IMPACT OF THE BAG EXCHANGE PROCEDURE ON RISK OF PERITONITIS

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Objective: We studied whether improper bag exchange predicts the first peritonitis episode in continuous ambulatory peritoneal dialysis (CAPD) patients.

Patients and Methods: Our single-center prospective observational study of 130 incident urban CAPD patients who started peritoneal dialysis (PD) between March 2005 and August 2008 aimed to determine the relationship between bag exchange procedures examined at the 6th month of PD and risk for a first peritonitis episode. All patients were followed until a first peritonitis episode, censoring, or the end of the study.

Results: These 130 patients experienced 22 first peritonitis episodes during the 14-month follow-up. During bag exchange evaluation, 51.5% of patients washed their hands improperly, 46.2% failed to check expiration date or bag leakage, and 11.5% forgot to wear a face mask and cap. Patients experiencing peritonitis were more likely to forget to wear a face mask and cap. In multivariate Cox regression model, not wearing a face mask and cap [hazard ratio (HR): 7.26; 95% confidence interval (CI): 2.6 to 20.1; \( p < 0.001 \)] and having anemia (HR: 0.96; 95% CI: 0.94 to 0.99; \( p = 0.005 \)) were independent risk factors for a first episode of peritonitis.

Conclusions: Not wearing a face mask and cap and having anemia were independent risk factors for peritonitis. A further randomized control study needs to verify the correlation between improper bag exchange technique and peritonitis in PD patients.


KEY WORDS: Peritonitis; training; anemia.

Peritonitis, a common complication of peritoneal dialysis (PD), contributes to treatment failure, hospitalization, and death rates (1–3). The International Society for Peritoneal Dialysis (ISPD) continues to focus attention on prevention and treatment of PD-related infections (4). The high risk of peritonitis is currently understood to be related to physiologic factors (old age, diabetes, malnutrition), psychosocial factors (low education and economic levels, depression, poor compliance), and technique-related factors (improper catheter placement, exit-site care, connection techniques) (5–11). Among the foregoing predictors of peritonitis, technique-related factors can be improved through strengthened training for clinical practitioners and PD patients, which thus has been highlighted in recent years (12–14).

Notably, although proper performance of bag exchanges to avoid peritonitis has been emphasized during the initial training for new PD patients, the home practices of the patients are not routinely monitored. Accordingly, data concerning the bag exchange procedure and its effect on the risk of peritonitis are lacking. On the other hand, preliminary data from our monthly continuous quality improvement conference indicated that most episodes of peritonitis occurred after 6 months of PD when improper bag exchange techniques were used. Previous studies also showed that the probability of peritonitis at 6 months was only 10% or so in PD patients in Hong Kong (8,15,16), Korea (17), and France (9). Although uremia and malnourishment are improved after 6 months for most patients, the probability of peritonitis increased. We therefore hypothesized that improper bag exchanges tend to occur around the 6th month on PD, when the techniques initially taught are gradually forgotten, probably predicting the risk for a first peritonitis episode.

In this prospective observational study, we evaluated clinical characteristics and bag exchange procedures at the 6th month of PD in incident patients. We explored how patients perform the bag exchange, and whether improper bag exchange predicts a first peritonitis episode. To our knowledge, our is the first study to address this issue.

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PATIENTS AND METHODS

SUBJECTS AND FOLLOW-UP

This observational prospective study included incident urban patients who started continuous ambulatory PD (CAPD) between March 2005 and August 2008. Patients had to be clinically stable, undergoing CAPD, and willing to have their bag exchange evaluated at the 6th month. Patients with a previous peritonitis episode and those incapable of being evaluated at the 6th month because of long distance from the hospital were excluded. All patients were followed to the date of the first peritonitis episode or were censored at death, transplantation, transfer to hemodialysis, or the end date of study (January 2009), whichever came first. Prophylactic cefazolin was administered before Tenckhoff catheter placement in all cases. Catheter care in the postoperative period and acute and chronic exit-site care followed the recommendations of the ISPD (4). Mupirocin cream is recommended to be applied to the skin around the exit site after daily cleansing with antiseptics. Dialysis was initiated promptly after catheter placement. All patients were dialyzed using glucose lactate-buffered PD solutions and the twin-bag connection system (Baxter Healthcare, Guangzhou, China). Three or four 2-L exchanges daily were prescribed to all patients. Written informed consent was obtained from each patient enrolled in the study.

