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RESEARCH ARTICLE

Clostridium Difficile Infection and Exposures in a Sample of Hospital Emergency Admissions in Massachusetts, Jan-Jun 2016

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Abstract

Background: Overuse of antibiotics has led to adverse events, including bacterial resistance and *Clostridium difficile* infections (CDI). Antibiotics prescribed by dentists have been implicated in CDI cases. An estimated 10% of outpatient antibiotics in the US are prescribed by dentists.

Methods: Massachusetts monitors emergency department (ED) visits to facilities across the state as part of a national syndromic surveillance project. We sampled 100 of the 1173 individuals who were admitted from an ED visit with a diagnosis code for enterocolitis due to *Clostridium difficile* -A04.7 (ICD-10), from Jan 1, 2016 - Jun 30, 2016, for CDI cases. Our CDI case definition required both laboratory and signs and symptoms consistent with a clinical diagnosis.

Results: Of the 100 records sampled, 80 met our definition. Most individuals with CDI differed from the demographics of cases in Massachusetts: white (74%), non-Hispanic (88%), aged 25-44 years (45%), and not previously diagnosed with CDI. The most common reported symptoms included watery diarrhea (55%), and nausea or vomiting (36%). Most had at least 1 co-morbidity; few (3/69) had documented recent outpatient dental antibiotic use.

Conclusions: Individuals with CDI presenting to EDs frequently had co-morbid conditions and multiple antibiotic exposures. Studies in other populations are needed to characterize the relationship between dental outpatient antibiotic use and contribution to antibiotic adverse events.

Practical implications: Understand the link between CDI and the regular use of antibiotics for all indications. Development of clinical practice guidelines for antibiotic use and antibiotic stewardship protocols are needed to improve the use of antibiotics in clinical practice of dentistry. Guidelines and protocols should be based on evidence and require a systematic review of studies and practices.

Keywords

Antibiotic resistance, *Clostridium difficile*, Antibiotic, Dentistry

Introduction

Clostridium difficile is an anaerobic gram+ spore-forming bacillus that induces bowel damage through the production of toxins. Infection can result in illness ranging from mild diarrhea to severe complications, such as Pseudomembranous colitis, toxic megacolon, sepsis, colectomy, and death [1]. Carriage in the gastrointestinal tract can also be asymptomatic. In 2011, *C. difficile* resulted in an estimated 453,000 infections, and about 29,000 deaths in the United States [2]. *Clostridium difficile* infections (CDI) have been reported outside of acute care facilities (i.e., hospitals), and have been diagnosed and treated in community and nursing home settings without prior hospitalization. However, hospitalizations for *C. difficile* increased 23% per annum from 2000-2005 [3]. Changes in strains and toxins have been associated with increases in frequency and severity of CDI [4]. Risk factors for community-associated CDI include antibiotic use, chronic renal failure, outpatient medical care, proton pump inhibitor use, and trazodone use within 12 weeks of onset [5,6]. Although CDI is commonly treated with oral vancomycin or metronidazole, recurrence and re-hospitalization are common [7]. Most patients with community-associated CDI have a recent outpatient health care exposure; studies of antibiotics from dental settings have found contributions in the range of 15% to 30% [6,8].

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Table 1: Demographic characteristics for the study sample of *Clostridium difficile* infection admissions Jan-Jun 2016.

