Shipshape: Sanitation Inspections on Cruise Ships, 1990–2005, Vessel Sanitation Program, Centers for Disease Control and Prevention

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Abstract

In the course of a successful collaboration between the Centers for Disease Control and Prevention (CDC) and the cruise ship industry on reducing common-source outbreaks, CDC's Vessel Sanitation Program (VSP) has expanded its training, education, and cruise ship inspection programs. The study reported here evaluated 15 years of ship sanitation inspection data from the National Center for Environmental Health and assessed performance in specific sanitation categories from 1996 to 2005. During the period 1990–2005, scores from cruise ship environmental sanitation inspections steadily improved. The percentage of inspections with violations decreased among five of nine categories. Those five categories were Washing Facilities, Contact Surfaces, Facility Maintenance, Food Handling, and Communicable Disease Practices. Inspection violations increased proportionally in the categories of Swimming Pools and Water System Protection/Chart Recording. Overall continued good performance in most sanitation categories is likely attributable to on-site training during inspections, improvements in ship construction, and a switch from hot-holding temperatures to time limits as a public health control for foods on display.

Background

In 1975, the then-Sanitation and Vector Control Activity (now the Vessel Sanitation Program [VSP]) at the Centers for Disease Control and Prevention (CDC) began surveillance for enteric diseases aboard passenger cruise ships. It did so in response to widespread findings of food-handling and water sanitation practice deficiencies that posed a significant potential for transmission of foodborne and waterborne diseases (Merson, Hughes, Wood, Yashuk, & Wells, 1975). To reduce the occurrence of outbreaks and identify unsafe sanitation practices, VSP also began conducting environmental sanitation inspections modeled on the Food and Drug Administration (FDA) *Food Code* (FDA, 2005), outlined in the *Vessel Sanitation Program Operations Manual* (Centers for Disease Control and Prevention, National Center for Environmental Health, 1989). Following 15 years of program implementation and development, an evaluation of the program between 1989 and 2001 reported a decline in foodborne outbreaks and gastroenteritis incidence rates on cruise ships associated with improved environmental sanitation performance by industry (Koo, Maloney, & Tauxe, 1993).

Since 2002, however, with the emergence of noroviruses associated with person-to-person and environmental transmission of disease, there has been an associated rise in the incidence rates of gastroenteritis on cruise ships (Cramer et al., 2006; Isakbaeva et al., 2005; Widdowson et al., 2004). Concurrently, the fleet sizes of major cruise lines have grown, with increasing numbers of passenger embarkations per year and larger, more complex vessels at sea (International Council Cruise Lines, 2005). In the course of the successful collaboration of CDC with the cruise industry on reducing common source outbreaks (Cramer, Gu, Durbin, 2003; Lawrence, 2004; Rooney et al., 2004) and on the challenges associated with environmental decontamination of noroviruses, VSP has expanded training, education, and inspection programs. This article presents 15 years of VSP ship sanitation inspection data, evaluates ship characteristics associated with performance on environmen-

tal sanitation inspections, and assesses sanitation performance in specific inspection categories in the context of a burgeoning cruise ship industry.

Methods

Sanitation Inspections

VSP environmental health officers (EHOs) conduct twice-annual, unannounced sanitation inspections (called routine inspections) of cruise ships sailing from foreign to U.S. ports and carrying 13 or more passengers. These inspections, scored on the basis of a possible 100 points, evaluate sanitation performance in six major categories: disease reporting, potable-water maintenance and distribution, swimming pools and spas, food safety and handling, medical log maintenance and reporting, and environmental health practices (e.g., housekeeping, disinfection, maintenance of child activity centers). Significant violations identified during inspections result in a loss of points; minor violations are noted on the inspection report and may not result in point deductions.

