

average 7.4 days of renal replacement. Three patients experienced encephalopathy with seizures and were managed with levetiracetam and corticosteroids for Stx-induced cerebral edema. One patient received eculizumab, a terminal complement inhibitor approved for atypical HUS, with resolution of seizures and return to his neurocognitive baseline but with persistent electroencephalographic abnormalities. There were no deaths, and all recruits had recovery of renal function.

Conclusion. This case series represents the largest STEC-HUS outbreak affecting a military population. Rates of HUS and mortality were lower than seen in prior outbreaks, in part due to a high level of baseline health and early detection and management of suspect cases. Early volume expansion and close monitoring of cases may have reduced the risk for HUS progression and long-term renal sequelae.

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1099. Antibiotic Prescriptions for Acute Gastroenteritis during Office and Emergency Department Visits—United States, 2006–2015

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Background. Acute gastroenteritis (AGE) is a major cause of office and emergency department (ED) visits in the United States. Most patients can be managed with supportive care alone, although some require antibiotics. Limiting unnecessary antibiotic use can minimize side effects and the development of resistance. We used national data to assess antibiotic prescribing for AGE to target areas for stewardship efforts.

Methods. We used the 2006–2015 National Hospital Ambulatory Medical Care Survey of EDs and National Ambulatory Medical Care Survey to describe antibiotic prescribing for AGE. An AGE visit was defined as one with a new problem (<3 months) as the main visit indication and an ICD-9 code for bacterial or viral gastrointestinal infection or AGE symptoms (nausea, vomiting, and/or diarrhea). We excluded visits with ICD-9 codes for *Clostridium difficile* or an infection usually requiring antibiotics (e.g., pneumonia). We calculated national annual percentage estimates based on weights of sampled visits and used an alpha level of 0.01, recommended for these data.

Results. Of the 12,191 sampled AGE visits, 13% (99% CI: 11–15%) resulted in antibiotic prescriptions, equating to an estimated 1.3 million AGE visits with antibiotic prescriptions annually. Antibiotics were more likely to be prescribed in office AGE visits (16%, 99% CI: 12–20%) compared with ED AGE visits (11%, 99% CI: 9–12%; $P < 0.01$). Among AGE visits with antibiotic prescriptions, the most frequently prescribed were fluoroquinolones (29%, 99% CI: 21–36%), metronidazole (18%, 99% CI: 13–24%), and penicillins (18%, 99% CI: 11–24%). Antibiotics were prescribed for 25% (99% CI: 8–42%) of visits for bacterial AGE, 16% (99% CI: 12–21%) for diarrhea without nausea or vomiting, and 11% (99% CI: 8–15%) for nausea, vomiting, or both without diarrhea. Among AGE visits with fever ($T \geq 100.9^\circ\text{F}$) at the visit, 21% (99% CI: 11–31%) resulted in antibiotic prescriptions.

Conclusion. Patients treated for AGE in office settings were significantly more likely to receive prescriptions for antibiotics compared with those seen in an ED, despite likely lower acuity. Antibiotic prescribing was also high for visits for nausea or vomiting, conditions that usually do not require antibiotics. Antimicrobial stewardship for AGE is needed, especially in office settings.

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1100. Characterization of Enteropathogenic *Escherichia coli* (EPEC) in Cancer Patients With Diarrhea

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Background. Biofire FilmArray multiplexed nucleic acid amplification tests (NAAT) for bacterial diarrhea include probes specific for EPEC. However, the platform does not differentiate typical EPEC (tEPEC, defined as carrying *eaeA* and *bfp*) which have strong epidemiologic associations with diarrhea from atypical EPEC (aEPEC, carrying *eaeA* but not *bfp*) for which there is a weaker association. Nevertheless, emerging data suggest that aEPEC subsets carrying *efa1/lifA* which encodes for adherence factor 1/lymphocyte inhibitory factor A, are associated with diarrhea. The role of EPEC and its subtypes as agents of bacterial diarrhea have not been well defined in immunosuppressed and cancer patients.

Methods. We characterized EPEC subtypes in stools from healthy individuals with no diarrhea (HI, $N = 21$), cancer patients with diarrhea and negative NAAT (DN, $N = 25$) and patients with diarrhea positive NAAT for EPEC (DP, $N = 54$). EPEC isolated from stool cultures were tested for *eaeA* and *bfp*, *stx* and other *E. coli* pathotypes. We estimated the number of fecal EPEC using a qPCR for *eaeA*, *efa1/lifA* that detected 5.6×10^1 to 5×10^7 cfu/mg of stool.