INITIAL TRAINING PROGRAM AND BAG EXCHANGE EVALUATION

The standard initial training program lasted for 3 – 5 days (3 – 4 hours daily). The actual time depended on the education level and learning skills of patients. During this period, all patients watched a video first and were then trained by primary nurses on the bag exchange procedure. The standard procedure includes 8 items:

- Checking fingernail cleanliness (18)
- Ultraviolet radiation for 20 minutes
- Checking expiration date and bag leakage
- Putting on a face mask and cap
- Proper hand-washing with soap for at least 15 seconds (19)
- Steps to connect and disconnect the bag
- Flushing before filling
- Avoiding any suspected contamination

Ultraviolet light was requested to be set up in the room for the bag exchange before PD catheter placement. Patients were asked to keep the light on for 20 minutes before each bag exchange session. As recommended by the Centers for Disease Control and Prevention, we taught patients to wash their hand with soap; to rub hands together vigorously, covering all surfaces of the hands and fingers; to rinse hands with water; and to dry thoroughly with a disposable towel. Hand-washing was judged improper if any error happened (19). Patients were then supervised during practice so that each mistake could be corrected immediately, with guidance through the correct steps. Patients also learned how to perform the exchange safely, how to recognize contamination or infection, and how to promptly respond to suspected contamination while performing the bag exchange. Patients or their helpers were asked to keep practicing until they could perform the procedure skillfully. Thereafter, the primary nurse would test the bag exchange according to the standard procedures taught and would ask some critical questions related to procedures. Generally, patients or their helpers could correctly perform the bag exchange and answer all the questions at the end of initial training. Otherwise, they would be requested to continue to practice at clinic visits within the first month of PD. Patient were trained one-to-one by their primary nurses. Home visits for initial training were not routinely arranged except for a few disable patients who could not visit the hospital.

Bag exchange was evaluated at the 6th month of PD by primary nurses in our clinic. Using the 8 procedural items taught during the initial training, we developed a score sheet that set out 8 errors consistent with procedure (Table 1). Each item was recorded as “yes” or “no,” and the total items in error were calculated. The nurses pointed out errors after the patients had completed the bag exchange. If patients were suspected to have experienced contamination during the bag exchange, they would be prescribed antibiotic medication according to ISPD recommendations (4). All the primary nurses in our unit came to an agreement on the protocol of initial training and were trained to evaluate the bag exchange using the score sheet. The intra-observer consistency was 100%, because most items on the score sheet were objective.

DEMOGRAPHICS AND BIOCHEMISTRY

We collected demographic data at the start of PD, such as age, sex, presence of a home helper (family member or private nurse who assisted with the bag exchange), body mass index (BMI), education and income level, and history of diabetes mellitus (DM). Biochemical indices, including serum albumin, creatinine, and hemoglobin, as analyzed by an automatic Hitachi chemistry analyzer (Hitachi High Technologies, Maidenhead, U.K.) within 1 month of bag exchange evaluation, were used as the baseline values.
The primary outcome was the peritonitis incidence. Peritonitis was defined as the presence of at least two of the following conditions:

- Abdominal pain or tenderness
- Presence of white blood cells in peritoneal effluent in excess of 100 cells/mL, comprising at least 50% polymorphs
- Positive dialysate culture results

Bacterial culture of PD effluent was performed using the Bactec Blood System (BD Biosciences, Franklin Lakes, NJ, U.S.A.). Peritonitis was treated using the recommended standard antibiotic protocol. Initial antimicrobial therapy for peritonitis consisted, in general, of intraperitoneal administration of a third-generation cephalosporin plus cefazolin according to ISPD committee guidelines (4). No patients were on prophylactic antimicrobial therapy in our study.

