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Survival After Suspected Urinary Tract Infection in Individuals with Advanced Dementia

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Abstract

OBJECTIVES—To determine whether antimicrobial treatment for suspected urinary tract infections (UTIs) improves survival in nursing home residents with advanced dementia.

DESIGN—Prospective cohort study.

SETTING—Thirty-five nursing homes in Boston, Massachusetts.

PARTICIPANTS—Nursing home residents who experienced at least one suspected UTI over a 12-month period (N = 110); mean participant age 86.4 ± 6.2, 84% female.

MEASUREMENTS—Analyses were at the level of the UTI episode. Antimicrobial treatment for each suspected UTI was categorized as none, oral, intramuscular, or intravenous or hospitalization. Survival was calculated from the date of suspected UTI episode until death or last known follow-up date. Covariates included resident and episode characteristics. Cox proportional hazards regression was used to examine the association between treatment group and risk of death after adjusting for covariates.

RESULTS—Residents experienced 196 suspected UTIs over the follow-up period; 33% (n = 36) died during follow-up. There was no antimicrobial use for 25.0% of the 196 suspected UTIs, oral antimicrobial use in 59.7%; intramuscular antimicrobial use in 9.2%, and intravenous antimicrobial use or hospital transfer in 6.1%. After multivariable adjustment, antimicrobial treatment was not significantly associated with mortality (oral, adjusted hazard ratio for death

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(AHR) = 1.09, 95% confidence interval (CI) = 0.43–2.75; intramuscular, AHR = 0.66, 95% CI = 0.08–5.66; intravenous or hospitalization, AHR = 1.83, 95% CI = 0.44–7.60).

CONCLUSION—Although the majority of suspected UTIs that nursing home residents with advanced dementia experienced were treated with antimicrobials, treatment was not associated with survival.

Keywords

advanced dementia; urinary tract infection; antimicrobial therapy

Suspected infections, the most common of which are urinary tract infections (UTIs), often accompany advanced dementia.^{1–4} Approximately 75% of suspected UTIs in nursing home (NH) residents with advanced dementia are treated with antimicrobials.^{1–4} Whether antimicrobial treatment of suspected UTIs confers any survival benefit in this population has not been well studied.

There is a well-recognized need to improve the management of infections in NH residents with advanced dementia.^{1–6} Although antimicrobials are extensively prescribed for suspected UTIs in these residents, recent work suggests that much of this use may be inappropriate because antimicrobials are unnecessary (clinical presentation does not support the presence of a bacterial infection) or unwanted (inconsistent with preferences).^{1,3} A recent report found that only 19% of treated suspected UTIs in NH residents with advanced dementia met minimal clinical criteria to initiate antimicrobials.³

Overuse of antimicrobials in advanced dementia is troubling from a public health perspective and the standpoint of minimizing patient burden near the end of life. Antimicrobial exposure is the strongest risk associated with the acquisition of antimicrobial-resistant organisms—a serious and growing problem in NHs.^{3,7–10} In a recent prospective study, 67% of NH residents with advanced dementia were colonized with a multidrug-resistant organism (MDRO) at some point over 12 months.³ Moreover, although the vast majority of proxies for NH residents with advanced dementia state that comfort is the primary goal of care, most of these residents do not have directives restricting antimicrobial use.³ Although a minority of proxies want their loved one with advanced dementia to receive aggressive interventions (mechanical ventilation) to prolong their lives, many may still opt for potentially curative, life-prolonging treatments that are relatively less burdensome, such as antimicrobials.

There are no rigorous data examining whether treatment of suspected UTIs with antimicrobials prolongs the survival of NH residents with advanced dementia, whose life expectancy is already limited. Thus, this report analyzed data from a 12-month prospective cohort study of NH residents with advanced dementia to examine whether treatment with antimicrobials for a suspected UTI prolonged their survival.

