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Increased Length of Stay Associated with Antibiotic Use in Older Adults with Advanced Cancer Transitioned to Comfort Measures

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Abstract

Background: Antibiotic use may increase hospital length-of-stay (LOS) among older patients with advanced cancer who are transitioned to comfort measures.

Methods: We studied a cohort of advanced cancer patients aged ≥ 65 years who were transitioned to comfort measures during admission from July 1, 2014 through November 30, 2016. We evaluated the association between antibiotic exposure and LOS using a Poisson regression model adjusted for age, gender, cancer type, comorbidities, infection, and intensive care unit admission.

Results: Among 461 advanced cancer patients, median age was 74 years (range 65–99), 49.0% (n=226) were female, and 20.6% (n=95) had liquid tumors. Overall, 82.9% (n=382) received ≥ 1 antibiotic and 64.6% (n=298) had ≥ 1 infection diagnosis during hospitalization. Infection diagnoses commonly included sepsis (35%, n=16/461), pneumonia (25%, n=117/461), and urinary tract infection (14%, n=66/461). Among those receiving antibiotics, the most common choices included vancomycin (79%, n=300/382), cephalosporins (63%, n=241/382), and penicillins (45%, n=172/382). In a multivariable Poisson regression model, LOS was 34% longer (count ratio=1.34, [95% CI: 1.20–1.51]) among those exposed versus unexposed to antibiotics.

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Conclusions: Antibiotic use among advanced cancer patients who are transitioned to comfort measures is associated with longer LOS. These data illustrate the importance of tradeoffs associated with antibiotic use, such as unintended increased LOS, when striving for goal-concordant care near the end of life.

Keywords

Advanced cancer; hospital length-of-stay; antibiotic use; comfort measures

Introduction

Patients with advanced cancer are predisposed to infection due to a variety of host and treatment-associated factors.^{1–5} For example, patients with multiple myeloma may have hypogammaglobulinemia that increases risk for encapsulated bacterial infection whereas patients with solid tumors are prone to mechanical obstruction that may facilitate polymicrobial infection.^{5–9} As a result, antibiotic use is common among hospitalized patients with advanced cancer.^{10–12} Moreover, following transition to comfort measures, approximately one-third of hospitalized patients with advanced cancer continue to receive antibiotic therapy.^{10,13}

A variety of complex social and behavioral factors may drive antibiotic prescribing in this population. These include beliefs that infections may be cured with treatment, the desire to respect the wishes of patients or family, perceptions that antibiotic side effects are minimal, or the desire to alleviate pain from infection near the end of life.¹⁴ Nevertheless, it is unclear whether antibiotics offer palliative benefit. A systematic review of publications between 2001 and 2011 did not conclude that antibiotics offer symptomatic relief in hospice and palliative care patients.¹⁵ Moreover, one report of 309 advanced cancer patients admitted to hospice found that 79% preferred no antimicrobials or limited antimicrobials for symptomatic use only.¹⁶

To improve antibiotic use in terminally ill patients, the Infectious Diseases Society of America and Society for Healthcare Epidemiology of America have identified a potential role for antibiotic stewardship near the end of life.¹⁷ Patients with advanced cancer represent an important target for antibiotic stewardship given the focus on comfort and quality of life. Given that antibiotics predispose to conditions that reduce quality of life, such as nausea and vomiting, diarrhea, *Clostridioides difficile* infection, and acquisition of multidrug-resistant organisms requiring contact precautions or room isolation, it is recommended to view antibiotics as “aggressive care” rather than comfort care near the end of life.¹⁷

Recent data from a systematic review and meta-analysis suggest that restricting antibiotic use may reduce hospital length-of-stay (LOS) in general medicine populations.¹⁸ Less is known regarding the impact of antibiotic use on LOS in patients with advanced cancer. Given that the optimal management of infection aligns treatment with advanced cancer patients’ goals and values, it is important to ascertain whether treatment with antibiotics prolongs hospitalization, an outcome that may be undesirable for some advanced cancer patients. We evaluated the association between antibiotic use and LOS among older adults

with advanced cancer who were transitioned to comfort measures to inform approaches to infection management at the end of life that align with patient goals of care.