Inspections are conducted in U.S. ports within one day or less by one to three inspectors, depending on the size and complexity of each vessel. For vessels that do not meet the minimum passing score of 86 or higher, an unannounced re-inspection within 45 days of a failed inspection is conducted. Immediately following the conclusion of each inspection, EHOs review the inspection findings and sanitation deficiencies with the ship's master and the senior management personnel on board each vessel. Cruise ships are asked to submit corrective-action statements to VSP in response to violations cited on inspection reports within 30 days of an inspection. Cruise lines may submit appeals of inspection scores to VSP for review. Inspection scores and violations associated with each ship inspection are recorded and stored in the VSP database at CDC in Atlanta, Georgia, and can be accessed at http://wwwn.cdc.gov/vsp/InspectionQueryTool/Forms/InspectionSearchBasic.aspx.

VSP Operations Manual

Guidelines for environmental sanitation practices on ships are outlined in the *Vessel Sanitation Program Operations Manual*, originally published and provided to the cruise industry in 1989. In 2000, a revised edition was introduced to expand guidelines for food-handling practices, detail gastroenteritis reporting requirements, and update pool and spa guidelines (CDC, National Center for Environmental Health, 2000). The updated manual was introduced during the 12-month period of November 2000 to November 2001. During this period, deficiencies not described in the first edition were subject to a grace period in which no violation points were deducted unless the item was critical to public health performance. More information and a copy of the *Vessel Sanitation Program Operations Manual 2005* are available at www.cdc.gov/nceh/vsp.

VSP Program Operations

EHOs of the VSP are commissioned officers of the U.S. Public Health Service. EHO procedures and practices are standardized internally through administrative reviews of inspection reports and standardization meetings held five times per year. In addition to inspections, VSP offers training for cruise line personnel in food safety and sanitation during three-day courses held in Miami five times per year. To assist the cruise industry with implementing public health standards during ship construction, EHOs provide fee-for-service construction inspections in shipyards throughout Europe and North America. The VSP program budget is funded exclusively through fees charged for each vessel inspection on a cost-recovery basis. Fees are based on gross registered tonnage of each vessel. The authority for inspection and enforcement of the program is provided by the Public Health Services Act, Part G, Quarantine and Inspection (Public Health Services Act: Quarantine and Inspection Regulations, 42 U.S.C. § 264).

Outcomes

VSP evaluated median routine inspection scores and numbers of routine and construction inspections on cruise ships during 1990–2005. The association between ship and sanitation inspection characteristics and inspection scores was examined by examination of the 2001–2005 data. Electronic ship characteristic data were incomplete before 2001. To assess violation-specific performance by the cruise ship industry over time, we evaluated the frequency of violations among sanitation inspections during 1996–2005. Continuous variables were described by means of medians and interquartile ranges (e.g., inspection scores, age of ship, year) and categorical variables (e.g., inspection regions, inspectors, year, ship size, fleet size, violations). The descriptions used frequencies and percentiles. An inspection score of less than 86 is defined as a failed inspection.