Results. Demographic characteristics and underlying malignancy were similar between DN and DP groups. DP were more likely to have diarrhea on admission than DN [46/52 (88%) vs. 13/25 (52%), $P < 0.01$]. Stool cultures confirmed EPEC in 24/52 (60%) DP of which 23/24 (96%) were aEPEC. Fecal qPCR for *eaeA* confirmed EPEC in 43/52 (83%) of DP, 0/25 DN and in 3/21 (14%) of HI ($P < 0.001$). DP excreted a higher number of EPEC cfu/mg of stool than HI (median 168 vs. 1.18 cfu/mg, $P <$

0.001) and only DP excreted EPEC *efa1/lifA* (+) [14/52 DP (27%) vs. 0/25 DN and 0/21 HI; $P < 0.001$]. When compared with DP EPEC *efa1/lifA* (-), DP EPEC *efa1/lifA* (+) had a longer median duration of illness (3 days vs. 1 day, $P < 0.05$); more likely to be hematopoietic stem cell transplant recipients [7/14 (50%) vs. 7/38 (18%), $P < 0.05$] and had a higher EPEC *eaeA* fecal burden (median 3885 vs. 84 cfu/mg, $P < 0.05$). Co-infections with other pathogens were equally represented in *efa1/lifA* (-) and *efa1/lifA* (+) DP subgroups [8/14 (57%) vs. 21/38 (55%) $P = \text{NS}$].

Conclusion. Most EPEC in cancer patients with diarrhea are aEPEC acquired in the community and when carrying *efa1/lifA* (+), are associated with more severe disease.

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1101. Comparison of Clinical Characteristics and Demographics of GII.4 vs. Other GII Noroviruses Associated With Sporadic Acute Gastroenteritis in Children in Nashville, TN, 2012–2015

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Background. Norovirus is a leading cause of acute gastroenteritis (AGE) in all age groups. Although at least 28 different genotypes infecting humans have been reported, most outbreaks over the last 15 years have been caused by genogroup II (GII) viruses, of which GII.4 viruses have caused more than 50%. Since clinical differences between different genotypes are poorly understood, we sought to compare clinical characteristics in children infected with GII.4 and non-GII.4 viruses.

Methods. Children between 15 days and 17 years who presented with AGE defined as diarrhea (≥ 3 loose stools in a 24 hour period) or vomiting (≥ 1 episodes in a 24 hour period) within 10 days duration were recruited in outpatient, emergency, and inpatient settings in Nashville, TN, during 2012–2015. Stool specimens were tested by RT-qPCR for GI and GII norovirus. Norovirus-positive specimens were genotyped by sequencing of a partial region of the capsid gene. In this study, we excluded children infected with GI, mixed GI/GII and non-typeable GII viruses.

Results. Of 3,705 AGE subjects enrolled, 2,892 (78%) specimens were collected, 637 (22%) tested norovirus-positive (567 [89%] GII, 62 [10%] GI, and 8 [1%] mixed GI/GII). Of the 567 GII viruses, 461 (81%) were able to be genotyped and of those 238/461 (51.6%) were typed as GII.4 and 223/461 (48.3%) were typed as other GII genotypes (non-GII.4, primarily GII.3 [65/461, 14.1%], GII.6 [48/461, 10.4%] and GII.7 [36/461, 7.8%]). Over three AGE seasons, GII.4 represented 64/117 (54%), 79/178 (44%), and 71/166 (57%), of the GII infections, respectively. Compared with non-GII.4 subjects, GII.4 subjects were more likely to be younger (15.5 vs. 21.3 months, $P < 0.01$), and less likely to attend daycare (23% vs. 39%, $P < 0.01$). GII.4 subjects also were more likely to present with diarrhea (75% vs. 57%, $P < 0.01$) and had higher median modified Vesikari score (7 vs. 6, $P < 0.01$).

Conclusion. Children infected with GII.4 viruses were younger, less likely to attend child care, more likely to present with diarrhea, and had a more severe illness compared with those with non-GII.4 infections. These data provide important information on the genotype distribution of norovirus in children with AGE in Tennessee and highlight GII.4 as the most prevalent strain.

