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Concise Communication

Patient-level information underlying overdiagnosis of urinary tract infections in nursing homes: A discrete choice experiment

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Abstract

The overdiagnosis of urinary tract infections (UTIs) in nursing home residents is a significant public health threat. Using a discrete choice experiment and a diagnostic guideline, we examined which patient-level information was associated with the overdiagnosis of UTIs and found that urinalysis results and lower urinary tract status were most associated.

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Urinary tract infections (UTIs) are the most common infections in nursing homes,[1] and the most overdiagnosed.[2] Antibiotic overuse in nursing homes leads to antibiotic resistance, a major health threat.[2] Which categories of patient-level information drive UTI overdiagnosis remains unclear because most research in this field has been observational.[3] In this study, we address the question: "How likely is it that the patient has a UTI?" using the choices "likely," "uncertain," and "unlikely."[4] Specifically, using a novel experimental design, we sought to determine which patient-level information was most associated with a "false positive" diagnosis or "overdiagnosis" of a suspected UTI.

Methods

Analyses from a discrete choice experiment (DCE) systematically manipulated 9 categories of patient-level information: urinalysis, body temperature, lower urinary tract status, physical examination, mental status, UTI risk, functional status, goals of care, and patient type (ie, age and dementia status) (Table 1).[5,6] Each category contained different types of related information, such as dysuria, change in urine color or odor, gross hematuria, new or increased frequency, or no urinary tract signs or symptoms for the "lower urinary tract status" category. Using an orthogonal design, we then created scenarios using 1 type of information from each category, yielding 7,520 possible scenarios for nursing home clinicians to view. Nursing home clinicians included a total of 1,748 participants including primary care physicians, physician assistants, and nurse practitioners (collectively referred to as PCPs) as well as nursing home registered nurses (RNs) recruited from a US healthcare panel. They each completed 19 discrete choice scenarios randomly allocated from the possible scenarios. For each scenario, respondents indicated whether they thought the hypothetical patient had a UTI (response options: "yes," "no," "uncertain"). We collected demographic and clinical information on all participants including years of experience and attitudes toward antibiotic stewardship.

Using an international guideline for diagnosing UTIs in nursing homes,[7] we classified each scenario as either likely or unlikely a UTI, and, by extension, whether a UTI diagnosis would be a false-positive diagnosis or overdiagnosis (ie, the clinician diagnosed a UTI while the guideline did not). We considered the presence of either dysuria or increased or new frequency in isolation as a true UTI, given the algorithm notes, "one very bothersome localizing sign or symptom with no other cause" would be considered a UTI.[7] Additionally, the algorithm notes that antibiotics should not be prescribed in the face of negative urinalysis. Therefore, all scenarios with a negative urinalysis where a nursing home clinician felt that a UTI was likely were considered false-positive diagnoses. We chose this guideline due to its strong methodology, the participation of leaders in the field, the rigor in its development, the high rate of participation,[8] and its use in other work.[9,10]

We fit a multilevel logistic model that tested the effect of the 9 clinical categories on odds of a false-positive diagnosis, adjusting for 7 preselected clinician characteristics (ie, age, sex, UTI knowledge, attitude toward reducing antibiotics, perceived external demand for antibiotics, perceived external influence for antibiotics, and years of experience) plus clinical role. The details of these clinician characteristics can be found in our prior work.[4] We then examined model parameter estimates for a multivariable logistic mixed-effects model of UTI false positivity on patient-level information. The University of North Carolina at Chapel Hill Institutional Review Board approved the study.