Group	**Selected CDI Sample (n = 80)**	**All ED visits with CDI diagnosis code (A04.7) and admitted as inpatient (n = 1173)**
Variable	**Count (Percentage)**	**Count (Percentage)**
Age		
< 25	16 (20.0%)	20 (1.7%)
25-44	36 (45.0%)	70 (6.0%)
45-64	26 (32.5%)	289 (24.6%)
> 65	2 (2.5%)	595 (50.7%)
Unknown	0 (0.0%)	199 (17.0%)
Gender		
Female	35 (43.8%)	649 (55.3%)
Male	45 (56.2%)	524 (44.7%)
Race		
White	59 (73.8%)	1035 (88.2%)
Black/African-American	9 (11.2%)	70 (6.0%)
Asian	2 (2.5%)	16 (1.4%)
Pacific Islander	0 (0.0%)	0 (0.0%)
American Indian/Alaskan Native	0 (0.0%)	0 (0.0%)
Other/Unknown	10 (12.5%)	52 (4.4%)
Ethnicity		
Hispanic	2 (2.5%)	42 (3.6%)
Non-Hispanic	70 (87.5%)	1123 (95.7%)
Other/Unknown	8 (10.0%)	8 (0.7%)

In addition to selection for bacterial multidrug resistance and CDI [9], the overuse and injudicious use of antibiotics has short term risks including allergic reactions, toxicities and side effects resulting from damage to normal flora [10-12]. It is estimated that 20% of all emergency department visits are related to adverse events associated with antibiotic use [11]. Both long term and immediate risks are a serious threat to the public health.

Dentists in the United States write roughly 13.17% of all antibiotic prescriptions [13], and this trend has increased over since 2010. A study in British Columbia found that the proportion of prescriptions written by dentists for antibiotics increased to 11.3% (2013) from 6.7% (1996) over a 17-year period [9]. Dentists can play an important role in preventing CDI by way of antibiotic stewardship [13]. The objectives for this report are: 1) To describe CDI identified from a sample of ED reports in Massachusetts and identify possible low-level surveillance trends for recent outpatient dental antibiotic use in that sample; and 2) To briefly review information about CDI for oral health clinicians and their part in antibiotic stewardship.

Methods

Population and case definition

Massachusetts monitors disease events in emergency department (ED) visits across the state as part of a national, Centers for Disease Control and Prevention (CDC) funded project called the National Syndromic Surveillance Program (NSSP) [14]. We selected visits associated with International Statistical Classification of Disease, Tenth Revision (ICD-10), diagnosis code for A04.7 ("enterocolitis due to *Clostridium difficile*") reported from participating emergency department (ED) facilities from Jan 1, 2016 - Jun 30, 2016, as part of validation the syndromic surveillance system.

During the 6-month period, there were 1379 reports associated with an ICD-10 of A04.7 from 37 facilities; of these, 1173/1379 (85%) were admitted. We sampled medical records for 100/1173 (8.5%) cases from 5 facilities, 20 records each. We defined a validated case as a patient whose records documented both a positive laboratory result and signs or symptoms of CDI.

Data collection

We developed a standardized data collection tool capturing clinical and laboratory relevant information of CDI (Table 1) and using the customizable National Healthcare Safety Network (NHSN) form 57.126 [15]. Massachusetts Department of Public Health (MDPH) epidemiologists conducted the chart reviews at the facilities. Data were entered into the Massachusetts Virtual Epidemiologic Network (MAVEN) [16]. MAVEN captures information for CDI events in MA and is used by state and local boards of health and clinical providers [16].

The date of the event was the date of admission to the ED that submitted the report via the syndromic surveillance system, and the discharge date was as indicated in the medical record. The length of stay was the number of days between the date of admission and the date of discharge. The CDI diagnosis was considered new or first episode if a positive fecal sample with no previous history of CDI was documented in the medical record. A recurrent case was indicated by a positive assay result within 2-8 weeks of the current admission.

Location prior to admission was divided into 5 categories: home, subacute care facility, long-term care, residential facility, and other/unknown. Information on history of healthcare exposures included hospital admission within the previous 12 weeks, dental care, antibiotic use and indication within 12 weeks, current use of proton pump inhibitors or trazodone, and concurrent co-morbidities. We also collected select demographics: gender, date of birth, ethnicity, and race. For the clinical evaluation, we collected recorded signs and symptoms, laboratory testing, and the treatment prescribed for the *C. difficile* event associated with the emergency department visit.