Statistical analysis was performed using the SPSS software (version 11.0: SPSS, Chicago, IL, U.S.A.). Continuous variables are expressed as mean ± standard deviation; categorical variables are expressed as a percentage or ratio. The unpaired Student t-test was used to compare differences between patients with and without peritonitis during the study period, and chi-square, Fisher exact test, and nonparametric statistical tests were used when appropriate. A univariate Cox regression proportional hazards model was used to individually predict the hazard associated with the presence of each error during the bag exchange and some recognized confounders for developing a first episode of peritonitis. The errors included dirty nails, insufficient ultraviolet radiation, failing to check the expiration date or bag leakage, improper hand washing, failing to wear a face mask and cap, nose or hair not covered by the face mask or cap, no flushing before filling, and suspected connection contamination. The confounders included age (5), sex (5), income level (<$3000 annually, ≥$3000 annually) (20), education level (high school or lower) (6), BMI (7), presence or absence of DM (8), whether the home helper aided with the bag exchange (9), albumin (10) and hemoglobin (11). Patient follow-up time was computed from the date of the bag exchange evaluation to the date of the first peritonitis episode or was censored at death, transplantation, transfer to hemodialysis, or the end of study, whichever came first. The dependent variable was the first peritonitis episode. The multivariate Cox model was used to determine the predictive effect of errors during bag exchange and other confounders that showed significant differences in a univariate analysis. Kaplan–Meier analysis and the log-rank test were used to examine differences in the peritonitis-free periods according to the presence of errors shown to be

**Table 1**

<table>
<thead>
<tr>
<th>Items</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dirty nails*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insufficient ultraviolet radiation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not-checking the expiration date and bag leakage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improper hand washing**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not wearing face mask and cap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nose or hair not fully covered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not flushing before filling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected connection contamination</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total errors</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Fingernail cleanliness was evaluated according to traces of foreign matter under the nail (18). A visual assessment was done before the bag exchange.

** As the Centers for Disease Control and Prevention recommend, we taught patients to wash their hand with soap; to rub hands together vigorously, covering all surfaces of the hands and fingers; and then to rinse hands with water and dry thoroughly with a disposable towel. Any error led to a determination of improper hand-washing (19).
significant in the multivariate Cox model. Variables with a significance level of 0.10 in the univariate models were analyzed in the multivariate model. Only variables with a significance level of 0.05 were retained in the multivariate model. The hazard ratios (HRs) and their 95% confidence intervals (CIs) for the first peritonitis episode are shown in the final results, with \( p < 0.05 \) considered to be statistically significant.

### RESULTS

During the study period, 310 incident urban CAPD patients began their PD program in our unit. We excluded 23 patients who withdrew within 6 months of starting PD, 7 patients who experienced a peritonitis episode within 6 months of starting PD, and 150 patients whose bag exchange could not be examined at the 6th month because they lived far from the hospital and could arrive early for this examination. The remaining 130 patients were recruited to the study and were examined at the 6th month.

The mean age of the 130 patients was 59.1 ± 14.2 years (range: 15 – 83 years). Patients with DM constituted 40% of the sample (52/130); 47 patients had diabetic nephropathy. Other causes for renal failure were chronic glomerulonephritis (52/130), hypertensive nephrosclerosis (41 patients), tubulointerstitial nephritis (52/130), ischemic nephropathy (8/130), polycystic kidney disease (2/130), and unknown kidney diseases (25/130). There were no significant differences in age, sex, BMI, education and income level, DM, home helper assistance, or hemoglobin level between the two groups.

During the follow-up period, 16 of the 130 patients died, 5 transferred to hemodialysis, 1 underwent renal transplantation, and 1 shifted to another unit. The remaining 107 patients were still on PD at the end of the study. The cause of death was cardiovascular disease in 8 patients, multiple organ failure in 7, and unknown in 1.

We observed 22 first episodes of peritonitis during the study period, which included 8 episodes caused by gram-positive organisms (3 Staphylococcus aureus, 3 Streptococcus species, 1 Enterococcus species and 1 Neisseria species), 4 caused by gram-negative organisms (3 Escherichia coli, 1 bacillus Alcaligenes), 1 caused by fungi, 1 polymicrobial episode, 7 culture-negative episodes, and 1 episode with no culture result. In 4 episodes, the peritonitis resulted in transfer to hemodialysis but not death. The average time to a first peritonitis or censoring was 14.3 ± 9.5 months (range: 1 – 41 months).

Table 2 compares baseline demographic and clinical characteristics between patients with and without peritonitis episodes. We observed no differences in age, sex, BMI, education and income level, DM, home helper assistance, or hemoglobin level between the two groups (\( p > 0.05 \)). Patients with peritonitis had significantly lower albumin levels than did patients without peritonitis (34.8 ± 3.6 g/L vs 36.9 ± 3.5 g/L, \( p = 0.02 \)).

