SMALL ANIMALS/ EXOTIC

Performance of a veterinary urine dipstick paddle system for diagnosis and identification of urinary tract infections in dogs and cats

Winnie L. Ybarra, DVM; Jane E. Sykes, BVSc, PhD; Yenlie Wang, DVM; Barbara A. Byrne, DVM, PhD; Jodi L. Westropp, DVM, PhD

Objective—To evaluate the performance of a veterinary urine dipstick paddle (UDP) for diagnosis and identification of urinary tract infection (UTI) in dogs and cats.

Design—Prospective, randomized, blinded study.

Sample—207 urine specimens.

Procedures—UDPs were inoculated by 2 investigators and incubated according to manufacturer's instructions. Results, including presence or absence of bacterial growth, organism counts, and identification of uropathogens, were compared between investigators and with microbiology laboratory results. A subset of UDPs with bacterial growth was submitted to the laboratory for confirmation.

Results—The laboratory reported 64 (30.9%) specimens had growth of bacteria. Bacterial growth was reported for 63 (30.4%) and 58 (28.0%) of the UDPs by investigators 1 and 2, respectively. Sensitivity and specificity of the UDP for detection of bacterial growth were 97.3% and 98.6%, respectively, for investigator 1 and 89.1% and 99.3%, respectively, for investigator 2. For UPDs with ≥ 10^5 colony-forming units/mL, organism counts correlated well between the laboratory and investigators 1 (r = 0.95) and 2 (r = 0.89). Pathogen identification was not always accurate. Only 25 of 33 (75.8%) UDPs submitted for confirmation yielded bacteria consistent with those isolated from the original bacterial culture of urine.

Conclusions and Clinical Relevance—The veterinary UDP system was a sensitive test for screening patients for bacterial UTI, but uropathogen identification was not always accurate. When UDPs have bacterial growth, a fresh urine specimen should be submitted to the laboratory to confirm the identity of the organisms and to permit antimicrobial susceptibility testing. (*J Am Vet Med Assoc* 2014;244:814–819)

Approximately 14% of dogs develop a bacterial UTI during their lifetime, with a variable age of onset.[1] Bacterial cystitis is less common in young cats than in old cats, but infections are more common in older cats, most likely because of the presence of other comorbidities such as hyperthyroidism and diabetes mellitus.[2,3] Although UTIs can comprise mixed bacterial infections, most UTIs involve a single bacterial species. *Escherichia coli* is the pathogen most commonly isolated from the urine of cats and dogs, followed by *Staphylococcus* spp, *Proteus* spp, *Klebsiella* spp, *Enterococcus* spp, and *Streptococcus* spp.[4]

The collection of urine by use of cystocentesis followed by complete urinalysis and QABC is recommended to confirm a bacterial UTI for dogs or cats with signs of lower urinary tract disease.[5] If it is not possible to obtain a sample with cystocentesis, collection of a urine sample by use of a urinary catheter is considered acceptable, provided QABC is performed. Quantitative aerobic bacterial culture of urine provides an estimate of the number of bacteria present and is important when determining whether the bacteria are clinically relevant. The number of organisms that constitutes clinically relevant bacteriuria for the various collection methods in dogs and cats has been reported.[6]

Because of the expense, veterinarians do not always submit urine for QABC and antimicrobial susceptibility testing. Instead, empirical antimicrobial treatment is often started for a presumptive diagnosis of UTI made on the basis of clinical signs of lower urinary tract disease with or without results for bacterial culture of urine. Repeated treatment of animals with recurrent lower urinary tract signs without consideration of QABC and antimicrobial susceptibility test results may lead to incorrect antimicrobial choices, unnecessary ad-

Abbreviations

CFU	Colony-forming unit
CI	Confidence interval
QABC	Quantitative aerobic bacterial culture
UDP	Urine dipstick paddle
UTI	Urinary tract infection

From the Veterinary Medical Teaching Hospital (Ybarra, Wang) and the Departments of Veterinary Medicine and Epidemiology (Sykes, Westropp) and Pathology, Microbiology, and Immunology (Byrne), School of Veterinary Medicine, University of California-Davis, Davis, CA 95616.

Supported in part by the Center for Companion Animal Health.