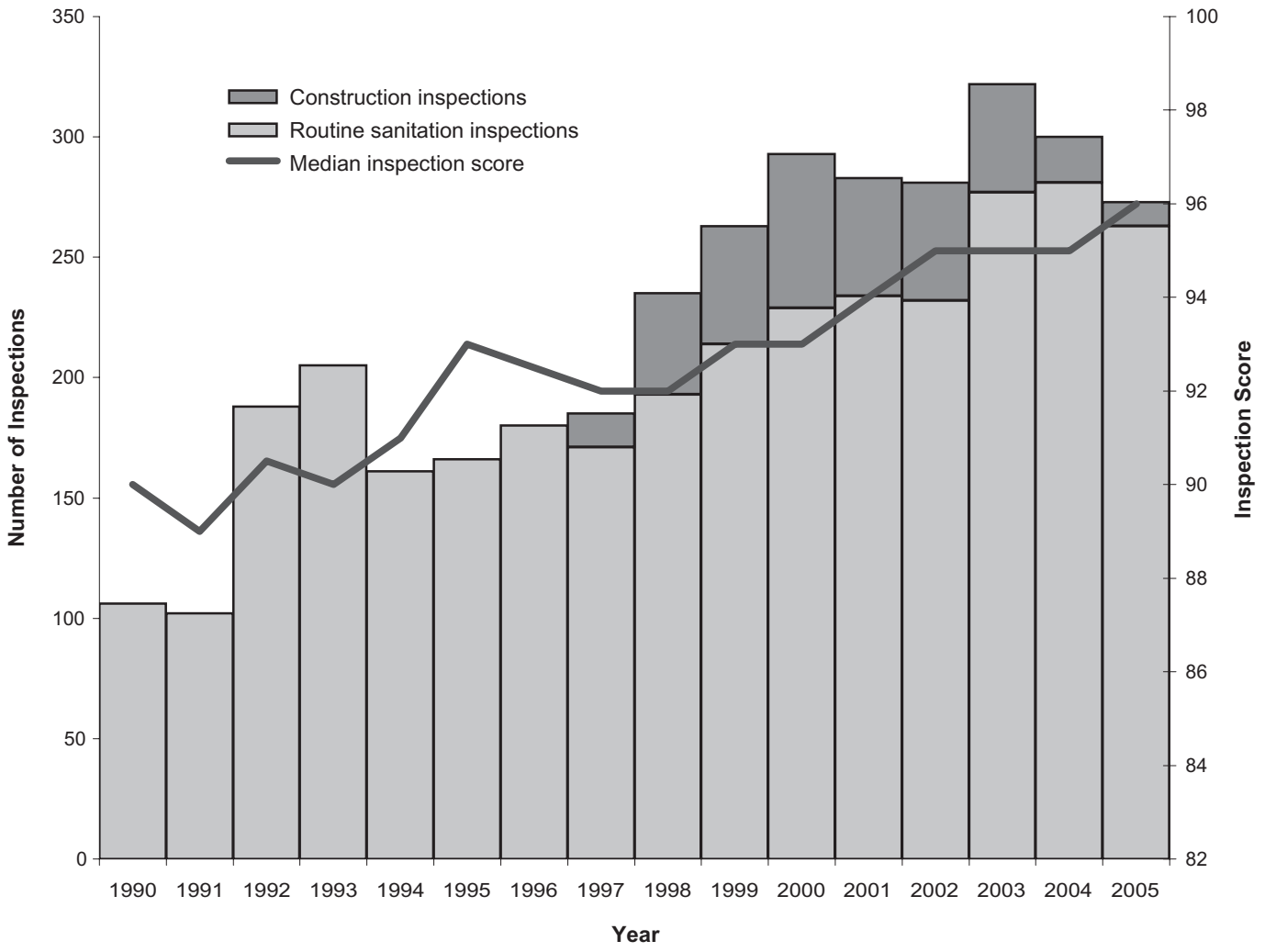
Analysis

Using the VSP inspection database records for each ship inspection for the period 1990–2005, VSP analyzed median routine sanitation inspection scores. For the period 2001–2005, VSP performed a univariate analysis of the association between inspection scores and ship and inspection characteristics, including ship age (in years); fleet size (number of vessels in the fleet of a cruise line); ship size (in gross registered tonnage); inspector (14 of 17 inspectors who performed inspections during the study period were included; three were excluded because they had conducted a total of less than 12 months of inspections during the study period); and inspection region (grouped into eight regions: Northwest [Washington, Oregon, and Alaska], Hawaii [Hawaiian Islands, Saipan, and Guam], Southwest [California] , South [all ports on the Gulf of Mexico excluding Florida], Northeast [all states north of and including North Carolina], Southeast [Florida, Georgia, and South Carolina], and the Caribbean Islands). Data originating from ships not participating in VSP inspections (e.g., ships with domestic itineraries only) were not represented in the analysis. Ships listed in the database with no routine inspection scores during the entire study period and erroneous reports (e.g., missing inspection scores) were excluded from further analysis.