Methods

We conducted a retrospective cohort study of patients ≥ 65 years of age with advanced cancer who were transitioned to comfort measures during admission to Yale New Haven Hospital, a 1,541-bed tertiary care center in New Haven, CT, from July 1, 2014 through November 30, 2016. Advanced cancer was defined as stage III-IV solid tumors; stage III-IV lymphomas; or acute, refractory, relapsed or active liquid tumors requiring chemotherapy or targeted therapies. All advanced cancers were identified by *International Classification of Diseases (ICD), Tenth Revision* codes and confirmed on pathology or medical record review. Patients were not receiving hospice care prior to admission. We excluded patients whose comfort measures orders were reversed permanently. The Yale Human Investigation Committee approved this study.

For all patients, we collected demographics, comorbidities, code status data, infectious diseases or palliative care consultation data, microbiology data, and hospitalization information. Hospitalization information included admission and discharge dates, hospital mortality, encounter diagnoses recorded at the time of admission, dates of admission to an intensive care unit, and receipt of mechanical ventilation or vasopressor support, hemodialysis or tube feeding. Encounter diagnoses recorded at the time of admission, such as dehydration, biliary obstruction, status epilepticus, or abdominal pain, were independent of diagnoses associated with patients' problem list. We further assessed whether patients experienced infection based on *ICD, Ninth or Tenth Revision* codes.

Antibiotic administration was ascertained from medical record review. Antibiotic groups included aminoglycosides, carbapenems, cephalosporins, clindamycin, glycopeptides, lipopeptides, macrolides, metronidazole, monobactams, nitrofurantoin, oxazolidinones, penicillins, polymyxins, quinolones, streptogramins, sulfonamides and trimethoprim, and tetracyclines. Antibiotics administered orally, intravenously or by enema were evaluated. Topical, vaginal, ophthalmic, otic and nasal antibiotics were excluded. Among those receiving antibiotics, we ascertained the antibiotic days of therapy to estimate the burden of antibiotic therapy consistent with guidelines from the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America.¹⁷ An antibiotic day of therapy was defined as the administration of a single antibiotic on a given day regardless of the number of doses or dosing strength.^{17,19,20} For example, administration of vancomycin as a single 1000 mg dose or three 1000 mg doses given 8 hours apart both represent 1 antibiotic day of therapy. A patient receiving vancomycin and metronidazole on one day would be defined as receiving 2 antibiotic days of therapy.

Patient characteristics were calculated as the percentage of total patients with the specified attribute. We applied the Chi Square test with the Bonferroni correction to compare differences in patient characteristics according to antibiotic exposure. Antibiotic days of therapy were determined for all patients and stratified by antibiotic class. Microbiological data and infection diagnoses were stratified by type of culture and infection, respectively.

The primary outcome LOS was assessed overall from admission to discharge or death and for specified subgroups. LOS from admission to comfort measures, and LOS from comfort measures to discharge or death was reported among patients exposed versus unexposed to antibiotics. To further evaluate the association between antibiotic exposure and LOS, we used a multivariable Poisson regression model adjusted for age (65 to 74 years, 75 to 84 years, and 85 years and above), gender (male versus female), type of cancer (solid tumor versus liquid tumor), number of comorbidities, admission to an intensive care unit, and presence of infection. We then calculated the predicted LOS estimate for categorical variables using LSMEAN from the adjusted multivariable model. All analyses were performed using SAS version 9.4 software (SAS Institute, Cary, NC).

Results

Patient Characteristics

We identified 646 patients aged 65 years or older with advanced cancer who were transitioned to comfort measures during hospitalization. Of these, 185 were excluded due to reversal of comfort measures (N=23) and lack of advanced cancer confirmation on pathology or medical record review (N=162). Table 1 summarizes patient characteristics of the remaining 461 patients included in analysis. Median age was 74 years (range 65–99 years). Approximately half were female (N=226, 49.0%), and 20.6% had liquid tumors (N=95). Among all patients, the most common encounter diagnoses at the time of admission included palliative care encounter (n=147), acute kidney injury (n=122), dietary surveillance and counseling (n=119), anemia (n=113), cough (n=96), and dehydration (n=93).

Antibiotic Use

Overall, 82.9% (n=382) of advanced cancer patients received at least one antibiotic during hospitalization. Among those receiving antibiotics, the most common choices included vancomycin (79%, n=300/382), cephalosporins (63%, n=241/382), and penicillins (45%, n=172/382) (Table 2). Carbapenems (7%, n=26/382) were less common; tigecycline (<1%, n=2/382) and colistin (<1%, n=1/382) were rarely chosen (Table 2). Among patients who received vancomycin, 22 patients received oral vancomycin and 1 patient received vancomycin enema. Nearly all patients who were exposed to antibiotics received intravenous antibiotic therapy (94%, n=358/382). Among the 24 patients who received oral antibiotic therapy only, the most common antibiotics included fluoroquinolones (n=14) and metronidazole (n=3).