Presented in part at the American College of Veterinary Internal Medicine Forum, New Orleans, May 2012.

The authors thank John Kirby for technical assistance and Dr. Phillip H. Kass for assistance with statistical analysis.

Address correspondence to Dr. Westropp (jlwestropp@ucdavis.edu).

verse effects of drug treatment, and possible selection of resistant bacterial populations. Widespread antimicrobial resistance is an emerging problem in small animal medicine[7] and in humans.[8]

Urine dipstick paddles (also known as dip slides or paddle testers) have been used for decades in human medicine for the detection of bacterial cystitis.[9–12] In humans, the overall reported sensitivity of UDPs is 73% to 99% with a specificity of 94% to 99%, compared with results of QABC performed in a diagnostic microbiology laboratory as the criterion-referenced standard.[13,14] The bacterial species is correctly identified in 54% to 95% of samples,[15] but the proportion of bacteria correctly identified is lower when multiple organisms are present.[16,17]

Recently, a UDP system has been marketed for in-clinic veterinary use. The system consists of a culture paddle embedded with 2 standard culture media (one side with cysteine lactose electrolyte–deficient medium, and the other side with eosin methylene blue medium), which support the growth of the uropathogens that most commonly cause UTIs in dogs and cats. Culture results for these UDPs are reported by the manufacturer to be highly correlated (99%) with results for a reference laboratory culture method. If substantial bacterial growth is detected, the manufacturer recommends submission of the UPD to a reference laboratory for confirmation of the organisms and antimicrobial susceptibility testing because antimicrobial susceptibility information cannot be obtained from the UPDs. Such UDPs have the potential to be an inexpensive means for veterinarians to screen for UTIs before initiation of antimicrobial treatment. They could be particularly useful when culture results of the UPDs are negative, which therefore could decrease the use of inappropriate empirical antimicrobial treatment.

The objective of the study reported here was to compare results of bacterial culture and quantitation of bacterial numbers as determined with the veterinary UDP system with those determined with QABC performed at a microbiology laboratory. We also compared various methods of inoculation of the UDP and examined level of agreement between users of the UDP.

Materials and Methods

Sample—Urine specimens from dogs and cats were selected for use in the study. Specimens were a subset of all urine specimens submitted to the University of California-Davis William R. Pritchard Veterinary Medical Teaching Hospital for urinalysis at the diagnostic laboratory and QABC at the microbiology laboratory. Specimens were collected between March and October 2011 by use of cystocentesis, use of a urinary catheter, or midstream catch. Urine specimens were obtained because bacterial culture of urine was deemed clinically indicated by the attending clinician. All owners signed a consent form to acknowledge that they were informed of the potential use for the biological specimens; approval by an institutional animal care and use committee and owner consent specifically related to the study reported here were not required.

Microbiology laboratory procedures—Personnel at the microbiology laboratory performed QABC by using a calibrated loop to streak urine onto 5% defibrinated sheep blood agar and MacConkey agar (10 µL on each agar). Plates were incubated at 35°C in 5% CO_2. Species of bacteria were identified on the basis of results for routine microbiological biochemical testing, including Gram stains, spot tests (indole and oxidase), tubed biochemical media, and bacterial identification kits.[a–c] Results of conventional culture were considered negative when there was no bacterial growth after incubation for 5 days.

UDP system procedures—Specimens were selected for inoculation onto a UDP system[d] by 1 trained technician; this technician was aware of results of the urinalysis. Specimens with cytologic evidence suggestive of infection (eg, pyuria, hematuria, and bacteriuria) detected during urinalysis were prioritized by the technician for inclusion in the study to optimize the number of specimens that might contain bacteria. The technician also randomly selected urine specimens with inactive sediments for UDP inoculation.

Two investigators (investigator 1 [WLY] and 2 [YLW]), who were unaware of the results of urinalysis and QABC for each urine specimen, used the UDP system. Each media-embedded paddle was provided in an individual plastic screw-cap container **(Figure 1)**. Each investigator inoculated an aliquot of each urine specimen onto a UDP. Maximum elapsed time between collection of each urine specimen and inoculation of the UDP was 6 hours. Prior to use, UDPs were stored at room temperature (approx 22°C) as recommended by the manufacturer.

