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Clinical Features to Identify UTI in Nursing Home Residents: A Cohort Study

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Abstract

Objective—To identify, among non-catheterized nursing home residents with clinically suspected UTI, clinical features associated with bacteriuria plus pyuria.

Design—Prospective, observational cohort study from 2005 to 2007.

Setting—Five New Haven, CT area nursing homes.

Participants—551 nursing home residents each followed for one year for the development of clinically suspected UTI.

Measurements—The combined outcome of bacteriuria (>100,000 colony forming units on urine culture) plus pyuria (>10 white blood cells on urinalysis).

Results—After 178,914 person-days of follow-up, 228 participants had 399 episodes of clinically suspected UTI with a urinalysis and urine culture performed; 147 episodes (37%) had bacteriuria plus pyuria. The clinical features associated with bacteriuria plus pyuria were dysuria (relative risk [RR]=1.58, 95% confidence interval [CI] 1.10, 2.03), change in character of urine (RR=1.42, 95% CI 1.07, 1.79), and change in mental status (RR=1.38, 95% CI 1.03, 1.74).

Conclusions—Dysuria, change in character of urine, and change in mental status were significantly associated with the combined outcome of bacteriuria plus pyuria. Absence of these clinical features identified residents at low risk of having bacteriuria plus pyuria (25%), while presence of dysuria plus one or both of the other clinical features identified residents at high risk of having bacteriuria plus pyuria (63%). Diagnostic uncertainty still remains for the vast majority of residents who meet only one clinical feature. If validated in future cohorts, these clinical features

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with bacteriuria plus pyuria may serve as an evidence-based clinical definition of UTI to assist in management decisions.

Keywords

UTI; nursing home; long-term care; definition; infection control

INTRODUCTION

Clinicians frequently must determine whether changes in clinical status of nursing home residents are due to a treatable urinary tract infection (UTI). This clinical dilemma exists because cognitively impaired residents may not recall or report their symptoms, residents often do not present with classic genitourinary symptoms, and other illnesses (e.g., pneumonia) may present with non-specific symptoms similar to UTI (e.g., fever, altered mental status).^{1,2} Additionally, asymptomatic bacteriuria, defined as bacteriuria (>100,000 colony forming units [CFU] on urine culture) without urinary tract specific symptoms, is highly prevalent (e.g., 15–50%) among nursing home residents;³ 90% of those with asymptomatic bacteriuria also have pyuria.^{4,5} Thus, bacteriuria plus pyuria alone are not sufficient to make the diagnosis of UTI in a nursing home resident.

Given the current management uncertainties, antibiotics are commonly prescribed; presumed UTIs account for 30% to 56% of antibiotic prescriptions in the nursing home setting.⁶ Use of antibiotics in nursing home residents is associated with the development of multi-drug antibiotic-resistant organisms,^{7,8} drug-related adverse effects, and increased costs.⁹ Therefore, it is important to identify residents for whom the potential benefits of antibiotic therapy outweigh the risks.

With few empirical data, criteria for UTI surveillance, diagnosis, and treatment in nursing home residents have been developed by consensus groups which have been endorsed by specialty societies and government regulatory agencies.^{10–14} These consensus based criteria have specificities of 79% to 89% for bacteriuria plus pyuria and predictive values ranging from 52% to 61%.¹⁵ As a result, we sought to derive an evidence-based definition of UTI. It is agreed that bacteriuria (>100,000 CFU on urine culture) plus pyuria (>10 white blood cells [WBC] on urinalysis) is a necessary, though not sufficient, component of any UTI definition.^{16–22} Therefore, the objective of this study was to identify clinical features among non-catheterized nursing home residents that are associated with bacteriuria plus pyuria as a first step in developing an evidence-based definition of UTI that includes both clinical and laboratory components.

