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Reducing Peritoneal Dialysis-Related Peritonitis Rate

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ABSTRACT

Background: Peritoneal dialysis-related peritonitis is an important negative risk of peritoneal dialysis. Peritonitis results when organisms enter the normally sterile peritoneal space, and the peritoneal immune system is unable to prevent the proliferation of the organisms.

Methods: The process of reducing the rate of peritonitis includes identification of the need for reducing peritonitis, identification of the cause of the high peritonitis rate through root cause analysis, and intervention.

Results: Interventions vary depending upon the type of organism causing peritonitis. Nonenterococcal gram-positive peritonitis and *Pseudomonas* peritonitis are related to contamination and are potentially preventable; enteric peritonitis is difficult to prevent.

Conclusion: The rate of peritonitis can be reduced through a strong continuous quality improvement team because the majority of peritonitis episodes can be prevented.

INTRODUCTION

Peritoneal dialysis-related peritonitis is an important negative risk of peritoneal dialysis worldwide, with varying prevalence depending upon location. Normally, the peritoneal space is sterile. Peritonitis results when organisms enter the peritoneal space, and the immune system in the peritoneum is unable to prevent the proliferation of these organisms. In patients on peritoneal dialysis, the peritoneal immune system is weakened by the dilution of the protective system through the presence of fluid and also by the denudation of the peritoneal mesothelium over time as a result of the dialysis.

Peritoneal dialysis-related peritonitis is classified as preventable and nonpreventable. Preventable peritonitis includes all gram-positive peritonitis cases except enterococcal peritonitis and most *Pseudomonas* peritonitis. Nonpreventable peritonitis includes the majority of the nonpseudomonal gram-negative, fungal, and mycobacterial peritonitis. Some rarer organisms also raise concerns in specific situations such as acquiring infection from pets.[1]

Preventing peritonitis first involves preventing organisms from entering the peritoneal space, but then if they do, taking steps to prevent their growth. Patient education for peritoneal dialysis includes training in the steps necessary to prevent peritonitis, and the varying application of these steps among patients leads to the different peritonitis rates seen across dialysis centers. In its 2011 statement paper on the prevention of peritonitis, the International Society for Peritoneal Dialysis (ISPD) noted that if the peritonitis rate is high in a particular dialysis center, an effective root cause analysis can identify the cause of such a high rate and the appropriate measures to take to rectify the lapses causing peritonitis.[2] This review summarizes the various steps that were applied successfully to create a 5-fold reduction of peritonitis rates at our dialysis center.[3]

PROCESS FOR REDUCING THE PERITONITIS RATE

Reducing peritonitis rates in a dialysis center involves 3 primary steps.

Step 1. Identification of the Need to Reduce Peritonitis

Every dialysis center monitors peritonitis rates during meetings of the quality assurance and performance improvement (QAPI) team. Peritonitis rates generally are expressed in 1 of 2 ways: number of episodes per 12 patient months or number of months of dialysis for each episode of peritonitis. Although most dialysis units report the latter way, the ISPD Standards and Guidelines Committee suggests reporting the number of episodes per 12 patient months.[2] Investigation and intervention are triggered

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if an organization's peritonitis rate is higher than national figures or the standards set for that unit.

Step 2. Identification of the Cause of High Peritonitis Rates

The cause of high peritonitis rates can be identified through root cause analysis at the dialysis unit level. Operating on the theories that every case of peritonitis has a cause and the majority of cases are preventable will help achieve lower incidence rates. The QAPI team has the responsibility to perform the root cause analysis and to develop plans to control the peritonitis.

Step 3. Intervention(s) Depending Upon the Cause of the Problem

Interventions generally involve teaching patients about areas of deficiency or stress.

QAPI TEAM

The Centers for Medicare and Medicaid Services conditions for coverage require dialysis facilities to develop and implement a QAPI program and to achieve measurable improvements by using appropriate indicators and performance measures. QAPI teams usually meet once a month in dialysis units, but if a high peritonitis rate is discovered, additional meetings may be held to address the cause(s).

The typical QAPI team includes the peritoneal dialysis nurse, nurse manager, dialysis administrator, nephrologists managing patients on peritoneal dialysis, and medical director of the dialysis unit. Depending upon the gravity of the situation, experts from outside the institution, a statistician, or a continuous quality improvement (CQI) expert may be consulted. More details on members of the QAPI team follow.