Incubation of the UDPs yielded visible colonies on the culture media, which could then be identified on the basis of color changes in the cysteine lactose electrolyte–deficient medium (changed from green to yellow or blue, depending on the pathogen). The UDP system could reportedly be used to identify *E coli*, *Enterococcus* spp, *Staphylococcus* spp, *Klebsiella* spp, *Proteus* spp, *Pseudomonas* spp, and yeasts. An estimate of the colony count (CFUs/mL) also could be obtained by comparing the growth on each UDP to a chart provided by the manufacturer.

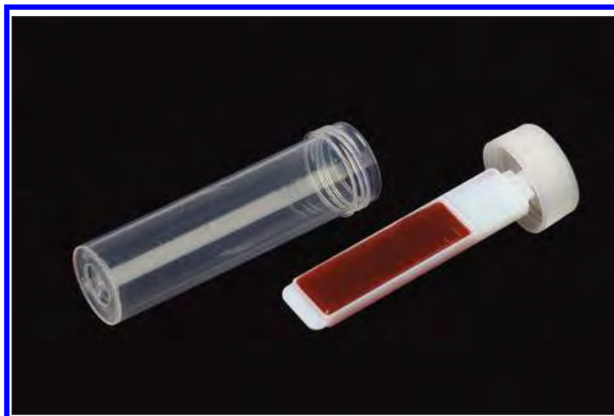


Figure 1—Photograph of a veterinary UDP for the detection of bacteriuria. Each side of the paddle is embedded with a different standard culture medium (cysteine lactose electrolyte–deficient medium and eosin methylene blue medium) that supports the growth of uropathogens that most commonly cause UTIs in dogs and cats. After the paddle is inoculated with urine, it is securely placed into the plastic container and then incubated to promote bacterial growth.

The manufacturer recommended pouring the urine onto the UDPs, but there usually were insufficient quantities of urine collected from dogs and cats to enable this. Therefore, we evaluated 2 protocols for UDP inoculations that could be translated into clinical practice. We determined that a urine volume of 0.25 mL was optimal to coat a side of the UDP. Therefore, for each urine specimen, 1 UDP was inoculated by dripping 0.25 mL of urine from a syringe onto each side; excess urine was allowed to run off the sides (drip method). A second UDP was inoculated with urine applied to each side of the UPD by use of a 10-µL calibrated loop. Preliminary experiments confirmed that 0.25 mL of urine was sufficient, and colony counts were comparable ($r = 0.99$; $P < 0.001$; data not shown) for the drip method and calibrated loop; therefore, all results were reported for samples that were inoculated onto the UDPs by use of the drip method.

Inoculated UPDs were placed in an incubator[e] recommended by the manufacturer, which was calibrated to maintain a mean ± SD temperature of 36 ± 2°C. The manufacturer suggested that visible growth of bacterial colonies could be identified 16 to 24 hours after inoculation; however, the 2 investigators examined the UDPs 16 to 24, 48, and 72 hours after inoculation. Each side of the UDP was examined at each time point. If growth was observed, each of the 2 investigators separately recorded the bacterial species and colony count using reference charts supplied by the manufacturer.

Confirmation of UDP isolates—A subset of UDPs on which the investigators identified bacterial growth were randomly selected and submitted to the microbiology laboratory to confirm the bacterial species isolated. The lid of each of the UPDs was tightly closed to secure the media-embedded paddle within the container; UPDs were stored at room temperature for no longer than 24 hours before bacterial culture at the microbiology laboratory. At the microbiology laboratory, colonies from each UDP were selected for subculture (5% defibrinated sheep blood agar incubated at 35°C in 5% CO_2). Subculture bacterial isolates were identified on the basis of the previously described biochemical methods. Plates were examined daily for 5 days after inoculation before a final result was reported. For each urine specimen, the bacterial species isolated from the UDP during subculture was compared with the bacterial species identified for the original urine specimen via QABC at the microbiology laboratory.

Statistical analysis—The McNemar test was used to identify significant differences in results for bacterial growth and organism identification between the microbiology laboratory and each of the investigators. Cohen κ coefficients were also calculated to assess interinvestigator agreement. Spearman correlations were used to compare colony counts obtained by the investigators and the microbiology laboratory. Values of $P < 0.05$ were considered significant. Statistical software[f] was used for the analyses.