METHODS

Setting and Participants

Surveillance of this cohort occurred between May 2005 and May 2007. Five New Haven, CT area nursing homes ranging in size from 120–360 beds participated. These homes were selected in order to include residents from diverse socioeconomic and racial backgrounds with a range of physical and cognitive functioning. Residents were excluded if they: 1) were not anticipated to remain in the nursing home for long-term care (i.e., short-term rehabilitation residents; pending discharge; terminal [anticipated life expectancy < 4 weeks]); 2) were <65 years old; 3) had indwelling catheters; 4) were on dialysis; 5) were on chronic suppressive antibiotic or anti-infective therapy for recurrent UTI; or 6) had residence for < 4 weeks (providers did not have adequate time to determine resident's baseline). All eligible residents (or their surrogates) that could be contacted were approached for verbal consent. If the nursing home resident's primary physician had determined that the resident was unable to make decisions for him or

herself, the designated surrogate was approached for consent (92% of participants). Of 644 residents who met eligibility criteria and were contacted, 551 residents (86% response rate) enrolled (see Figure 1).

Participants were followed for one year or until any of the following occurred: death, placed on chronic suppressive antibiotic therapy, discharged, or insertion of a long-term indwelling catheter. The study was approved by the Yale University Human Investigation Committee, the Hospital of St. Raphael's IRB, and the Medical Boards of each participating nursing home.

Data Collection

At baseline, chart review and urinary dipstick tests (Chemstrip® 10 SG Urine Test Strips) were performed for each participant by study staff. Asymptomatic urine specimens for dipstick and urine culture were obtained in continent participants who could provide a clean catch specimen; however, only 76 participants (14% of the cohort) were able to provide this sample. Dipsticks were performed for the remaining participants on wet incontinence pads.²³ The presence of nine comorbidities was assessed. Nursing home staff members (i.e., nurses and nurse's aides) involved in the care of each participant were interviewed regarding assessment of mental status, behavioral symptoms, functional status, and continence. Interview questions regarding these assessments were adapted from the Minimum Data Set, a federally mandated and validated core set of items that must be assessed on a quarterly basis for each nursing home resident.²⁴ Medications, both prescription and non-prescription, which the resident received during the previous 2 weeks, were recorded.

At the time of clinically suspected UTI, defined as the nursing home resident's physician or nurse clinically suspecting a UTI, nursing home staff was asked to perform the dipstick. Clinical suspicion of UTI often was initiated by the primary nurse's aide or nurse caring for the participant. Chart review was performed by the study nurse in order to obtain laboratory data (i.e., urinalysis, urine culture, dipstick results, WBC count, blood culture results) and recorded vital signs (i.e., temperature, blood pressure, heart rate). In addition, staff members were asked the open ended question, "What caused suspicion of UTI?", and up to three clinical reasons were recorded. The primary nurse's aide caring for a participant was interviewed by one study nurse to assess mental status (i.e., change in level of consciousness, periods of altered perception, disorganized speech, or lethargy), behavior (i.e., resists care), functional status (i.e., activities of daily living [ADLs]), and change in voiding pattern (i.e., change in urinary frequency, decreased urinary output, urinary retention, change in incontinence, increased diaper changes, or urinary urgency). The primary nurse caring for a participant was interviewed by the same study nurse to assess flank pain or tenderness, abdominal or suprapubic pain or tenderness, acute dysuria, change in character of urine (i.e., gross hematuria, change in color of urine, change in odor of urine), constitutional symptoms (i.e., new weakness, new fatigue, or new malaise), cough, shortness of breath, and diarrhea. For mental status, behavior, and functional status, change was determined by a change in assessment at the time of clinically suspected UTI from the baseline assessment. For subjective clinical features (e.g., dysuria), the feature was considered present if the participant complained or if she exhibited discomfort that the nurse/nurse's aide attributed to that feature. These clinical features were assessed because in prior studies, they were identified as clinical reasons for suspecting UTI²⁵ and the evaluation of these clinical features by nursing home staff members was reliable.²⁶ Specifically, although all DMV IV criteria for delirium were assessed, only those four measures that were reliable in a prior study were used to define change in mental status in this study.²⁶ Urine cultures and urinalyses were ordered by nursing home practitioners (i.e., physicians, physician assistants, or nurse practitioners) on all participants with clinically suspected UTI; the specimens were sent to the contracted laboratory. Each nursing home participating in this study used standard practices for obtaining clean-catch and catheterized urine specimens.