Peritoneal Dialysis Nurse

Peritoneal dialysis nurses have traditionally played important roles in patient treatment, including teaching, caregiving, and mentoring. Patients' technique is strongly impacted by the quality of their training. Therefore, the peritonitis rate, which often relates to the level of patient knowledge and practice, reflects the quality of nurse training. Holding nurses accountable has to be done carefully through an educative exercise and not a punitive one, empowering the nurses to build a stronger care team.

Nurse Manager

The nurse manager is held accountable for the positive and negative outcomes in the dialysis unit and should take partial ownership of reducing the rates of peritonitis by addressing any problems in patient training, nurse education, and staffing. The manager should ensure that the training nurses get dedicated time for their own training and for the training they deliver to patients. Patient training usually takes 5 days or longer, and nurses should have the ability to extend patient training if they feel more time is necessary.

Nephrologist(s)

Each physician who treats peritoneal dialysis patients should be included on the QAPI team because they can diagnose the cause(s) of peritonitis. If the treating physician(s) cannot attend the meetings, the minutes of each meeting should be shared with him or her. Interdisciplinary involvement from all the physicians and members of the team provides the benefit of greater expertise and can help to create greater accountability among the team members.

Medical Director

The medical director is responsible for providing good care for all patients in the dialysis center irrespective of the primary nephrologist. If the center's peritonitis rate is high, the medical director has the responsibility to create a quality improvement team, separate peritonitis by organisms, evaluate the culture techniques, review the training material, review the skill of training nurses, review the skill of the patients, reassess the use of appropriate connectology, reevaluate the wet contamination policy, and review the peritonitis protocol. Nurse and physician experts can also be consulted to perform the root cause analysis and implement appropriate interventions. In this era of quick exchange of information, consulting experts in the field around the world is relatively easy.

ROLE OF THE PATIENT

The patient is the most important stakeholder of any medical care. Patients must understand that the majority of peritonitis cases are preventable and feel that they are responsible for their care and outcome in a self-care model.

Ideally, patients who develop peritonitis should see their nephrologist within 7 days of onset before they forget the events preceding the onset of symptoms. For example, the patient might reveal that a cap fell off, the tubing was leaking, the transfer set had a hole, a foreign object was introduced into the equipment, or he/she had a recent gastrointestinal or genitourinary procedure. The visit is more productive if the culture result is available when the nephrologist sees the patient because the organism provides a clue to the cause.

As part of the nursing evaluation, patients should be asked to answer a questionnaire about different

