Table 2: Antibiotic exposure and clinically diagnosed infection in first 100 days from HSCT

	Overall n=689	CDI n=132	No CDI n=557	p-value
	n (%)			
Antibiotics				
Carbapenem	498 (72.3)	100 (75.8)	398 (71.5)	0.32
Cephalosporin	189 (27.4)	46 (34.8)	143 (25.7)	**0.034**
Penicillin	153 (22.2)	28 (21.2)	125 (22.4)	0.76
Vancomycin	235 (34.1)	59 (44.7)	176 (31.6)	**0.004**
Clindamycin	18 (2.6)	2 (1.5)	16 (2.9)	0.55
Fluoroquinolones	109 (15.8)	26 (19.7)	83 (14.9)	0.17
Other antibiotics	217 (31.5)	42 (31.8)	175 (31.4)	0.93
Antifungals	49 (7.1)	11 (8.3)	38 (6.8)	0.54
Antivirals	46 (6.7)	13 (9.8)	33 (5.9)	0.10
Infections				
Bacteremia	123 (17.9)	29 (22.0)	94 (16.9)	0.17
Pneumonia	75 (10.9)	22 (16.7)	53 (9.5)	**0.018**
Urinary Tract Infection	87 (12.6)	22 (16.7)	65 (11.7)	0.12
Abscess	8 (1.2)	3 (2.3)	5 (0.9)	0.18
Skin/Soft Tissue Infection	57 (8.3)	8 (6.1)	49 (8.8)	0.30
Viral	31 (4.5)	9 (6.8)	22 (3.9)	0.15
Fungal	12 (1.7)	2 (1.5)	10 (1.8)	0.99
Gastrointestinal	78 (11.3)	10 (7.6)	68 (12.2)	0.13
Upper Respiratory Infection	72 (10.4)	10 (7.6)	62 (11.1)	0.23
Any infection	341 (49.5)	74 (56.1)	267 (47.9)	0.093

Table 3: Characteristics for patients with CDI

	CDI n=132
	n (%)
Infection within 30 days prior to CDI	50 (37.9)
Infection type	
No identified source	15 (30.0)
Bacteremia	9 (18.0)
Pneumonia	9 (18.0)
Urinary tract infection	9 (18.0)
Abscess	3 (6.0)
Gastroenteritis	1 (2.0)
Skin/soft tissue infection	4 (8.0)
Viral upper respiratory tract infection	4 (8.0)
White blood cell (WBC) count	
Neutropenia (absolute neutrophil count ≤ 500)	47 (35.6)
WBC < 2,000	10 (7.6)
WBC 2,000-15,000	61 (46.2)
WBC > 15,000	14 (10.6)
Acute kidney injury (creatinine ≥ 1.5 baseline)	6 (4.6)
Albumin < 3	69 (53.1)
Hypotension (mean arterial pressure < 65)	11 (8.4)
Ileus present	2 (1.5)
American College of Gastroenterology Severity Score	
Mild-moderate	54 (40.9)
Severe	10 (7.6)
Severe-complicated	68 (51.5)
Infectious Diseases Society of America Severity Score	
Mild-moderate	107 (81.1)
Severe	14 (10.6)
Fulminant	11 (8.3)
Treatment	
Metronidazole (intravenous and/or oral)	91 (68.9)
Oral vancomycin	21 (15.9)
Combination metronidazole and oral vancomycin	20 (15.2)
CDI treatment duration > 2 weeks	30 (22.7)
Recurrence (within 60 days)	26 (19.7)

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2673. Risk Factors for *Clostridium difficile* Infection in Lung Transplant Patients

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Background: *Clostridium difficile* infection is a serious and common illness affecting almost 500,000 people in the United States each year. Solid-organ transplant recipients are at increased risk for this infection, with lung transplant patients being at the highest risk. Temple University Hospital (TUH) in Philadelphia has performed the most lung transplants in the United States over the last 2 years.

Methods: A retrospective case–control study was performed to identify patients diagnosed with *C. difficile* following lung transplantation at our institution between January 1, 2014 and April 30, 2018 (N = 35). We randomly selected control patients (N = 35) who had lung transplantation performed during this time but did not develop *C. difficile* infection. The study objectives were to characterize risk factors that are associated with *C. difficile* infection in lung transplant recipients and compare clinical outcomes in recipients with and without *C. difficile*. Statistical analysis was performed using Epi Info (CDC, Atlanta GA).