Outcome

The study outcome was bacteriuria (>100,000 CFU on urine culture) plus pyuria (>10 WBC on urinalysis). If more than one episode of clinically suspected UTI occurred for a given participant during the year of follow-up, each episode was evaluated for the presence or absence of bacteriuria plus pyuria.

Analysis

The longitudinal data were modeled to accommodate serial correlation among repeated episodes utilizing the generalized estimating equations (GEE) approach.²⁷ First, unadjusted bivariate regression models were fit for each individual clinical feature. Next, a multivariable regression model was fit by backward elimination using clinical features whose relative risks were greater than 1.0. Since the outcome event rate of bacteriuria plus pyuria was 37%, odds ratios did not provide good approximations of relative risks. For binary predictors, relative risks were estimated from odds ratios using the formula $RR = OR / [(1-P) + (P \times OR)]$, where P is the prevalence of bacteriuria plus pyuria in the group that did not have the given predictor.²⁸ For continuous predictors, relative risks were estimated from regression models using a log link.²⁹ Clinically plausible interactions were investigated (e.g., change in character of urine $\times$ dysuria).

Model goodness of fit was verified by examination of residuals and relevant fit statistics. A longitudinal bootstrapping procedure was used to measure potential bias in the parameter estimates for the multivariable model.³⁰ All inference was based on two-tailed statistical tests from logistic regression models with P-values <0.05 indicating significance. Statistical analyses were performed with SAS software, version 9.1.3.³¹

RESULTS

Baseline characteristics

Baseline descriptions of the 551 participants are shown in Table 1. The mean age was 85.9 years, 81.3% were women, and 89.1% were white. Large proportions were dependent in ADLs. The majority of participants had dementia (63.3%). Of the 76 participants in whom baseline urine specimens were obtainable, 25 had growth on urine culture (15 with >100,000 CFU, 5 with 10,000–100,000 CFU, and 5 with <10,000 CFU), 22 had no growth, and 29 specimens had mixed flora, yielding a 20% rate of asymptomatic bacteriuria.

Outcomes

Over the one-year of follow-up, 551 participants had 178,914 person-days of follow-up; 240 participants had 454 episodes of clinically suspected UTI. Of the 406 episodes that had results for urinalysis and urine culture, 7 episodes occurred within 7 days of completion of antibiotic therapy and were excluded, leaving 399 episodes for final analyses (see Figure 1). In response to the question regarding clinical reasons for suspecting UTI, 5 episodes had no specific reason, 250 had one reported reason, 120 had two reported reasons, and 24 had three reported reasons. The distribution of these clinical reasons is presented in Table 2. Clinical reasons reported for first episode of clinically suspected UTI were similar to those reported for recurrent episodes.

Of 399 episodes of clinically suspected UTI, 228 were first episodes, and 171 were recurrent episodes. Of 399 episodes, 147 (37%) had bacteriuria plus pyuria and 252 (63%) did not. Of 147 episodes with bacteriuria plus pyuria, 141 (96%) received antibiotic therapy; 93 of 252 (37%) without bacteriuria plus pyuria received antibiotic therapy. In total, antibiotic therapy was prescribed in 234 episodes (59%). The median number of clinically suspected UTI episodes was 1 (range 1–6). The median number of days between recurrent episodes was 66 days. Three episodes had documented bacteremia (only 13 episodes had blood cultures

performed). Twenty-five participants were hospitalized. Thirty episodes (7.5%) met criteria for sepsis (defined as two or more of the following: temperature $>38^{\circ}\text{C}$ or $<36^{\circ}\text{C}$; heart rate >90 beats/minute; respiratory rate >20 breaths/minute or $\text{PaCO}_2 <32$ mmHg; $\text{WBC} >12,000$ cells/ mm^3 or <4000 cells/ mm^3),³² but only 11 of these episodes had bacteriuria plus pyuria. Fourteen participants died within 30 days of clinically suspected UTI, but none of the deaths were thought to be related to UTI. The median number of days from clinically suspected UTI to day of antibiotic therapy initiation was 3 days; 13% of those prescribed antibiotic therapy received the antibiotic on the day of clinically suspected UTI suggesting that most practitioners waited for urine results to initiate antimicrobial therapy. Of all 234 episodes for which antibiotics were prescribed, only one participant developed a rash and one participant developed *Clostridium difficile* colitis. No other adverse drug effects (i.e., drug-drug interactions or antibiotic associated diarrhea) were reported in the resident's medical record.