Table 1—Bacterial species isolated from 207 canine and feline urine specimens submitted to a veterinary diagnostic microbiology laboratory.

Bacteria	No. of isolates*	No. of times the pathogen was isolated with > 1 other bacterial species
Escherichia coli	38	11
Staphylococcus spp	10	3
Enterococcus spp	19	6
Proteus spp	3	0
Streptococcus spp	5	3
Klebsiella spp	2	2
Pseudomonas spp	3	1
Other†	4	3

*The number of bacteria reported exceeds the number of urine specimens because > 1 pathogen or multiple strains of 1 pathogen were isolated from 11 urine specimens. †Other includes *Citrobacter* spp, *Actinomyces* spp, and *Enterobactor* spp.

Results

QABC of urine at the microbiology laboratory—A total of 207 urine specimens were analyzed; 149 were from dogs, and 58 were from cats. Sixty-four of 207 (30.9%) specimens (13 from cats and 51 from dogs) yielded bacterial growth for QABC performed at the microbiology laboratory (**Table 1**). Of these, 58 were collected via cystocentesis and 6 were collected with midstream catch. Eleven specimens yielded growth of > 1 uropathogen. The remaining 143 (69.1%) specimens did not yield bacterial growth. Of these, 138 had been collected via cystocentesis, 3 by use of a catheter, and 1 with midstream catch. The collection method was not recorded for 1 urine specimen.

Interinvestigator and laboratory agreement—Investigator 1 reported growth on 63 of 207 (30.4%) UDPs, whereas investigator 2 reported growth on 58 of 207 (28.0%) UDPs. There was excellent agreement between results for the microbiology laboratory and results for investigator 1 (κ = 0.92; 95% CI, 0.86 to 0.98; $P < 0.001$) and investigator 2 (κ = 0.91; 95% CI, 0.84 to 0.97; $P < 0.001$) for identification of the presence or absence of bacterial growth. Growth was identified by both investigators

Table 2—Sensitivity and specificity (95% CI) of the UDP system for detection of the pathogens most commonly cultured from urine samples of dogs and cats.

Variable	Sensitivity (%)		Specificity (%)	
	Investigator 1	Investigator 2	Investigator 1	Investigator 2
Bacterial growth (n = 63)	95.3 (87–100)	89.1 (79–95)	98.6 (95–99)	99.3 (96–100)
E coli (n = 31)	93.6 (79–100)	83.8 (66–95)	98.9 (96–100)	97.2 (93–100)
Enterococcus spp (n = 19)	68.4 (43–87)	52.6 (29–75)	98.9 (96–100)	98.9 (96–100)
Staphylococcus spp (n = 9)	55.6 (21–86)	66.7 (97–100)	98.5 (96–100)	99.5 (97–100)

Results for the microbiology laboratory were the criterion-referenced standard.

within the first 24 hours after inoculation for all UDPs that yielded growth, and results for growth were the same at all times (16 to 24, 48, and 72 hours); thus, all results were reported for growth at 24 hours after inoculation.

Compared with investigator 1, investigator 2 reported more culture results as negative, but the difference was not significant ($P = 0.07$). When results for each investigator were compared with those of the microbiology laboratory, investigator 2 was significantly ($P = 0.04$) more likely to identify a UDP culture result as negative than was the microbiology laboratory. For investigator 1, sensitivity and specificity of the UDP system for detection of bacterial growth were 95.3% and 98.6%, respectively. For investigator 2, sensitivity and specificity were 89.1% and 99.3%, respectively (**Table 2**). False-positive results (n = 3) were not commonly reported by investigators 1 (1 false-positive result) and 2 (2 false-positive results). False-negative results (n = 9) were reported slightly more often by investigators 1 (3 false-negative results) and 2 (6 false-negative results).

Interinvestigator agreement differed with regard to the identity of the bacterial species that grew on the UDPs. There was perfect interinvestigator agreement with regard to identification of *E coli* on the UDPs ($\kappa = 1.00$; 95% CI, 1.00 to 1.00; $P < 0.001$). Interinvestigator agreement was substantially lower with regard to *Staphylococcus* spp ($\kappa = 0.77$; 95% CI, 0.35 to 1.00; $P = 0.048$) and *Enterococcus* spp ($\kappa = 0.68$; 95% CI, 0.36 to 0.99; $P = 0.003$).

