Comparison of Disinfection Procedures on the Catheter Adapter-Transfer Set Junction

Peritonitis is a significant complication of peritoneal dialysis (PD), contributing to mortality and technique failure. Suboptimal disinfection and/or a loose connection at the catheter adapter-transfer set junction are forms of touch contamination that can compromise the integrity of the sterile fluid path and lead to peritonitis. Proper use of the right disinfectants for connections at the PD catheter adapter-transfer set interface can help eliminate bacteria at surface interfaces, secure connections, and prevent bacteria from entering into the sterile fluid pathway. Three studies were conducted to assess the antibacterial effects of various disinfecting agents and procedures, and ensuing security of the catheter adapter-transfer set junction. An open-soak disinfection procedure with 10% povidone iodine improves disinfection and tightness/security of catheter adapter-transfer set connection.

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A growing number of patients with end-stage renal disease are being managed with peritoneal dialysis (PD) worldwide (1). Infection is the second leading cause of death among patients receiving PD, as with hemodialysis (2,3), and is a

major cause of technique failure. The International Society for Peritoneal Dialysis has recognized infection as a global problem in patients on PD and has released a position paper directed at reducing PD-related infections (4).

The infection of greatest concern in PD is peritonitis (5). *Staphylococcus aureus*, the cause of 12% to 14% of peritonitis episodes, is one microorganism that can often result in relapse and transfer to hemodialysis (6,7). While there are several possible portals of entry for the development of peritonitis, touch contamination continues to be a substantial factor (4,8). One potential site for touch contamination is the PD catheter adapter-transfer set junction. Of particular concern is potential contamination with *S. aureus* at this interface. We sought to assess the effectiveness of various disinfectants and disinfectant procedures on antimicrobial activity and on their ability to maintain the integrity of the catheter adapter transfer set junction.

MATERIALS AND METHODS

Three studies were conducted. In Study 1, 2 disinfectants, 10% povidone iodine (Purdue Products L.P., Stamford, CT, USA) and 0.55% sodium hypochlorite (Alcavis 50, Angelini Pharma Inc., Gaithersburg, MD, USA), and 4 disinfectant procedures were assessed with regard to their ability to eliminate bacterial contamination at the catheter adapter-transfer set junction. Both titanium (Baxter, Deerfield, IL, USA) and plastic (Quinton BETA-CAP, Covidien, Mansfield, MA, USA) catheter adapters were evaluated. An inoculum of 10^6 colony-forming units of *S. aureus* was applied to the catheter adapter-transfer set junctions while mated, but not fully tightened. The catheter adapters were then fully hand-tightened. In Procedure A, the catheter adapter-transfer set unit underwent 2 1-minute scrubs on the external surface of the connection with a disinfectant-soaked gauze pad; the unit was then disconnected using aseptic technique. In Procedure B, the catheter adapter-transfer set unit underwent a 1-minute scrub on the external surface of the connection with disinfectant-soaked gauze, followed by a 5-minute soak of the external surface of the closed connection in ~ 8.0 mL of disinfectant prior to disconnecting. In Procedure C, the external surface of the catheter adapter-transfer set unit connection was scrubbed with disinfectant-soaked gauze for 1 minute, twisted open, and the open catheter adapter segment (internal/external surfaces) was soaked in ~ 6.0 mL of disinfectant for 5 minutes. In Procedure D, the external surface catheter adapter-transfer set unit connection was scrubbed with disinfectant-soaked gauze for 5 minutes, soaked in ~ 8.0 mL of disinfectant for 5 minutes, twisted open, and the open catheter adapter segment (internal/external surfaces) soaked in ~ 6.0 mL of disinfectant for 5 minutes. At the end of each procedure, the catheter adapters were placed in bacterial growth media. Overall, 22 samples were evaluated for each disinfectant-procedure combination. With this sample size, the absence of bacterial growth in all cultures would indicate a 90% confidence level that the tested procedure was 90% effective.

In Study 2, titanium adapters were soaked for 10 minutes in 1.15% sodium hypochlorite (Amuchina, Ancona, Italy), 0.2% chlorhexidine (Chlorhexamed Forte, GlaxoSmithKline, Hamburg, Germany), 7.5% povidone iodine (Braunol; B. Braun, Bethlehem, PA, USA), 10% povidone iodine (Purdue), or 0.1% octenadine hydrochloride (Octenisept; Schulke & Mayr, Norderstedt, Germany) before hand-connecting to the transfer set at a pre-defined torque. The security of the connection was evaluated by measuring counterclockwise torque off with a hand torque gauge after 24 hours.

Study 3 evaluated the security of the plastic Quinton BETA-CAP catheter adapter and the transfer set connection following submersion of the adapter threads in either 10% povidone iodine or 0.55% sodium hypochlorite for 10 minutes prior to connection in 30 samples. Counterclockwise torque assessment of the security of the connection was evaluated at disconnection times of 1 hour and 48 hours following immersion in the disinfectant. A 2-sample *t*-test was performed comparing the torque required for disconnection of the catheter adapter-transfer set.