Clinical features associated with bacteriuria plus pyuria

Each of the clinical features tested in bivariate analyses are listed in Table 3. Age, change in character of urine, female gender, and dysuria were significantly associated with bacteriuria plus pyuria in the bivariate analyses. For those 142 participants with a clinically suspected UTI that had a positive dipstick at baseline, 62 had bacteriuria plus pyuria during the first clinically suspected UTI episode yielding a positive predictive value of the baseline dipstick of 44%. In the multivariable model, dysuria, change in character of urine, and change in mental status were significantly associated with the outcome of bacteriuria plus pyuria (see Table 4). Only dysuria $\times$ change in mental status showed a statistically significant interaction ($P=0.04$). Table 4 lists the probabilities for bacteriuria plus pyuria of combinations of the clinical features identified in the multivariable model. There were only 4 episodes of clinically suspected UTI for which all three clinical features were met, and bacteriuria plus pyuria was present in each instance (100%). There were an additional 6 episodes of clinically suspected UTI in which dysuria and change in mental status were present of which 4 had bacteriuria plus pyuria (66.7%).

Dipstick results

The two components of dipstick results that were evaluated included leukocyte esterase (negative, trace, +, or ++) and nitrite (positive or negative). Positive dipstick was defined as positive to either leukocyte esterase (trace, +, or ++) or nitrite (positive). Negative dipstick was defined as negative to both leukocyte esterase and nitrite. The dipstick was performed in 219 episodes of clinically suspected UTI. Nursing home staff did not perform the dipstick for 180 episodes. There were no participant characteristics that were associated with the presence or absence of dipstick testing. Of the 180 episodes with a positive dipstick result, 73 had bacteriuria plus pyuria (40.5%). None of the 39 episodes with a negative dipstick result had bacteriuria plus pyuria (0%).

Comparator groups for clinical features

Of 399 episodes of clinically suspected UTI, 26 also had clinically suspected pneumonia but did not have bacteriuria plus pyuria. Of these 26 episodes, 10 had none of the three clinical features, 4 had change in character of urine, 10 had change in mental status, and 2 had change in mental status and change in character of urine. Dysuria was not present in any of these episodes. Of the 76 participants that had baseline urine specimens collected, 70 had none of the three clinical features, 5 had change in mental status, 1 had change in character of urine, and none had dysuria. Therefore, none of these 76 participants had the combination of dysuria plus one of the other clinical features.

DISCUSSION

Dysuria, change in character of urine, and change in mental status were the only clinical features significantly associated with bacteriuria plus pyuria among participants with clinically suspected UTI, supporting their inclusion in an evidence-based definition of UTI in nursing home residents. Of these clinical features, dysuria most effectively discriminated those with and without bacteriuria plus pyuria. Based on these data, presence of dysuria plus one or both of the other two significant clinical features (change in character of urine and change in mental status) predicted 63% of episodes with bacteriuria plus pyuria. All episodes having all three clinical features had bacteriuria plus pyuria, but only three participants fell into this category. Twenty-five percent of episodes with none of the three clinical features still had bacteriuria plus pyuria, possibly representing the background prevalence of asymptomatic bacteriuria in this population. Negative dipstick results can effectively identify those residents without bacteriuria plus pyuria.³³

Any one of the three significant clinical features alone only predicted bacteriuria plus pyuria 39% of the time in this cohort. Although the presence of dysuria identified those residents with bacteriuria plus pyuria most effectively, not all participants with acute dysuria had bacteriuria plus pyuria perhaps because other conditions (e.g., genital prolapse, prostatic enlargement) can cause a similar sensation.¹ Similarly, change in character of urine can be attributable to conditions other than bacteriuria such as dehydration and ingestion of certain foods (e.g., asparagus). Although change in mental status was the most frequent clinical reason for causing suspicion of UTI and can be attributed to many conditions, it was associated with bacteriuria plus pyuria. Given the non-specific nature of all three clinical features, it is not surprising that combinations of these features rather than any single clinical feature alone were most predictive of bacteriuria plus pyuria.