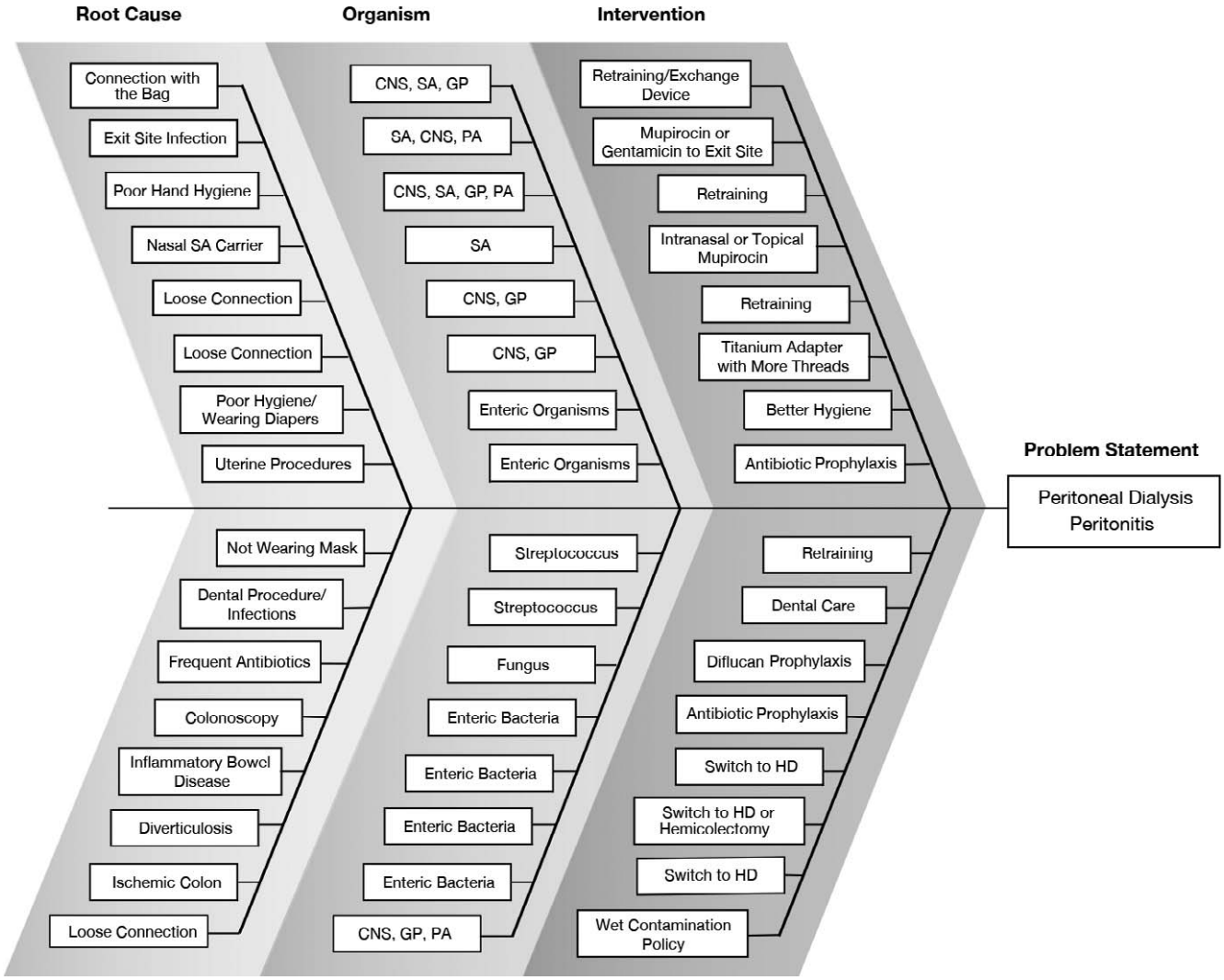

Figure 1. Fishbone diagram depicting the root cause analysis of peritonitis reduction strategies. CNS, coagulase-negative *Staphylococcus*; GP, gram positive; HD, hemodialysis; PA, *Pseudomonas aeruginosa*; SA, *Staphylococcus aureus*. Note: Enteric organisms include enterococci, *E coli*, Enterobacteriae, and other enteric bacteria.

avenues of contamination to help identify the cause of peritonitis.

ROOT CAUSE ANALYSIS AND INTERVENTIONS

At our center, the peritonitis rate was 1 episode per 7.5 months, a high and unacceptable rate. We made a commitment to reduce the peritonitis rate to an empirically acceptable rate of 1 episode every 12 months. We created a CQI team, now called the QAPI team, that consisted of 2 physicians; all the nurses involved in the peritoneal dialysis unit, including the nurse manager; the dialysis unit administrator; and a CQI expert. In addition, we consulted several experts in the field of peritoneal dialysis from different parts of the world. As outlined in the following sections, we performed a root cause analysis and implemented appropriate interventions (Figure 1). Through our multifaceted CQI program, we improved peritonitis rates from 1 episode per 7.5 patient-months (over 512 patient-months) in 1998 to 1 episode per 36.5 patient-months (over 292 patient-months) as of September 2002.

High Culture-Negative Peritonitis Rate

We had very high culture-negative peritonitis rates in 1998; general recommendations call for culture-negative peritonitis rates $<20\%$.[2] We had been sending an aliquot of peritoneal dialysis effluent for culture. We started sending the fluid for culture by injecting 10 mL of fresh dialysate into the large blood culture bottles at the bedside in the dialysis unit. This practice reduced the culture-negative peritonitis rate from 31% to 22%.[4]