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Table 1. Model Parameter Estimates for a Multivariable Logistic Mixed Effects Model of UTI Rating False Positivity on Patient-Level Information, N = 1,718[a,b]

Patient-Level Information by Category	%	Odds Ratio	95% CI	*P* Value
Urinalysis (Reference = Negative leukocyte esterase, negative nitrates, urine culture results pending)	49.2			
Unavailable/Not performed	16.0	2.67	2.26–3.15	<.001
Positive leukocyte esterase, negative nitrates, urine culture results pending	15.9	7.19	6.09–8.50	<.001
Positive leukocyte esterase, positive nitrates, urine culture results pending	18.9	32.44	26.98–39.00	<.001
Body temperature (Reference = 97.5°F or 36.4°C)	37.6			
96.5°F (or 35.8°C)	37.8	0.85	0.76–0.95	.006
99.5°F (or 37.5°C)	12.2	1.81	1.50–2.19	<.001
101.5°F (or 38.6°C)	12.5	2.53	2.10–3.03	<.001
Lower urinary tract status (Reference = No signs or symptoms)	24.4			
Obvious blood in urine	21.4	7.44	6.36–8.71	<.001
New or worsening frequency	16.3	2.57	2.14–3.08	<.001
Change in urine clarity or odor	22.2	4.41	3.79–5.14	<.001
Painful or difficult urination	15.7	9.71	8.16–11.55	<.001
Physical examination (Reference = Normal)	23.0			
New or increased cough and work of breathing	30.6	0.74	0.64–0.85	<.001
New or increased area of redness and warmth on left lower leg	30.9	0.69	0.60–0.79	<.001
New suprapubic tenderness or costovertebral angle tenderness	15.6	3.00	2.54–3.55	<.001
Mental status (Reference = Usual state of health)	24.5			
Sleeping more than usual	24.8	1.18	1.02–1.37	.022
New or worsening agitation	24.6	1.48	1.29–1.71	<.001
New or worsening confusion	26.1	1.59	1.38–1.82	<.001
UTI risk (Reference = No history of UTIs or current indwelling catheters)	24.7			
Current indwelling catheter but no history of prior UTIs over past year	24.8	1.18	1.01–1.37	.038
History of 3 UTIs over past year but no current indwelling catheter	25.8	1.67	1.45–1.93	<.001
Current indwelling catheter and history of 3 UTIs over the past year	24.7	2.14	1.83–2.49	<.001
Functional status (Reference = Usual state of health)	20.1			
New or increased resistance to care	20.0	1.04	0.89–1.22	.62
Reduced intake of food and liquids	19.6	1.00	0.85–1.17	.98
New or increased falls	20.0	1.13	0.96–1.32	.13
New or worsening difficulties with ambulation or transfers	20.3	1.04	0.89–1.22	.58
Goals of care (Reference = Comfort care measures)	33.6			
Full scope of treatment	33.3	1.17	1.03–1.32	.014
Limited additional interventions	33.0	1.11	0.98–1.25	.097
Patient type (Reference = 84-year-old cognitively intact man)	25.1			
84-year-old woman with dementia	23.9	1.16	1.01–1.33	.038
84-year-old cognitively intact woman	25.6	1.11	0.96–1.27	.15
84-year-old man with dementia	25.4	1.16	1.01–1.33	.042

Note. Excludes "antibiotic request" domain due to differences in information presented to PCPs and RNs. Model specification includes the binomial family, logit link, and a random effect for clinicians; Models also include 7 clinician-level characteristics covariates and clinical role designation (results not pictured). For each scenario, the clinician was asked whether they thought the hypothetical patient had a UTI with possible responses: "yes," "no," or "uncertain." Model was only applied to observations or scenarios where clinician was certain, the true diagnosis was the absence of a UTI according to the guideline, and the outcome was a false-positive diagnosis (scenario n = 11,551).

[a]Model adjusted for age, gender, UTI knowledge, attitude toward reducing antibiotics, perceived external demand for antibiotics, perceived external influence for antibiotics, and years of experience.

[b]Clinician no. excludes the 30 participants with incomplete data across clinician and patient-level characteristics.

