Evaluation of open versus closed urine collection systems and development of nosocomial bacteriuria in dogs

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Objective—To determine whether use of a closed urine collection system would decrease the incidence of nosocomial bacteriuria in hospitalized dogs, compared with use of an open urine collection system (used, sterile IV bags).

Design—Randomized controlled trial.

Animals—51 hospitalized dogs requiring indwelling urinary catheterization for ≥ 24 hours.

Procedures—Dogs were randomly assigned to an open or closed urine collection system group. A standardized protocol for catheter placement and maintenance was followed for all dogs. A baseline urine sample was collected via cystocentesis for aerobic bacterial culture, with additional urine samples obtained daily from the urine collection reservoir.

Results—27 dogs were assigned to the open urine collection system group, and 24 were assigned to the closed urine collection system group. The incidence of nosocomial bacteriuria in dogs with open urine collection systems (3/27 [11.1%]) was not significantly different from incidence in dogs with closed urine collection systems (2/24 [8.3%]). Median duration of catheterization was 2 days for dogs in both groups; the range was 1 to 7 days for dogs in the open group and 1 to 5 days for dogs in the closed group.

Conclusions and Clinical Relevance—Results suggested that for dogs requiring short-term indwelling urinary catheterization, the type of urine collection system (open vs closed) was not associated with likelihood of developing nosocomial bacteriuria. Use of a strict protocol for urinary catheter placement and maintenance was likely key in the low incidence of nosocomial bacteriuria in the present study. (J Am Vet Med Assoc 2010;237:187–190)

The incidence of catheter-related urinary tract infection in a recent study involving dogs in a small animal intensive care unit was 10.3%, which was substantially lower than incidences in previous reports. Indwelling urinary catheterization can lead to nosocomial infection, and although the causative bacteria are frequently uropathogens, there is increasing concern regarding bacterial resistance to commonly used antimicrobial agents. Reducing the rate of nosocomial infection may relate to several factors, including shorter duration of catheterization, a standardized protocol for urinary catheter placement and maintenance, the type of urinary catheter, and potentially the type of urine collection system used.

The use of closed urine collection systems, which allow urine to be removed from the reservoir bag without disconnection from the urinary catheter, is standard practice in human medicine, but in veterinary medicine, open urine collection systems, often incorporating recycled IV fluid bags, are still commonly used. The use of recycled bags necessitates disconnecting the bag from the collection line and replacing it with a new bag when the urine reservoir is full. Results of a prospective veterinary study indicated that previously used, properly stored IV bags are not an important contributor to aerobic bacterial contamination when used as part of a urine collection system, but there is concern that disconnecting the line exposes the system to the external environment. This may increase the likelihood of nosocomial bacteriuria. The objective of the study reported here was to determine whether use of a closed urine collection system would decrease the incidence of nosocomial bacteriuria in hospitalized dogs, compared with use of an open urine collection system (used, sterile IV bags). We hypothesized that in hospitalized dogs requiring urinary catheterization, use of a closed urine collection system following standardized catheter placement and maintenance would result in a decreased incidence of nosocomial bacteriuria, compared with use of an open urine collection system.

Materials and Methods

Dogs—Dogs hospitalized in the critical care unit of the Veterinary Teaching Hospital at Colorado State University between October 2008 and March 2009, in which indwelling urinary catheterization was required for ≥ 24 hours, were included in the study. Written informed consent was obtained from all dog owners prior to study enrollment. Information recorded for each dog enrolled in the study included age, sex, breed, reason for hospitalization, absence or presence of bacteriuria on admission, type of urine collection system used, duration of indwelling urinary catheterization, results of
aerobic bacterial culture of daily urine samples, number of days until nosocomial bacteriuria was detected (if applicable), daily antimicrobial administration, and whether there was a potential for immunosuppression (as determined by exogenous administration of glucocorticoids, diabetes mellitus, or hyperadrenocorticism). All dogs received appropriate supportive care for their underlying disease as determined by the primary clinician. The study protocol was approved by the Colorado State University Institutional Animal Care and Use Committee.

Urinary catheter placement and maintenance and urine collection—A baseline urine sample was collected for aerobic bacterial culture via cystocentesis before urinary catheter placement. If cystocentesis was contraindicated because of patient condition (eg, coagulopathy, thrombocytopenia, thrombocytopenia, or transitional cell carcinoma), a baseline urine sample was collected via the catheter immediately after placement.

All urinary catheters were silicone-coated Foley catheters. Catheters were placed with a standardized procedure (Appendix), followed by use of a routine catheter maintenance protocol, adapted from a published protocol. Dogs were randomly assigned by means of a random number generator to an open or closed urine collection system group. Open urine collection systems consisted of an empty, previously used IV fluid bag. All bags were 1 L, had not contained any dextrose, and were stored in a cabinet located 3 feet above the hospital floor for ≤ 7 days. Some bags retained the IV-line spike as a stopper, with three-fourths of the IV line cut off and the remaining fourth tied in a knot. The remaining bags had had the IV spike completely removed and replaced by a sterile 1-ml syringe as a stopper. For use as an open urine collection system, a used IV bag was connected to a macrodrip set, which was then attached to the urinary catheter. Closed urine collection systems included standard commercial urine collection bags. Urine was retrieved from the collection systems in a standardized fashion.