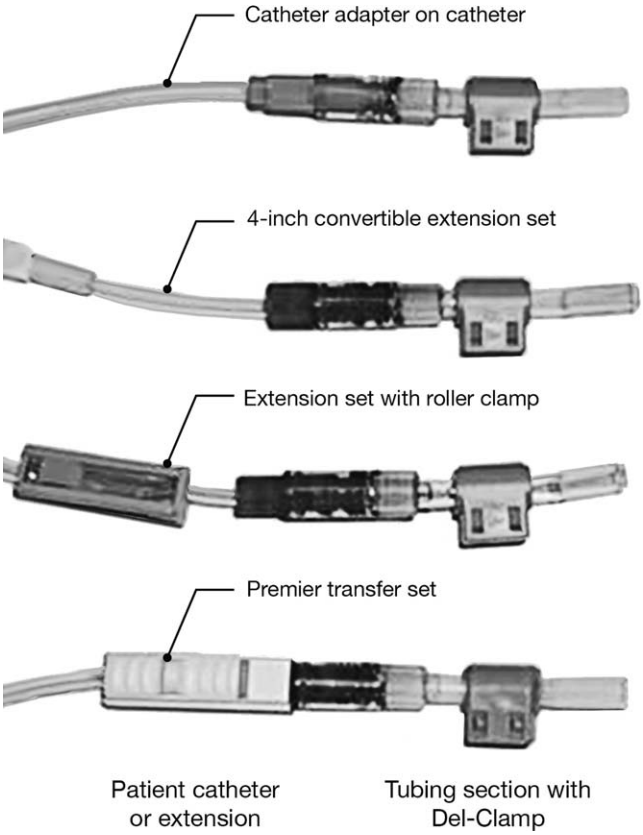

Figure 2. Older Fresenius Medical Care connectology.

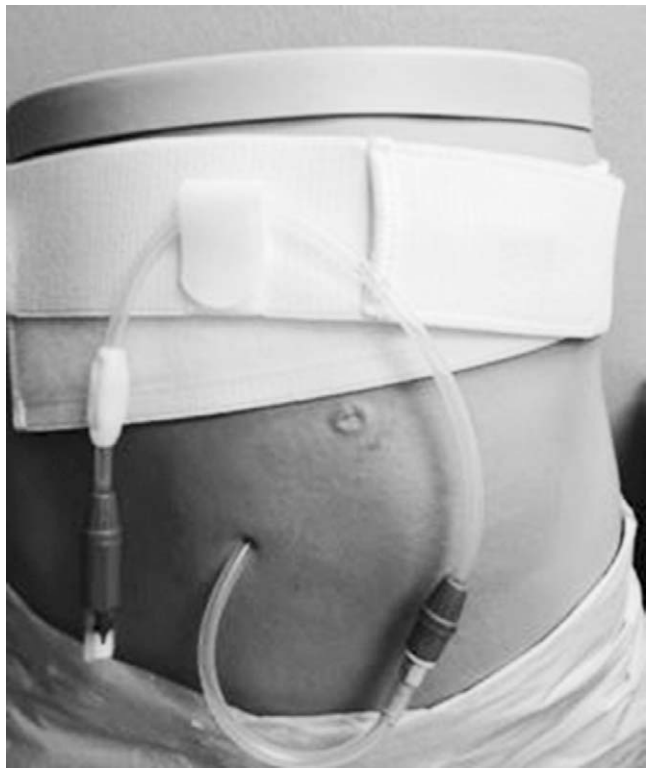

Figure 3. Newer Fresenius Medical Care connectology: the stay•safe system.

Coagulase-Negative Staphylococcal Peritonitis Rate

The majority of our patients' peritonitis was caused by coagulase-negative staphylococci. Coagulase-negative staphylococcal peritonitis is generally caused by contamination and is thought to be technique related. Retraining the training nurses, making them accountable for preventable peritonitis, and empowering them can help improve the incidence of this type of peritonitis. However, retraining patients every 6-12 months, doing a periodic peritonitis risk assessment, and educating patients at every monthly visit are the main ways to reduce preventable peritonitis. We retrained every patient who developed peritonitis.

During every visit, we stressed the importance of good hand washing and fully drying the hands before touching the catheter. Hand care prior to bag exchange has a major effect on touch-contamination levels. Proper hand washing by the physicians and nurses in the dialysis unit before examining the patients' abdomens sets a good example.

Miller and Findon[5] found that accidental touch contact of connecting devices with unprepared hands using a peritoneal dialysis bag exchange procedure led to the translocation of $\leq$500 microorganisms to the connector device. If the hands were wet at the time of contact, as many as 4,500 microorganisms were translocated. Hand drying with an air towel before touch contact reduces translocation by 95%-99%.[5]

We noticed wet contamination fairly frequently because of either loose connections between the catheter and the transfer set or ineffective clamping of the Del-Clamp. These wet contamination episodes were not being reported; therefore, the patients were not being treated until they developed peritonitis. The importance of promptly reporting wet contamination and subsequent treatment with 1 dose of intraperitoneal antibiotics (vancomycin 2 g and gentamicin/tobramycin 80-120 mg) after an episode of wet contamination was stressed to the patients and nurses to prevent peritonitis.