Consensus-based criteria identified many of the same clinical features that were associated with bacteriuria plus pyuria in the current study. However, in this study, flank pain and fever, which are included in consensus criteria,^{10, 13} were not significantly associated with bacteriuria plus pyuria. A previous study demonstrated that consensus criteria have predictive values of 52–61%.¹⁵ In this cohort, for dysuria plus one or both of the two other clinical features, the predicted probability for bacteriuria plus pyuria was 63%. This empirically derived group of clinical features is comparable to consensus criteria. The results of this study suggest which clinical features included in previous consensus criteria have the best predictive probability, thereby giving justification for their inclusion in an evidence-based definition of UTI in nursing home residents.

The main strength of this study was the prospective surveillance of clinically suspected UTI among a cohort of nursing home residents. In addition, nursing home staff, who were the primary caregivers of these residents, provided the clinical information, and only those assessments that were deemed to be reliable and valid were utilized in this study.²⁶ Because of the high participation rate (86%), these results are generalizable to the nursing home population. Our study had several potential limitations. First, only participants that were clinically suspected of having UTI could be evaluated for clinical features. Our definition of clinically suspected UTI was used specifically to mimic the real-world setting of nursing home practice. Although many of the clinical features that we evaluated were among the clinical reasons that caused suspicion of UTI, change in mental status and change in character of urine were still able to distinguish those participants with versus those without bacteriuria plus pyuria. Second, asymptomatic urine specimens could only be obtained in a small subset of the cohort because of ethical and logistical challenges involving collecting urine in incontinent, incompetent participants. Thus, comparisons of asymptomatic urine specimens and clinically suspected UTI specimens and adjustment for pre-existing asymptomatic bacteriuria could not

be performed. However, the combination of dysuria plus one or both of the change in character of urine or change in mental status was not present in any of the small subset who provided asymptomatic urine specimens. Third, dipstick testing at the time of clinically suspected UTI was performed in only 55% of participants. Additionally, nursing staff that performed the dipstick were aware of the results and could have been biased in their clinical features assessment. Fourth, the outcome of bacteriuria plus pyuria occurred in 37% of episodes, similar to the reported baseline incidence of asymptomatic bacteriuria.³ However, in this study, the strict outcome of bacteriuria plus pyuria was utilized, not bacteriuria alone. Out of 399 episodes, 206 (52%) had bacteriuria alone, significantly higher than the 20% rate of asymptomatic bacteriuria identified in the comparator group.

This study has empirically identified three clinical features (i.e., dysuria, change in character of urine, and change in mental status) that can be utilized in the clinical assessment of UTI in nursing home residents. Unfortunately, however, this combination of clinical features does not capture all episodes of bacteriuria plus pyuria. For residents with none of the clinical features and a negative dipstick, further evaluation of UTI should be terminated. Ordering of urine cultures and urinalyses could be reserved for those individuals with dysuria plus one or both of the two other clinical features while empiric antimicrobial therapy could be initiated awaiting results. If validated in future studies, these clinical features can provide an evidence-based approach to guide management decisions of nursing home residents with clinically suspected UTI. Diagnostic uncertainty still remains for the vast majority of residents who meet only one clinical feature. Future studies should identify other criteria, possibly other urinary biomarkers, which can assist in the identification of residents who warrant antibiotics for UTI.

