

Outbreak Bias in Illness Reporting and Case Confirmation in Ciguatera Fish Poisoning Surveillance in South Florida

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SYNOPSIS

Objective. Ciguatera fish poisoning is a potentially life-threatening disease caused by eating coral reef fish contaminated with ciguatoxins and is the most common marine poisoning. However, existing surveillance systems capture few cases. To improve regional ciguatera surveillance in South Florida, this study compared ciguatera illnesses in the Florida Poison Information Center–Miami (FPICM) call database to ciguatera cases in the Florida Department of Health (FDOH) disease surveillance systems.

Methods. Univariate and multivariate logistic regression were used to identify predictors of when FPICM reported ciguatera illnesses to FDOH and whether FDOH confirmed reported ciguatera cases.

Results. FPICM staff preferentially reported ciguatera illnesses that were of shorter duration (adjusted odds ratio [AOR]=0.84 per additional illness day; 95% confidence interval [CI] 0.74, 0.97); outbreak-associated (AOR=7.0; 95% CI 2.5, 19.5); and clinically more severe (AOR=21.6; 95% CI 2.3, 198.5). Among ciguatera illnesses reported to FDOH, outbreak-associated illnesses were more likely than single, sporadic illnesses to become confirmed surveillance cases (crude OR=11.1; 95% CI 2.0, 62.5).

Conclusions. The over-representation of outbreak-associated ciguatera cases underestimates the true contribution of sporadic illnesses to ciguatera disease burden. This bias should be considered when evaluating surveillance systems that include both outbreak-associated and sporadic illness reports.

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Ciguatera fish poisoning is a potentially life-threatening disease caused by eating coral reef fish contaminated with ciguatoxins and is the most common marine poisoning.¹ Ciguatera classically presents with gastrointestinal and neurological symptoms, including unusual dyesthesias such as reversal of hot and cold sensations and perioral and peripheral parathesias.^{1,2} Intravenous mannitol has been used for acute treatment of ciguatera, although its efficacy remains controversial.^{1,3,4} Ciguatera is endemic in Florida and Hawaii, and these states report most of the outbreaks in the United States.⁵ However, many nonendemic areas have experienced ciguatera outbreaks associated with imported coral reef fish.^{5,6}

Ciguatera outbreaks, like all foodborne illness outbreaks, are reportable in all states, including Florida.⁷ Single, sporadic ciguatera cases are also reportable in Florida. Ciguatera surveillance is highly challenging because no clinical diagnostic tests exist to facilitate either diagnosis or laboratory-based reporting. Also, few clinicians, even in endemic regions, are aware of the disease.⁸ The Florida Department of Health (FDOH) identifies relatively few ciguatera cases each year (Table 1) and was interested in finding ways to improve ciguatera surveillance in the state.

One of the largest single sources of ciguatera illness reports to FDOH is the Florida Poison Information Center/Miami (FPICM), which is a nonprofit organization funded primarily by state and federal grants. The FPICM is staffed by poison information specialists (usually physicians or nurses) and provides diagnostic, treatment, and educational information to clinicians and the public. The FPICM primarily serves Broward, Miami-Dade, Monroe, and Palm Beach counties. All calls to the national poison information center number are automatically routed to FPICM in that geographic

area. Since 1997, FPICM has also operated a marine and fresh water illness hotline to encourage calls to the center specifically about marine- and fresh water-associated illnesses.

The objective of our study was to identify ways to improve ciguatera surveillance in Florida by comparing illnesses clinically diagnosed as ciguatera fish poisoning during phone calls to FPICM and FDOH ciguatera surveillance cases, specifically looking at predictors of case reporting by FPICM and case confirmation by FDOH. We report here on lessons learned.

METHODS

Ciguatera surveillance in Florida

Florida has two forms of ciguatera surveillance data: (1) case-based data collected by Florida's county health departments and forwarded to the FDOH, and (2) outbreak-based data collected as part of the FDOH outbreak investigations unit. The case-based surveillance database includes reported ciguatera illnesses that met Florida's ciguatera case definition: a clinically compatible illness in a patient with a history of fish consumption in the 24 hours before onset of symptoms. Cases are confirmed by examining information provided by the reporting clinician to assess if the case meets the surveillance case definition. If additional information is needed, it is sought from the reporter or patient, if possible. The outbreak surveillance database contains reported ciguatera outbreaks and single ciguatera cases described by vehicle, etiologic agent, and number of associated ciguatera cases.