For all dogs in the study, urine samples were collected daily from the urine collection system and submitted for aerobic bacterial culture. Samples were obtained from the infusion plug with a 22-gauge needle and syringe, after the plug had been wiped with isopropyl alcohol and allowed to dry.

Bacterial culture techniques—Urine samples were stored at approximately 4°C until processed. Storage time (< 24 hours vs 24 to 48 hours) until plating was recorded for all samples. Samples were plated on MacConkey and Columbia agar plates. Plates were incubated at 35°C and examined for bacterial and fungal growth every 24 hours for up to 5 days. Colony counts were performed on all urine samples from which growth was obtained. A positive urine culture result was defined as a bacterial colony count ≥ 10^3 cfu/mL. Nosocomial bacteriuria was defined as development of a positive urine culture result in dogs with a negative urine culture result on admission or a change in the bacterial flora in dogs with a positive urine culture result on admission.

Data analysis—The incidence of nosocomial bacteriuria was compared between the open urine collection and closed urine collection groups by use of the Fisher exact test. A P value < 0.05 was considered significant.

Results
Fifty-one dogs were enrolled in the study, of which 21 were female (2 sexually intact and 19 spayed) and 30 were male (3 sexually intact and 27 neutered). Age ranged from 8 months to 13 years (mean ± SD, 6.13 ± 3.56 years). There were 13 dogs with neoplasia, 12 dogs with intervertebral disk disease, 9 dogs that had sustained polytrauma, 4 dogs that had undergone surgery, 4 dogs with leptospirosis, 3 dogs that had ingested toxins, and 6 dogs with miscellaneous diseases. A baseline urine sample was collected for bacterial culture via cystocentesis in 49 dogs before urinary catheter placement. In 2 dogs, cystocentesis was contraindicated (1 because of thrombocytopenia and the other because of transitional cell carcinoma) and the baseline urine sample was collected immediately after catheter placement.

Antimicrobials were administered to 27 dogs, with 13 dogs receiving a single antimicrobial and 14 dogs receiving ≥ 1 antimicrobial. Antimicrobials that were administered included cefazolin (n = 12 treatments [28%]), enrofloxacin (10 [23%]), ampicillin (6 [14%]), potentiated penicillin (6 [14%]), cefoxitin (3 [7%]), clindamycin (2 [5%]), metronidazole (2 [5%]), doxycycline (1 [2%]), and chloramphenicol (1 [2%]). Potential immunosuppression was documented in 14 (27%) dogs and was attributed to exogenous corticosteroid administration (10 [20%]), an underlying endocrinopathy (2 [4%]), or both (2 [4%]). Endocrinopathies included hyperadrenocorticism (3) and diabetes mellitus (1).

Urine collection systems were defined as open for 27 dogs and closed for 24 dogs. Median duration of catheterization was 2 days (range, 1 to 7 days) for dogs with open urine collection systems and 2 days (range, 1 to 5 days) for dogs with closed urine collection systems. Nosocomial bacteriuria occurred in 3 of 27 (11.1%) dogs with open urine collection systems and 2 of 24 (8.3%) dogs with closed urine collection systems. There was no significant (P = 1.000) difference in the incidence of nosocomial bacteriuria between dogs with open versus closed urine collection systems. Power of this comparison, calculated on the basis of number of animals enrolled in the study and the observed incidence of nosocomial bacteriuria, was 0.061. Overall incidence of nosocomial bacteriuria when the 2 groups were combined was 9.8% (5/51).

A single bacterial isolate was obtained from 4 dogs, and 2 bacterial isolates were obtained from 1 dog. Bacterial isolates included Pseudomonas aeruginosa (n = 2), Escherichia coli (1), Staphylococcus intermedius (1), β-Streptococcus spp (1), and Enterococcus spp (1). Antimicrobial resistance was variable among isolates, with Pseudomonas and Staphylococcus isolates having the greatest resistance to commercially used antimicrobials. Time until plating was < 24 hours for 158 samples and 24 to 48 hours for 16 samples. Of the samples plated between 24 and 48 hours after collection, 3 were positive for nosocomial bacteriuria and 13 were negative for nosocomial bacteriuria.
Discussion

Results of the present study suggested that for dogs requiring short-term indwelling urinary catheterization, the type of urine collection system (open vs closed) was not associated with likelihood of developing nosocomial bacteriuria. This suggests that there is no clinical significance in choosing one system over another in hospitalized dogs requiring short-term urinary catheterization.

The overall incidence of nosocomial bacteriuria in the present study was 9.8% (5/51), which was similar to the incidence reported in a recent study that used similar catheter placement and maintenance protocols. The low incidence of bacteriuria in the present and the previous study was likely due, at least in part, to use of a standard protocol for urinary catheter placement and maintenance. The short duration of catheterization (median, 2 days for both groups; range, 1 to 7 days for the open urine collection system group and 1 to 5 days for the closed urine collections system group) also likely played a role in the low incidence of bacteriuria in the present study because a different study found that the odds of infection increased by 27% for each 1-day increase in duration of catheterization. In contrast, the type of catheter used in the present study may have led to a higher incidence of nosocomial bacteriuria. In the present study, silicone-coated Foley catheters were used in all dogs. Studies of other types of catheters (eg, hydrogel silver–coated and nitrofurazone-impregnated catheters) have indicated that these alternative catheters may help reduce the number of nosocomial urinary tract infections.