Among the 382 patients who received antibiotics, the median days of therapy was 12 days (interquartile range [IQR]: 5–23 days). Forty percent of patients (n=154/382) who received antibiotics remained on antibiotics until the date of discharge or death. The median number of days from discontinuation of antibiotic therapy, defined as the most distal calendar-day of antibiotic administration in a given patient, to discharge or death was 1 (IQR: 0–2 days). Among patients who received antibiotics, 61% (n=231/382) expired. Among the 231 patients who received antibiotics and expired, 33% (n=77) expired in an intensive care unit.

Microbiologic Testing for Infection

Among all patients with advanced cancer, 93% (n=430/461) had at least one microbiological culture collected during hospitalization. The most common microbiological cultures collected included blood cultures (n=324), urine cultures (n=310), and sputum cultures (n=111). Laboratory testing for *Clostridioides difficile* testing was performed in 14 patients. A total of 73 patients had at least one microbiological culture collected on or after the date patients transitioned to comfort measures. Ten patients who received antibiotics during hospitalization had no microbiological cultures collected.

Infection Diagnoses

The most common indications for antibiotic use included sepsis (n=161), pneumonia (n=117), and urinary tract infection (n=66). Additional infection diagnoses identified among advanced cancer patients are shown in Table 3. Ten patients with an infection diagnosis did not receive antibiotic therapy. Among these patients, infection diagnoses included gastroenteritis and colitis, pancreatitis (n=2), unspecified septicemia, pneumonia with unspecified organism, bronchitis, septic shock, diarrhea, fever, and cholecystitis. Six of these patients expired during hospitalization, and 4 patients were discharged to hospice.

Hospital Length of Stay

Overall, median LOS was 6.8 days (IQR: 3.3–13.1 days) among all advanced cancer patients who were transitioned to comfort measures. Among the subset of patients who were admitted to an intensive care unit (n=276), median days in an intensive care unit was 3.4 (IQR: 1.7–6.8 days). Table 4 shows the median days from transition to comfort measures to discharge or death according to type of cancer. In a multivariable Poisson regression model adjusted for age, gender, type of cancer, number of comorbidities, admission to an intensive care unit, and presence of an infection diagnosis, LOS was 34% longer (count ratio=1.34, [95% CI: 1.20–1.51]) among those who received antibiotics versus those who did not receive antibiotics. Additional factors associated with LOS are shown in Table 5.

Discussion

There is a predictable decline in health near the end of life among advanced cancer patients.²¹ The end-of-life period coincides with increased utilization of palliative chemotherapy and healthcare costs.^{22–24} Over 25% of Medicare spending occurs in the last year of life, and hospitalizations account for the largest component of healthcare spending in cancer patients.^{23–25} We show that the duration of hospitalization may be lengthy among advanced cancer patients who are transitioned to comfort measures, and antibiotic use is associated with increased LOS even after accounting for demographics, comorbidities, cancer type, infection, and intensive care unit admission. These results underscore the importance of considering the potential treatment burdens associated with antibiotic use among advanced cancer patients in palliative care settings.²⁶ Combined with limited evidence suggesting antibiotics improve symptom relief,¹⁵ our findings indicate that antibiotics may be inappropriate when life-prolonging interventions are not desired among hospitalized older adults with advanced cancer who are transitioned to comfort measures.

Similar to published reports, our work confirms the majority of advanced cancer patients receive antibiotics during their terminal admission,^{10,11,13} and antibiotic use remains common in the period after transition to comfort measures.¹⁰ We show that 89% of hospitalized older adults with advanced cancer who are transitioned to comfort measures receive antibiotics, and 40% of those who receive antibiotics remain on antibiotics until the date of discharge or death. However, few studies have examined the association between antibiotic use and LOS, particularly in older adults with advanced cancer. Prior studies in both intensive care unit²⁷ and non-intensive care unit²⁸ populations suggest inappropriate antibiotic use increases hospital LOS. Although we did not evaluate antibiotic appropriateness, we show that any antibiotic exposure is associated with a 34% longer LOS among hospitalized older adults with advanced cancer. In patients in whom survival may be a secondary goal to symptom relief, these additional days of hospitalization may prolong potential suffering.