Ciguatera reporting at FPICM. FPICM staff, like all Florida clinicians, are required by law to comply with public health reporting requirements. Also, FPICM

Table 1. Overlap between Florida Department of Health (FDOH) confirmed ciguatera surveillance cases and Florida Poison Information Center–Miami (FPICM) ciguatera illness calls, 1998–2001

Year	FDOH surveillance data		FPICM illnesses ^a	FPICM illnesses found in FDOH data ^b	
	Case-based	Outbreak			
	<i>n</i>	<i>n</i>	<i>n</i>	<i>n</i>	Percent
1998	1	12	12	2	17
1999	1	6	20	1	5
2000	11	29	31	20	65
2001	8	25	40	11	28
All years	21	72	103	34	33

^aFPICM illnesses are illnesses clinically diagnosed as ciguatera fish poisoning during calls to FPICM (i.e., the caller was told by FPICM staff that the illness was ciguatera or probably was ciguatera). All cases/illnesses are from Miami-Dade (formerly Dade County), Broward, Palm Beach, and Monroe counties only.

^b"FPICM illnesses found in FDOH data" are FPICM illnesses found in FDOH surveillance data (i.e., in either the case-based or outbreak data).

encourages FPICM staff to report all reportable illnesses to FDOH, including ciguatera. If a staff member chooses to report an illness, the electronic FPICM call record is automatically formatted to be forwarded to FDOH, and the illness is recorded as reported in the FPICM database.

Identifying ciguatera illnesses in FPICM call database. We defined FPICM ciguatera illnesses as illnesses clinically diagnosed as ciguatera fish poisoning during calls to FPICM (i.e., the caller was told by FPICM staff that the illness was ciguatera or probably ciguatera). We identified these illnesses by querying the FPICM database for foodborne illness calls received from 1998 to 2001, where the recorded exposure substance was ciguatoxins or a type of fish typically associated with ciguatera (e.g., barracuda and grouper). We read all identified electronic call records and excluded records that contained redundant information from repeat calls on same incident, miscoded exposures, asymptomatic people, and records documenting an illness that was not, or was unlikely to be, ciguatera. During the record review, ciguatera cases were recorded as occurring in the county in which the diagnosis was made, if a community clinician (i.e., not an FPICM clinician) diagnosed them. For those patients who did not see a community clinician, ciguatera was recorded as occurring in the place from which the patient called FPICM.

Predictors of FPICM reporting. We identified predictors of which ciguatera illnesses were reported by FPICM staff to FDOH. Predictors included the following variables obtained from review of the electronic record: type of fish eaten, fish source, symptoms, symptom timing relative to exposure, presence of caller's contact information, and whether health care was received or recommended by FPICM. We also examined the number of outbreak-associated illnesses, which were defined as ciguatera illnesses that were noted to have the same fish exposure as another ciguatera illness. Reporting status was a separate dichotomous variable (i.e., yes/no) in the FPICM database, as described above. Stata 7 was used to perform significance testing (i.e., chi-square test or Fischer's exact test for any cells <5) and logistic regression (univariate and multivariate).⁹

Predictors of case confirmation at FDOH. Using data from 1998 to 2001, we compared FPICM ciguatera illnesses to FDOH surveillance cases (i.e., ciguatera cases in either the case-based or outbreak data). We matched FPICM cases to FDOH cases using the following variables: (1) outbreak data: fish implicated, outbreak date, exposure county, and number of people ill; (2) case-based data: age, gender, ZIP Code, event

date, diagnosis county, and location acquired. These cases were matched without patients' names because we were not able to access surveillance data names from Miami where this project was being conducted. However, matching was straightforward with the existing variables described above because of the relatively small number of cases. We defined "overlap cases" as ciguatera illnesses found in the FPICM call record database and in at least one of FDOH's surveillance databases.

We then identified predictors of whether a reported FPICM ciguatera became a confirmed case in an FDOH surveillance database (i.e., was an overlap case). Data analysis included chi-square testing and univariate logistic regression. A similar analysis was done for FPICM ciguatera cases not reported to FDOH. The small sample size precluded the use of multivariate regression for these two analyses.

RESULTS

We identified 198 potential ciguatera illnesses in the FPICM call database based on our search parameters. We excluded 16 duplicate records, seven asymptomatic callers, four miscoded exposures, and 22 records where FPICM staff documented that the illness was not, or was unlikely to be, ciguatera. Thirty-four individuals were diagnosed outside of Florida, including 14 who called from Florida but were exposed and diagnosed in the Caribbean. Nearly all ciguatera illnesses diagnosed in Florida (113/115) were diagnosed in the FPICM catchment region. Table 1 presents counts of FPICM ciguatera illnesses and FDOH surveillance ciguatera cases for the FPICM geographic catchment region.

