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Original Study

Nursing Home Clinicians' Decision to Prescribe Antibiotics for a Suspected Urinary Tract Infection: Findings From a Discrete Choice Experiment

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A B S T R A C T

Objective: To determine which nursing home (NH) resident characteristics were most important to clinicians' decision to prescribe antibiotics for a suspected urinary tract infection (UTI), including both evidence-based and non-evidence-based characteristics.
Design: Web-based discrete choice experiment with 19 clinical scenarios. For each scenario, clinicians were asked whether they would prescribe an antibiotic for a suspected UTI.
Setting: Online survey.
Participants: Convenience sample of 876 NH physicians and advanced practice providers who practiced primary care for NH residents in the United States.
Methods: Each scenario varied information about 10 resident characteristics regarding urinalysis results, resident temperature, lower urinary tract symptoms, physical examination, antibiotic request, mental status, UTI risk, functional status, goals of care, and resident type. We derived importance scores for the characteristics and odds ratios (ORs) for specific information related to each characteristic from a multinomial logistic regression.
Results: Approximately half of the participants were male (56%) with a mean age of 49 years. Resident characteristics differed in their importance (ie, part-worth utility) when deciding whether to prescribe for a suspected UTI: urinalysis results (32%), body temperature (17%), lower urinary tract symptoms (17%), physical examination (15%), antibiotic request (7%), mental status (4%), UTI risk (4%), functional status (3%), goals of care (2%), and resident type (1%). Information about "positive leukocyte esterase, positive nitrates" was associated with highest odds of prescribing [OR 19.6, 95% confidence interval (CI) 16.9, 22.7], followed by "positive leukocyte esterase, negative nitrates" (OR 6.7, 95% CI 5.8, 7.6), and "painful or difficult urination" (OR 4.8, 95% CI 4.2, 5.5).
Conclusions and Implications: Although guidelines focus on lower urinary tract symptoms, body temperature, and physical examination for diagnosing a UTI requiring antibiotics, these characteristics were considered less important than urinalysis results, which have inconsistent clinical utility in NH residents. Point-of-care clinical decision support offers an evidence-based prescribing process.

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Antibiotic resistance globally endangers human health, with the World Health Organization recommending immediate and drastic changes to prescribing practices to avert catastrophic levels of untreatable infections.[1,2] Although antibiotic stewardship programs can successfully reduce overuse in hospitals, nursing home (NH) antibiotic stewardship programs have had mixed effects. For example, although targeted programs for catheter-associated urinary tract infections (UTIs) successfully reduced antibiotic prescribing,[3] and global stewardship efforts decreased prescribing without an increase in mortality or morbidity,[4–6] their effect sizes were modest.[7] Therefore, it is important to pursue new strategies to effect change. Targeting clinician decision making may represent another route to improving antibiotic stewardship, particularly if decision making is biased, misinformed, or hurried.[8] Supporting the rationale for this tactic, NH clinicians often appear to deviate from the evidence when making decisions related to antibiotic prescribing.[9–12]

Antibiotic prescribing for UTIs is particularly important because suspected UTIs account for the majority of antibiotics prescribed in NHs.[6,13] In addition to evidence-based practice guidelines, they also consider non–evidence based information such as functional status changes that may be present in UTIs but are more likely in non-UTI conditions.[9–11] Also, time pressure, a common issue in the health care setting, increases prescribing in primary care and may occur in NHs,[14,15] suggesting that more deliberation may improve prescribing.

Understanding clinician decision making when diagnosing UTIs may represent an important step to reduce inappropriate prescribing. Discrete choice experiment (DCE) methodology is widely used to understand medical decision making because it allows a controlled examination of the influence of multiple types of information on a specific decision and may predict real-world clinician choices.[16,17] For example, a DCE examining patient preferences for topical acne antibiotics found that the results aligned with their actual choice of medication.[18] Another DCE of physician decisions for antibiotic duration for uncomplicated pyelonephritis found that desires to limit treatment failure and avoid side effects most influenced the choice of antibiotic duration.[19] Thus, a DCE can provide a quantitative valuation of the relative importance of NH resident characteristics to the antibiotic prescribing decision. To our knowledge, no such experiment has been conducted to examine clinicians' prescribing behavior in NH residents, which is the focus of this study.

Methods

Study Design

We conducted an online DCE study with US clinicians who provide primary care for NH residents. Clinicians were recruited via an e-mail invitation describing the study (ie, duration, focus, incentives), including an electronic link to eligibility questions, an informed consent page, and then the survey. Once participants provided online consent, they began the survey, starting with an introduction about the resident characteristics under consideration in the study and an explanation of the discrete choice scenarios. They were told that for each scenario, they would receive a "telephone call from the NH" about a hypothetical resident (see Figure 1). Each scenario included 10 types of clinical information that varied over each scenario. After providing their responses for 19 scenarios, they completed demographic and clinical background measures. We used Sawtooth Software to design and conduct the DCE. This research was approved by the Institutional Review Board at the University of North Carolina at Chapel Hill (IRB no. 16-0207).

To understand whether encouraging deliberation influenced the decision-making process, we randomized all participants to either a self-paced (n = 421, 48.6%) or deliberative (n = 446, 51.4%) time condition for the DCE scenarios. In the self-paced group, participants answered questions at their own pace (as quickly or slowly as they chose), whereas in the deliberative group, participants were required to wait at least 30 seconds before an answer could be selected. Self-paced participants completed the 19 scenarios 9 minutes faster (P = .003) than the deliberative participants (mean = 18.6, standard deviation = 39.4, vs mean = 27.7, standard deviation = 48.9).