Results: The average age was 62.4 years, 64.7% were male, 75% were white and 69.1% of transplants were performed for underlying idiopathic pulmonary fibrosis. 52.9% of patients had "non-severe" *C. difficile* infection as defined by the 2018 Infectious Disease Society of America guidelines. Patients with *C. difficile* infection were more likely to have been treated for cytomegalovirus (CMV) viremia (OR 8.2, 95% CI 2.4–28.2, P = 0.0006) and were more likely to have received third- to fifth-generation cephalosporins (OR 4.0, 95% CI 1.4–11.2, P = 0.01) and/or carbapenems (OR 3.7, 95% CI 1.4–9.9, P = 0.02). Patients with *C. difficile* infection were more likely to experience multiple hospitalizations when compared with *C. difficile*-negative patients (3.6 vs. 8.4, P = 0.003). 22 of the 68 evaluable patients died during the study period, 9 of whom had *C. difficile* infection (P = NS).

Conclusion: Patients who received lung transplants and developed *C. difficile* infection were more likely to be treated for CMV viremia, receive antibiotics including cephalosporins and/or carbapenems and require repeat hospitalizations when compared with control patients who did not develop *C. difficile* infection following transplant.

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2674. Microbiome and Cumulative Antibiotic Use as Predictors of Stenotrophomonas maltophilia Infection in Patients with Acute Myeloid Leukemia Receiving Remission-Induction Chemotherapy

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Background: *S. maltophilia* infections are increasingly common in patients with acute myeloid leukemia (AML) and associated with high mortality. *S. maltophilia* is a frequent colonizer in AML patients but relatively little is known about factors that drive *S. maltophilia* infection. We sought to evaluate the utility of cumulative antibiotic use and the microbiome as predictors of *S. maltophilia* infection in AML patients receiving remission induction chemotherapy (RIC).

Methods: We performed a subanalysis of a prospective, observational cohort study between September 2013 and August 2015 of adult patients with AML receiving RIC. In this study, fecal and oral microbiome samples collected every 96 hours from the start of RIC until neutrophil recovery were assessed for the relative abundance of *S. maltophilia* via 16s rRNA quantitation. The primary outcome, microbiologically proven *S. maltophilia* infection, was analyzed using a time-varying Cox proportional hazards model accounting for *S. maltophilia* relative abundance and cumulative antibiotic exposure. Patients were censored at neutrophil recovery or death.

Results: 90 patient were included; of whom, 8 (9%) developed *S. maltophilia* infection (pneumonia, n = 6; skin/soft-tissue infection, n = 2). 4/8 (50%) patients were bacteremic. 7/8 (88%) patients with *S. maltophilia* infection had detectable oral 16s oral reads mapping to *S. maltophilia* vs 22/82 (27%) without infection (P < 0.01). An oral *S. maltophilia* relative abundance of 36% predicted infection (sensitivity: 96%, specificity 93%, likelihood ratio +: 17.08). No association of *S. maltophilia* infection with the fecal relative abundance was seen. Cumulative meropenem exposure was associated with increased infection risk (hazard ratio [HR] 1.17, 95% CI 1.01 – 1.35, P = 0.03), while levofloxacin was associated with decreased infection risk (HR 0.83, 95% CI 0.66 – 1.04, P = 0.10).

Conclusion: The oral microbiome may play an important role in *S. maltophilia* pathogenesis in AML patients. Cumulative antibiotic exposure likely modifies *S. maltophilia* infection risk. These data suggest that real-time molecular monitoring of the oral cavity for *S. maltophilia* in AML patients could identify patients at high risk for *S. maltophilia* infection and improve targeted therapy.

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2675. Changing Epidemiology of Bloodstream Infection During Chemotherapy for Acute Leukemia: Impact of Prophylactic Fluoroquinolone Restriction and Carbapenem Saving Strategy

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Background: Fluoroquinolone prophylaxis has been widely used in high-risk neutropenic patients with hematological malignancies, which may reduce bloodstream infection (BSI) and mortality. However, concerns about antibiotic resistance also exist. The aim of this study was to assess the impact of new institutional strategy of restricting fluoroquinolone prophylaxis and saving carbapenem, applied since October 2016. Fluoroquinolone prophylaxis was adopted only in remission induction chemotherapy, and carbapenems were saved until other antibiotics prove no effectiveness

Methods: We retrospectively reviewed all consecutive intensive chemotherapy episodes for acute leukemia from April 2016 to March 2017 at the Catholic Hematology Hospital. In addition, antibiotics consumption was assessed by calculating defined daily doses (DDDs) per 100 bed-days.

Results: Among 420 admissions during the study period, 201 and 219 admissions were identified before (period 1) and after (period 2) the strategy modification. Baseline characteristics including types of leukemia, chemotherapy, severity and duration of neutropenia were not different between the two periods.Development of febrile neutropenia (83.6% vs. 84.0%, $P = 0.487$), BSI (46.3% vs. 52.5%, $P = 0.291$), and septic shock (4.0% vs. 6.4%, $P = 0.268$) were not significantly different. Polymicrobial BSI increased significantly (7.1% vs. 20.0%, p = 0.012) in period 2. Quinolone resistance (97.8% vs. 43.6%, $P < 0.001$) and extended-spectrum β-lactamase producers (50% vs. 29.1%, $P = 0.032$) among *Enterobacteriaceae* were significantly reduced. Carbapenem-resistant *Enterobacteriaceae* was not isolated in period 2. Vancomycin resistance among enterococci (66.7% vs. 15%, $P = 0.006$) decreased. Consumption of ciprofloxacin (37.2 vs. 13.8) and carbapenem (22.3 vs. 16.8) decreased, while piperacillin/tazobactam consumption increased (5.2 vs. 13.0). BSI-related death (1.0% vs. 0.9%) was not increased.