Future studies may consider evaluating whether the increased LOS associated with antibiotic use in this population is attributable to the desire to complete an empiric course of antibiotic therapy. It is possible that LOS is prolonged because additional days of hospitalization are required to continue receiving intravenous antibiotic therapy. In our sample, 94% of patients who were exposed to antibiotics received them intravenously, and median days of therapy among patients who received antibiotics without an infection diagnosis was 6 days. Antibiotics were subsequently discontinued a median of 1 day prior to discharge or death. Qualitative interviews of patients, family members, and providers may reveal the perceived benefit of continued intravenous antibiotic therapy during hospitalizations involving transition to comfort measures.

Notably, the use of broad-spectrum intravenous antibiotic therapy was frequent. Nearly two-thirds of all older adults with advanced cancer who transitioned to comfort measures received vancomycin during hospitalization. In addition, over one-third of patients received fluoroquinolones despite safety concerns among older adults.^{29,30} Despite intensive efforts by the Centers for Disease Control and Prevention to improve antibiotic use in hospitals, these results parallel those previously reported by Thompson and colleagues.^{10,31} Moreover, administering and monitoring intravenous antibiotics such as vancomycin with repeated blood draws may burden older adults with advanced cancer who are transitioned to comfort measures. Frequent vancomycin use may not only confer clinically meaningful patient and population harms such as leukopenia, ototoxicity, and transmission of antibiotic-resistant organisms such as vancomycin-resistant *Enterococcus* but also delay transitions of care as many hospice facilities may prohibit intravenous antibiotics.^{11,32}

Many patients also underwent continued evaluation for infection after transitioning to comfort measures. Seventy-three patients had a total of 179 microbiological cultures, including 30 blood cultures and 26 urine cultures, collected on or after the date patients transitioned to comfort measures. The reasons for obtaining these cultures are likely multifactorial and may include the desire to respect the wishes of patients and family members or the desire to treat possibly reversible causes of illness. Although the time from transitioning to comfort measures to discharge or death is short, or approximately 1 day in our sample, the continued evaluation for infection may distract from the focus of comfort at

the end of life in older adults with advanced cancer. Furthermore, obtaining microbiological cultures may even cause discomfort (e.g., catheterization to collect urine specimens). Intervention studies should evaluate the impact of implementing restrictions on the collection of microbiological cultures following transition to comfort measures in older adults with advanced cancer.

Our work highlights a potential role in palliative care for antibiotic stewardship programs. Prior guidelines¹⁷ suggest antibiotic stewardship programs should facilitate clinical decision-making in terminally ill patients with the recommendation that antibiotics be considered “aggressive care” in end-of-life settings. Our findings support these recommendations by demonstrating that antibiotic use is an independent predictor of prolonged hospitalization. Among advanced cancer patients in whom antibiotic use is consistent with goals of care, antibiotic stewardship programs may recommend alternatives to continued intravenous antibiotic therapy, such as long-acting single-dose parenteral regimens with demonstrated efficacy against Gram positive bacteria or oral options with high bioavailability.^{33,34} Future work may consider evaluating the impact of infection management strategies with and without antibiotics on LOS and quality of life among older adults with advanced cancer near the end of life.

Our study has several limitations. First, we could not account for all factors increasing LOS in hospitalized older adults with advanced cancer such as family decision-making regarding goals of care and physical and psychological symptom burden.³⁵ Second, we did not account for antibiotic appropriateness.³⁶ Although the definition of antibiotic appropriateness may be challenging, it is possible that LOS may have varied between those who received appropriate versus inappropriate antibiotic therapy.³⁶ Third, we used administrative codes to identify infection; the sensitivity and specificity to detect infection using administrative data may vary.³⁷ Finally, our results may lack generalizability to other institutions.

In summary, we show that antibiotic use in hospitalized older adults with advanced cancer who transition to comfort measures is associated with prolonged LOS. These results may inform antibiotic goals of care discussions, provide evidence to support antibiotic stewardship interventions in hospitalized older adults with advanced cancer at the end of life, and support the delivery of goal-concordant care by aligning patient preferences with outcomes associated with antibiotic use in this population.

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Table 1.

Descriptive characteristics of hospitalized older adults with advanced cancer who were transitioned to comfort measures at one institution.