For this analysis, violations cited during inspections were grouped into nine inspection categories: Disease Reporting (gastroenteritis syndromal case reporting to CDC and medical log maintenance); Water Bunkering (production and distribution system halogen residual maintenance); Water System Protection/Chart Recorder (cross-connection control and backflow prevention, maintenance of chart recorders and valves and of caps and hoses); Swimming Pools (pool and spa halogen residual and safety equipment maintenance); Communicable Disease Practices (handwashing practices, knowledge, and monitoring); Food Handling (temperature and food source monitoring and protection, thawing, prevention of cross-contamination); Contact Surfaces (food and nonfood contact surface wash, rinse, and sanitizing practices); Ware-Washing Facilities (equipment and utensil cleaning and maintenance); and Facilities Maintenance (solid and liquid waste management, equipment lighting and venting). We used the regression adjustment method of "marginal

FIGURE 1

Inspection Scores by Year, 1990–2005, CDC Vessel Sanitation Program



For routine sanitation inspections, $n = 3,202$. For construction inspections, $n = 341$.

prediction" to calculate adjusted percentages of violations, by year, for each inspection category (Wilcosky & Chambless, 1985). Statistical computations were performed in 2006 with SAS software, Version 9.1.3 (SAS Institute Inc., Cary North Carolina).

Results

For the period 1990–2005, 3,904 inspections were recorded in the VSP database; 359 were excluded from further analysis because they represented re-inspection reports or were reports not associated with a final score or ship name. Of the remaining records, 3,202 were routine inspection records representing 330 unique vessels; 341 were construction inspection records on 153 unique vessels. The number of routine, unannounced inspections on ships ranged from 102 to 281 per year (median was 199). Median inspection scores gradually increased from 90 in 1990 to 96 in 2005 ($t = -24.58$; $p < .001$) (Figure 1).

By univariate analysis, ship size and fleet size were correlated with median inspection scores and inversely associated with failed inspections (Table 1). Newer ships were associated with higher median inspection scores and were less likely to fail inspections. There was no association between inspection region and failed inspections. For the 14 sanitation inspectors who performed inspections during at least 12 months of the study period, the median number of inspections performed was 93 (range was 17–197); median inspection scores varied significantly among inspectors (Kruskal Wallis Chi square = 93.35; $p < .001$; [range of median inspection scores was 93–97]).

During 1996 to 2005, the percentage of inspections with point deductions decreased in five of the nine inspection categories: Ware-Washing Facilities ($F = 131.8$, $p < .01$), Contact Surfaces ($F = 56.5$, $p < .001$), Facilities Maintenance ($F = 27.3$, $p < .001$), Food Handling ($F = 87.3$, $p < .001$), and Communicable Disease Practices ($F = 6.0$, $p < .014$). During