For the 64 urine specimens with bacterial growth for QABC performed at the microbiology laboratory, there was agreement between each investigator and the microbiology laboratory regarding the bacterial species for 52 (81.3%) and 46 (71.9%) specimens for investigators 1 and 2, respectively. Sensitivity and specificity of the UDP system for detection of specific uropathogens were summarized (Table 2). Both investigators almost always correctly identified *Enterococcus* spp and *Staphylococcus* spp, but sensitivity for the detection of these organisms was < 70% for both investigators. Agreement for identification of bacterial species between each investigator and the microbiology laboratory was summarized (**Table 3**).

For the 11 urine specimens that yielded growth of > 1 uropathogen for QABC performed at the microbiology laboratory, investigators 1 and 2 correctly identified at least one of the organisms in 6 and 5 specimens, respectively; however, mixed bacterial growth was not identified by either investigator. Organisms isolated from these specimens by the laboratory that were not detected with the UDP system included *Enterococcus* spp (n = 19), *Staphylococcus* spp (10; 2 strains were from the same specimen), *Pseudomonas* spp (3; 2 strains were from the same specimen), *Enterobacter* spp (3; 2 strains were from the same specimen), *Klebsiella* spp (n = 2), *Citrobacter* spp (1), and *Actinomyces* spp (1).

Confirmation of UDP isolates—Thirty-three UDPs with bacterial growth were submitted to the microbiology laboratory for testing. The pathogen identified on the UDP was the same as that isolated directly from the original urine specimen via QABC performed at the microbiology laboratory for 25 of the 33 (75.8%) UDPs. The microbiology laboratory was unable to culture any organisms from 3 of the UDPs, despite the investigators' reports of bacterial growth. For the 5 remaining UDPs, the organism isolated from the UDP by the microbiology laboratory differed from that isolated directly from the original urine specimen (**Table 4**).

Evaluation of colony counts—The investigators were able to use the veterinary UDP system to identify substantial bacterial growth ($\geq 10^5$ CFUs/mL), but obtaining accurate counts was not possible. Investigator 1 identified 51 of 64 (79.7%) cultures with growth of $\geq 10^5$ CFUs/mL according to the UDP system; investigator 2 identified 44 of 64 (68.8%) cultures with growth of $\geq 10^5$ CFUs/mL. The microbiology laboratory identified 57 of 64 (89.1%) cultures with growth of $\geq 10^5$ CFUs/mL. Of the 64 cultures with bacterial growth, the investigators were in agreement and identified the exact same colony count for 33 (51.6%) UDPs. For 44 of these 64 UDPs, the investigators quantified the bacterial load as $\geq 10^5$ CFU/mL, but the precise colony count differed between the investigators.

When evaluating UPDs with bacterial growth of $\geq 10^5$ CFUs/mL as determined with the UDP system, organism counts correlated well between the 2 investigators ($r = 0.93$; $P < 0.001$). Organism counts also correlated well between

Table 3—Cohen κ coefficient (95% CI) for agreement between each investigator and the microbiology laboratory for growth of bacteria and species identification of *E coli, Staphylococcus* spp, and *Enterococcus* spp.

Variable	Investigator 1	Investigator 2
Bacterial growth (n = 63)	0.94 (0.89–1.0)*	0.91 (0.84–0.97)*
E coli (n = 31)	0.92 (0.85–0.99)*	0.81 (0.70–0.92)*
Enterococcus spp (n = 19)	0.74 (0.57–0.91)*	0.62 (0.41–0.82)*
Staphylococcus spp (n = 9)	0.70 (0.49–0.91)*	0.74 (0.50–0.98)*

*Results for the investigator were significantly ($P < 0.001$) correlated with results for the microbiology laboratory.

Table 4—Results for 8 UDPs for which the pathogens identified on subculture of these UDPs by the microbiology laboratory differed from those isolated from the original urine specimen.