Characteristic	No. of Patients (%)
Age	
65 to 74 years	236 (51%)
75 to 84 years	160 (35%)
85 years and above	65 (14%)
Gender	
Female	226 (49%)
Male	235 (51%)
Race	
White	445 (97%)
Black	10 (2%)
Other	6 (1%)
Ethnicity	
Non-Hispanic	429 (93%)
Hispanic	25 (5%)
Other	7 (2%)
Cancer Type	
Liquid tumor ^a	95 (21%)
Lung tumor	99 (21%)
Gastrointestinal tumor	100 (22%)
Other solid tumor ^b	167 (36%)
Selected Comorbidities	
Cardiovascular	95 (21%)
Diabetes	90 (20%)
Pulmonary disease	59 (13%)
Cerebrovascular disease	52 (11%)
Code Status on Admission	
Full code	366 (79%)
No resuscitation, no intubation or both	89 (19%)
Comfort measures	6 (1%)
Antibiotic Exposure	
Antibiotic use	382 (83%)
No antibiotic use	79 (17%)
Hospital Interventions	
Intensive care unit admission ^c	276 (60%)
Mechanical ventilation	91 (20%)

Characteristic	No. of Patients (%)
Vasopressor support	119 (26%)
Tube feeding	88 (19%)
Hemodialysis	9 (2%)
Consultations	
Palliative Care	208 (45%)
Infectious Diseases	50 (11%)
Discharge Disposition	
Expired ^c	256 (55%)
Hospice	184 (40%)
Skilled Nursing Facility	13 (3%)
Home	8 (2%)

^a Liquid tumors include lymphoma (28), myeloid malignancy (43), plasma cell malignancy (18), and lymphoid malignancy (6)

^b Other solid tumors include genitourinary cancer (49), breast cancer (23), female reproductive cancer (18), melanoma (14), head and neck cancer (12), connective tissue cancer (6), central nervous system cancer (3), thyroid (3), and unknown primary (39)

^c Intensive care unit admission (n=255, 67% versus n=21, 27%, $p<.0001$) and death (n=231, 61% versus n=25, 32%, $p<.0001$) were more common among patients exposed versus unexposed to antibiotics, respectively; there were no other differences in patient characteristics according to antibiotic exposure.

Table 2.

Days of therapy according to antibiotic class among hospitalized older adults with advanced cancer exposed to antibiotics who were transitioned to comfort measures (n=382).

Class	Patients, n (%) ^a	Days of Therapy	Days of Therapy per 1000 Patient-Days ^b
Vancomycin	300 (79%)	1578	340.5
Cephalosporins ^c	241 (63%)	1377	297.1
Penicillins ^d	172 (45%)	1018	219.6
Metronidazole	159 (42%)	858	185.1
Fluoroquinolones ^e	139 (36%)	728	157.1
Tetracyclines	70 (18%)	283	61.1
Sulfonamides ^f	34 (9%)	319	68.8
Carbapenems ^g	26 (7%)	256	55.2
Clindamycin	16 (4%)	55	11.9
Gentamicin	11 (3%)	16	3.5
Rifaximin	8 (2%)	97	20.9
Fosfomycin	4 (1%)	5	1.1
Daptomycin	3 (<1%)	35	7.6
Macrolides ^h	3 (<1%)	11	2.4
Aztreonam	3 (<1%)	9	1.9
Tigecycline	2 (<1%)	53	11.4
Nitrofurantoin	2 (<1%)	8	1.7
Linezolid	2 (<1%)	18	3.9
Isoniazid	1 (<1%)	3	0.6
Fidaxomicin	1 (<1%)	1	0.2
Colistin	1 (<1%)	1	0.2

^aSome patients received antibiotics from multiple antibiotic classes

^bDefined as days of therapy divided by cumulative total length of stay across all patients who were exposed and unexposed to antibiotics

^cIncludes cefazolin, cefdinir, ceftazidime, ceftriaxone, cefuroxime, and cephalixin

^dIncludes amoxicillin, amoxicillin/clavulanate, ampicillin, ampicillin-sulbactam, oxacillin, penicillin G, piperacillin-tazobactam

^eIncludes ciprofloxacin and moxifloxacin

^fIncludes sulfadiazine and sulfamethoxazole-trimethoprim

^gIncludes ertapenem and meropenem

^hIncludes clarithromycin and erythromycin

Table 3.

Hospital length of stay according to infection diagnosis among older adults with advanced cancer who were transitioned to comfort measures.