Conclusion: Fluoroquinolone prophylaxis restriction and carbapenem saving strategies resulted in significant reduction of resistant bacterial BSIs, without increase in febrile neutropenia, BSI, septic shock, and BSI-related death. Antibiotics stewardship program can be tried in neutropenic patients, which may improve the ultimate outcome.

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2676. Effect of β-Lactam Allergy on Appropriateness of Antibiotic Use in Patients with Febrile Neutropenia

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Background: Over 80% of patients with hematologic malignancies develop some form of infectious complication, most commonly febrile neutropenia. Patients with febrile neutropenia have 10% mortality, which increases if antibiotic administration is delayed past 30 minutes. Studies have suggested β-lactam allergy may delay administration of antibiotic while putting patients at greater risk for inappropriate antibiotic choice and adverse effects stemming from this. We sought to describe the risks associated with β-lactam allergy in the neutropenic population.

Methods: We conducted a retrospective, descriptive study from January 2016 to December 2017 identifying patients with febrile neutropenia and a reported history of β-lactam allergy. Baseline characteristics, allergy data, treatment data, and outcomes were collected and analyzed.

Results: We identified 31 patients with febrile neutropenia and β-lactam allergy during this time period. Etiologies of neutropenia were hematologic malignancy (61.2%), stem cell transplantation (12.9%), solid-organ malignancy (22.6%), and autoimmune (3.3%). Reported reactions to β-lactams were rash (41.9%), hives (9.7%), anaphylaxis (3.2%), other (9.7%), and unknown (35.5%). Average time to antibiotic administration was 142.5 minutes. Antibiotic choice was cefepime (61.3%), piperacillin–tazobactam (6.5%), carbapenem (22.6%), fluoroquinolone (6.5%), cefepime and fluoroquinolone (3.2%), and vancomycin (58.1%). 51.6% received initial antibiotics consistent with the 2010 IDSA guidelines. Six patients underwent penicillin skin testing, all negative. 1 patient developed *C. difficile* infection, 1 developed MRSA colonization, and 3 developed VRE colonization. Mortality was 3.2% at 30 days and 16.1% at 90 days.

Conclusion: Our study estimated the antibiotic usage patterns and outcomes in patients with febrile neutropenia and reported β-lactam allergy. This showed low adherence to an established guideline for antibiotic choice in these patients. With rising antimicrobial resistance, there is a need to develop strategies to reduce inappropriate antimicrobial use, especially in patients with febrile neutropenia. Preemptive β-lactam allergy evaluation warrants further evaluation in the neutropenic population.

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2677. Infection-Related Outcomes in Patients With Malignancy-Related Febrile Neutropenia: A National Perspective

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Background: Febrile neutropenia (FBN) is a life-threatening oncological emergency requiring hospitalization and early treatment with broad-spectrum antibiotics. We aimed to study differences in infection-related outcomes for febrile neutropenia in various malignancies.

Methods: The National Inpatient Sample (NIS) data set was queried from 2007 to 2014 to identify all patients with a diagnosis of neutropenic fever (ICD-9: 780.6x and 288.5x or 288.0x or 284.1x). Diagnoses for various cancers were determined via their respective Clinical Classification Software (CCS) codes. Diagnoses of pneumonia (481.x, 482x), bacterial meningitis (320.x), *Clostridium difficile* (008.45), infectious colitis due to neoplastic agents (009.x), urinary tract infection (599.0x), pyelonephritis (590.1x, 590.80), skin and soft-tissue infection (682.x, 684.x, 686.8x, 686.9x), mucositis (528.01), influenza (CCS 487), sepsis (995.91), severe sepsis (995.92), septic shock (785.52), *E. coli* septicemia (038.42), *Pseudomonas septicemia* (038.43), MRSA septicemia (038.12) and Streptococcal septicemia (038.0) were identified using their respective ICD/CCS codes. Variables were analyzed via multivariate analysis using the program SAS.