Statistical analysis

All statistical analyses were conducted with R version 3.4.1 assuming a 2-tailed α of 0.05. Univariate analysis was used to describe the demographic, clinical characteristics, and treatment applications. Bivariate analyses were performed for these characteristics in respect to first CDI, recurrent CDI and unknown cases using Chi-square, or Fisher's exact tests where indicated.

Results

Record reviews identified 80 individuals among the 100 ED visits who met the criteria for validity (i.e., laboratory testing and signs/symptoms of CDI). While all individuals admitted from ED visits with the CDI diagnosis code during the 6-month period were frequently white, non-Hispanic, our sample population was younger, and more frequently male (Table 1).

Almost half of the cases had no documentation of a previous CDI event (Table 2). These individuals were significantly less likely to have a previous hospital admis-

Table 2: Pre-admittance exposure, co-morbidities, outcomes, and length of stay by diagnosis as primary CDI versus recurrent CDI*.

Variable	First (n = 39)	Recurrent (n = 30)	Unknown (n = 11)	Significance testing: Chi-square (Fisher's exact)
Previously admitted to hospital				
Yes	13 (33.3%)	22 (73.3%)	7 (63.6%)	p = 0.01109 (0.00761)
No	14 (35.9%)	2 (6.7%)	2 (18.2%)	
Unknown	12 (30.8%)	6 (20.0%)	2 (18.2%)	
Antibiotic Use‡				
Yes	23 (59.0%)	27 (90.0%)	3 (27.3%)	p = 0.0003413 (0.0002164)
No	16 (41.0%)	3 (10.0%)	8 (72.7%)	
Antibiotic Indication				
Pre-surgical	2 (5.2%)	0 (0.0%)	0 (0.0%)	p = 0.02618 (0.008044)
Tx Infection	12 (30.8%)	19 (63.3%)	1 (9.1%)	
Other or multiple	5 (12.8%)	5 (16.7%)	2 (18.2%)	
Prophylaxis	1 (2.6%)	0 (0.0%)	0 (0.0%)	
Unknown	19 (48.7%)	6 (20.0%)	8 (72.7%)	
Location for Antibiotic Prescription				
Dental Outpatient	1 (2.6%)	2 (6.7%)	0 (0.0%)	p = 0.009908 (0.003503)
Inpatient	9 (23.1%)	3 (10.0%)	0 (0.0%)	
Outpatient	9 (23.1%)	19 (63.3%)	3 (27.3%)	
Other/Multiple	1 (2.6%)	0 (0.0%)	0 (0.0%)	
Unknown	19 (48.7%)	6 (20.0%)	8 (72.7%)	
Type of Antibiotic Use †,‡				
Quinolone	4 (10.3%)	4 (13.3%)	0 (0.0%)	
Penicillin	2 (5.2%)	1 (3.3%)	1 (9.1%)	
Cephalosporin	3 (7.7%)	0 (0.0%)	0 (0.0%)	
Clindamycin	1 (2.6%)	0 (0.0%)	0 (0.0%)	
Other	16 (41.0%)	21 (70.0%)	2 (18.2%)	
None	19 (48.7%)	6 (20.0%)	8 (72.7%)	
Current PPI Use				
Yes	13 (33.3%)	11 (36.7%)	5 (45.5%)	p = 0.7161 (0.7418)
No	14 (35.9%)	11 (36.7%)	5 (45.5%)	
Unknown	12 (30.8%)	8 (26.7%)	1 (9.1%)	
Current Trazadone Use				
Yes	6 (15.4%)	1 (3.3%)	2 (18.2%)	p = 0.4063 (0.3775)
No	25 (64.1%)	24 (80.0%)	8 (72.7%)	
Unknown	8 (20.5%)	5 (16.7%)	1 (9.1%)	
Concurrent Co-morbidities¶				
Diabetes	5 (12.8%)	10 (33.3%)	2 (18.2%)	
Recurrent UTI	0 (0.0%)	4 (13.3%)	1 (9.1%)	
Chemotherapy	1 (2.6%)	4 (13.3%)	0 (0.0%)	
Dialysis	3 (7.7%)	0 (0.0%)	0 (0.0%)	

