch contamination, the 17 patients who subsequently developed peritonitis came exclusively from the wet contamination group. Furthermore, our experience suggests that the prophylactic use of antibiotics dramatically reduces the risk of peritonitis in cases of wet contamination. Among patients with wet contamination, only 1 developed MRCNS peritonitis despite the

use of prophylactic oral quinolone. Those observations imply that for patients with wet contamination, clinicians should be more vigilant for the development of peritonitis, and prophylactic antibiotics should be prescribed in addition to a change of transfer set.

Prior studies have described a vast diversity of microorganisms related to touch contamination in PD systems (4), and hence the antibiotics used for prophylaxis should cover both the gram-positive and the gram-negative spectrum. We chose levofloxacin as the prophylactic agent because it is easy to administer and provides good coverage for common gram-positive and -negative organisms, with good penetration into peritoneal fluid (5). Previous studies at our unit had verified that adequate levels for treating peritonitis could be achieved with oral ofloxacin in a 400 mg loading dose, followed by 300 mg daily (6,7). Because ofloxacin is a racemic mixture consisting of 50% levofloxacin and 50% dextro-ofloxacin (which is biologically inactive), the dose of levofloxacin used in the present study (half the dose of oral ofloxacin used in previous studies) was expected to suffice. We use a similar dose of oral levofloxacin for peritonitis prophylaxis during colonoscopy, with good results (8). Our data support the effectiveness and convenience of this antibiotic regimen for prophylaxis.

One concern about the use of levofloxacin prophylaxis is the potential for selection of quinolone-resistant organisms. In fact, only 1 episode of MRCNS peritonitis developed despite the use of levofloxacin prophylaxis (sensitivity data also showed levofloxacin resistance). The other 16 peritonitis episodes occurred in patients not receiving levofloxacin prophylaxis. Review of available cultures showed that the organisms in patients with MSSA and MSCNS peritonitis were sensitive to levofloxacin and that organisms in patients with MRCNS peritonitis also demonstrated resistance to levofloxacin. Among patients with gram-negative peritonitis, all organisms were still sensitive to levofloxacin (although the sensitivity of *Acinetobacter* to quinolones was not routinely available at our center). We have used levofloxacin in 182 cases of contamination over 15 years, and we have not seen increasing resistance to quinolones after adoption of that prophylaxis policy.

The outcome of peritonitis related to contamination depends largely on the organism involved. More than half the cases in our series involved either culture-negative or staphylococcal species (*S. aureus* or coagulase-negative *Staphylococcus*), all being organisms commonly involved in touch contamination (9). Culture-negative peritonitis usually involves gram-positive organisms and generally has favorable outcomes; most cases respond well to intraperitoneal antibiotics (10,11). Staphylococcal peritonitis

can sometimes be refractory to antibiotics, especially in cases with concomitant exit-site or tunnel infection or biofilm formation (9). Unlike peritonitis episodes that involve concomitant exit-site or tunnel infections, the staphylococcal peritonitis episodes in our series were a result of touch contamination and, hence, had more favorable outcomes. Most episodes responded to intraperitoneal antibiotics; only 1 patient developed secondary fungal peritonitis requiring Tenckhoff removal. As previously reported, patients in our series with *Pseudomonas* or *Acinetobacter* peritonitis had poor clinical outcomes and a high incidence of catheter removal (12,13).

Apart from a change of transfer set and use of prophylactic antibiotics, accurate and meticulous PD fluid exchange practice is a prerequisite to preventing contamination and peritonitis. Our study showed that the 3 leading causes of contamination were accidental disconnection of the mini-cap or transfer set, touch contamination of the transfer set, and unnoticed leaks in the PD solution bag. Other causes may include accidental cutting of the transfer set or PD catheter during a dressing change. Patients should be reminded to check the security of the cap and to periodically inspect for accidental disconnection. Patients should also be alert to any leak or breach in the tubing or bag before performing a PD exchange, and they should avoid using scissors to remove dressings over the Tenckhoff catheter. Patients should also avoid using sharp items to handle their dressing. These potential pitfalls should be emphasized during initial PD training and any subsequent retraining to minimize the chance of contamination and peritonitis.

In our series, the overall risk of peritonitis after contamination was only 3.1%; the risk was even lower with the prophylactic use of antibiotics. However, it might be argued that our results are not truly representative of the clinical situation given two drawbacks of our study. On the one hand, some data relied on patient-volunteered history, and underreporting is always a potential concern. However, if underreporting occurred, the risk of contamination-associated peritonitis would have been lower than what we observed. On the other hand, some data were derived retrospectively using questionnaires and history-taking in patients with peritonitis; hence, there was a potential for recall bias in those instances. Nevertheless, we believe that our findings are reasonably close to the realistic clinical situation because we have tried our best to identify the cause of every episode of peritonitis in our routine practice. We also expect that not all risk factors for peritonitis were fully exhausted in the present study; it is therefore possible that the peritonitis episodes reported in here are actually related to causes other than contamination. However, records showed that

none of the patients had a concomitant exit-site infection or other common risk factor such as constipation or dental caries, and the causative organisms were all either skin commensals or environmental bacteria. Hence, we decided that contamination was the most likely cause of peritonitis in the study patients.

CONCLUSIONS

The overall risk of peritonitis is low after contamination. Wet contamination is associated with a significantly higher risk of peritonitis, and the use of oral prophylactic antibiotics after wet contamination is effective in preventing peritonitis.

DISCLOSURES

The authors have no financial conflicts of interest to declare.

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