METHODS

Data were obtained from the Study of Pathogen Resistance and Exposure to Antimicrobials in Dementia (SPREAD), a prospective study of NH residents with advanced dementia

conducted between September 2009 and November 2012. The goal of SPREAD was to examine infection management and outcomes in advanced dementia. Details of SPREAD are described elsewhere.^{3,11} The Hebrew Senior-Life institutional review board approved the study's conduct. Residents' healthcare proxies provided written informed consent.

Resident Characteristics

Residents with advanced dementia were recruited from 35 Boston-area NHs. Eligibility criteria included aged 65 and older, dementia (any type, from chart), an available English-speaking proxy, and a Global Deterioration Scale (GDS) score of 7 (from nurse) (range 1–7, higher scores indicate worse dementia).¹² A GDS score of 7 is characterized by profound memory deficits (cannot recognize family), verbal ability of less than five words, incontinence, and nonambulatory status. Of the SPREAD cohort (N = 362), residents who experienced at least one suspected UTI (N = 110, 30.4%) were included in the analyses presented in this report.

Each resident was followed for up to 12 months. Data were collected using full assessments conducted at baseline, quarterly, and at death and monthly infection screens. Research assistants obtained data from residents' charts at baseline on demographic characteristics (age, sex, race), and existing diagnoses of congestive heart failure, diabetes mellitus, and chronic obstructive pulmonary disease). Research assistants examined residents at baseline to assess their mental status using the Test for Severe Impairment (TSI) (range 0–24; lower scores indicating more-severe impairment).¹³ TSI was dichotomized as 0 versus greater than zero for analyses. Functional status was assessed at baseline and quarterly by interviewing a nurse with direct-care responsibilities for the resident using the Bedford Alzheimer's Nursing Severity-Subscale (BANS-S) (range 7–28, with higher scores indicating worse function).¹⁴ Information as to whether the resident had a feeding tube was also collected at each full assessment based on chart review.

Episode Characteristics

Research assistants reviewed charts at baseline, monthly, and at death to determine whether a physician, physician assistant, nurse practitioner, or nurse had specifically documented the occurrence of a suspected UTI in the prior 30 days. For each suspected UTI, whether antimicrobials were prescribed and, if so, by what route (oral, intramuscular or intravenous); whether the resident was transferred to the hospital (admission or emergency department visit); presence of a Foley catheter; temperature data; and symptoms and signs of dysuria, frequency, urgency, hematuria, costovertebral tenderness, suprapubic pain, rigors, or change in mental status (mental status change, lethargy, alteration from cognitive status from baseline) was ascertained. Whether a clinical examination by physician, nurse practitioner, or physician assistant was documented within 72 hours of presentation was also determined.

Episodes were classified as having or not having the symptoms and signs to meet the minimal clinical criteria for antimicrobial initiation for suspected UTIs in the NH setting as set forth by the Society for Healthcare Epidemiology of America (SHEA).¹⁵ For residents without Foley catheters, this required the presence of dysuria or fever and at least one of frequency, urgency, hematuria, costovertebral tenderness, suprapubic pain, mental status

change, or rigors. Although mental status and rigors were not in the original SHEA guidelines for noncatheterized NH residents, they were included given the inability of residents with advanced dementia to verbalize other supporting symptoms.^{1,3} Fever was defined as a single oral temperature greater than 100°F (>37.8°C), two or more oral temperatures greater than 99°F (>37.2°C), or an increase in temperature of more than 2°F (>1.1°C) over baseline temperature. For residents with Foley catheters, minimum symptoms and signs to meet the SHEA criteria included fever, rigors, or change in mental status.