To reduce the risk of a loose connection between the catheter and the transfer set, we switched from plastic adapters that had 1½ threads to titanium adapters that have 2½ threads. To avoid potentially ineffective Del-Clamps, we switched to Baxter Healthcare Corporation transfer sets. Over the last 2 decades, Fresenius Medical Care connectology has improved considerably. Figures 2 and 3 demonstrate the changes. The Fresenius Medical Care Premier Transfer Set is the more evolved version of the

connectology. To further improve the system, Fresenius Medical Care has added the stay•safe system to make peritoneal dialysis easier for people with poor manual dexterity. Whether this new system has improved infection rates is unclear, but it has made exchanges easier. The system includes a pin as an additional barrier to contamination, but this pin also is an additional site for failure and contamination.

In patients on cycler-assisted peritoneal dialysis, HomeChoice cyclers (Baxter Healthcare Corporation) provide the option to use the compact exchange device to avoid contamination when spiking solution bags.

We believe that using appropriate connectology helped us reduce peritonitis, but this relationship has not been adequately studied, and connectology has improved since our observation. Most important, however, patients and nurses must be able to identify defective connectology regardless of the manufacturer because problems arise in any system periodically.

Staphylococcus aureus Peritonitis

Staphylococcus aureus is usually transferred from the nose and skin. Reminding patients how the bacteria can find their way from the nostril to the hand to the catheter will reinforce the importance of good hand washing and keeping the nails short and clean, the need for good exit site care, and the importance of prophylactic antibiotics at the exit site. Good evidence suggests that prophylaxis with intranasal mupirocin,[6] mupirocin applied to the exit site,[7] or oral rifampin reduces exit site infections. Weaker evidence supports the use of mupirocin at the exit site and oral rifampin to reduce *S. aureus* peritonitis.[8] In a randomized study comparing polysporin triple antibiotics with topical mupirocin, McQuillan et al[9] found similar exit site infection and peritonitis rates, but redness around the exit site was twice as common in the polysporin group. Fungal exit site infection and fungal peritonitis also were more common in the polysporin group. In a randomized study comparing daily mupirocin vs daily gentamicin cream at the exit site, Bernardini et al[10] showed that gentamicin use was a significant predictor of lower peritonitis rates (relative risk, 0.52; 95% confidence interval, 0.29-0.93; $P<0.03$), controlling for center and incident vs prevalent patients. Gentamicin cream applied daily to the peritoneal catheter exit site reduced *Pseudomonas aeruginosa* and other gram-negative catheter infections and reduced peritonitis by 35%, particularly cases caused by gram-negative organisms. Gentamicin cream was as effective as mupirocin in preventing *S aureus* infections.[10]

Pseudomonas Peritonitis

As mentioned in the previous section, topical gentamicin reduces *Pseudomonas* exit site infection and peritonitis rates. This treatment is the only currently known intervention for prevention of *Pseudomonas* peritonitis.

Enteric Peritonitis

Enteric peritonitis is the hardest type to prevent. Peritonitis following colonoscopy can be prevented by administering antibiotics intraperitoneally the night before the colonoscopy, performing the colonoscopy after draining the dialysate, and keeping the abdomen empty for 8-24 hours. Usually 2 g of vancomycin and 80-120 mg of gentamicin or tobramycin should be administered the night before the colonoscopy. These recommendations are based on anecdotal experience, reflecting the fact that during the last 20 years, we have seen no cases of peritonitis after colonoscopy among patients who received premedication with antibiotics.

Diverticulitis, inflammatory bowel disease, and ischemic bowel can predispose patients for enteric peritonitis, but in the majority of enteric peritonitis, the cause of transmural transmission of enteric organisms to the peritoneal space is not obvious. Computed tomography scan of the abdomen is frequently performed to find a cause, but the yield is fairly low. A small amount of free air under the diaphragm is common in all patients on peritoneal dialysis without bowel perforation, and small abscesses are difficult to diagnose in the presence of free dialysate in the abdomen.

Avoiding constipation is believed to decrease transmural transmission of bacteria, and patients on peritoneal dialysis should get laxatives to have 1-2 bowel movements daily. Diarrhea can also be predisposing for peritonitis, but this relationship could be the result of the etiology of diarrhea, such as colitis that may increase transmural transmission of enteric organisms. Chuang et al[11] have found hypokalemia to be an independent risk factor for Enterobacteriaceae peritonitis. Although treatment of hypokalemia has not been proven to reverse this risk, treating hypokalemia by liberalizing the diet and, if necessary, prescribing oral potassium supplementation with closer monitoring of serum potassium is reasonable.

CONCLUSION

Peritonitis continues to be an important problem in patients on peritoneal dialysis. With adequate root cause analysis, appropriate intervention can be implemented and peritonitis rates can be reduced. Combining the skills of nurses and physicians is an important and effective part of root cause analysis.

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