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1102. Food Insecurity and Reported History of Cholera in Haitian Households: An Analysis of the 2012 Demographic and Health Survey (DHS)

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Background. Food insecurity is defined as a lack of consistent access to food in adequate quantity or quality. Both cholera and food insecurity tend to occur in impoverished communities where poor access to food, inadequate sanitation, and an unsafe water supply often coexist. The relationship between the two, however, has not been previously studied.

Methods. We performed a secondary analysis of household-level data from the 2012 Demographic and Health Survey in Haiti, a nationally and subnationally representative cross-sectional household survey conducted every 5 years. We used multivariable logistic regression to evaluate the relationship between household food insecurity (as measured by the Household Hunger Scale) and (1) reported history of cholera since 2010 by any person in the household and (2) reported death by any person in the household from cholera. We used survey commands to apply sampling probability weights and account for clustering and stratification in sample design. We performed a complete case analysis because there were no missing data on household food insecurity or cholera and <1% for the other covariates of interest.

Results. There were 13,181 households in the survey, 2,104 of which reported at least one household member with history of cholera. Both moderate hunger in the household [adjusted odds ratio (AOR) 1.47, 95% confidence interval (CI) 1.27–1.71;

$P < 0.0001$] and severe hunger in the household (AOR 1.71, 95% CI 1.42–2.05; $P < 0.0001$) were significantly associated with reported history of cholera in the household after controlling for urban setting, household size, wealth index, water source, time to water source, latrine, and housing materials. Severe hunger in the household (AOR 2.81, 95% CI 1.58–5.00; $P = 0.0005$), but not moderate hunger in the household, was independently associated with reported death from cholera in the household.

Conclusion. This is the first study to identify an independent relationship between household food insecurity and reported history of cholera and death from cholera. The directionality of this relationship is uncertain and should be further explored in future prospective research.

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1104. Deployment-Associated Infectious Gastroenteritis and Associations With Irritable Bowel Syndrome, Post-Traumatic Stress Disorder, and Combat Stress: A Retrospective Cohort Study Among Deployed United States Military Personnel
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Background. Previous studies have shown an association between post-traumatic stress disorder (PTSD) and the development of irritable bowel syndrome (IBS) in deployed service members. Deployment places soldiers at risk for chemical, physical, psychological, and infectious stressors. Acute stress can alter the gastrointestinal barrier leading to gut barrier dysfunction, which is an independent risk factor for infectious gastroenteritis (IGE). We sought to assess if there was an association between IBS and PTSD in military deployed in support of recent and ongoing military operations.

Methods. We conducted a retrospective cohort study of United States service members who participated in a combat deployment to the Middle East from 2001 to 2013 with no prior Axis I disorders or PTSD diagnoses based on data from the Defense Medical Surveillance System. Univariate and multivariate logistic regression models were used to assess the differential risk of PTSD following a combat deployment among those with and without a predeployment diagnosis of IBS. These models were controlled for confounders/covariates of interest (IGE, age, duration of deployment, sex, race, marital status, education level, military rank, branch of service, number of deployments).

Results. Among the 3825 subjects, those who developed IGE had a 34% ($P = 0.02$) increased risk of PTSD compared with those with no IGE during deployment. Additionally, those with IBS predeployment had a 40% ($P = 0.001$) increased risk of PTSD upon return from deployment compared with those without IBS predeployment. Duration of deployment was significantly ($P < 0.0001$) associated with PTSD with an increasing risk with increasing duration of deployment.

Conclusion. IGE and IBS were significantly associated with PTSD further supporting previous studies describing their association. Baseline chronic dysbiosis and acute stress-related microbiota perturbations may lead to short- and long-term resilience and performance deficits in our soldiers that may compromise mission capabilities and decrease the quality of life in returning soldiers. Further understanding the potential interactions between the gut-brain-microbiome may have immediate and long-term impacts on improving warfighter health and performance.

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1105. Vibriocidal Titer Variation and Likelihood of Protection in Children Compared With Adults in a Cholera Endemic Area

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Background. *Vibrio cholerae*, the causative agent of cholera, is responsible for significant morbidity and mortality worldwide. Children less than 5 years old have the highest disease burden of cholera in endemic areas. While children develop serum vibriocidal antibody responses to cholera vaccines, they derive less protection from vaccination compared with adults. The aim of our study was to determine whether the vibriocidal immune responses to *V. cholerae* infection are equally accurate as markers of protection in all age groups.