When urinalyses or urine cultures were performed, the results were ascertained. Urinalyses were considered positive if microscopic analysis showed more than 10,000 white blood cells per liter or if a urine dipstick was positive for white blood cells, leukocyte esterase, or nitrites.¹⁶ A urine culture was considered positive if it grew more than 10⁵ colony forming units (cfus) of at least one bacterial organism in residents without a Foley catheter and more than 10³ cfus of at least one bacterial organism in residents with a Foley catheter.^{17,18}

Statistical Analysis

Descriptive statistics were generated for all residents, and episode characteristics were generated using means and standard deviations or percentages where appropriate. Cox proportional hazards regression was used to determine the association between treatment of the suspected episode (main independent variable) and survival (outcome). This analysis was conducted at the level of the episode. Survival after each suspected UTI was defined as the number of days from episode onset as documented in the chart until death for residents who died during the study or until the end of the follow-up period for those who survived. For the main analyses, antimicrobial treatment was categorized to reflect the aggressiveness of treatment as none (reference), oral, intramuscular, and intravenous or hospitalization. Hospitalization was grouped with intravenous antimicrobials based on the assumption that these episodes were treated as such in the hospital setting. If antimicrobials were administered using multiple modalities for a single episode, that episode was categorized in the most-aggressive treatment group. For example, if oral and intravenous antimicrobials were given, the episode was categorized in the intravenous group. In a sensitivity analyses, dichotomizing the treatment variable as any versus no antimicrobials was explored.

Resident and episode characteristics available in the SPREAD dataset that were deemed potentially associated with survival in advanced dementia after a UTI were included as covariates. Resident characteristics included age, sex, race (white vs nonwhite), comorbidities (congestive heart failure, diabetes mellitus, chronic obstructive pulmonary disease), TSI, BANS-S score (functional status), and presence of a feeding tube. Time-varying covariates (BANS-S score and feeding tube) were selected from the full assessment that reflected the resident's status at the time of the suspected UTI. All other resident variables were static and were thus brought forward from the baseline assessment. Episode characteristics selected as covariates included presence of a Foley catheter, highest recorded temperature (oral, axillary, rectal), change in mental status, and clinical examination within 72 hours. For the main analyses, highest temperature was categorized as less than 99°F (reference), 99°F to 101°F, and greater than 101°F. Multiple imputation (10 datasets) was used to impute highest temperature for 18 suspected infection episodes for which these data

were missing. Whether minimal criteria to initiate antimicrobials were present for the episode was also considered as a covariate, even though several of the aforementioned individual covariates (fever, mental status change) are part of these criteria. Finally, whether urinalyses and urine cultures were both positive (necessary to support the diagnosis of a UTI) was considered as a covariate for the subset of episodes for which these tests were available.

Unadjusted analyses were conducted to examine the associations between each independent variable and survival. Covariates associated with survival in the unadjusted models at $P < .10$ were then entered into a multivariable model along with the main independent variable—treatment type. All models were adjusted for clustering at the resident and facility level using generalized estimating equations.¹⁹ Survival curves after a suspected UTI were constructed for each treatment group based on the final adjusted multivariable model. Hazard ratios (HRs) and 95% confidence intervals (CIs) were generated from these analyses. All analyses were performed using SAS version 9.3 (SAS Institute, Inc., Cary, NC).

RESULTS

Episode Characteristics

One hundred ten residents experienced 196 suspected UTIs (range 1–9 episodes/resident) over a median follow-up of 182 days. Sixty-four (58%) had one suspected UTI, 27 (25%) had two, 10 (9%) had three, and nine (9%) had four or more. Thirty-six of these residents died after their suspected UTI. None of the residents were lost to follow-up. Residents in the cohort had a mean age of 86.4 ± 6.2 (range 68–105); 84.2% of episodes occurred in women and 89.8% in white residents (Table 1). Forty-six percent of episodes occurred in residents with a TSI score of 0, and the mean BANS-S score was 21.4, indicating extremely impaired cognitive and functional status.

There was no antimicrobial use for 25.0% of the 196 suspected UTIs, oral antimicrobial use in 59.7%; intramuscular antimicrobial use in 9.2%, and intravenous antimicrobial use or hospital transfer in 6.1%. Foley catheters were present in 11.2% of episodes. The highest recorded temperature was less than 99°F for 72.4% of suspected UTIs, and a mental status change was documented for 41.8% of episodes. A provider recorded a physical examination within 72 hours of presentation for 50.0% of suspected UTIs. Only 16% of episodes met the minimal criteria for antimicrobial initiation.