Based on FPICM records, 44 of 103 (43%) illnesses diagnosed as ciguatera were reported to FDOH. In univariate analysis, we found ciguatera illnesses in the FPICM database with the following characteristics more likely to be reported to FDOH: documented fish consumption, outbreak-associated, shorter symptom duration, and higher clinical severity (Table 2). Also, ciguatera illnesses with a physician visit or an FPICM staff recommendation for mannitol treatment were more likely to be reported. Ciguatera illnesses with classic symptoms including hot and cold sensation reversal and parathesias were not more likely to be reported to FDOH. In multivariate analysis, ciguatera illnesses were more likely to be reported if they were more severe clinically, shorter duration, and outbreak-associated (Table 3).

Most but not all reported FPICM ciguatera in the catchment region (27/44; 61%) were matched with a FDOH surveillance system ciguatera case. In univariate

Table 2. Frequency of Florida Poison Information Center–Miami (FPICM) reporting to Florida Department of Health (FDOH) for ciguatera fish poisoning illnesses by illness characteristics, 1998–2001

Illness characteristics	No	Illness reported to FDOH		p ^a
		Yes	Percent yes	
Outbreak illness ^b				
No/unknown	37	10	21	Reference
Yes	22	34	61	<0.001
Symptom duration in days at call				
Mean	8	2		<0.001
Clinical visit type				
None	8	0	0	Reference
Any	26	35	57	0.002
Outpatient	7	4	36	0.103
ED	9	28	76	0.001
Inpatient	8	3	27	0.228
Unknown visit type	2	0	0	NC ^c
Unknown if had visit	25	9	26	0.168
Mannitol recommended by staff				
Not specified	29	9	24	Reference
Already given	3	7	70	0.001
Yes	21	26	55	0.006
"Too late" per staff	6	2	25	1.000
Fish ingestion				
No/not documented	26	8	24	Reference
Yes	33	36	52	0.006
Illness severity				
Minimal clinical effect	15	1	6	Reference
More serious effects	44	43	49	<0.001
Restaurant or grocery fish source				
No	4	9	69	Reference
Yes	9	17	65	
Unknown	46	18	28	<0.001
Hot and cold reversal				
No	44	30	41	Reference
Yes	15	14	48	0.475
Parathesias (peripheral or perioral)				
No	28	14	33	Reference
Yes	31	30	49	0.110
Overall	59	44	43	

^ap-value for chi-square test or Fischer's exact test if any cell less than 5, except for symptom duration where the p-value is for a t-test.

^bOutbreak illness is a case with the same food exposure as at least one other case.

^cNot calculable because column total = zero.

ED = emergency department

analyses, ciguatera illnesses associated with outbreaks and of shorter duration were more likely than other ciguatera illnesses in the FPICM database to be classified as confirmed cases by FDOH (Table 4). Illnesses with a documented incubation period (i.e., time from exposure until first symptom onset) were much more likely to be FDOH-confirmed ciguatera cases (crude OR=47.7; 95% CI 5.1, 443.9). Ciguatera illnesses in the FPICM database with records documenting both fish ingestion and illness onset within 24 hours of ingestion

were highly likely to be confirmed by FDOH (crude OR=84.5; 95% CI 8.6, 834.6). In a stratified analysis, 100% of outbreak-associated illnesses that met these two criteria were confirmed FDOH cases, and none of the non-outbreak ciguatera illnesses that did not meet these criteria were confirmed. Of note, ciguatera illnesses not meeting the symptom timing criteria all lacked incubation period information rather than having a documented incubation period >24 hours.