Participants

All participants were recruited from the research panel of Medefield, an Accredited Gold Seal Member of the Marketing Research and Intelligence Agency, located in the United States. The primary care medical research panel is verified through lists from licensure databases such as the American Board of Medical Specialties. Panel members are actively screened and must offer 100% validation of medical professional degrees from regulatory bodies. All panelists are double opt-in and managed on Confirmit, the world's leading software for market research. Their internal processes are audited semiannually by a third party. Eligibility criteria to participate in our study included being (1) a licensed physician (allopathic or osteopathic medicine) or advance practice provider (nurse practitioner or physician assistant), (2) having English language proficiency, and (3) currently practicing primary care in an NH in the United States. We specifically requested at least one-third of the sample be advance practice providers, given the rising presence of these providers in NHs.[20]

Survey Development and Pretesting

The survey was developed in 3 steps. First, using clinical experience and literature, the research team developed a list of resident characteristics, each with a range of information typically used in the decision to diagnose a UTI.[5,9,21–26] A survey prototype was developed with 19 DCE scenarios and demographic information (described below). From December 2016 to February 2017, we conducted in-depth cognitive interviews with 28 clinicians from the research panel. Interviews were conducted over the phone using a structured interview guide via shared screens; they gauged participants' reactions to the experimental design format, individual items, scenarios, response options, and use of the web interface. Interviews lasted approximately 30 to 50 minutes; interviewees received $175 for participating.

We then conducted a pilot test of the survey in September 2017 in a sample of 82 clinicians from the research panel to confirm the feasibility of administering the survey and to explore illogical response patterns to the DCE scenarios. Participants received an honorarium of $75 via Medefield on completion of the survey. After minor modifications to wording, the final version of the survey containing a total of 94 items was administered in April 2018 and then again in July 2018 to boost the sample as a result of detected outliers (see below). Participants who were randomized into the self-paced condition received an honorarium of $40, and participants in the deliberative condition received $75 on completion of the survey.

Measures

The primary component of the study was the 19 DCE scenarios related to NH residents with suspected UTIs. Information in the scenarios was systematically varied on 10 distinct resident

characteristics: urinalysis results, resident temperature, lower urinary tract symptoms, physical examination, antibiotic request, mental status, UTI risk, functional status, goals of care, and resident type (Table 1). We included characteristics and information that are indications to prescribe and also not to prescribe. Each scenario contained 1 type of information related to each characteristic, with each characteristic containing 3 to 6 possible types of information. At the end of the scenario, clinicians were asked "What would you do?" given the information available (with additional workup pending; see Figure 1).

Demographic and clinical data included items for gender, age, race, ethnicity, and response to 2 personality scales, the Ten-Item Personality Inventory (TIPI).[27] TIPI items are coupled into pairs assessing the 5 factors of personality, that is, extraversion, agreeableness, conscientiousness, emotional stability, and openness to experiences.[28] They are scored using reverse scoring for 1 item in each factor, serving the dual purpose as a personality measure (not included in these analyses) and an attention check.[27] We expect that a participant who answers one item in a certain direction would answer its companion item in a similar way. If a participant was inattentive, he or she would have discrepant scores on the paired TIPI items because of reverse coding. Clinical data included characteristics of the NH where they practice (eg, use of electronic health records), work and resident load in the NH (eg, days per week at NH, percentage of residents in NH), certified medical director status, geriatrics subspecialty, and education (eg, degree type, degree year).

Data Analysis

We used recently published methodologies to calculate the sample size of our multiattribute DCE.[29] Given an α of 0.05, we needed 878 clinicians to have 80% power to detect an effect size of 0.5. Although 1070 individuals participated in the survey, a proportion (n = 135, 12.6%) were excluded because they failed the eligibility questions or did not complete the DCE or demographic questions; an additional proportion (n = 68, 6.4%) were excluded as outliers if they met any of 4 prespecified criteria: (1) total survey completion time >720 minutes, (2) total survey completion time <[(median survey minutes) − 2.5 × (median absolute deviation)], (3) complete