Urine specimen results were available for 147 (75%) of the 196 suspected UTIs, and the urinalyses and cultures were both positive for 80.3% (118/147) of these specimens.

Survival

Twenty-five percent of residents died within 135 days of the suspected UTI (median survival could not be calculated because 50% of the cohort remained alive at the end of the follow-up period). In unadjusted analyses, treatment with intravenous antimicrobials or hospitalization was associated with shorter survival (HR = 3.17, 95% CI = 0.85–11.84, $P = .09$). There was no survival difference between episodes treated with oral or intramuscular antimicrobials and those treated with no antimicrobials. The treatment variable examined

dichotomously, none versus any treatment route, was not significantly associated with survival (HR = 1.29, 95% CI = 0.54–3.07).

Covariates associated with shorter survival in the unadjusted analyses at $P < .10$ included higher BANS-S score (worse function) (HR = 1.10, 95% CI = 0.98–1.24) and highest recorded temperature greater than 101°F (vs <99°F) (HR = 2.31, 95% CI = 1.02–5.25). Mental status change was significantly associated with longer survival (HR = 0.40, 95% CI = 0.20–0.84). In the subset of suspected UTIs with available urine specimen results ($n = 147$), a positive urinalysis and culture was marginally associated with a risk of death that was more than three times as great (HR = 3.32, 95% CI = 0.96–11.49, $P = .06$).

Adjusted for BANS-S score, highest temperature, and change in mental status, antimicrobial treatment was not significantly associated with risk of death (oral, adjusted HR (AHR) = 1.09, 95% CI = 0.43–2.75; intramuscular, AHR = 0.66, 95% CI = 0.08–5.66; intravenous or hospitalization, AHR = 1.83, 95% CI = 0.44–7.60). Figure 1 shows survival curves after a suspected UTI for each treatment group based on the final adjusted multivariable model.

A sensitivity analysis in which only the suspected UTI infections with complete data were included (participants who were not missing information on highest temperature recorded) showed consistent results (data not shown).

DISCUSSION

This prospective cohort study found that 75% of suspected UTIs in NH residents with advanced dementia were treated with antimicrobials, but regardless of route of administration, antimicrobial treatment was not associated with a survival benefit. These findings may inform treatment decisions for suspected UTIs in individuals with advanced dementia, particularly residents for whom life prolongation remains a goal of care.

This study corroborates and extends what is currently known about the management and outcomes of suspected UTIs in individuals with advanced dementia. The finding that the majority of episodes were treated using antimicrobials, often through a parenteral route, is consistent with prior research,^{1–3} although to the knowledge of the authors, no prior report has rigorously compared survival in NH residents with advanced dementia with suspected UTIs who received antimicrobials with survival of those who did not. There are several possible clinical explanations for the lack of association observed. First, as this study and others have indicated,^{1,3,20} the clinical status changes attributed to UTIs in these residents were probably not due to bacterial infections in the majority of cases. The finding that only 16% of suspected UTIs met criteria to start antimicrobials supports this possibility.^{1,3} Treatment of asymptomatic bacteriuria does not prolong survival in NH residents,^{21,22} although clear-cut symptoms of UTIs are not easy to discern in individuals with advanced dementia, who are profoundly cognitively impaired and effectively mute. Mental status changes are commonly the basis for suspecting UTIs in advanced dementia but should not be the sole criteria for initiating treatment in the absence of other symptoms supporting the presence of bacterial infection.¹ Mental status changes were associated with a survival benefit, although the reason for the underlying association was unclear and merits further

study. The fact that urinalyses and urine cultures are frequently positive, regardless of whether mental status changes are present, further confounds the diagnosis of UTIs in individuals with advanced dementia.¹ In the current study, 80% of urine specimens had positive urinalyses and cultures, but this factor was not associated with mortality. An additional possible clinical explanation for the findings is that, even if some residents had UTIs, they may have been too debilitated from their underlying advanced dementia to derive a survival benefit from antimicrobials.