One limitation of the present study was the variation in time from urine collection to plating for bacterial culture. Refrigeration of urine samples for up to 24 hours in the hospital setting rarely causes changes in identified organism type, and overnight refrigeration appears to be a satisfactory means of urine preservation for culture. One study of dogs found that after 24 hours of sample refrigeration, there were no false-positive results. However, 4% of the samples had false-negative results. Therefore, the possibility exists that results for at least some of the 13 samples negative for nosocomial growth that were plated ≥ 24 hours after collection were falsely negative.

The low incidence of bacteriuria and low number of dogs enrolled in the present study limited our ability to evaluate the potential effects of other important variables, such as sex, antimicrobial administration, immunosuppression, duration of catheterization, and type of catheter, that may also have influenced infection rate. A larger prospective study is required to definitively determine whether a true advantage exists for closed urine collection systems. For many veterinary facilities, the most important factors in preventing nosocomial bacteriuria likely include minimizing the duration of catheterization and using a technique that encourages aseptic catheter placement and maintenance.

References

Appendix

Standardized technique for urinary catheter placement and maintenance and urine collection in dogs.

### Technique for urinary catheter placement

**Catheter insertion:**

1. Follow aseptic technique throughout procedure
2. Clip hair from vulva or distal aspect of the prepuce and ventral aspect of the abdomen to maintain a hair-free area of at least 2 inches surrounding the catheter insertion site
3. Wash hands and put on examination gloves
4. If there is any visible exterior exudate, wipe free with chlorhexidine surgical scrub and sterile water
5. Flush vestibule or prepuce 5 times with 0.05% chlorhexidine solution (1 to 10 mL depending on patient size)
6. Perform surgical preparation of the distal aspect of the penis with 3 to 5 mL of 0.05% chlorhexidine solution and sterile water
7. Instill 1 mL of 2% lidocaine or 0.5 to 3 mL of lidocaine jelly with a sterile syringe into the vestibule
8. Replace examination gloves with sterile gloves
9. If needed on the basis of patient position and movement, create a sterile field with a barrier drape with an access hole cut to surround the vulva or penis
10. Lubricate an appropriately sized, sterile, silicone-coated Foley catheter with sterile lubricating jelly
11. For female patients, use a digital placement technique (advance catheter ventral to finger into urethral papilla). If unsuccessful, use a disinfected instrument to aid in visualization and placement (eg, laryngoscope, speculum, or otoscope)
12. For male patients, extrude penis and advance catheter into urethral opening
13. If necessary, aspirate to confirm placement and flush with sterile saline solution
14. Inflate Foley catheter balloon with volume of sterile saline solution indicated on catheter

**Urine collection system:**

1. For closed collection systems, open the sterile Bard collection bag and aseptically attach to the Foley catheter
2. For open collection systems, attach a macrodrip IV set to the Foley catheter then attach a properly stored, used IV fluid bag to the end of the macrodrip set
3. Test catheter placement by applying gentle caudal traction
4. Secure catheter to patient with 1-inch white tape and 3-0 nylon suture

### Technique for urinary catheter maintenance and care in dogs

**Catheter maintenance should be performed every 8 hours or whenever catheter is visibly soiled**

**Open and closed systems:**

1. Wash hands and put on examination gloves
2. If there is any visible exterior exudate, wipe free with chlorhexidine surgical scrub and sterile water
3. Gently clean the vulva or penis with 0.05% chlorhexidine solution and sterile water
4. Flush the vestibule or prepuce 5 times with 0.05% chlorhexidine solution (1 to 10 mL depending on patient size)
5. Wipe the exposed catheter surface with 0.05% chlorhexidine solution
6. Ensure all urinary catheter connections are tight and that the urine collection bag is resting on the floor on top of a clean cardboard tray

### Technique for removing urine from the urine collection system

**Urine should be removed every 6 hours or as dictated by the primary clinician**

**Open system:**

1. Wash hands and put on examination gloves
2. Obtain a clean, properly stored 1-L IV fluid bag
3. While holding the urine collection bag off the floor, disconnect the fluid bag, save urine for quantification, and discard the used bag
4. Attach the new fluid bag to the macrodrip set
5. Ensure all urinary catheter connections are tight
6. Rest bag on the floor on top of a clean cardboard tray

**Closed system:**

1. Wash hands and put on examination gloves
2. Place the bag’s exterior drainage tubing into a clean collection chamber (eg, a measuring cup)
3. Open the tubing valve to allow urine to flow from the bag into the measuring cup
4. After all urine has drained, close tubing valve and secure tubing at the appropriate place
5. Ensure all urinary catheter connections are tight
6. Rest bag on the floor on top of a clean cardboard tray