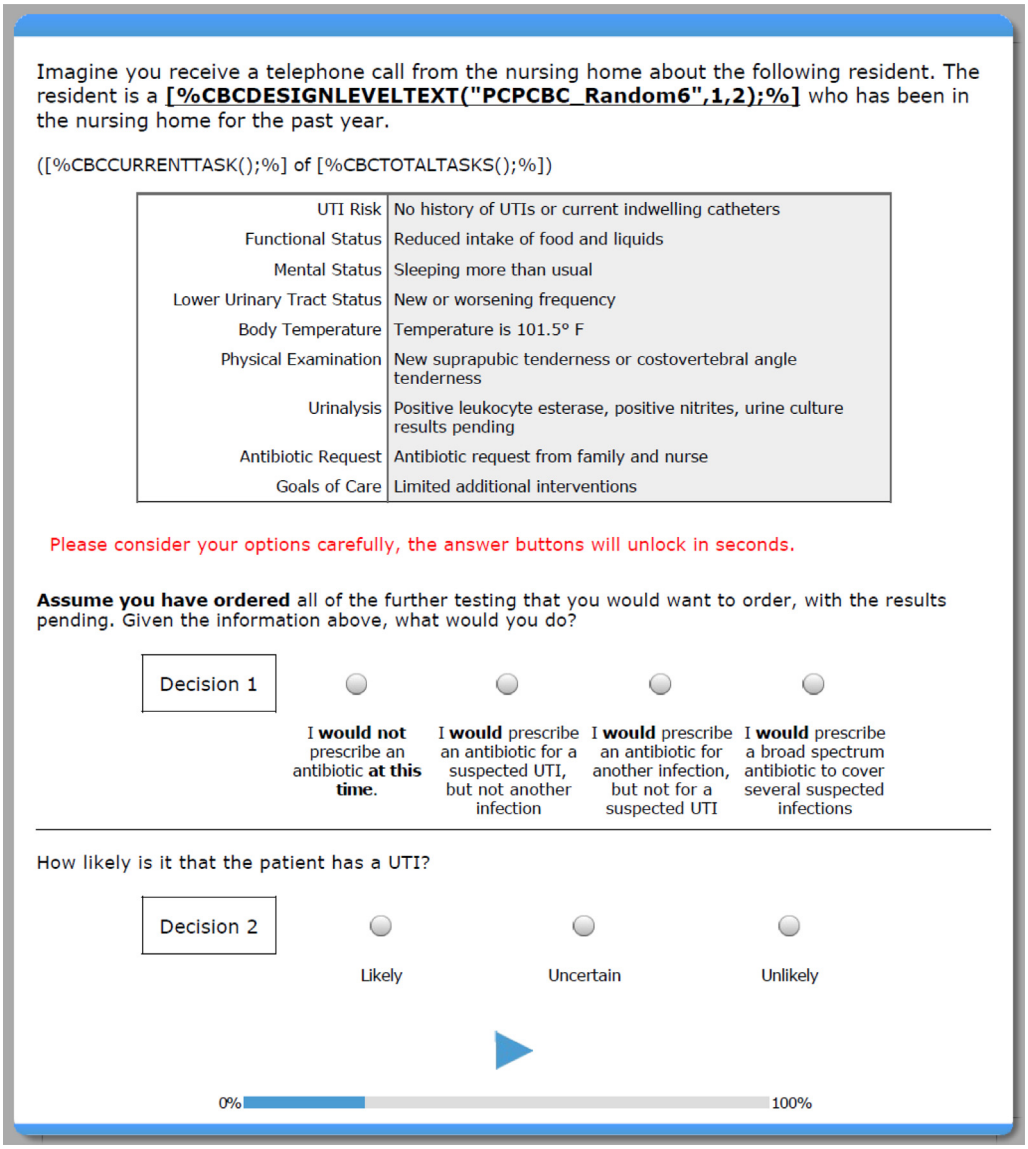

Fig. 1. General layout of the discrete choice scenarios*. *[%CBCDESIGNLEVELTEXT("PCPCBC_Random6", 1,2);%] populates with resident's age and gender based on the individual scenario. ([CBCCURRENTTASK();%] OF [%CBCTOTALTASKS();%]) populates with the number of the current scenario out of the 19 scenarios to be completed. CBC, choice-based conjoint; PCPCBC, primary care provider choice-based conjoint.

Table 1
Clinical Information Incorporated Into the Discrete Choice Scenarios by Resident Characteristic

Resident Characteristic	Type of Information	Evidence-Based Information*	
		Indication to Prescribe	Indication to Not Prescribe
Urinalysis	• *Negative leukocyte esterase, negative nitrates, urine results pending*	No	Yes
	• Positive leukocyte esterase, positive nitrates, urine results pending	No	No
	• Positive leukocyte esterase, negative nitrates, urine results pending	No	No
	• Unavailable or not performed	No	No
Body temperature	• *Temperature is 97.5°F*	No	Yes
	• Temperature is 101.5°F	Yes	No
	• Temperature is 99.5°F	Yes	No
	• Temperature is 96.5°F	No	No
Lower urinary tract status	• *No lower urinary tract signs or symptoms*	No	Yes
	• Painful or difficult urination	Yes	No
	• Obvious blood in urine	Yes	Yes
	• Change in urine clarity or odor	No	Yes
	• New or worsening frequency	Yes	No
Physical examination	• *Normal physical examination*	No	Yes
	• New suprapubic tenderness or costovertebral angle tenderness	Yes	No
	• New or increased area of redness and warmth on left lower leg	No	Yes
	• New or increased cough and work of breathing	No	Yes
Antibiotic request†	• *No antibiotic request from either resident, family, or nurse*	No	No
	• Antibiotic request from family and nurse	No	No
	• Antibiotic request from resident and nurse	No	No
	• Antibiotic request from resident	No	No
	• Antibiotic request from family	No	No
	• Antibiotic request from nurse but not resident or family	No	No
Mental status	• *Usual state of health*	No	Yes
	• New or worsening confusion	Yes	Yes or equivocal
	• New or worsening agitation	Yes	Yes
	• Sleeping more than usual	No	Yes
UTI risk	• *No history of UTIs or current indwelling catheters*	No	No
	• Current indwelling catheter and history of 3 UTIs over the past year	Equivocal	No
	• History of 3 UTIs over past year but no current indwelling catheter	No	No
	• Current indwelling catheter but no history of prior UTIs over past year	Equivocal	No
Functional status	• *Usual state of health*	No	Yes
	• New or worsening difficulties with ambulation or transfers	No	Yes
	• New or increased falls	No	Yes
	• Reduced intake of food and liquids	No	Yes
	• New or increased resistance to care	No	Yes
Goals of care	• *Comfort care measures*	No	Yes
	• Full scope of treatment	No	No
	• Limited additional interventions	No	No
Resident type	• *84-y-old cognitively intact man*	No	No
	• 84-y-old man with dementia	Equivocal	Equivocal
	• 84-y-old cognitively intact woman	Equivocal	No
	• 84-y-old woman with dementia	Equivocal	Equivocal

Italicized items represent DCE reference category.