TABLE 1

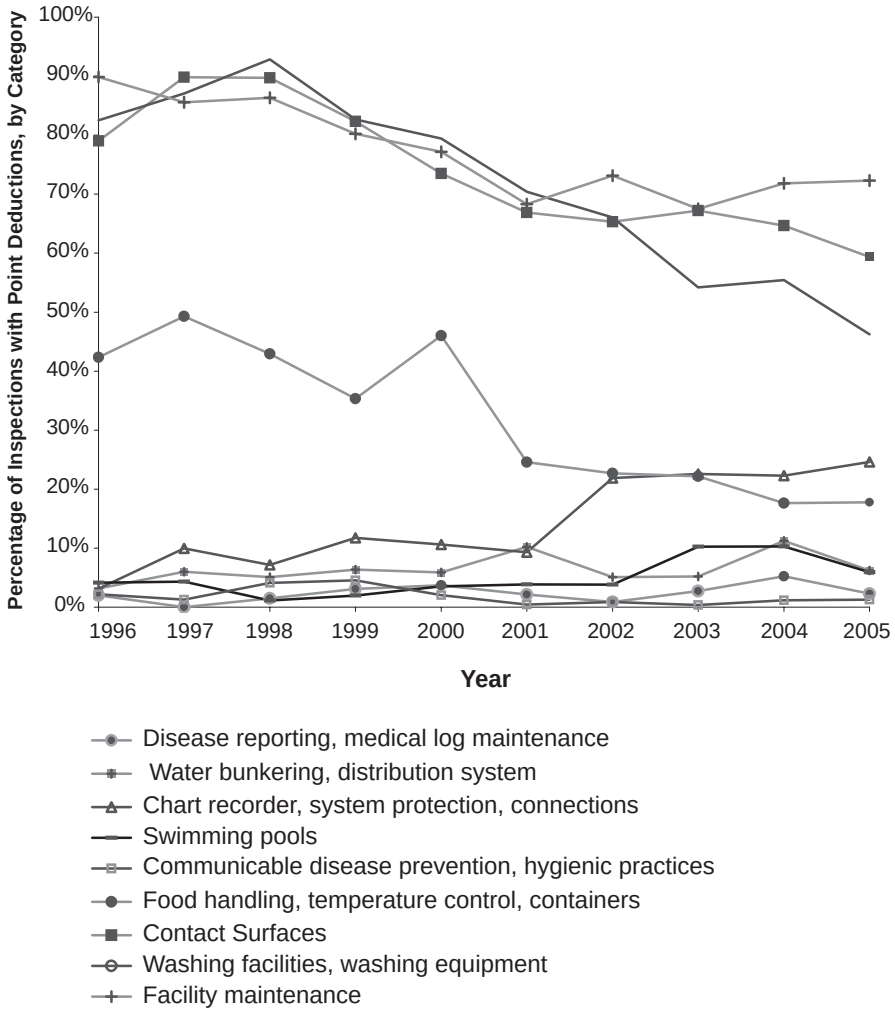
Characteristics of Cruise Ships and Sanitation Inspections (*n* = 1,287), 2001–2005

Ship and Sanitation and Inspection Characteristics	Number of Inspections (%)	Median Inspection Score (Interquartile Range)			Failed Inspections (%)		
			Test Statistic	*p*-Value		Test Statistic	*p*-Value
Ship Size (Gross Registered Tonnage)							
91–1,499	95 (7.4)	91 (6.0)	$r = .376$[a]	<.001	9 (9.5)	5.73[c]	<.001
1,500–19,999	191 (14.9)	94 (7.0)			19 (10.0)		
20,000–59,999	356 (27.8)	95 (5.0)			8 (2.3)		
60,000–79,999	337 (26.4)	96 (5.0)			5 (1.5)		
80,000–151,000	300 (23.5)	97 (4.0)			3 (1.0)		
All (median = 59,652)	1279						
Ship Age (Years)							
0–5	515 (40.1)	97 (5.0)	$r = -.375$[a]	<.001	13 (2.5)	–4.06[c]	<.001
6–10	283 (22.1)	95 (4.0)			6 (2.1)		
11–15	224 (17.5)	94.5 (4.0)			5 (2.2)		
16–20	98 (7.6)	94 (4.0)			4 (4.1)		
21–51	163 (12.7)	92 (6.0)			17 (10.4)		
All (median = 9 years)	1283						
Fleet Size (Number of Ships)							
1–9	644 (50.0)	94 (6.0)	35.78[b]	<.001	38 (5.9)	20.24[d]	<.001
10–23	643 (50.0)	96 (5.0)			8 (1.2)		
U.S. Inspection Region							
Carribean Islands (C)	246 (19.1)	96 (5.0)	Chi = 14.32[b]	.026	7 (2.9)	2.85[d]	.827
Hawaii (HI)	50 (3.9)	95.5 (5.0)			1 (2.0)		
North Eastern (NE)	172 (13.4)	95.0 (5.0)			5 (2.9)		
North Western (NW)	196 (15.2)	95.0 (5.0)			10 (5.1)		
South (S)	83 (6.5)	94.0 (5.0)			2 (2.4)		
South Eastern (SE)	451 (35.0)	95.0 (5.0)			18 (4.0)		
South Western (SW)	89 (6.92)	95.0 (5.0)			3 (3.4)		
Sanitation Inspector							
A	73 (5.8)	94 (5.0)	Chi = 93.35[b]	<.001	1 (1.4)	34.44[d]	.001
B	43 (3.4)	93 (6.0)			7 (16.3)		
C	17 (1.4)	95 (5.0)			0 (0)		
D	148 (11.8)	96 (5.0)			1 (0.7)		
E	159 (12.7)	94 (6.0)			10 (6.3)		
F	197 (15.7)	96 (5.0)			4 (2.0)		
G	105 (8.4)	96 (4.0)			2 (1.9)		
H	95 (7.6)	95 (5.0)			3 (3.2)		
I	166 (13.2)	93 (5.0)			9 (5.4)		
J	91 (7.3)	95 (6.0)			3 (3.3)		
K	23 (1.8)	94 (3.0)			1(4.3)		
L	95 (7.6)	97 (4.0)			3 (3.2)		
M	23 (1.8)	96 (4.0)			2 (9.1)		
N	20 (1.6)	96.5 (6.0)			0 (0)		