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Figure 1.
Profile of Study Population

Table 1
Baseline Characteristics of Enrolled Cohort

	(n=551)
Demographics	
Age, mean (SD)	85.9 (7.1)
Number of co-morbidities, mean (SD)	2.2 (1.2)
Dementia, n (%)	349 (63.3)
COPD, n (%)	68 (12.3)
Stroke, n (%)	129 (23.4)
CHF, n (%)	126 (22.9)
Cancer, n (%)	80 (14.5)
Diabetes, n (%)	144 (26.1)
Liver disease, n (%)	6 (1.1)
Kidney disease, n (%)	63 (11.4)
Depression, n (%)	251 (45.6)
Number of medications, mean (SD)	8.6 (3.6)
Female, n (%)	448 (81.3)
White, n (%)	491 (89.1)
ADLs in past 7 days ^{*,†}	
Bed mobility – dependent, n (%)	146 (26.5)
Transfer – dependent, n (%)	182 (33.0)
Locomotion off unit – dependent, n (%)	394 (71.5)
Eating – dependent, n (%)	106 (19.2)
Toilet use – dependent, n (%)	280 (50.8)
Personal hygiene – dependent, n (%)	276 (50.1)
Bathing – dependent, n (%)	409 (74.4)
Bowel incontinence, n (%)	246 (44.7)
Bladder incontinence, n (%)	273 (49.6)
Mental Status in past 7 days [*]	
Level of consciousness – non-responsive, n (%)	5 (0.9)
Periods of altered perception – present, n (%)	210 (38.2)
Episodes of disorganized speech – present, n (%)	163 (29.6)
Periods of lethargy – present, n (%)	148 (26.9)
Behavior in past 7 days ^{*,‡}	
Resists care – present, n (%)	125 (22.8)
Baseline dipstick ^{‡§}	
Negative dipstick result, n (%)	225 (41.0)

* Each of these questions was adapted from the Minimum Data Set.

[†] For each item in the ADL section, dependent=totally dependent or not done versus partially dependent or independent.

[‡] n=549.

[§]The two components of dipstick results that were evaluated included leukocyte esterase (negative, trace, +, or ++) and nitrite (positive or negative). Positive dipstick was defined as positive to either leukocyte esterase (trace, +, or ++) or nitrite (positive). Negative dipstick was defined as negative to both leukocyte esterase and nitrite.

Table 2**Clinical Reasons for Suspicion of UTI***

Clinical Reasons	Number of episodes	Percent of total (n=399)
Change in Mental Status	156	39.1
Change in Behavior	76	19.0
Change in Character of Urine	62	15.5
Fever or Chills	51	12.8
Change in Gait or Fall	35	8.8
Dysuria	31	7.8
Change in Voiding pattern	28	7.0
Other infection	27	6.8
Flank pain	23	5.8
Other work-up	20	5.0
Patient or Family Request	15	3.8
Abnormal labs	11	2.8
Change in Functional status	10	2.5
Previous UTI	7	1.8
Malaise	5	1.3
Dehydration	3	0.8
Syncope	2	0.5

* **Note:** Episodes had up to three clinical reasons, and therefore, the number of episodes exceeds 399 and the combined percentages exceed 100.

Table 3Unadjusted Associations of Clinical Features with Bacteriuria plus Pyuria (N=399)^{*,†}

Predictor Variable	Total Number	Bacteriuria plus pyuria, No. (%)	Relative Risk (95% Confidence Interval) [‡]	P-Value [‡]
Gender			2.69 (1.54, 4.00)	0.001
Female	341	138 (40.5)		
Male	58	9 (15.5)		
Race			1.05 (0.65, 1.52)	0.818
Non-white	36	14 (38.9)		
White	363	133 (36.6)		
Age (continuous)	--	--	1.03 (1.00, 1.05)	0.027
Number of comorbidities (continuous)	--	--	1.01 (0.89, 1.14)	0.908
Number of medications (continuous)	--	--	1.00 (0.96, 1.03)	0.798
Dysuria			1.49 (1.07, 1.90)	0.022
Present	44	24 (54.6)		
Absent	355	123 (34.7)		
Character of Urine			1.46 (1.14, 1.79)	0.003
Change	144	68 (47.2)		
No change	255	79 (31.0)		
Serum WBC[*]			1.30 (0.78, 1.82)	0.280
>10	30	15 (50.0)		
<10	106	41 (38.7)		
Fever[*]			1.25 (0.88, 1.65)	0.197
Present	55	23 (41.8)		
Absent	301	107 (35.6)		
Behavior			1.23 (0.88, 1.61)	0.202
Change	68	30 (44.1)		
No change	331	117 (35.4)		
Mental Status			1.22 (0.93, 1.54)	0.147
Change	170	70 (41.2)		
No change	229	77 (33.6)		
Shortness of breath			1.16 (0.61, 1.79)	0.607
Present	18	8 (44.4)		
Absent	381	139 (36.5)		
Cough			1.12 (0.68, 1.62)	0.630
Present	32	13 (40.6)		
Absent	367	134 (36.5)		
Voiding Pattern			1.10 (0.80, 1.42)	0.538
Change	86	34 (39.5)		
No change	313	113 (36.1)		
Constitutional symptoms			1.06 (0.82, 1.34)	0.627
Present	110	42 (38.2)		