*Evidence-based information could either be in favor or against prescribing antibiotics, a "yes" response means evidence favors that column, an "equivocal" response means evidence is mixed, and a "no" means there is no evidence for that type of information being related to that column. References available on request. The following categories of data were considered as evidence: level A (controlled trials), level B (comparative studies) and level C (expert opinion); and both nursing home-specific studies and studies about older persons in general were considered relevant.

†Although antibiotic request is neither an indication for antibiotic prescribing or not prescribing, it is known to influence prescribing and so was included for that reason.

avoidance of a UTI choice option, and (4) total TIPI item-pair difference score >[(median score) + 5.0 × (median absolute deviation)]. Bivariate comparisons on those designated as outliers (n = 68) found that these excluded participants did not demonstrate any demographic or clinical differences from included participants aside from having a greater likelihood for working more days per week in the NH (+1.9 days/wk, $P = .007$). Nonqualifier and noncompleter participants did not complete enough items to merit meaningful bivariate comparisons. After removing nonqualifiers, noncompleters, and outliers, 867 (81.0%) of participants remained for analysis. Statistical significance was defined throughout as $P < .05$ (2-tailed). Part-worth utilities were transformed into odds ratio (OR) estimates with corresponding 95% confidence interval (CI) estimates for ease of interpretation.

We estimated the importance of each characteristic and type of information using unconditional multinomial logistic regression appropriate for the categorical responses of the DCE scenarios. The part-worth utilities of each characteristic (ie, attribute) and type of information (ie, level) were estimated using a multinomial logistic regression at the sample level. Because all utilities are uniformly scaled, the utilities within characteristics can be compared across clinicians and used to determine the relative importance of each type of information compared with all other types of information. Each part-worth utility is therefore a numerical representation of the relative importance of each type of information in the clinician's decision to prescribe an antibiotic. Reference groups were chosen to reflect the type of information least likely to encourage or indicate antibiotic prescribing. To examine the potential role of deliberation, the sample-level utilities were (1) first compared between the groups (self-paced vs deliberative) to compare the scales of the utilities via a Swait-Louviere test that decomposed the traditional Chow test into subtests for differences in preferences vs differences in scales appropriate for ordinal responses, and then were (2) used to compute importance scores.[30] Additionally, we compared the distribution of individual-level clinicians' importance scores by the clinical characteristics in Table 2 to determine if any differences in what type of

Table 2
Clinician Characteristics (No. of Clinicians = 867)

Characteristic	n (%) or Mean (SD)
Demographic	
Male	485 (55.9)
Age	49.0 (11.0)
Race	
White	665 (75.6)
Asian American	139 (16.0)
Black	34 (3.9)
Other	39 (4.5)
Hispanic/Latino	40 (4.6)
Ten-Item Personality Inventory (1–7)	
Extraversion	4.2 (1.5)
Agreeableness	5.7 (1.1)
Conscientiousness	6.2 (0.9)
Emotional stability	5.6 (1.2)
Openness to experiences	5.2 (1.1)
Clinical	
NH uses electronic health records	775 (89.4)
NH has wireless network	627 (72.3)
Days per week in NH	1.8 (1.5)
Hours per month in NH	32.3 (42.4)
% of patients in NH	25.9 (26.4)
Work in a practice that serves long-term care only*	44 (23.3)
Certified medical director*	39 (20.6)
Specialty	
General practice	71 (8.2)
Family medicine	477 (55.0)
Internal medicine	301 (34.7)
Other	18 (2.1)
Has a subspecialty*	189 (21.8)
Geriatrics	84 (44.4)
Hospice and palliative medicine	30 (15.9)
Other	95 (50.3)
Degree	
MD, DO	515 (59.4)
Nurse practitioner	209 (24.1)
Physician assistant	143 (16.5)
Years since obtained degree	20.2 (11.4)
Obtained degree in United States	780 (90.0)
Prescribing decision†	
"I would not prescribe an antibiotic."	5084 (30.9)
"I would prescribe for a UTI."	5562 (33.8)
"I would prescribe for another infection."	2502 (15.2)
"I would prescribe a broad-spectrum antibiotic."	3325 (20.2)

DO, doctor of osteopathy; MD, doctor of medicine; SD, standard deviation.
*Skip item; n = 189.
†No. of observations = 16,473 (867 × 19).

information is important to clinicians are due to underlying characteristics. We also sought to see if any of these differences in prescribing decisions might be associated with what they considered to be the most important resident characteristic.

Results

Sample Characteristics

Of the 867 participants, 56% were male and 76% white, with a mean age of 49 years (Table 2). Participants reported 1.8 days/wk and 32.3 hours/mo in the NH on average. Almost one-quarter (23%) worked in a long-term care only practice. More than one-fifth (22%) had a subspecialty, with 44% of those noting their subspecialty was geriatrics. Most participants (59%) had a medical degree (doctor of medicine or doctor of osteopathy); 24% were nurse practitioners and 17% physician assistants.