Infection Diagnoses ^a	No. of Patients ^b	Length of Stay, Median (Interquartile Range) Days
Sepsis	161	8.2 (4.2–16.8)
Pneumonia	117	9.3 (4.6–17.3)
Urinary Tract Infection	66	8.1 (4.8–19.9)
Diarrhea ^c	63	11.1 (4.7–18.8)
Fever	29	11.2 (5.7–20.9)
Other ^d	29	11.5 (6.1–21.7)
Upper Respiratory Tract	23	8.5 (4.1–15.2)
Hepatobiliary ^e	20	16.2 (7.7–22.4)
Cellulitis	19	13.1 (5.8–27.1)
Antibiotic-Resistant Organism	12	18.1 (5.7–44.1)
Line-Associated Bacteremia	6	19.8 (15.3–29.1)
Bacteremia	5	18.1 (10.6–21.7)
Joint Infection	5	11.9 (10.0–18.1)

^aShown for those occurring in 5 or more patients

^bSome patients had multiple infection diagnoses

^cIncludes unspecified diarrhea, enterocolitis due to *C. difficile* infection, intestinal infection, unspecified gastroenteritis and colitis, and ulcerative colitis

^dIncludes infections following a procedure, infections in conditions classified elsewhere and of unspecified site, peritoneal adhesions, and post-operative infections.

^eIncludes acute cholecystitis, acute pancreatitis, biliary acute pancreatitis, calculus of bile duct with cholecystitis, calculus of gallbladder with acute cholecystitis, calculus of gallbladder and bile duct with chronic cholecystitis, and other chronic pancreatitis

Hospital length of stay according to cancer type among older adults with advanced cancer who were transitioned to comfort measures only (CMO).^a

Table 4.

Length of Stay	Solid Tumor, Median (Interquartile Range) Days			Liquid Tumor, Median (Interquartile Range) Days		
	Total, n=366	Antibiotic Exposed, n=297	Antibiotic Unexposed, n=69	Total, n=95	Antibiotic Exposed, n=85	Antibiotic Unexposed, n=10
Overall	6.7 (3.3–12.1)	7.4 (3.8–13.9)	4.3 (2.7–6.4)	7.2 (3.4–17.1)	8.2 (3.7–17.3)	4.1 (3.1–6.8)
Admission to CMO	5.5 (2.1–10.9)	6.2 (2.7–12.0)	2.2 (1.1–4.9)	6.2 (2.2–15.7)	7.1 (2.3–15.8)	2.6 (1.4–5.1)
CMO to Discharge	1.0 (0.4–2.0)	1.0 (0.4–2.0)	1.2 (0.8–1.9)	0.9 (0.3–1.8)	0.9 (0.3–1.8)	1.4 (0.4–3.1)

^aThere was no difference in median overall length of stay between patients with solid versus liquid tumors (p=0.42)

Table 5.

Factors associated with hospital length of stay (LOS) among older advanced cancer patients who were transitioned to comfort measures in a multivariable Poisson regression model.

Variable	Count Ratio (95% CI)	P value	Absolute LOS Estimate (95% CI)
Age			
65 to 74 years (reference)	1.00	--	9.1 days (8.5, 9.6)
75 to 84 years	0.81 (0.76, 0.86)	<.0001	7.3 days (6.8, 7.8)
85 or more years	0.75 (0.68, 0.82)	<.0001	6.8 days (6.1, 7.4)
Gender			
Male (reference)	1.00	--	7.9 days (7.4, 8.4)
Female	0.94 (0.89, 1.00)	0.04	7.4 days (6.9, 7.9)
Cancer Type			
Solid Tumor (reference)	1.00	--	7.2 days (6.8, 7.6)
Liquid Tumor	1.14 (1.07, 1.22)	0.0001	8.2 days (7.6, 8.8)
Number of Comorbidities	0.97 (0.94, 1.00)	0.07	--
Intensive Care Unit			
Not Admitted (reference)	1.00	--	7.0 days (6.6, 7.5)
Admitted	1.19 (1.03, 1.12)	<.0001	8.3 days (7.8, 8.9)
Infection Diagnosis ^a			
Not Present (reference)	1.00	--	5.9 days (5.5, 6.3)
Present	1.69 (1.56, 1.82)	<.0001	9.9 days (9.3, 10.6)
Antibiotic Use			
Not Exposed (reference)	1.00	--	6.6 days (6.0, 7.3)
Exposed	1.34 (1.20, 1.51)	<.0001	8.8 days (8.4, 9.3)

^aBased on administrative data