Organism cultured from original urine specimen via QABC performed at the microbiology laboratory	Organism identified by use of UDP		
	Investigator 1	Investigator 2	Microbiology laboratory*
Enterococcus spp and *Klebsiella* spp	*Enterococcus* spp	*Enterococcus* spp	No growth
Streptococcus bovis subsp *equinus*	*Enterococcus* spp	*Enterococcus* spp	No growth
Enterococcus spp	*Enterococcus* spp	*E coli*	No growth; positive result for Gram stain
E coli and *Enterobacter* spp	*Klebsiella* spp	*Pseudomonas* spp	*E coli*
Enterococcus spp and *Streptococcus* spp	*Staphylococcus* spp	*E coli*	*Enterococcus* spp
E coli and *Streptococcus* spp	*E coli*	*E coli*	*E coli*
No growth	*Staphylococcus* spp	No growth	*Enterococcus*
Enterococcus spp	*E coli*	*Staphylococcus* spp	*Enterococcus* spp and *Pseudomonas* spp

*Represents results for subculture of the UPDs at the microbiology laboratory.

investigator 1 and the microbiology laboratory ($r = 0.95$; $P < 0.001$) and between investigator 2 and the microbiology laboratory ($r = 0.89$; $P < 0.001$).

Discussion

In the present study, the veterinary UDP system was sensitive and specific for the detection of bacteriuria, and there was excellent agreement between the investigators regarding growth and no growth. There also was good agreement between the individual investigators and the microbiology laboratory. Our findings are similar to those reported for similar UDPs used for human patients.[13,14] The UDP may be a good option for screening urine specimens from dogs and cats for bacteriuria, and it might be a cost-effective option when the specimen is negative for growth. It has been recommended that urine be submitted for QABC both during and after antimicrobial treatment for dogs and cats with clinical, recurrent UTIs, and the UDP system may also provide a more cost-effective tool for monitoring bacterial culture of urine in these patients. However, bacterial isolation should only be attempted in clinics with appropriate laboratory facilities, equipment, and biosafety level 2 containment and waste management, which may be lacking in some veterinary hospitals.[5]

Although the UDP system included charts and tables to aid in the objective identification of organisms and colony counts, not all uropathogens could be accurately identified with the UDP system in the present study. Neither investigator reported results that consistently agreed with the results of QABC performed in the microbiology laboratory. Although false-positive results were uncommon, false-negative results were reported 9 times; 2 of these UDPs had growth of bacteria that could not be identified with this UDP system (*Actinomyces* spp and *Streptococcus* spp). Pathogen identification was particularly unreliable when multiple bacterial species were cultured. This is similar to findings reported in humans.[16,17] Charts provided by the manufacturer for bacterial identification only contained examples of infections with a single organism; therefore, the investigators chose the organism that appeared to best match the chart descriptions provided by the manufacturer. Some organisms, such as *E coli*, were easier to identify because of a characteristic appearance of the colonies (dark colonies with a green metallic sheen). Other organisms (eg, *Enterococcus* spp) were harder to identify because of the more subtle, less distinctive appearance of the bacterial colonies, particularly when colonies with a more dramatic appearance (eg, *E coli*) were present concurrently. However, few specimens contained gram-positive bacteria in this study, so additional studies may be warranted to evaluate performance of the UDP system for gram-positive bacteria.

In accordance with recommendations made by the manufacturer, UDPs that yielded evidence of bacterial growth were submitted to a microbiology laboratory for confirmation of the identity of bacterial isolates as well as for antimicrobial susceptibility testing. In the present study, results for only 25 of 33 (75.8%) UDPs submitted to the microbiology laboratory matched the original QABC results for the same specimen. The reasons for this are not clear. Contamination of the UDP by environmental bacteria may have led to the detection of *Pseudomonas* spp on 1 paddle by the laboratory. All UDPs were stored at room temperature pending confirmation of pathogen identity. The manufacturer recommended the UDPs be refrigerated only if they were not shipped to a commercial microbiology laboratory on the same day they were removed from the incubator.[g] Other storage and handling protocols for submitting UDPs to a microbiology laboratory should be evaluated in future studies. Contamination of UDPs during submission to a microbiology laboratory could result in false-positive culture results and inappropriate use of antimicrobials. On the other hand, no growth was obtained on subculture of some UPDs despite observed growth of bacteria on the UDPs and on QABC of the original urine specimen. This may have reflected loss of organism viability during storage and transport to the laboratory, although UDPs were stored for ≤ 24 hours. On the basis of these results, we recommend submission of a stored refrigerated aliquot of the original urine specimen (or another urine sample collected via cystocentesis if the original specimen has been stored for > 24 hours) to a microbiology laboratory for QABC and antimicrobial susceptibility testing whenever the UDP system yields growth and that the UDPs be used only as an initial screening tool.