Resident Characteristics

For the decision to prescribe an antibiotic for a UTI, urinalysis results had the highest importance score (32%) (Table 3). The rest of the categories had the following importance: body temperature (17%), lower urinary tract symptoms (17%), physical examination (15%), antibiotic request (7%), mental status (4%), UTI risk (4%), functional status (3%), goals of care (2%), and resident type (1%). The most important characteristic to clinicians' choice to prescribe for another infection or a broad-spectrum antibiotic was physical examination (45% and 24%, respectively); body temperature was the second most important characteristic (26% and 21% respectively) for those decisions, and urinalysis was also important to the decision for a broad-spectrum antibiotic (21%). Also, for these choices, the importance scores for characteristics related to mental status, UTI risk, functional status, goals of care, and resident type were consistently low (≤4.5%).

Types of Clinical Information

The ORs of the utilities for the 33 types of clinical information (ie, the levels of all resident characteristics) are found in Table 3. Across all 33 types of information, 28 (85%) were significantly associated with prescribing an antibiotic for UTI. Information about "positive leukocyte esterase, positive nitrates" was associated with highest odds of prescribing (OR 19.6, 95% CI 16.9, 22.6), followed by "positive leukocyte esterase, negative nitrates" (OR 6.7, 95% CI 5.8, 7.6), and "painful or difficult urination" (OR 4.8, 95% CI 4.2, 5.5). The least important clinical information was related to the presence or absence of dementia by gender, where none of this type of information was more important than the reference category of "an 84-year-old cognitively-intact man." A low body temperature ("Temperature is 96.5°F") and a "current indwelling catheter" were also not more important than "Temperature is 97.5°F" and a "No history of UTIs or current indwelling catheter." Only the physical examination information of "new or increased area of redness and warmth on the left lower leg" and "new or increased cough and work of breathing" were significantly and negatively associated with prescribing for a UTI [OR 0.72 (95% CI 0.63, 0.83) and OR 0.61 (95% CI 0.54, 0.70), respectively].

Deliberation and Clinician Characteristics

As Table 4 shows, no differences existed by deliberation group on the distribution of importance scores for any of the 3 choices and only small differences across all categories. Swait-Louviere tests found that the deliberation groups did not have significant differences in their utility preferences after adjusting for scale differences ($P = .75$). The distribution of importance scores varied somewhat in bivariate analyses of a few purposively chosen clinical characteristics. We examined days per week spent working in the NH, practice location (long-term care only or other), training background (doctor of medicine, doctor of osteopathy, nurse practitioner, or physician assistant), the presence of specialty training (geriatrics or other), and duration of clinical practice (>20 years or ≤20 years). To examine how much differences in the distributions of importance scores were driven by the most important resident characteristic, we used a multivariable model to examine the association between these clinician characteristics and having urinalysis as the most important resident characteristic for prescribing antibiotics for a UTI. As Table 4 shows, we found that clinicians who spent >1 day/wk in the NH had lower odds of having urinalysis as the most important resident characteristic as compared to clinicians who spent 1 day/wk or less in the NH (OR 0.66, 95% CI 0.45, 0.96). No association was found between the other clinical characteristics (eg, practice location, training background, specialty, or duration of clinical practice) and having *urinalysis* as the most important resident characteristic.

Table 3
Resident Characteristics and Types of Information With Associated Importance Scores and Utility-Derived Odds Ratios by Response Option (No. of Clinicians = 867)