[a] Spearman's correlation coefficient.
[b] Kruskal-Wallis.
[c] Cochrane-Armitage.
[d] Chi-square.

FIGURE 2

Regression-Adjusted Cruise Ship Sanitation Inspection Violations[a] by Year, by Inspection Category



[a]n = 2,227.

the same period, there was no significant change in the percentage of inspections that had inspection point deductions in the categories of Disease Reporting (F = 3.2, p < .074) and Water Bunkering Practices (F = 3.78, p < .052). Violations associated with Swimming Pools (F = 14.2, p < .001) and Water System Protection/Chart Maintenance (F = 45.35, p < .001) increased proportionally (Figure 2).

Discussion

As more ships at sea have called on U.S. ports since 1990, VSP has performed increasing numbers of annual sanitation inspections. During the period 1990–2005, the industry as a whole steadily improved its performance and implementation of environmental sanitation programs, as evidenced by increasing median inspection scores. Because characteristics associated with cruise ships such as age, size, and number of ships in the fleet significantly affect performance on sanitation inspections, it is likely that with newer, larger ships at sea and old ships being retired or repositioned outside of North America, as well as growing fleet sizes, this positive trend will continue.

Since 1996, performance in specific sanitation inspection categories improved significantly in five major areas. Newer ships constructed with better, more easily maintained facilities account for improvements in the maintenance of food and nonfood contact surfaces and the overall maintenance of physical structures such as decks, bulkheads, walls, ceilings, lighting, and ventilation. On the basis of published inspection reports and unpublished findings by EHOs, past deficiencies in cleaning noted during inspections have been mitigated to some extent by improved facility construction and improved equipment (e.g., blast chillers), with better interfaces between the two. In addition, enhanced performance has resulted from more consistent sanitizing, faster repair and replacement of equipment, improvements in environmental health program implementation through better and more consistent supervision (Dahl, 2004), hiring of dedicated public health managers, better self-monitoring, and greater participation in training programs.

Since 1996, increased violations occurred in two major areas. Because of additional requirements for daily calibration of water chart recorders, violations associated with Water System Chart Maintenance have occurred proportionally more frequently among inspection violations. Violations associated with the Swimming Pools category have also occurred proportionally more frequently, an increase likely associated with the growing numbers and complexity of pools and spas now featured on ships. In late 2000, changes to the *Vessel Sanitation Program Operations Manual* afforded the opportunity for cruise ships to switch from minimum hot-holding temperatures to time limitations as the public health control for foods on display. Because of the volumes of self-service foods provided on ships, using temperature as a control measure is challenging, and the industrywide change to management systems overseeing time as a control dramatically improved performance in this category. It is estimated that 90 percent of ships are now using time as a food-handling measure, unlike most land-based operations. The change was introduced with a one-year grace period, 2000–2001, during which a greater emphasis was placed on training than on point deductions.