Chronic Renal Disease	3 (7.7%)	3 (10.0%)	1 (9.1%)	
None of the Above	4 (10.3%)	1 (3.3%)	0 (0.0%)	
Other	30 (76.9%)	22 (73.3%)	6 (54.5%)	
Unknown	1 (2.6%)	3 (10.0%)	1 (9.1%)	
Died				
Yes	1 (2.6%)	2 (6.7%)	0 (0.0%)	p = 0.5253 (0.7294)
No	38 (97.4%)	28 (93.3%)	11 (100.0%)	
Length of Stay				
≤ 1 day	3 (7.7%)	5 (16.7%)	0 (0.0%)	p = 0.6404 (0.6619)
2-4 days	11 (28.2%)	10 (33.0%)	3 (27.3%)	
5-7 days	10 (25.6%)	6 (20.0%)	2 (18.2%)	
8-14 days	9 (23.1%)	3 (10.0%)	4 (36.4%)	
> 14 days	4 (10.3%)	2 (6.7%)	1 (9.1%)	
Unknown	2 (5.2%)	4 (13.3%)	1 (9.1%)	

*Clostridium difficile infection (CDI); †Antibiotic use within the last 3 months, prior to admission date; ‡Percentages may add up to more than 100% because patient may have taken multiple antibiotics; ¶Patients that have multiple co-morbidities will be counted in multiple rows.

Table 3: Reported signs and symptoms associated with CDI, along with rendered treatment summary.

Variables	**Count (Percentage)**
Signs and Symptoms*	
Acute Abdomen Pain	18 (22.5%)
Abdominal Cramping	13 (16.25%)
Watery Diarrhea	**44 (55%)**
Bloody Diarrhea	17 (21.25%)
Anorexia	1 (1.25%)
Fever	17 (21.25%)
Nausea/Vomiting	**24 (30%)**
Lethargy/Malaise	11 (13.75%)
Lower Abdominal Tenderness	5 (6.25%)
Dehydration	9 (11.25%)
Other	**29 (36.25%)**
Treatment (non-antibiotic)‡	
Fecal Transplant	5 (6.25%)
Toxin Binding Agents	0 (0%)
Neutralizing Agents	0 (0%)
Toxoid Vaccine	0 (0%)
Other	14 (17.5%)
Treatment Antibiotics‡	
Vancomycin	51 (63.75%)
Metronidazole	27 (33.75%)
Fidaxomicin	0 (0%)
Treatment Probiotics‡	
Lactobacillus species	7 (8.75%)
Saccharomyces boulardii	2 (2.5%)

*Percentage adds up to more than 100%, because patients have multiple symptoms reported per case; ‡Percentages may add up to more or less than 100%, because patient may have received multiple treatments.

sion or evidence of recent antibiotic use. Persons with recurrent CDI more frequently had a history of antibiotic use related to an outpatient visit and documented infection. The three most common chief complaints for these cases with CDI as a primary code included diarrhea 44/80 (55%), nausea/vomiting 24/80 (30%), and others such as acute abdominal pain, cramping, and fever. The text words "*clostridium difficile*" were listed in the chief complaints in 29/80 (36%) of records.

We identified three cases that had a history of recent outpatient dental care and antibiotic use: one case was a primary CDI and two were recurrent CDI cases. The antibiotics documented among the 3 patients were a quinolone (1), cephalosporin (1), clindamycin (1), and other (2). Only one patient had a documented dental home. Other descriptive characteristics: current proton pump inhibitor (PPI) use, trazadone use, reported co-morbidities, outcome, and length of stay were not statistically significant with recurrent CDI.