Predictor Variable	Total Number	Bacteriuria plus pyuria, No. (%)	Relative Risk (95% Confidence Interval) [†]	P-Value [‡]
Absent	289	105 (36.3)		
Functional Status			1.00 (0.70, 1.33)	0.977
Change	294	107 (36.4)		
No change	105	40 (38.1)		
Flank Pain			0.95 (0.50, 1.51)	0.844
Present	25	8 (32.0)		
Absent	374	139 (37.2)		
Tachycardia			0.85 (0.48, 1.35)	0.536
Present	36	11 (30.6)		
Absent	293	104 (35.5)		
Diarrhea			0.82 (0.22, 1.85)	0.708
Present	9	3 (33.3)		
Absent	390	144 (36.9)		
Abdominal Pain			0.69 (0.35, 1.18)	0.199
Present	32	8 (25.0)		
Absent	367	139 (37.9)		
Hypotension[*]			0.57 (0.12, 1.69)	0.392
Present	8	2 (25.0)		
Absent	323	114 (35.3)		

* Some variables have missing values: fever 43, serum WBC 263, tachycardia 70, and hypotension 68. Fever is defined as >37.9° C [100° F] or 1.5° C [2.4° F] above baseline temperature. Hypotension is defined as a systolic blood pressure of <90 mmHg or a reduction of >40mmHg from baseline. Tachycardia is defined as a heart rate >90 beats/min or 20 beats/min above baseline heart rate).³²

[†] Unadjusted GEE logistic regression models were fit for each predictor variable separately.

[‡] For dichotomous variables, relative risks and confidence intervals were approximated using the formula in Methods. For continuous variables, relative risks and confidence intervals were approximated with an unadjusted GEE regression model with a log link. All P-values are taken from unadjusted GEE logistic regression models.

Table 4

Individual Clinical Features and Combinations of Clinical Features Associated with Bacteriuria plus Pyuria (N=399)

*

Individual Clinical Features ^{†,‡}	Relative Risk (95% CI)	P-Value	
Dysuria	1.58 (1.10, 2.03)	0.017	
Change in Character of Urine	1.42 (1.07, 1.79)	0.016	
Change in Mental Status	1.38 (1.03, 1.74)	0.034	
Combinations of Clinical Features	Number of episodes	Number of episodes with bacteriuria plus pyuria	Predicted Probability (95% CI) [§]
None of the 3 clinical features	121	29	.25 (.18, .34)
Only one clinical feature	202	78	.39 (.32, .46)
Change in Mental Status and Character of Urine	51	23	.46 (.33, .59)
Dysuria plus one or both of the other two clinical features	25	17	.63 (.44, .79)
Total	399	147	

* Relative risks with confidence intervals were estimated and reported to promote clinical interpretability; P-values are from the GEE multivariable logistic regression model providing the odds ratios from which relative risks were approximated.

[†] Nursing home, age, gender, number of comorbidities, and number of clinically suspected UTI episodes were forced into the multivariable model as control variables.

[‡] Bootstrapping was conducted on 1000 samples that were constructed from the data of the study participants. Mean bootstrapped parameter estimates from the multivariable models of these three clinical criteria suggested a bias of 4.9% for dysuria, 0.4% for change in character of urine, and 1.5% for change in mental status from the original model.

[§] The predicted probabilities were obtained from an unadjusted GEE logistic regression model in which "None of the 3 clinical features" was used as a reference group and the three remaining variables were coded as dummy variables.