Although it was challenging to exactly quantify bacterial growth, the UDP system allowed recognition of clinically relevant bacterial growth. The microbiology laboratory reported a maximum of 10^5 CFUs/mL, whereas the UDP system had charts that aided in identification of growth of up to 10^6 CFUs/mL. Although it was extremely difficult to report exact counts in that range, it was easy to detect large amounts of growth, and they correlated well with the microbiology laboratory findings of growth that exceeded 10^5 CFUs/mL The distinction between important and nonimportant growth is clinically useful and is necessary, particularly when urine is collected by use of a catheter or during antimicrobial treatment.[6]

One limitation of the study was that not all of the UDPs with bacterial growth were submitted to the microbiology laboratory for confirmation of the bacterial species cultured. However, we believe that sufficient numbers of UDPs were evaluated to determine that the result of subculture of UDPs by the microbiology laboratory did not always reflect the true infection status as determined by direct QABC of the original urine specimen. Furthermore, there were only a few urine specimens evaluated in the study that contained less common uropathogens (eg, *Klebsiella* spp, *Pseudomonas* spp, *Proteus* spp, and yeasts), so the sensitivity and specificity of the UDP system for detection of these organisms could not be accurately reported. Finally, the study included insufficient numbers of specimens that yielded mixed bacterial growth to accurately assess the performance of the UDP system for accurate diagnosis of mixed bacterial infections.

The veterinary UDP system tested in the present study provided a method for screening patients for bacterial UTIs and was a sensitive test for identifying the presence or absence of bacteriuria. Identification of the uropathogens present was not always accurate with this system. When UDPs have bacterial growth, a fresh urine specimen should be submitted whenever possible to a microbiology laboratory for QABC to confirm the identity of the organisms present and to permit antimicrobial susceptibility testing. If submission of a fresh urine specimen is not possible, the UDPs could be submitted, but this would be less optimal.

a. API 20E, bioMérieux, Durham, NC.
b. API 20 NE, bioMérieux, Durham, NC.
c. API 20 Strep, bioMérieux, Durham, NC.
d. Uricult Veterinary System, LifeSign, Skillman, NJ.
e. Cultura M, LifeSign, Skillman, NJ.
f. StatXact, version 9, Cytel Inc, Cambridge, Mass.
g. Claire Gentile, Technical Director, LifeSign, Skillman, NJ: Personal communication, 2013.