Table 3 reports the reported signs and symptoms and treatment among all cases reviewed. Individuals frequently had more than one symptom or treatment. The most commonly reported symptoms among the patients in our sample included watery diarrhea, other (such as fever or dehydration), and nausea or vomiting. Treatment strategies for CDI included antibiotics (vancomycin and metronidazole) most frequently. Nine cases received probiotics (*Lactobacillus* species and *Saccharomyces boulardii*) and 5 received a fecal transplant in combination with antibiotic therapy.

Three of the cases reviewed were associated with a fatal outcome. Co-morbidities documented during the patient chart review include a history of diabetes mellitus, recurrent urinary tract infections (UTI), chemotherapy, dialysis, and chronic renal disease, among others.

Discussion

The sample of cases of CDI admitted to hospitals from EDs in Massachusetts reviewed in this article points to a large public health concern and illustrates critical issues around the severity and burden of *C. difficile* disease in the population to oral health clinicians. The demographics of cases in our sample were younger than the national age was most are greater than 65 years of age [2], and their risk factors (e.g., recent antibiotic therapy, previous healthcare exposures and co-morbidities such as chronic renal failure, urinary tract infections, and diabetes), signs and symptoms at presentation, and selected clinical treatment options reflect the general epidemiology of CDI. As part of the healthcare team, oral health

Table 4: Summary of Clinical Aspects of Clostridium difficile Infection (CDI).

Risk Factors for CDI*		
• Antibiotic or antimicrobial agent exposure (duration, and the number of antibiotics the patient has been exposed to increases the risk for CDI, but cases have been shown to results from a single course of an antibiotic) • Acid reducing medications (including histamine-2 blockers and proton pump inhibitors) • Gastrointestinal surgery/manipulation • Longer duration of hospitalization • Underlying co-morbidities • Immunocompromising conditions (ex. cancer chemotherapy, HIV, autoimmune disease) • Advanced age (specifically > 64 years of age)		
Antibiotic Classes Associated with increased risk for CDI †		
Frequently Associated	**Occasionally Associated**	**Rarely Associated**
Fluoroquinolones Clindamycin‡ Penicillins (broad spectrum example: ampicillin and amoxicillin)‡ Cephalosporins (broad spectrum)‡	Other Penicillins Macrolides‡ Trimethoprim Trimethoprim-sulfamethoxazole Sulfonamides	Aminoglycosides Bacitracin Tetracyclines‡ Chloramphenicol Metronidazole‡ Vancomycin

Laboratory tests used to diagnose CDI¶				
Polymerase Chain Reaction (PCR): Detects one or more genes responsible for CDI as quickly as within an hour and is almost as sensitive as the CCCA.	**EIA for toxin A&B:** This assay tests for toxin A and B. One, or both toxins can be present with CDI, however toxin B is the most clinically relevant toxin.	**EIA for glutamate dehydrogenase (GDH):** Great for initial screening however this is less sensitive than PCR and cannot differentiate between toxigenic and non-toxigenic strains.	**Selective Anaerobic Culture:** Cultures grow Clostridium difficile, the most sensitive test however it does not differentiate between toxigenic and non-toxigenic strains.	**Cell Culture Cytotoxic Assay (CCCA):** This is the gold standard for testing for CDI, it takes about 2 days for the lab tests to be complete.

Resources Used: *CDC-*Clostridium difficile* Infection Information for Patients (https://www.cdc.gov/hai/organisms/cdiff/cdiff-patient.html). (Archived by WebCite® at http://www.webcitation.org/archive.php); †[39], ‡[29], ¶[40].

clinicians should have knowledge and understanding of CDI in general and understand the unintended effects of antibiotic prescribing (Table 4).