For the 59 ciguatera illnesses recorded by FPICM

Table 3. Univariate and multivariate logistic regression modeling of predictors of Florida Poison Information Center (Miami) reporting ciguatera fish poisoning illnesses to the Florida Department of Health, 1998-2001

Predictors	Odds of illness being reported to Florida Department of Health					
	Univariate analysis ^a		MLR Model 1 ^a		MLR Model 2 (final) ^a	
	Crude OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Fish ingestion						
No/not documented	1.0	Reference	1.0	Reference		
Yes	3.5	1.4–8.9	3.1	0.9–10.3		
Outbreak illness ^b						
No/unknown	1.0	Reference	1.0	Reference	1.0	Reference
Yes	5.7	2.4–13.8	8.1	2.5–26.4	7.0	2.5–19.5
Duration of symptoms in days						
Each additional day	0.8	0.7–0.9	0.9	0.8–1.0	0.8	0.7–0.97
Mannitol recommended by staff						
Not specified	1.0	Reference	1.0	Reference		
Already given	7.5	1.6–35.3	1.7	0.2–15.8		
Yes	4.0	1.6–10.2	1.7	0.4–7.3		
“Too late” per FPICM	1.1	0.2–6.3	3.7	0.4–34.6		
Illness severity						
Minimal clinical effect	1.0	Reference	1.0	Reference	1.0	Reference
More serious effects	14.3	1.9–113.2	31.8	2.8–359.6	21.6	2.3–198.5

^aN=100 observations. Model 1 contains all predictors, and Model 2, the final model, contains only those predictors that were significant at $p<0.05$ after controlling for all other variables in the model (i.e., in Model 1).

^bOutbreak illness = illness with same food exposure as at least one other FPICM illness.

MLR = multivariate logistic regression

OR = odds ratio

CI = confidence interval

but not reported to FDOH, only seven (12%) were matched to a case within the FDOH surveillance database. These patients all had visited a physician. No significant predictors of case confirmation were identified for these 59 illnesses.

DISCUSSION

We compared ciguatera illnesses identified through calls to the FPICM with confirmed ciguatera cases in the FDOH surveillance databases. We specifically examined what illness and call record characteristics predicted successful capture of ciguatera illnesses during two key disease surveillance steps: (1) FPICM reporting ciguatera illnesses to FDOH, and (2) FDOH confirming reported ciguatera illnesses as ciguatera cases. FPICM clinicians were more likely to report ciguatera illnesses of greater severity, shorter duration, and those associated with an outbreak, suggesting preferential reporting of ciguatera illnesses they believed needed further investigation. Among reported ciguatera illnesses, FDOH epidemiologists were more likely to confirm outbreak-related illnesses compared

to sporadically occurring illnesses, resulting in additional bias favoring inclusion of outbreak-related cases in the surveillance database. Also, because a specific time period is required from fish exposure to disease (i.e., incubation period) in the FDOH ciguatera case definition, FDOH rarely confirmed the illness as a ciguatera case if the incubation period was missing from a call record.

All Florida clinicians are required to report ciguatera illnesses to appropriate public health officials. At FPICM (and all poison information centers [PICs] nationally), disease reporting is facilitated by automated report generation; however, the process requires that the individual PIC clinician taking calls initiate the report by clicking on the “generate foodborne disease report” button in the electronic record. Our analysis suggested that some misconceptions existed regarding disease reporting among FPICM staff. Specifically, FPICM staff appeared to be more familiar with the outbreak investigation function of disease reporting and less familiar with the surveillance function; i.e., they were more likely to report serious, outbreak-related illnesses. Classic clinical characteristics of ciguatera (such

as the reversal of hot and cold temperature sensations) did not predict reporting, supporting our hypothesis that reporting was associated with factors other than diagnostic certainty. To our knowledge, this bias favoring reporting diseases associated with outbreaks has not been previously documented; however, it could be widespread, given clinicians' poor understanding of public health surveillance activities.¹⁰⁻¹²

Reporting rates could likely be improved by using

quality assurance measures such as periodic automated searches of the FPICM call database for reportable diseases and by determining the proportion of these illnesses that were reported to FDOH through the existing automatic reporting field. As a long-term goal, automated reporting when certain exposure substances are coded (e.g., ciguatera) would simplify the reporting process and reduce the PIC clinician and staff reporting-related time burden. However, the

Table 4. Univariate predictors of case confirmation by Florida Department of Health (FDOH) for ciguatera illnesses reported by Florida Poison Information Center-Miami (FPICM), 1998–2001