Continued good performance on environmental sanitation inspections and in most inspection categories during the implementation of changes to the *Vessel Sanitation Program Operations Manual* is likely attributable to a number of factors: The one-year transition period allowed for an adjustment to new requirements by food and water handlers, front-line managers, and the inspectors implementing those changes; inspections afforded an opportunity for inspectors to provide one-on-one training and more detailed reports of violations during the transition; and the frequency of training courses for the

industry increased from three classes per year to five per year commencing in 2000.

Although inspection scores are not correlated with norovirus-associated gastroenteritis outbreaks, scores and specific categories of violations on cruise ships are clearly associated with common-source foodborne illness. In particular, inadequate temperature control, infected food handlers, contaminated raw ingredients, cross-contamination, and inadequate heat treatment have been implicated in foodborne-disease outbreaks associated with passenger ships (Lawrence et al., 2004; Rooney, Cramer, et al., 2004). Ship-associated waterborne outbreaks have also been associated with specific deficiencies in water handling, including uploading from an unsafe source, inadequate residual disinfection, water tank contamination, defective backflow prevention, and cross-connections between potable and nonpotable water (Rooney, Bartram, et al., 2004). Similar studies of land-based restaurants report associations between specific inspection violations and outbreaks (Tebutt, 1991). A matched case control study in Seattle–King County reported that restaurants with poor inspection scores and violations of proper temperature controls of potentially hazardous foods were between 5 and 10 times more likely to have outbreaks than restaurants with better scores (Irwin, Ballard Grendon, & Kobayashi, 1989). A Los Angeles County analysis of a risk-based restaurant inspection system reported an association between foodborne outbreaks and the size of the restaurant, the incorrect storage of food, the reuse of food, and the presence of any food protection violation (Buchholz, Run, Kool, Fielding, & Mascola, 2002). There are no published data to specifically associate training courses with prevention of outbreaks on cruise ships; however, land-based studies report better scores for time and temperature violations among restaurants with supervisors and food handlers who have received food service education courses and among restaurants with certification of food handlers (Cotterchio, Gunn, Coffill, Tormey, & Barry, 1998; Fielding, Aguirre, & Palaiologos, 2001; Jones, Pavlin, LaFleur, Ingram, & Schaffner, 2004; Kassa, Harrington, Bisesi, & Khuder, 2001; Mathias, Riben, et al., 1994; Mathias, Sizton, Hazlewood, & Cocksedge, 1995; Mullen, Cowden, Cowden, & Wong, 2002; Riben et al., 1989).

Several limitations of our study were noted during data analysis. Violation data were incomplete before 1995, making evaluation of violations during 1990–1995 impracticable. Because a new operations manual was introduced in November 2000, we expected to see an overall increase in the occurrence of all violations, with an accompanying decline in median inspection scores for the categories of violations affected by the change. Because, however, the revisions were not enforced during most of 2001 as a result of a grace period, we did not see a proportionally significant increase for the pertinent violation categories. Because inspections are conducted over the course of approximately eight hours in a U.S. port during one day, the increasing complexity and size of ships has limited the extent to which the time spent on all inspection categories and the detail with which they are examined can be increased.

Overall, the findings of this study bode well for the cruise industry and the traveling public. Violations representing deficiencies in food-handling practices continue to decrease, while violations associated with water sanitation remain proportionally low. Continued effective inspection program implementation and enforcement, on-site education, and formal training programs are essential to assisting the industry to maximize sanitation program performance and keep its fleets shipshape.

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