High-quality medical decision-making should involve weighing the risks and benefits of treatment options against the individual's desired goal of care. Advanced dementia is a terminal illness.^{4,5,23} As such, more than 90% of proxies in SPREAD³ and similar cohorts⁴ state that comfort is the main goal of care for their loved ones with advanced dementia. Examination (e.g., catheterization) and treatment (e.g., parenteral antimicrobials) of suspected UTIs can be sources of discomfort in these frail individuals, and antimicrobial treatment does not clearly promote their comfort beyond what can be accomplished with high-quality palliative care. This study brings into further question antimicrobial use for suspected UTI infections in residents who opt for treatment because the possibility that antimicrobials will prolong their life outweighs their potential risks. These risks include colonization with MDROs,^{3,7–10} *Clostridium difficile* infections,²⁴ adverse drug reactions, and the potential discomfort associated with antimicrobial administration, particularly when it involves a parenteral route or hospitalization.²⁵

There are several limitations of the current study that should be acknowledged. First, this was not a randomized trial. Although highest temperature and the presence of clinical criteria to start antimicrobials were adjusted for, it is possible that potentially confounding factors associated with treatment and survival (e.g., episode severity) were not adequately adjusted for. Despite this, residents who received the most-aggressive treatment (intravenous or hospitalization) had the shortest survival. Second, there may have been inadequate power in the intramuscular and intravenous antimicrobial treatment groups to detect a significant association with survival, but when all treatment modalities were combined in the analysis, similar results were found, with no association with survival. Finally, it is possible that there were some inaccuracies in the data extracted from residents' charts regarding details of UTI episodes.

The findings of this report suggest that the treatment of suspected UTIs with antimicrobials in NH residents with advanced dementia does not prolong survival. Regardless of whether this observation reflects the possibility that most of these episodes are not actually UTIs or that residents with advanced dementia are too frail to derive a survival benefit, it adds to the mounting list of reasons for practitioners to pause when considering antimicrobial use for a suspected UTI in this population. Moreover, this report supports the need for greater counseling of families about the pitfalls and common misconceptions related to the identification and treatment of suspected UTIs in advanced dementia. Such education and advance care planning may help avoid the use of antimicrobials when they are of limited clinical benefit, not aligned with the goal of care, potentially burdensome and risky for the resident, and troubling from a public health perspective.