Resident Characteristics and Types of Information	Importance Scores (%) and Utilities [OR (95% CI)]		
	"I would prescribe for a UTI"	"I would prescribe for another infection"	"I would prescribe a broad-spectrum"
Urinalysis	31.7%	3.7%	21.4%
Negative leukocyte esterase, negative nitrates	0.00	0.00	0.00
Positive leukocyte esterase, positive nitrates	19.54 (16.92, 22.57)*	0.77 (0.64, 0.93)*	8.77 (7.50, 10.27)*
Positive leukocyte esterase, negative nitrates	6.65 (5.83, 7.58)*	0.87 (0.75, 1.01)	3.29 (2.84, 3.81)*
Unavailable or not performed	2.53 (2.22, 2.87)*	0.82 (0.72, 0.94)*	1.77 (1.53, 2.04)*
Body temperature	16.9%	25.8%	21.3%
Temperature is 97.5°F	0.00	0.00	0.00
Temperature is 101.5°F	4.65 (4.05, 5.33)*	6.17 (5.24, 7.27)*	8.68 (7.44, 10.11)*
Temperature is 99.5°F	1.89 (1.68, 2.14)*	1.83 (1.57, 2.13)*	2.02 (1.75, 2.33)*
Temperature is 96.5°F	0.95 (0.84, 1.07)	1.12 (0.97, 1.30)	1.02 (0.89, 1.18)
Lower urinary tract status	16.7%	4.2%	13.2%
No lower urinary tract signs or symptoms	0.00	0.00	0.00
Painful or difficult urination	4.80 (4.15, 5.54)*	1.15 (0.97, 1.37)	3.80 (3.22, 4.47)*
Obvious blood in urine	3.14 (2.72, 3.61)*	0.85 (0.72, 1.01)	2.80 (2.38, 3.28)*
Change in urine clarity or odor	2.31 (2.01, 2.66)*	1.02 (0.87, 1.19)	1.78 (1.52, 2.10)*
New or worsening frequency	1.96 (1.68, 2.28)*	1.10 (0.92, 1.31)	1.87 (1.57, 2.23)*
Physical examination	14.7%	44.8%	24.4%
Normal physical examination	0.00	0.00	0.00
Suprapubic or costovertebral angle tenderness	2.43 (2.18, 2.72)*	1.38 (1.08, 1.77)*	2.00 (1.66, 2.40)*
Redness and warmth on left lower leg	0.72 (0.63, 0.83)*	23.69 (19.54, 28.72)*	11.89 (10.10, 14.00)*
Cough and work of breathing	0.61 (0.54, 0.70)*	10.71 (8.84, 12.98)*	7.82 (6.67, 9.16)*
Antibiotic request	6.8%	8.8%	6.7%
No antibiotic request	0.00	0.00	0.00
Antibiotic request from family + nurse	1.88 (1.59, 2.23)*	1.87 (1.51, 2.30)*	1.97 (1.61, 2.40)*
Antibiotic request from resident + nurse	1.81 (1.53, 2.14)*	1.65 (1.34, 2.02)*	1.61 (1.33, 1.95)*
Antibiotic request from resident	1.70 (1.44, 2.02)*	1.42 (1.16, 1.75)*	1.71 (1.41, 2.07)*
Antibiotic request from family	1.65 (1.40, 1.95)*	1.58 (1.28, 1.95)*	1.80 (1.48, 2.19)*
Antibiotic request from nurse	1.59 (1.37, 1.85)*	1.38 (1.15, 1.66)*	1.63 (1.37, 1.93)*
Mental status	4.1%	3.6%	3.7%
Usual state of health	0.00	0.00	0.00
New or worsening confusion	1.48 (1.30, 1.67)*	1.29 (1.11, 1.50)*	1.45 (1.26, 1.67)*
New or worsening agitation	1.36 (1.20, 1.54)*	1.29 (1.11, 1.51)*	1.41 (1.23, 1.63)*
Sleeping more than usual	1.22 (1.08, 1.38)*	1.18 (1.02, 1.37)*	1.14 (0.99, 1.32)
UTI risk	3.5%	1.3%	2.8%
No history of UTIs or current indwelling catheters	0.00	0.00	0.00
Current indwelling catheter + history of 3 UTIs	1.39 (1.22, 1.59)*	1.10 (0.93, 1.29)	1.33 (1.14, 1.55)*
History of 3 UTIs over past year	1.37 (1.21, 1.56)*	1.01 (0.86, 1.19)	1.26 (1.09, 1.45)*
Current indwelling catheter	1.08 (0.94, 1.23)	1.01 (0.87, 1.18)	1.02 (0.88, 1.19)
Functional status	2.5%	1.7%	1.3%
Usual state of health	0.00	0.00	0.00
New or worsening difficulties with ambulation/transfers	1.26 (1.10, 1.45)*	1.12 (0.94, 1.32)	1.14 (0.98, 1.34)
New or increased falls	1.24 (1.08, 1.42)*	1.06 (0.89, 1.25)	1.12 (0.95, 1.31)
Reduced intake of food and liquids	1.20 (1.05, 1.38)*	1.13 (0.96, 1.34)	1.06 (0.90, 1.24)
New or increased resistance to care	1.17 (1.02, 1.34)*	1.08 (0.91, 1.28)	1.06 (0.91, 1.25)
Goals of care	2.2%	4.5%	3.8%
Comfort care measures	0.00	0.00	0.00
Full scope of treatment	1.23 (1.11, 1.37)*	1.37 (1.20, 1.56)*	1.47 (1.30, 1.66)*
Limited additional interventions	1.13 (1.01, 1.26)*	1.24 (1.09, 1.41)*	1.24 (1.09, 1.40)*
Resident type	0.8%	1.5%	1.4%
84-y-old cognitively intact man	0.00	0.00	0.00
84-y-old man with dementia	1.06 (0.89, 1.26)	0.96 (0.78, 1.19)	0.96 (0.78, 1.17)
84-y-old cognitively intact woman	1.02 (0.90, 1.16)	0.96 (0.82, 1.12)	0.96 (0.83, 1.10)
84-y-old woman with dementia	0.98 (0.82, 1.17)	0.90 (0.72, 1.11)	0.87 (0.71, 1.06)

Reference response not displayed ("I would not prescribe an antibiotic").
*$P < .05$; 2-sided.

Discussion

This national study of NH clinicians represents the first to our knowledge to provide a quantitative valuation of the relative importance of NH resident characteristics to the decision to prescribe antibiotics. We found that urinalysis was the most important resident characteristic in deciding to prescribe an antibiotic for a presumed UTI. This is an alarming finding given that guidelines do not recommend the use of a urinalysis to diagnose a UTI in an NH resident.[5,26,31–33] The importance of resident characteristics did not vary by deliberation, although clinicians who practice >1 day/wk in the NH had reduced odds of having urinalysis as the most important resident characteristic in their decision-making.