References

1. Ling GV, Rohrich PJ, Ruby AL, et al. Canine urinary tract infections: a comparison of in vitro antimicrobial susceptibility test results and response to oral therapy with ampicillin or with trimethoprim-sulfa. *J Am Vet Med Assoc* 1984;185:277–281.
2. Bailiff NL, Nelson RW, Feldman EC, et al. Frequency and risk factors for urinary tract infection in cats with diabetes mellitus. *J Vet Intern Med* 2006;20:850–855.
3. Bailiff NL, Westropp JL, Nelson RW, et al. Evaluation of urine specific gravity and urine sediment as risk factors for urinary tract infections in cats. *Vet Clin Pathol* 2008;37:317–322.
4. Ling GV, Norris CR, Franti CE, et al. Interrelations of organism prevalence, specimen collection method, and host age, sex, and breed among 8,354 canine urinary tract infections (1969–1995). *J Vet Intern Med* 2001;15:341–347.
5. Weese JS, Blondeau JM, Boothe D, et al. Antimicrobial use guidelines for treatment of urinary tract disease in dogs and cats: antimicrobial guidelines working group of the international society for companion animal infectious diseases hospitals [published online ahead of print]. *Vet Med Int* 2011;2011:263768.
6. Pressler B, Bartges JW. Urinary tract infection. In: Ettinger SJ, Feldman EC, eds. *Textbook of veterinary internal medicine*. 7th ed. St Louis: Saunders Elsevier, 2010;2036–2047.
7. Cooke CL, Singer RS, Jang SS, et al. Enrofloxacin resistance in *Escherichia coli* isolated from dogs with urinary tract infections. *J Am Vet Med Assoc* 2002;220:190–192.
8. Rijal A, Ghimire G, Gautam K, et al. Antibiotic susceptibility of organisms causing urinary tract infection in patients presenting to a teaching hospital. *J Nepal Health Res Counc* 2012;10:24–27.
9. Guttmann D, Naylor GR. Dip-slide: an aid to quantitative urine culture in general practice. *Br Med J* 1967;3:343–345.
10. Van Dorsten JP, Bannister ER. Office diagnosis of asymptomatic bacteriuria in pregnant women. *Am J Obstet Gynecol* 1986;155:777–780.
11. Granild-Jensen J, Mikkelsen MM, Veirum JE, et al. Urine samples from children collected in their homes [in Danish]. *Ugeskr Laeger* 2010;172:2136–2139.
12. Craig WA, Kunin CM. Quantitative urine culture method using a plastic "paddle" containing dual media. *Appl Microbiol* 1972;23:919–922.
13. Winkens R, Nelissen-Arets H, Stobberingh E. Validity of the urine dipslide under daily practice conditions. *Fam Pract* 2003;20:410–412.
14. Scarparo C, Piccoli P, Ricordi P, et al. Evaluation of the DipStreak, a new device with an original streaking mechanism for detection, counting, and presumptive identification of urinary tract pathogens. *J Clin Microbiol* 2002;40:2169–2175.
15. Morandi PA, Mauris A, Deom A, et al. External quality control results of urine dip-slide devices. *Diagn Microbiol Infect Dis* 2007;57:235–241.
16. Palmqvist E, Aspevall O, Burman E, et al. Difficulties for primary health care staff in interpreting bacterial findings on a device for simplified urinary culture. *Scand J Clin Lab Invest* 2008;68:312–316.
17. Aspevall O, Kjerstadius T, Lindberg L, et al. Performance of Uricult Trio assessed by a comparison method and external control panels in primary healthcare. *Scand J Clin Lab Invest* 2000;60:381–386.

From this month's *AJVR*

Effects of experimental mechanical manipulations on local inflammation in the jejunum of horses

Charlotte C. S. Hopster-Iversen et al

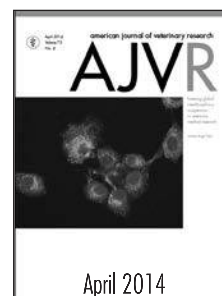
Objective—To determine characteristics of the inflammatory reaction in jejuna of horses in response to various mechanical manipulations.

Animals—12 adult warmblood horses without gastrointestinal tract disorders.

Procedures—The proximal aspect of the jejunum in each horse was divided into 5 segments, and the following manipulations were performed: manual emptying, placement of Doyen forceps, enterotomy alone, enterotomy with mucosal abrasion, and serosal abrasion. Jejunum samples were collected before (control), immediately after, and 30 minutes after the end of manipulations and histologically evaluated to determine distribution of neutrophil and eosinophil granulocytes.

Results—Macroscopically, all manipulations resulted in jejunal hemorrhage and edema. Compared with results for control samples, neutrophil numbers were significantly higher after manipulations in the serosa (after all manipulation types), circular muscle layer (after manual emptying), submucosa (after placement of Doyen forceps), and mucosa (after all manipulations except enterotomy alone). Eosinophil numbers were significantly higher in the submucosa after mechanical abrasion of the serosa and manual emptying versus control samples.

Conclusions and Clinical Relevance—Results indicated mechanical manipulations of the jejunum resulted in local inflammatory reactions characterized predominantly by infiltration of neutrophils. This could contribute to the development of postoperative ileus or adhesions in horses without macroscopically detectable injury of the jejunum during surgery. (*Am J Vet Res* 2014;75:385–391)



April 2014

See the midmonth issues of *JAVMA* for the expanded table of contents for the *AJVR* or log on to avmajournals.avma.org for access to all the abstracts.