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REFERENCES

1. D'Agata E, Loeb MB, Mitchell SL. Challenges in assessing nursing home residents with advanced dementia for suspected urinary tract infections. *J Am Geriatr Soc.* 2013; 61:62–66. [PubMed: 23311553]
2. D'Agata E, Mitchell SL. Patterns of antimicrobial use among nursing home residents with advanced dementia. *Arch Intern Med.* 2008; 168:357–362. [PubMed: 18299489]
3. Mitchell SL, Shaffer ML, Loeb MB, et al. Infection management and multidrug-resistant organisms in nursing home residents with advanced dementia. *JAMA Intern Med.* 2014; 174:1660–1667. [PubMed: 25133863]
4. Mitchell SL, Teno JM, Kiely DK, et al. The clinical course of advanced dementia. *N Engl J Med.* 2009; 361:1529–1538. [PubMed: 19828530]
5. Chang A, Walter LC. Recognizing dementia as a terminal illness in nursing home residents: Comment on “Survival and comfort after treatment of pneumonia in advanced dementia”. *Arch Intern Med.* 2010; 170:1107–1109. [PubMed: 20625014]
6. Givens JL, Jones RN, Shaffer ML, et al. Survival and comfort after treatment of pneumonia in advanced dementia. *Arch Intern Med.* 2010; 170:1102–1107. [PubMed: 20625013]
7. Mody L. Optimizing antimicrobial use in nursing homes: No longer optional. *J Am Geriatr Soc.* 2007; 55:1301–1302. [PubMed: 17661973]
8. Pop-Vicas A, Mitchell SL, Kandel R, et al. Multidrug-resistant gram-negative bacteria in a long-term care facility: Prevalence and risk factors. *J Am Geriatr Soc.* 2008; 56:1276–1280. [PubMed: 18557965]
9. Stone ND, Lewis DR, Johnson TM II, et al. Methicillin-resistant *Staphylococcus aureus* (MRSA) nasal carriage in residents of Veterans Affairs long-term care facilities: Role of antimicrobial exposure and MRSA acquisition. *Infect Control Hosp Epidemiol.* 2012; 33:551–557. [PubMed: 22561709]
10. O'Fallon E, Kandel R, Schreiber R, et al. Acquisition of multidrug-resistant gram-negative bacteria: Incidence and risk factors within a long-term care population. *Infect Control Hosp Epidemiol.* 2010; 31:1148–1153. [PubMed: 20923286]
11. Mitchell SL, Shaffer ML, Kiely DK, et al. The study of pathogen resistance and antimicrobial use in dementia: Study design and methodology. *Arch Gerontol Geriatr.* 2013; 56:16–22. [PubMed: 22925431]
12. Reisberg B, Ferris SH, de Leon MJ, et al. The Global Deterioration Scale for assessment of primary degenerative dementia. *Am J Psychiatry.* 1982; 139:1136–1139. [PubMed: 7114305]
13. Albert M, Cohen C. The Test for Severe Impairment: An instrument for the assessment of patients with severe cognitive dysfunction. *J Am Geriatr Soc.* 1992; 40:449–453. [PubMed: 1634695]
14. Volicer L, Hurley AC, Lathi DC, et al. Measurement of severity in advanced Alzheimer's disease. *J Gerontol.* 1994; 49:M223–M226. [PubMed: 8056941]
15. Loeb M, Bentley DW, Bradley S, et al. Development of minimum criteria for the initiation of antibiotics in residents of long-term-care facilities: Results of a consensus conference. *Infect Control Hosp Epidemiol.* 2001; 22:120–124. [PubMed: 11232875]

16. Little P, Turner S, Rumsby K, et al. Dipsticks and diagnostic algorithms in urinary tract infection: Development and validation, randomised trial, economic analysis, observational cohort and qualitative study. *Health Technol Assess*. 2009; 13:iii–iv. ix–xi, 1–73. [PubMed: 19364448]
17. Nicolle LE, Bradley S, Colgan R, et al. Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. *Clin Infect Dis*. 2005; 40:643–654. [PubMed: 15714408]
18. Hooton TM, Bradley SF, Cardenas DD, et al. Diagnosis, prevention, and treatment of catheter-associated urinary tract infection in adults: 2009 International Clinical Practice Guidelines from the Infectious Diseases Society of America. *Clin Infect Dis*. 2010; 50:625–663. [PubMed: 20175247]
19. Liang KY, Zeger SL. Longitudinal data-analysis using generalized linear-models. *Biometrika*. 1986; 73:13–22.
20. Loeb M, Simor AE, Landry L, et al. Antibiotic use in Ontario facilities that provide chronic care. *J Gen Intern Med*. 2001; 16:376–383. [PubMed: 11422634]
21. Nicolle LE. Asymptomatic bacteriuria in the elderly. *Infect Dis Clin North Am*. 1997; 11:647–662. [PubMed: 9378928]
22. Phillips CD, Adepoju O, Stone N, et al. Asymptomatic bacteriuria, antibiotic use, and suspected urinary tract infections in four nursing homes. *BMC Geriatr*. 2012; 12:73. [PubMed: 23176555]
23. Mitchell SL, Black BS, Ersek M, et al. Advanced dementia: State of the art and priorities for the next decade. *Ann Intern Med*. 2012; 156:45–51. [PubMed: 22213494]
24. Kyne L, Merry C, Connell B, et al. Factors associated with prolonged symptoms and severe disease due to *Clostridium difficile*. *Age Ageing*. 1999; 28:107–113. [PubMed: 10350405]
25. Morrison RS, Ahronheim JC, Morrison GR, et al. Pain and discomfort associated with common hospital procedures and experiences. *J Pain Symptom Manage*. 1998; 15:91–101. [PubMed: 9494307]