The contribution of recent antibiotics from outpatient dental indications remains unquantified. While we found 3/80 cases had documented exposure from dental practices, further surveillance is needed to explore the relationship between dental outpatient antibiotic use and CDI in populations more representative of the outpatient dental setting. Antibiotic use in dental settings has not been well described, partially due to lack of diagnostic codes. Although antibiotic use is indicated for successful treatment of an oral infection, the frequency with which antibiotics are prescribed for this indication is unknown. Furthermore, clinical guidelines for prescribing in dental settings are lacking, and there is evidence that adherence to guidelines that exist may be low among dentists [17]. In medicine, it is estimated that 30-50% of all antibiotic prescriptions during pediatric ambulatory care or adult outpatient care were unnecessary. With the inappropriate use of antibiotics, the risk of selecting for antibiotic resistance is increasing along with increased costs and risk for adverse events, and creation of demand for new antibiotics [18,19].

Among the elderly, the cost and risk of death have been shown to increase following the year after the incident episode of a CDI [20]. The total financial burden for hospitalization for CDI in the United States is nearly $6 billion dollars annually, without including outpatient treatment costs [21]. The cost of antibiotic use is paid not only by patients, but also puts an economic burden on society [22,23]. Improving the appropriateness of antibiotic use will prevent adverse drug reactions, decrease the economic burden on the healthcare system, and contribute to the control of drug resistance [24]. A comprehensive framework for combating antimicrobial resistance and subsequent disease includes preventing and controlling the spread of infection, tracking disease and the use of antibiotics, improving the use and decreasing the misuse of antibiotics through stewardship programs, and developing new drugs [25].

Antibiotic stewardship

Sir Alexander Fleming, the discoverer of penicillin in 1928, proposed the idea of antibiotic stewardship during his Nobel Peace Prize lecture, "It is not difficult to make microbes resistant to penicillin in the laboratory by exposing them to concentrations not sufficient to kill them, and the same thing has occasionally happened in the body" [26]. He understood the need for the proper indication, correct dosing, frequency, route, and duration of the drugs [26,27]. Antibiotic resistance and increased risk of death from resistant bacterial infections has been documented since the 1950's: The evolution of antibiotic resistance was described as "a novel antibiotic followed by the selection of resistant organisms, and an urgent need for a still newer drug" [25].

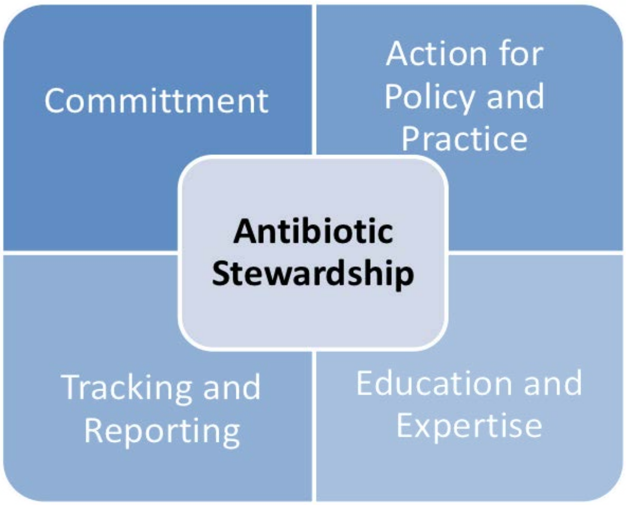

Figure 1: ‡Core Elements of Outpatient Antibiotic Stewardship [41].

Today, antimicrobial stewardship is defined by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America as "An activity that includes appropriate selection, dosing, route and duration of antimicrobial therapy" [18]. An antibiotic stewardship program is developed to ensure that patients receive antibiotics only when indicated, for the dose indicated, and for the duration that is indicated (see Figure 1). One of the recommendations from the White House Forum on Antibiotic Stewardship in June 2015 was to identify sources of data that can be used to actively monitor the use of antibiotics and adverse outcomes [27]; this study contributes to that recommendation. Inpatient, outpatient, and long-term care facilities have protocols for antibiotic stewardship, however development is still needed for similar programs in private dental offices.