Guidelines by the Society for Healthcare Epidemiology of America and the Infectious Disease Society of America recommend that a decision to prescribe an antibiotic for a suspected UTI should be based on clinical signs or symptoms of the lower urinary tract such as dysuria, urgency, frequency, and incontinence and the presence of systemic signs or symptoms of infection.[26,32] New Delphi-driven guidelines also recommend similar approaches.[33,34] A key aspect of these guidelines is that none of them recommend using a urinalysis to make prescribing decisions. However, in our study, urinalysis was the most important resident characteristic when prescribing antibiotics. Moreover, urinalysis may simply be a proxy for urine culture results, a known gateway for overprescribing.[35] Urine cultures are only useful for determining the right antibiotic choice after the decision to

Table 4
Importance Scores for the 5 Most Important Resident Characteristics by Time Pressure and Clinician Characteristics (No. of Clinicians = 867)

Characteristic	Evidence Category						*P*
	Urinalysis, %	Body Temperature, %	Lower Urinary Tract Status, %	Physical Examination, %	Antibiotic Request, %	All Others, %	
Total	31.7	16.9	16.7	14.7	6.8	13.1	
Time pressure (0, 1)							.61
Self-paced	32.4	17.1	16.5	14.5	6.9	12.6	
Deliberative	30.6	16.5	16.7	14.6	6.6	15.1	
Clinician characteristics (0, 1)							
Days in NH							<.001
0-1	29.9	16.1	16.8	14.3	7.4	15.4	
>1	32.5	17.3	16.4	14.8	6.5	12.6	
Long-term care only							<.001
Yes	28.6	14.0	12.5	11.4	10.6	23.0	
No	27.5	16.3	14.9	15.5	8.8	17.0	
Degree type							<.001
MD, DO	30.2	15.8	17.1	13.9	7.0	16.1	
NP, PA	31.7	17.5	14.9	14.7	7.8	13.4	
Subspecialty							.009
Geriatric	24.6	14.4	15.7	12.1	9.3	23.7	
Other	32.0	17.1	16.6	14.6	6.6	13.0	
Years since degree							.12
>Mean (20.2 y)	30.3	15.6	17.9	13.7	7.6	14.9	
≤Mean	31.2	17.2	14.7	14.7	6.8	15.3	

DO, doctor of osteopathy; MD, doctor of medicine; NP, nurse practitioner; PA, physician assistant.
Importance scores for response "I would prescribe for a UTI." *P* value tests structure of utilities of models (0, 1) against total model using Swait-Louviere likelihood ratio test; 2-sided. A significant *P* value indicates statistical differences between the distribution of importance scores by clinician characteristic

prescribe has been made.[36,37] The fact that urinalysis results were the most important resident characteristic demonstrates that significant efforts are needed to reframe clinical understanding of UTIs in NH residents. This finding remained consistent across all clinicians except those in NHs >1 day/wk, which may give them a better understanding of asymptomatic bacteriuria than other groups.

Because inappropriate reliance on the urinalysis appears to be widespread, clinicians seem to need more than just support in knowing and understanding clinical guidelines; they also need support in avoiding reliance on generalizations and heuristics.[38] One path forward could be through electronic clinical decision support systems at the point of care. To develop truly effective and feasible clinical decision support, developers will need to understand how decisions are actually made in the clinical setting.[39–41] Dual process theory posits that it is a natural tendency of people to make decisions through both rapid, intuitive means, and more deliberative, analytical processes (eg, carefully weighing one's options and their consequences).[42,43] Grounding clinical decision support in dual process theory would give clinicians access to more deliberative cognitive processing, helping them avoid reliance on non–evidence based information such as the urinalysis results.

Our work adds to the evidence that clinicians use a variety of resident characteristics and types of information when deciding to prescribe antibiotics. Other work has examined the associations between resident characteristics and positive urine cultures post hoc, which is problematic given the rates of asymptomatic bacteriuria in the NH population.[44] DCE allows us to quantify the importance of all characteristics in relationship to each other.[16,17] Reassuringly, our findings demonstrate that while characteristics with less evidence (such as worsening mental or functional status) are important to prescribing, they are markedly less important than more evidence-based characteristics such as body temperature and lower urinary tract status. Additionally, the physical examination findings related to other types of infections were negatively associated with prescribing for a UTI.

Limitations and Future Directions

This study has several limitations. Although large and geographically diverse, participants were a convenience sample; also, we do not have information about those who declined participation. We did not ask participants about the number of NHs in which they practiced; instead, we asked whether they practiced in other settings as well. We recognize that factors other than time in an NH may explain differences in UTI prescribing. Additionally, we measured responses to hypothetical scenarios and not actual prescribing; however, this limitation is offset by our ability to disentangle the amount of influence each type of patient information had on decision making, impossible to do in a clinical setting. Because of the complexities of decision making, this work supports the CDC recommendation to use clinical decision support to improve antibiotic prescribing.[45] That effort, combined with system efforts to control the use of urinalysis and urine cultures, promote local champions, and employ other educational efforts may be enough to bend the overprescribing rate.[22,46]

Conclusions and Implications

In a large US survey of NH primary care clinicians, we found a reliance on urinalysis to guide antibiotic prescribing for suspected UTIs, a practice known to lead to overprescribing. Future efforts need to focus on creating clinical support systems that not only educate clinicians on UTI management but encourage clinicians to use evidence-based information when making prescribing decisions.