RESULTS

In Study 1, disinfectant procedures A and B (external surface disinfection only), using either 10% povidone iodine or 0.55% sodium hypochlorite, failed to completely eliminate *S. aureus*. In contrast, procedures C and D (external and internal surface disinfection) successfully eliminated all bacteria irrespective of the disinfectant tested or the duration of external scrubbing time of the closed connection with disinfectant-soaked gauze (i.e., 1 minute vs 5 minutes) (Table 1).

In Study 2 the mean $\pm$ standard deviation (SD) removal torque with presoaking in 10% povidone iodine (4.08 ± 1.24 in-lbs) was significantly greater than that required with all other antiseptics assessed ($p < 0.001$). Titanium adapters soaked in 0.2% chlorhexidine and “dry” controls required about the same amount of torque to disconnect (mean $\pm$ SD 1.60 ± 0.50 in-lbs and 1.79 ± 0.25 in-lbs, respectively). We also examined the distribution of the torque (median and quartile

ranges) across all antiseptics and a “dry” connection (Figure 1) and observed similar results.

In Study 3, greater torque was needed to loosen the connection with 10% povidone iodine vs 0.55% sodium hypochlorite at both 1 hour (mean $\pm$ SD torque 3.23 ± 0.596 in-lbs vs 2.34 ± 0.386 in-lbs, respectively) and 48 hours (mean $\pm$ SD torque 3.41 ± 0.558 vs 2.60 ± 0.418 , respectively) after soaking ($p < 0.001$ for both time points). We also examined the distribution of the torque (median and quartile ranges) (Figure 2) and observed similar results to the mean values at both 1 and 48 hours.

DISCUSSION

The PD catheter adapter-transfer set junction is susceptible to contamination if it becomes loosened. This could lead to potential infection and peritonitis. When connections are re-tightened, it is important to realize that performing just an external scrub or soak may not be effective in eliminating bacteria. Proper catheter adapter-transfer set change procedures and choice of disinfectants have a potential role in reducing the likelihood of transfer of bacteria into the sterile fluid pathway resulting potentially in peritonitis, as well as helping to maintain a tight connection.

These studies demonstrated that both 10% povidone iodine and 0.55% sodium hypochlorite were effective at eliminating contaminating bacteria, but only when both the inner and outer surfaces of the adapter were disinfected. Thus, these data suggest that performing an open soak of the titanium catheter adapter is clinically preferred at the time of any catheter adapter-transfer set change and when connections become loosened, to eliminate introduction of bacteria and the risk of infection. We also conclude that the 5-minute soak of the closed connection in disinfectant could be eliminated from procedures as it was both time-consuming and ineffective in eliminating bacteria. Our data also suggest that the choice of disinfectant may influence the security of the connection and the likelihood of unintended partial or complete disconnection or loosening. Soaking the adapter in 10% povidone iodine prior

TABLE 1
Disinfection of the Catheter Adapter-Transfer Set Junctions

	10% Povidone iodine (Purdue)		0.55% Sodium hypochlorite (Alcavis 50)		Bacterial Challenge CFUs
	Titanium n/N	Plastic n/N	Titanium n/N	Plastic n/N	
Procedure A	0/22	0/22	0/22	0/22	4.56×10^6
Procedure B	0/22	0/22	0/22	0/22	3.93×10^6
Procedure C	22/22	22/22	22/22	22/22	4.83×10^6
Procedure D	22/22	22/22	22/22	22/22	3.67×10^6

CFUs = colony-forming units; n = number of units with no bacterial growth; N = number of units tested.

Procedure A–D: refer to Materials and Methods.

Figure 1 — Median and interquartile ranges of removal torque required for disconnection of titanium catheter adapter-transfer set with different antiseptics.

Figure 2 — Median and interquartile ranges of removal torque required for disconnection of the Covidien Quinton BETA-CAP adapter and the transfer set after soak of the adapter in 10% povidone iodine or 0.55% sodium hypochlorite.

to the catheter-transfer set connection results in a more secure connection when compared with other antiseptics or when a dry connection is made.

Our studies do have some limitations. Although soaking the adapter in 10% povidone iodine resulted in the most secure connection among the antiseptics evaluated, we did not assess the security of the connection beyond 48 hours. We also performed all assessments in a controlled environment. It is unknown how secure the connection may be in normal use by a patient or when attached by a clinician.

As suggested by the International Society for Peritoneal Dialysis (4), very low rates of infection can be achieved if close attention is paid to training and retraining in the use of appropriate equipment and if protocols for preventing infections are followed. Implementation of the procedural findings described here into routine practice should help accomplish these results.

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DISCLOSURES

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