Table 3 shows the numbers and prevalence of errors during the bag exchange. The most common errors in the whole cohort were improper hand-washing (51.5%) and failing to check expiration dates or bag leakage (46.2%). The total number of errors was not significantly different between patients with and without peritonitis. However, the prevalence of failing to wear a face mask and cap was significantly higher in patients with peritonitis than in those without: 40.9% versus 5.6% respectively (\( p < 0.001 \)). Significant differences in the prevalence of

### Table 2

<table>
<thead>
<tr>
<th>Parameters</th>
<th>No</th>
<th>Peritonitis?</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n)</td>
<td>108</td>
<td>22</td>
<td>—</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>58.4±15.1</td>
<td>59.6±14.8</td>
<td>0.73</td>
</tr>
<tr>
<td>Male sex [n (%)]</td>
<td>55 (50.9)</td>
<td>9 (40.9)</td>
<td>0.49</td>
</tr>
<tr>
<td>Mean body mass index</td>
<td>23.7±3.4</td>
<td>24.5±3.7</td>
<td>0.39</td>
</tr>
<tr>
<td>Diabetes [n (%)]</td>
<td>52 (48.1)</td>
<td>12 (54.5)</td>
<td>0.64</td>
</tr>
<tr>
<td>Home helper [n (%)]</td>
<td>41 (37.9)</td>
<td>6 (27.3)</td>
<td>0.29</td>
</tr>
<tr>
<td>Education level below high school [n (%)]</td>
<td>43 (39.8)</td>
<td>11 (50)</td>
<td>0.48</td>
</tr>
<tr>
<td>Annual income below $3000 [n (%)]</td>
<td>66 (61.1)</td>
<td>16 (72.7)</td>
<td>0.34</td>
</tr>
<tr>
<td>Mean albumin (g/L)</td>
<td>36.9±3.5</td>
<td>34.8±3.6</td>
<td>0.02(^b)</td>
</tr>
<tr>
<td>Mean hemoglobin (g/L)</td>
<td>112.7±17.6</td>
<td>105.5±27.9</td>
<td>0.29</td>
</tr>
</tbody>
</table>

\(^a\) Mean ± standard error of the mean, or number (percentage).

\(^b\) \( p < 0.05 \) comparing the two groups.
other errors were not observed between the two groups. Each error of bag exchange and each recognized confounder was analyzed individually to determine correlations with a first peritonitis episode. Among bag exchange items, only failure to wear a face mask and cap was a significant predictor of peritonitis in the univariate regression model (HR: 5.74; 95% CI: 2.22 to 13.54; p < 0.001; Table 4). Failure to wear a face mask and cap significantly predicted a shorter peritonitis-free period by Kaplan–Meier analysis (p < 0.001, Figure 1).

**TABLE 3**

<table>
<thead>
<tr>
<th>Item</th>
<th>Overall</th>
<th>No Peritonitis</th>
<th>Yes Peritonitis</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated</td>
<td>130</td>
<td>108</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Dirty nails [n (%)]</td>
<td>38 (29.2)</td>
<td>34 (31.5)</td>
<td>4 (18.2)</td>
<td>0.3</td>
</tr>
<tr>
<td>Insufficient ultraviolet radiation [n (%)]</td>
<td>37 (28.5)</td>
<td>29 (26.9)</td>
<td>8 (36.4)</td>
<td>0.44</td>
</tr>
<tr>
<td>Failure to check for expiration date or bag leakage [n (%)]</td>
<td>60 (46.2)</td>
<td>49 (45.4)</td>
<td>11 (50)</td>
<td>0.82</td>
</tr>
<tr>
<td>Improper hand washing [n (%)]</td>
<td>67 (51.5)</td>
<td>54 (50)</td>
<td>13 (59.1)</td>
<td>0.49</td>
</tr>
<tr>
<td>Failure to wear face mask and cap [n (%)]</td>
<td>15 (11.5)</td>
<td>6 (5.6)</td>
<td>9 (40.9)</td>
<td>&lt;0.001b</td>
</tr>
<tr>
<td>Nose or hair not covered [n (%)]</td>
<td>20 (15.4)</td>
<td>17 (15.7)</td>
<td>3 (13.6)</td>
<td>0.55</td>
</tr>
<tr>
<td>Failure to flush before filling [n (%)]</td>
<td>6 (4.6)</td>
<td>4 (3.7)</td>
<td>2 (9.1)</td>
<td>0.27</td>
</tr>
<tr>
<td>Suspected connection contamination [n (%)]</td>
<td>39 (30)</td>
<td>31 (28.7)</td>
<td>8 (36.4)</td>
<td>0.48</td>
</tr>
<tr>
<td>Total items in error</td>
<td>2 (0–8)</td>
<td>2 (0–6)</td>
<td>2 (0–8)</td>
<td>0.69</td>
</tr>
</tbody>
</table>