Predictors	n	Percent confirmed	Odds of confirmation	
			Crude OR	95% CI
Case definition components				
Fish Consumption				
No/unknown	8	0	NC ^a	
Yes	36	75		
Symptom timing documentation				
Undocumented	12	8	1.0	Reference
Documented	32	81	47.7	5.1, 443.9
Fish consumption and symptom onset ≤24 hrs				
No/not documented	14	7	1.0	Reference
Yes	30	87	84.5	8.6, 834.6
Other illness characteristics				
Outbreak illness ^b	0			
No/unknown	10	20	1.0	Reference
Yes	34	74	11.1	2.0, 62.5
Duration of symptoms in days at call				
Means	unconfirmed: 4; confirmed: 1		0.4 ^c	0.2, 0.7
Visit type				
None	0	—	NC ^a	
Outpatient	4	100		
ED	28	64		
Inpatient	3	67		
Unknown type	9	33		
Restaurant or grocery food source				
No/unknown	27	63	1.0	Reference
Yes	17	59	0.8	0.2, 2.9
Hot and cold reversal				
No	30	63	1.0	Reference
Yes	14	57	0.8	0.2, 2.8
Parathesias (peripheral or perioral)				
No	14	86	1.0	Reference
Yes	30	50	0.2	0.0, 0.9
Overall	44	61		

^aNC = odds ratio not calculable because of zero cell. For fish consumption, $p < 0.001$ by Fischer's exact test. For visit type, there were no significant differences between groups ($p = 0.13$ by Fischer's exact test).

^bOutbreak illness is a case with the same food exposure as at least one other case.

^cOdds of confirmation for each additional day of symptom duration at the time of the call to the poison information center.

OR = odds ratio

CI = confidence interval

ED = emergency department

current database structure is organized according to exposure substance rather than diagnosis, and implementing this change would increase the time burden for FDOH to sort through additional reports to identify confirmable cases.

Not all ciguatera illnesses reported by FPICM to FDOH were found in the FDOH surveillance databases. Reported ciguatera illnesses were much more likely to become confirmed FDOH cases if key requirements of the FDOH case definition (i.e., fish consumption and incubation period) were documented. In particular, it appears that missing information on incubation period prevented many ciguatera illnesses from meeting the FDOH ciguatera case definition. Consistent with the national PIC database structure, the FPICM database does not include a separate data field (i.e., a pick box) for incubation period. Without this information, applying an epidemiologic case definition for surveillance or investigation purposes is challenging. This challenge is particularly true nationally, because the free-text comment section where this information is sometimes documented is not transmitted from local centers to the national Toxic Exposure Surveillance System (TESS) maintained by the American Association of Poison Control Centers. Recontacting FPICM callers to collect this additional information is difficult if not impossible because many calls are made from hotels and other temporary numbers.¹³

Educating FPICM staff to include incubation period in the free-text comment section would improve regional, but not national, ciguatera tracking. As a long-term goal, adding a pick box to the national PIC database to record the amount of time elapsed from substance exposure until symptom onset would be helpful for toxin-mediated foodborne illness surveillance in general, because case confirmation is often based on clinical details alone. Nationally, TESS has already played an important role in outbreak investigation for toxin-mediated foodborne diseases such as the saxitoxin-related neurologic illness cluster associated with eating pufferfish.¹⁴ Further refinements would enhance the database's contribution to both disease monitoring and outbreak investigation.

We also found that case-confirmation among reported ciguatera illnesses was more likely for illnesses that were part of an outbreak. Why outbreak status was a predictor of case confirmation is unclear, because both individual case-based and outbreak surveillance databases include single ciguatera illnesses in Florida. The outbreak investigation staff at the state level receives the initial reports from FPICM. Because follow-up is part of their routine response to foodborne disease outbreaks, they may be more likely to follow up

on ciguatera illnesses that are part of a multi-person outbreak to obtain missing information than on single ciguatera illnesses. The loss of single illnesses at both the level of reporting and the level of case confirmation creates an overrepresentation of outbreak cases in the surveillance data, which should be taken into account when interpreting this data for public health prevention purposes.

The limitations of this study include the dependence on information available in existing FPICM call records regarding ciguatera illness characteristics. We could not accurately identify definite ciguatera cases among the calls about ciguatera illness because follow-up was not done to ascertain if undocumented symptoms were present or absent. Consequently, we could not calculate unbiased reporting rates. Also, these cases were matched without the benefit of identified data, but we believe the small number of cases allowed for successful matching based on other illness and patient characteristics.

Foodborne disease is an enormous cause of morbidity and mortality nationally,¹⁵ and ciguatera is the most common foodborne illness associated with a chemical toxin.² Surveillance data guides public health intervention for foodborne diseases. Our close analysis of ciguatera surveillance in South Florida identified an outbreak bias in reporting and case confirmation. This increased representation of outbreak-associated illnesses in ciguatera surveillance data overestimated the true proportion of outbreak-associated ciguatera in the overall ciguatera disease burden. This bias should be considered when evaluating other surveillance systems that include disease outbreak reports.

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