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Supplementary Table 1
Patient Characteristics and Types of Information With Associated Part-Worth Utilities by Response Option (No. of clinicians = 867)

Patient Characteristics and Types of Information	Utilities, β (95% CI)		
	"I would prescribe for a UTI"	"I would prescribe for another infection"	"I would prescribe a broad-spectrum"
Urinalysis			
Negative leukocyte esterase, negative nitrates	0.00	0.00	0.00
Positive leukocyte esterase, positive nitrates	2.97 (2.83, 3.12)	−0.26 (−0.44, −0.08)	2.17 (2.01, 2.33)
Positive leukocyte esterase, negative nitrates	1.89 (1.76, 2.03)	−0.14 (−0.29, 0.01)	1.19 (1.04, 1.34)
Unavailable or not performed	0.93 (0.80, 1.05)	−0.19 (−0.33, −0.06)	0.57 (0.43, 0.71)
Body temperature			
Temperature is 97.5°F	0.00	0.00	0.00
Temperature is 101.5°F	1.54 (1.40, 1.67)	1.82 (1.66, 1.98)	2.16 (2.01, 2.31)
Temperature is 99.5°F	0.64 (0.52, 0.76)	0.60 (0.45, 0.76)	0.70 (0.56, 0.85)
Temperature is 96.5°F	−0.05 (−0.17, 0.07)	0.12 (−0.03, 0.27)	0.02 (−0.12, 0.16)
Lower urinary tract status			
No lower urinary tract signs or symptoms	0.00	0.00	0.00
Painful or difficult urination	1.57 (1.42, 1.71)	0.14 (−0.03, 0.31)	1.33 (1.17, 1.50)
Obvious blood in urine	1.14 (1.00, 1.28)	−0.16 (−0.33, 0.01)	1.03 (0.87, 1.19)
Change in urine clarity or odor	0.84 (0.70, 0.98)	0.02 (−0.14, 0.18)	0.58 (0.42, 0.74)
New or worsening frequency	0.67 (0.52, 0.83)	0.09 (−0.08, 0.27)	0.63 (0.45, 0.80)
Physical examination			
Normal physical examination	0.00	0.00	0.00
Suprapubic/costovertebral angle tenderness	0.89 (0.78, 1.00)	0.32 (0.08, 0.57)	0.69 (0.51, 0.87)
Redness and warmth on left lower leg	−0.32 (−0.46, −0.18)	3.17 (2.97, 3.36)	2.48 (2.31, 2.64)
Cough and work of breathing	−0.49 (−0.62, −0.36)	2.37 (2.18, 2.56)	2.06 (1.90, 2.21)
Antibiotic request			
No antibiotic request	0.00	0.00	0.00
Antibiotic request from family + nurse	0.63 (0.46, 0.80)	0.62 (0.41, 0.83)	0.68 (0.48, 0.87)
Antibiotic request from resident + nurse	0.59 (0.42, 0.76)	0.50 (0.29, 0.70)	0.48 (0.28, 0.67)
Antibiotic request from resident	0.53 (0.36, 0.70)	0.35 (0.14, 0.56)	0.53 (0.34, 0.73)
Antibiotic request from family	0.50 (0.33, 0.67)	0.46 (0.25, 0.67)	0.59 (0.39, 0.78)
Antibiotic request from nurse	0.47 (0.32, 0.62)	0.32 (0.14, 0.51)	0.49 (0.32, 0.66)
Mental status			
Usual state of health	0.00	0.00	0.00
New or worsening confusion	0.39 (0.26, 0.51)	0.25 (0.10, 0.40)	0.37 (0.23, 0.52)
New or worsening agitation	0.31 (0.18, 0.43)	0.26 (0.10, 0.41)	0.35 (0.21, 0.49)
Sleeping more than usual	0.20 (0.07, 0.32)	0.17 (0.02, 0.32)	0.13 (−0.01, 0.28)
UTI risk			
No history of UTIs or current indwelling catheters	0.00	0.00	0.00
Current indwelling catheter + history of 3 UTIs	0.33 (0.20, 0.46)	0.09 (−0.07, 0.26)	0.28 (0.13, 0.44)
History of 3 UTIs over past year	0.32 (0.19, 0.44)	0.01 (−0.14, 0.16)	0.23 (0.09, 0.37)
Current indwelling catheter	0.07 (−0.06, 0.21)	0.01 (−0.15, 0.17)	0.02 (−0.13, 0.18)
Functional status			
Usual state of health	0.00	0.00	0.00
New or worsening difficulties with ambulation or transfers	0.23 (0.09, 0.37)	0.11 (−0.06, 0.28)	0.13 (−0.02, 0.29)
New or increased falls	0.21 (0.08, 0.35)	0.06 (−0.11, 0.23)	0.11 (−0.05, 0.27)
Reduced intake of food and liquids	0.18 (0.04, 0.32)	0.12 (−0.04, 0.29)	0.06 (−0.10, 0.22)
New or increased resistance to care	0.16 (0.02, 0.30)	0.07 (−0.09, 0.24)	0.06 (−0.10, 0.22)
Goals of care			
Comfort care measures	0.00	0.00	0.00
Full scope of treatment	0.21 (0.10, 0.32)	0.32 (0.18, 0.45)	0.38 (0.26, 0.51)
Limited additional interventions	0.12 (0.01, 0.23)	0.21 (0.08, 0.35)	0.21 (0.09, 0.34)
Patient type			
84-y-old cognitively-intact man	0.00	0.00	0.00
84-y-old man with dementia	0.05 (−0.12, 0.23)	−0.04 (−0.25, 0.17)	−0.04 (−0.24, 0.15)
84-y-old cognitively-intact woman	0.02 (−0.10, 0.15)	−0.04 (−0.19, 0.12)	−0.04 (−0.19, 0.10)
84-y-old woman with dementia	−0.02 (−0.19, 0.16)	−0.11 (−0.32, 0.11)	−0.14 (−0.34, 0.06)

Italicized items represent DCE reference category.