Challenges in dentistry

Dentists may feel pressure from other providers or patients to prescribe when antibiotics are not indicated. The guidelines for prophylactic antibiotic use have changed and the uptake of these recommendations in clinical practice is unclear. In dentistry, monitoring the indicated use of antibiotics is difficult. Currently, diagnostic and procedure codes do not exist to track treatment involving a prescription, or for the type and severity of infection in dentistry. Without these codes, it is difficult to monitor use through administrative or other data sets. Consistent with a recent Minnesota study that found that 15% of CDI cases over a 6-year period were linked to dental outpatient antibiotic use, we found that many medical records in EDs did not document the outpatient experience and treatment, specifically for dentistry, possibly because medical records were not integrated with dental records, or because CDI cases presenting to EDs had many non-dental healthcare and antibiotic exposures and further documentation or questions about recent dental care were unnecessary [8]. Special studies to measure dental home, current oral health status, and dental history may enrich data in patient records, and describe the impact of current dental antibiotic use. Much of the medical research on antibiotic use and misuse does not include dentistry. More research is needed to understand the current environment and design relevant programs to improve antibiotic use.

Future in dentistry

In dentistry, a collaborative approach between the American Dental Association (ADA), and all specialty organizations has been proposed to develop guidelines for clinical antibiotic use [27]. Without research, it is unclear how often and when antibiotics are being used inappropriately or unnecessarily because appropriate use has not been defined [19]. Previous studies have shown that outpatient dental antibiotic use is a risk factor for community-associated CDI [28]. In the future, stewardship efforts should include all aspects of outpatient care settings and long-term care facilities, including dental care [5].

Preliminary guidelines have been developed by the American Dental Association (ADA) Council on Scientific Affairs, proposing seven steps a prescriber should go through while prescribing an antibiotic for oral disease. However, for the most part, clinicians are left to their own judgement when prescribing antibiotics [29]. An example of a specific, evidence-based guideline produced by the Council of Scientific Affairs is the practice guideline for the use of antibiotic prophylaxis in dental patients with prosthetic joints [30]. Specialty societies, such as the American Academy of Pediatric Dentistry (AAPD), and American Academy of Endodontics have developed guidelines for their practitioners [31-33]. Guidelines that can be coordinated across all specialties of dentistry would be a valuable contribution to stewardship, an effort the ADA could lead. Once the guidelines are created, educating the profession and public with consistent messaging will encourage the adoption within the entire dental profession, dental organizations/partnerships, and society. Clear indications, and the use of individualized audit and feedback have demonstrated clinically significant reduction in antibiotic prescribing in general dental practice in Scotland [34,35]. Additional interventions that have been shown to be successful include online academic training, patient and provider centered interventions, and displayed clinical posters [36-38]. The incorporation of guidelines into current clinical software will also help the process of antibiotic stewardship to start in the field of dentistry [27].

Limitations

The first limitation lies within the case definition for a CDI which we set as a positive laboratory test and the report of signs and symptoms by the patient, recorded in the history and physical by the provider. Challenges in identifying a true positive case of CDI include: colonization, and absence or subjectivity of symptoms. Therefore, cases might underestimate actual disease if all information is not captured. Secondly, the medical records reviewed rarely documented a history of a dental home, dental visit, or current use of medications. This might result in an underestimation of the effect of dental exposures; however, because individuals presenting to EDs likely reflect a population with many other healthcare exposures, their dental exposures may have appeared less relevant. Integrating dental and medical electronic health records where feasible might address this concern.

Conclusion

A public health problem is resulting from the misuse of antibiotics, including antibiotic resistance and infections with *Clostridium difficile*. We can conclude that further surveillance is needed to monitor the relationship between dental outpatient antibiotic use, CDI, and antibiotic resistance. As others have suggested, combating this public health problem requires educating and informing patients, learning about ongoing research, starting an antibiotic stewardship program within private dental offices, and staying current with antibiotic recommendations and guidelines.

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