Figure 1. Survival in days after suspected urinary tract infection, stratified according to treatment: no antimicrobials (solid line), oral antimicrobials (dashed line), intramuscular antimicrobials (dotted line), and intravenous antimicrobials or hospitalization (dash-dotted line). Model adjusted for functional status (Bedford Alzheimer's Nursing Severity—Subscale Score), highest recorded temperature (<99°F, 99–101°F, >101°F), and mental status change.

Table 1**Characteristics of Suspected Urinary Tract Infectious Episodes and Their Association with Death**

Characteristic	All Episodes (N = 196)	Association with Death, Hazard Ratio (95% Confidence Interval)	
		Unadjusted	Adjusted ^a
Resident			
Age, mean ± SD (range 68–105)	86.4 ± 6.2	1.00 (0.92–1.08)	
Female, n (%)	165 (84.2)	0.64 (0.18–2.29)	
White, n (%)	176 (89.8)	0.60 (0.15–2.31)	
Congestive heart failure, n (%)	43 (21.9)	1.00 (0.34–2.89)	
Diabetes mellitus, n (%)	57 (29.1)	1.13 (0.40–3.21)	
Chronic obstructive lung disease, n (%)	20 (10.2)	2.16 (0.74–6.32)	
Test for Severe Impairment score 0, n (%) ^b	90 (45.9)	1.01 (0.43–2.38)	
BANS-S score, mean ± SD	21.4 ± 2.7	1.10 (0.98–1.24)	1.16 (1.02–1.30)
Feeding tube, n (%)	11 (5.6)	0.71 (0.08–6.69)	
Episode, n (%)			
Treatment with antimicrobials			
None	49 (25.0)	Reference	Reference
Oral	117 (59.7)	1.52 (0.69–3.31)	1.09 (0.43–2.75)
Intramuscular	18 (9.2)	0.77 (0.14–4.21)	0.66 (0.08–5.66)
Intravenous or hospitalization	12 (6.1)	3.17 (0.85–11.84)	1.83 (0.44–7.60)
Foley catheter	22 (11.2)	1.22 (0.31–4.86)	
Highest temperature			
<99°F	141 (72.4)	Reference	Reference
99–101°F	37 (18.7)	1.16 (0.41–3.27)	0.80 (0.25–2.63)
>101°F	18 (8.9)	2.31 (1.02–5.25)	1.51 (0.67–3.42)
Change in mental status	82 (41.8)	0.40 (0.20–0.84)	0.40 (0.18–0.93)
Clinical examination within 72 hours	98 (50.0)	1.32 (0.67–2.58)	
Minimal criteria for antimicrobial initiation present ^c	31 (15.8)	1.09 (0.29–4.15)	
Positive urinalysis and culture ^d	118 (80.3)	3.32 (0.96–11.49)	

^a Adjusted for factors associated with death in bivariate analyses at $P < .10$, including Bedford Alzheimer's Nursing Severity-Subscale (BANS-S) score (possible range 7–28, higher scores indicate more functional disability), treatment with antimicrobials, highest recorded temperature, and change in mental status.

^b Range 0–24, lower scores indicate greater cognitive impairment; dichotomized as 0 versus >0.

^c As set forth by the Society for Healthcare Epidemiology of America.

^d Urine specimen results only available for 147 episodes. Urinalyses were considered positive if microscopic analysis had >10,000 white blood cells/L or if urine dipstick was positive for white blood cells, leukocyte esterase, or nitrites. Urine cultures were considered positive if they grew >10⁵ colony forming units (cfus) of 1 bacterial organisms without a Foley catheter or >10³ cfus with.