Methods. Cholera patients and their household contacts, who are known to be at high risk of *V. cholerae* infection, were enrolled between 2001 and 2017 in Dhaka, Bangladesh. Baseline vibriocidal titers were measured at the time of enrollment of household contacts, and participants were followed prospectively for development of *V. cholerae* infection.

Results. We studied 50 contacts < 5 years old (“young children”), 228 contacts 5–16 years old (“older children”), and 548 contacts > 16 years old (“adults”). The

baseline serum vibriocidal titer was higher in contacts who remained uninfected from all age groups than in contacts who developed cholera during the follow-up period (young children: $P = 0.0092$; older children: $P = 0.0003$, adults: $P = 0.0012$).

Conclusion. We found that higher vibriocidal antibody titers were associated with protection against *V. cholerae* infection across all three age categories. These findings may help increase our understanding of the protective immune response against *V. cholerae* infection and have importance for future vaccine development strategies.

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1106. Infectious Etiologies of Acute Gastroenteritis in Children during the First 100 Days Post-Allogeneic Hematopoietic Cell Transplant

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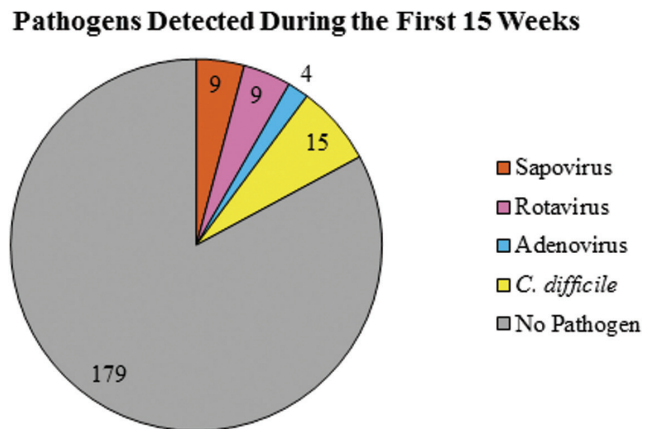
Background. Acute gastroenteritis (AGE) is a frequent sequela in children undergoing hematopoietic cell transplant (HCT). Although rotavirus and norovirus have been implicated as important causes of AGE, the frequency of other pathogens is unknown. Little data exist on longitudinal prevalence of infectious AGE in HCT.

Methods. From February 2015 to May 2016, subjects <18 years undergoing allogeneic HCT were enrolled at four CDC-NVSN sites: Oakland, Kansas City, Seattle, and Nashville. Stool samples were collected at enrollment, weekly until discharge or day 100 (whichever occurred earliest), during re-admissions within the first 100 days, and day 100. AGE was defined as unexplained ≥ 3 episodes diarrhea and/or ≥ 1 episode vomiting/24 hours. Specimens were tested using Luminex xTAG Gastrointestinal Pathogen Panel (Austin, TX) and real-time PCR for adenovirus, astrovirus, norovirus, and sapovirus.

Results. Thirty-one patients were enrolled at four sites (Seattle: 13, Kansas City: 8, Oakland: 6, Nashville: 4) with median age 5 (IQR 3–10) years. Two hundred sixteen samples were obtained with median 7 samples/subject. During the first 100 days, 29 (94%) subjects met the AGE definition. Thirty-six single pathogen detections occurred in 16 (52%) subjects. *Clostridium difficile* was the most frequent pathogen (Figure 1), with 14 detections in nine patients, all ≥ 3 years; 50% of detections were asymptomatic. Seven (50%) detections occurred at HCT onset and none received targeted *C. difficile* therapy. Sapovirus was detected nine times in four patients, with seven (78%) detections associated with AGE symptoms. Rotavirus was detected nine times, during five symptomatic episodes, in three patients. Adenovirus was detected four times in three patients and all were symptomatic.

Conclusion. We longitudinally characterized the etiology of infectious AGE in children undergoing HCT. Despite the majority of patients meeting the definition for AGE, only half had a pathogen detected, suggesting that differentiating infectious vs. noninfectious AGE (e.g., medication induced) in this population is difficult. Although all subjects with adenovirus and most with sapovirus were symptomatic, asymptomatic *C. difficile* detection was common. Interestingly, norovirus was not detected. Further investigation of AGE is warranted in this population.

Figure 1. Pathogens detected during the first 100 days post-HCT.



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