*Data shown as number (percentage), or median (range).

**TABLE 4**

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>p</th>
<th>Hazard ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin</td>
<td>−0.03</td>
<td>0.005a</td>
<td>0.96 (0.94–0.99)</td>
</tr>
<tr>
<td>Albumin</td>
<td>−0.01</td>
<td>0.84</td>
<td>0.99 (0.87–1.12)</td>
</tr>
<tr>
<td>Failure to wear a face mask and cap</td>
<td>1.98</td>
<td>&lt;0.001b</td>
<td>7.26 (2.62–20.13)</td>
</tr>
</tbody>
</table>

*a* p < 0.01.

*b* p < 0.001.

CI = confidence interval.

Figure 1 — Kaplan–Meier analysis of the probability of remaining peritonitis-free according to use of a face mask and cap. Time to the first peritoneal dialysis peritonitis episode was significantly shorter in patients failing to wear a face mask and cap (p < 0.001).
education level were not significant predictors. When failure to wear a face mask and cap, hemoglobin, and serum albumin were included in a multivariate Cox model, failure to wear a face mask and cap and hemoglobin level were independent predictors of a first episode of peritonitis, with adjusted HRs of 7.26 (95% CI: 2.62 to 20.13; \( p < 0.001 \)) and 0.96 (95% CI: 0.94 to 0.99; \( p = 0.005 \)) respectively (Table 4).

**DISCUSSION**

Our results revealed that, at the 6th month of PD, about half of our PD patients improperly washed their hands and forgot to check for expiration date or bag leakage, and 11.5% failed to wear a face mask and cap during the bag exchange. Failure to wear a face mask and cap and anemia were significantly independent predictors for a first episode of peritonitis (adjusted for serum albumin).

To our knowledge, evidence concerning the risk of failing to wear a face mask and cap during bag exchange is limited. Although our data showed its effect on the risk for a first peritonitis episode, this prospective observational study can not verify a causal link between lack of a mask or cap and peritonitis. So far, only one short report and one retrospective study on this issue have showed paradoxical data. A letter from Italy revealed that 22% of their patients who developed peritonitis claimed that they did not use a face mask (21). By contrast, Figueiredo et al. from Brazil showed no difference in the incidence of peritonitis between patients wearing and not wearing a mask in a retrospective observational study (22). Although data from our prospective observational study verified the important role of mask and cap in preventing peritonitis, we can not recommend wearing a face mask or cap until further randomized controlled studies confirm the benefit in decreasing the peritonitis risk. Notably, in the surgical area of the hospital, wearing a face mask can prevent downward dispersal of upper respiratory tract bacteria to blood agar plates, particularly during talking and head turning (23). Routine use of a face mask and ultraviolet light is also recommended in nonsurgical areas of hospitals and nursing homes (24). PD, as a home therapy, should achieve environmental hygiene similar to that in a nursing home. Obviously, we need to deal cautiously with this issue until data can be obtained from randomized controlled studies. After all, the cost of a face mask and cap cost is low, but peritonitis and its consequences are much more severe.

Interestingly, there seemed to be no relationship between peritonitis risk and failure to have nose and hair fully covered even though failing to wear a mask and cap was a significant predictor. One potential cause for this finding is that the quantity of bacteria originating from uncovered nose and hair was more than from nose and hair not fully covered. Whether infection develops actually depends on virulence, bacteria load, and the defensive ability of the immune system.