Results: We studied 381,043 patients with FBN. Leukemia was the most common malignancy associated with FBN (140,190, patients, 36.8%). Meningitis was found to be significantly associated with brain cancer, while other infections were associated with a range of malignancies. (Table.1) Methicillin-resistant *Staphylococcus aureus* was associated with cancers of the bone, breast, uterus and non- hodgkins lymphoma, while other microorganisms varied across different malignancies (Table 2). Septic Shock was associated with cancer of the pancreas, lung, bone, breast, leukemia, bladder, kidney, thyroid, myeloma, prostate, testis, cervix, brain, melanoma, non-hodgkins lymphoma, compared with other malignancies (Table 3).

Conclusion: Pathogen-specific and targeted antibiotic therapy is the cornerstone of treatment in FBN. Our study provides evidence of specific presentations and organisms causing infections in various malignancies. We hope that further outcomes-based research will provide objective evidence of certain high-risk infections, improving patient outcomes and minimizing redundant testing.

Table. 1: Significant association of an infection with malignancies at different location

Infection	Malignancy – Percentage of the infection (%)
Pneumonia	Head (2.6%), Lung (2.85 %), Bone (0.29%), Breast (0.46%), Kidney (0.42%), Leukemia (1.48%), Esophagus (2.05%), Colon (0.82%), Rectum (0.61%), Uterus (0.41%), (Ovaries 0.66%), (Bladder 0.54%), (Brain 0.66%)
Meningitis	Brain cancer (0.32%)
C. difficile	Head (3.17%), Lung (2.85%), Breast (2.75%), Bladder (1.85%), Leukemia (5.52%). Esophagus 2.91, Colon (3.81%), Bone (2.98%), Melanoma (3.53%), Prostate (2.83%), Bladder (1.85%)
Colitis	Stomach (0.57%), Rectum (0.21%), liver (0.49%), Pancreas (0.44%), Bone (0.11%), Breast (0.32%)
Urinary tract infection	Head (4.99%), Colon (11.39%), Rectum (16.04%), Pancreas, (10.80%), Lung (8.55%), Bone (3.87%), Breast (10.03%), Uterus (16.01%), Cervix (19.77%), Ovary (14.10%), Prostate (9.16%), Testis (3.24%), Bladder (22.90%), Brain (4.74%), Hodgkins Lymphoma (4.60%), Leukemia (5.24%), Myeloma (5.97%), Kidney (4.27%) , Melanoma (5.71%), Liver (5.14%), Non-Hodgkin's (7.36%)
Pyelonephritis	Cervical cancer (3.08%), Ovarian, (0.68%), Bladder (1.94%), Head (0.09%), Prostate (0.41%), Leukemia (0.16%)
Skin infection	Colon cancer (2.13%), Lung (2.84%), Leukemia (5.03%), Myeloma (2.62%), Head (5.02%), Hodgkins Lymphoma (3.19%), Brain (4.94%), stomach (3.56%), Prostate (3.17%), Testes (2.65%), Rectum (3.27%), Liver (3.16%)
Mucositis	Head cancers (13.57%), Esophagus (5.21%), Stomach (5.98%), Colon (3.40%), Pancreas (2.66%), Lung (2.24%), Bone (7.47%), Melanoma (2.02%), Breast (2.86%), Myeloma (6.93%) Leukemia (3.72%), Hodgkins (7.02%), Brain (3.17%), Kidney (2.06%), Prostate (2.41%), Bladder (2.94%), Testis (8.18%), Ovary (1.40%), Uterus (1.45%), Cervix (1.39%)
Influenza	Lung (0.20%), Leukemia (0.83%), Myeloma (0.94%), Head (0.19%), Colon (0.14%), Rectum (0.08%), Pancreas (0.00%), Lung (0.20%), Melanoma (0.00%), Breast (0.35%), Uterus (0.00%), Prostate (0.19%), Bladder (0.00%), Non Hodgkins Lymphoma (0.47%), Leukemia (0.83%), Myeloma (0.94%)

Table. 2: Significant association of specific bacterial infection with malignancies at different locations

Microorganisms	Malignancy – Percentage (%)
E. coli	Head (0.41%), Breast (0.65%), Leukemia (1.50%), Bone (0.60%), kidney (0.53%), Non-Hodgkin's (1.14%), Lung (0.87%), Head (0.41%), Breast (0.65%), Leukemia (1.50%)
Pseudomonas	Lung (1.02%), Non Hodgkins (0.97%%), Bone (0.34), Breast (0.51%), Hodgkin's (0.14%), Myeloma (0.44%), Ovary (0.32%), Brain (0.35%), Leukemia (0.74%), Liver (0.34%), Cervix (0.20%)
Streptococcus	Lung (0.38%), Bone, (0.26%), Breast (0.39%), Non Hodgkins (0.74%), Leukemia (1.66%), Head (0.51%), prostate (0.47%), rectum (0.575%), colon (0.46%), myeloma (0.62%),
Methicillin-resistant Staphylococcus aureus (MRSA).	Bone (0.08 %), Breast (0.14 %), Uterus (0.77%), Non-Hodgkin's lymphoma (0.29%)