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Results

Of the respondents, 867 were PCPs and 881 were RNs. Their mean age was 44.6 years (SD, 12.3) and 39.2% were male. PCPs and RNs differed on average years' experience: PCPs (20.2 years; SD, 1.4) versus RNs (6.1 years; SD, 5.2;$P < .001$). They also differed by sex: PCPs (56% male) versus RNs (23% male; $P < .001$). They differed by average age as well: PCPs (49.0 years; SD, 11.0) versus RNs (40.3 years; SD, 12.0; $P < .001$). On a 7-point Likert scale (ie, 7 = completely agree), PCPs felt reducing antibiotics for UTIs is appropriate more than did RNs: PCPs (5.3; SD, 1.6) versus RNs (4.4; SD, 1.9). Respondents were uncertain about diagnosis in 30.2% of scenarios. Of the remaining 69.8% of scenarios, correct UTI diagnosis occurred for 65.7%: PCPs (69.7% correct) versus RNs (61.6% correct).

In the model adjusting for clinical information and clinician characteristics, urinalysis information was the strongest predictor of a false-positive diagnosis (Table 1). Compared to patients with negative urinalysis findings, patients with positive leukocyte esterase with positive nitrates (odds ratio [OR], 32.44) or negative nitrates (OR, 7.19) had higher odds of a false-positive diagnosis, as did patients with no urinalysis testing (OR, 2.67). Additionally, lower urinary tract symptoms—obvious blood in urine (OR, 7.44), new or worsening frequency (OR, 2.57), change in urine clarity or odor (OR, 4.41), and painful or difficult urination (OR, 9.71)—were all strongly associated with greater odds of a false-positive diagnosis, as was new suprapubic tenderness or costovertebral angle tenderness (OR, 3.00). Changes in temperature, mental status, and UTI risk were also associated to a lesser extent with false positivity. Changes in functional status, goals of care, and patient age and dementia status were not associated with false positivity.

Discussion

Through a novel experimental design and analysis, we demonstrated that nursing home clinicians, both PCPs and RNs, rely heavily on positive urinalysis results when making a false-positive UTI diagnoses. Appropriate diagnosis of a UTI needing antimicrobial treatment requires the presence of both symptoms and a positive urinalysis (as a proxy for a positive urine culture). Symptoms in the lower urinary tract should rightly inform UTI diagnoses, except for changes in urine odor or color or gross hematuria. However, these symptoms should be considered in conjunction with other clinical information when making clinical assessments, particularly a negative urinalysis. Lower urinary tract symptoms in the presence of a negative urine culture should indicate an alternative diagnosis. Otherwise, overdiagnosis will result.[7] Different guidelines would likely have resulted in different associations, though our findings are consistent with prior research showing overdiagnoses associated with urinalysis results.[11] For example, in contrast to the Van Buul guidelines, the Stone guidelines include gross hematuria as a marker of a UTI.[12] We believe the interplay between lower urinary tract signs and symptoms and urinalysis and urine culture results remains important to the diagnosis of a UTI and merits continued study. Reductions in unnecessary urine cultures are associated with reductions in antimicrobial resistance.[13]

Although limited to responses to hypothetical scenarios, our DCE research design allowed examination of the influence of a wide range of patient-level information on clinical diagnoses. Our results suggest that PCPs and RNs have difficulty appropriately weighing the multiple pieces of clinical information needed to make a correct UTI diagnosis. Rather, they overly privileged information that confirms presence of a UTI, which is likely a primary driver of antibiotic overuse in nursing homes. Thus, nursing homes should embrace efforts to implement decision support into clinical practice and systemwide efforts to control the use of unnecessary testing such as urinalysis and urine cultures.[3] With increasing electronic health records in nursing homes, now is the time to advance clinical decision support.[14] Current interventions to improve the appropriateness of antibiotic prescribing for UTIs fail to sufficiently control for these issues and may explain their lack of success in long-term care.[15]

In conclusion, through a novel experimental design and analysis, we demonstrated that nursing home clinicians, both PCPs and RNs, struggle with the overdiagnosis of urinary tract infections in nursing home residents. Nursing homes should embrace efforts to implement point-of-care clinical decision support to control the use of unnecessary testing such as urinalysis and urine cultures.

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Conflicts of interest. All authors report no conflicts of interest relevant to this article.

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