Compared with failure to wear a face mask and cap, other suspected causes of contamination during an exchange procedure resulting in peritonitis—such as improper hand-washing, spiking of bags, having the tubing clamp open, failure to flush before fill—have been more often discussed in the PD community (13,25). Although we found no relationship between improper hand-washing and peritonitis, the high prevalence of improper hand washing in our cohort is worrying, and indicates that we need strengthen this aspect during initial training and retraining. In addition, we realized that ultraviolet radiation for 20 minutes before bag exchange is not routinely practiced in most PD units. However, Beijing, as the capital city of China, has battled with increasing urbanization and traffic congestion in recent years, both resulting in heavy indoor and outdoor air pollution (26,27), and the windy weather makes it much easier for pollutants and bacteria to enter the room used for dialysis exchange. We need more evidence showing the benefits of ultraviolet radiation in decreasing the peritonitis risk for PD patients in Beijing.

Our data also suggests that retraining should be strengthened during PD treatment. In China especially, the rapid growth of the PD population in recent years has led to a high ratio of patients to nurses—for example, 30:1 in our unit. Although initial training is conducted one-to-one, the fact that patients rarely follow the bag exchange procedure as taught points to a need for retraining. We are also interested in exploring whether monitoring the bag exchange at regular intervals can lower the prevalence of peritonitis in the future, given that initial training time is not correlated with the peritonitis rate (28).

Malnutrition and DM were not observed to be significant risk factors for peritonitis in this study as reported previously (8,29), which might reflect relatively good nutrition status, the presence of home helpers for 60% of patients with DM, and administration of subcutaneous rather than intraperitoneal insulin in our unit. Anemia was still a predictor of peritonitis as shown in our data, which indicates that patients who are probably immunocompromised because of anemia have to be more carefully monitored in their exchanges than do healthier patients. In other words, any shortcuts that patients with anemia take are more likely to result in peritonitis. Having bag exchanges performed by home helpers did not correlate with peritonitis risk in the present study—a finding that
differs from that in a recent report from France, which showed that patients receiving automated PD assisted by a private nurse had a higher risk of peritonitis. In France, care for one patient is not delivered by one fixed nurse (8). By contrast, home helpers in our unit are dedicated family members or dedicated nurses, probably with a higher extent of personal involvement and experience.

Our data showed only 8 episodes of peritonitis from gram-positive organisms. Arguably, contamination-related peritonitis is expected to come mostly from gram-positive organisms. Notably, all the gram-positive organisms found were oral or nasal ones, consistent with patients not wearing face mask. Moreover, 7 of 22 peritonitis episodes were culture negative, which indicated that our lab did not achieve the target no-growth rate of 20% recommended by the ISPD (4). A no-growth rate below this target has also been reported by U.S. and Korean authors (17,30). It is possible that our tests were not sensitive enough to detect the gram-positive organisms. Further, skin and uncovered hair are actually colonized by a wide variety of organisms, both gram-positive and gram-negative (31). A variety of organisms that colonize the upper respiratory tract also could be dispersed to the PD connection system through the uncovered mouth. These might be other potential reasons for the spectrum of organisms seen in this study.

The present study has several strengths. To our knowledge, it is the first prospective observational study that has examined the correlation between items of bag exchange and risk for peritonitis in PD patients. The bag exchange procedures were evaluated in detail. Most recognized confounders of peritonitis were simultaneously measured. The study also has a few limitations. First, the single observation of a bag exchange, the relatively small patient number, the high number of incident patients excluded, and the short follow-up prevented a robust observation of the relationship between potential risk factors and peritonitis. However, patients might be supposed to pay more attention to the bag exchange when being supervised by nurses at the clinic, and so a single observation would underestimate rather than overestimate the actual errors occurring in exchanges. Second, some potential risk factors, such as the effect of initial training and exit-site and tunnel function were not evaluated. Third, this is a single-center study based on an initial training protocol and a specific patient population. Whether our results are appropriate for other units is unknown.

CONCLUSIONS

Our data indicate that most PD patients failed to follow the full correct bag exchange procedure at the 6th month of PD. In a single evaluation of bag exchange, failure to wear a face mask and cap and anemia were independent risk factors for peritonitis. These results point to a need for more randomized controlled studies designed to determine the relationship between bag exchange procedures and peritonitis risk.

DISCLOSURES

No financial conflict of interest exists.

ACKNOWLEDGMENT

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REFERENCES


14. Nasso L. Our peritonitis continuous quality improvement project: where there is a will there is a way. *CANNT J* 2006; 16:20–3.


