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A SURVEY OF MICROBIAL CONTAMINATION ON RESTAURANT NONFOOD-CONTACT SURFACES

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ABSTRACT

Foodborne illnesses are a significant public health concern as they cause approximately 48 million illnesses per year in the U.S.A. It is important to identify and control potential sources of microbial contamination in restaurants to reduce the number of foodborne illnesses. In this study, we aimed to measure microbial contamination on nonfood-contact surfaces in restaurants. These surfaces include tables, chairs, highchairs and booster seats. We found the highest levels of total microbial contamination and staphylococci on booth seats and table chairs with total microbial counts of 151 and 184 CFU/100 cm^2, respectively. Other surfaces found to have over 100 CFU/100 cm^2 were booster seats and cleaning dishcloths. The cleaning dishcloth also contained 59 CFU/100 cm^2 of enteric bacteria. These results suggest the need for more studies aimed to determine the levels of microbial contamination on nonfood-contact surfaces in restaurants with the goal of providing better recommendations for cleaning practices and procedures.

PRACTICAL APPLICATIONS

The cleaning procedures for restaurant furniture and other nonfood-contact surfaces in restaurants are not highly regulated. The information from this study suggests the need for improved cleaning practices and procedures of nonfood-contact surfaces in restaurants. Development and implementation of better guidelines for cleaning has the potential to reduce microbial burden on these surfaces and therefore reduce the risk of foodborne illness.

INTRODUCTION

The Centers for Disease Control and Prevention (CDC) estimates there are approximately 48 million illnesses and 3000 deaths annually due to foodborne illnesses in America alone (CDC, 2015). Various microorganisms can be responsible for these diseases including bacteria, viruses and parasites. Foodborne illness can cause symptoms that include diarrhea, abdominal cramps, nausea and vomiting. The severity of such illnesses ranges from mild to life-threatening (CDC, 2015). Microbial contamination of food or food surfaces can occur at various points in the processes of producing and preparing food. Due to the high incidence of these diseases and their burden on public health, it is important to understand the factors that lead to foodborne illnesses to make efforts to decrease the rates of disease (Yepiz-Gomez *et al.*, 2006).

Potential sources of microbes causing foodborne illness are restaurant surfaces including both food-contact and nonfood-contact surfaces. The cleaning practices of food-contact surfaces in restaurants are highly regulated. These surfaces include kitchen equipment, utensils, food preparation surfaces, food containers and cooking surfaces. However, the regulations regarding nonfood-contact surfaces, like restaurant furniture, are not as strict. According to their regulations manual, SC Department of Health and Environmental Control (SC DHEC) requires that nonfood-contact

TABLE 1. SURFACE MATERIAL, SURFACE SIZE AND SWAB TOTALS FOR EACH SURFACE

Surface	Surface Material	Total Surface Size (area in cm^2)	Surface area sampled (cm^2)	Swab totals	Number of samples
Table	Wood	11,552	533.58	9 horizontal and 9 vertical	4
Booth table	Wood	9,234	533.58	9 horizontal and 9 vertical	4
Chair seat	Vinyl	1,780	533.58	9 horizontal and 9 vertical	4
Booth bench	Vinyl	5,900	533.58	9 horizontal and 9 vertical	4
Highchair seat	Wood	864	864	6 horizontal and 6 vertical	2
Highchair rails	Wood	322	322	1 forward and 1 backward per side (8 total)	2
Booster seat	Plastic	895	895	1 forward and 1 back for each rail and 4 horizontal and 4 vertical for the seat	2
Dishcloth	Cotton	1764	1764	Incubated directly in PBS	1

surfaces, like restaurant furniture, be maintained to avoid an accumulation of dust, dirt and residue and wiping cloths for this job be held in a specific chemical sanitizer solution between uses (SC DHEC, 2014).

Restaurant sanitation, though heavily stressed, is usually neglected on a microscopic scale. Often times, restaurant workers as well as restaurant goers do not concern themselves with that which they cannot see, even though microbial contamination can cause harm to individuals. However, studies have shown that the cleanliness of a restaurant is an important criterion for customers; customers are less likely to choose a restaurant that is not committed to food safety (Henson *et al.*, 2006; Knight *et al.*, 2007).

Most studies on foodborne illness focused on the food itself, food processing and food-contact surfaces. There are few studies aimed at studying nonfood-contact surfaces and their potential roles in microbial contamination and foodborne illness. Yepiz-Gomez *et al.* (2006), for instance, found high levels of microbial contamination on dishcloths used to clean tables and bars in restaurants. This study not only raises concern about the hygiene of cleaning cloths used in restaurants worldwide, but also questions the sanitary level of restaurant furniture on which the cleaning cloths are mainly employed.

The purpose of this study is to investigate the microbial contamination of various nonfood-contact surfaces in a restaurant to determine if the levels of microbial contamination of these surfaces were in an acceptable range. In addition, it aims to determine which surfaces contained the highest levels of contamination. We found that chairs and booth seats contained the highest levels of total microbial contamination, while the dishcloth used to clean restaurant furniture had the highest numbers of gram-negative enteric bacteria. This study provides evidence that nonfood-contact surfaces may benefit from more regular cleaning and could potentially contribute to the number of foodborne illnesses. More work is needed to further examine the microbial contamination of nonfood-contact surfaces and their cleaning practices.

MATERIALS AND METHODS

Sample Site

The study was conducted at a restaurant in Spartanburg, South Carolina during normal business hours. Samples were taken from surfaces that were considered ready for customers. The average cost for a meal at this restaurant is between $8 and 11.

Sample Collection

Samples were collected using 2″ by 1″ sterile Kimtech wipes pre-moistened with 100 μL of sterile phosphate buffered saline (PBS). Wipes were stored in 50 mL sterile conical tubes with screw tops. The wipes were removed from the conical tubes using a sterile glove. To limit variation, one individual performed all of the sampling.

Table 1 provides information on the samples, sample sizes and swabbing methods. Sterile 9″ by 9″ templates were used to swab the tabletops, booth benches and chair seats. Within each template, we collected the sample by wiping the surface with a swab nine times vertically and nine times horizontally, and the wipe was flipped over between the vertical and horizontal swabs. For the highchair, each of the four rails was swabbed twice, with a total of eight swabs. For the seat of the highchair, the sample was collected by wiping the surface with a swab six times vertically and six times horizontally, and the wipe was flipped over between the vertical and horizontal swabs. The booster seat was sampled by using one swab to wipe the back rail and two side rails and each rail was wiped twice. The same swab was used to sample the seat of the booster seat, which was wiped four times horizontally and four times vertically. The wipe was flipped over between

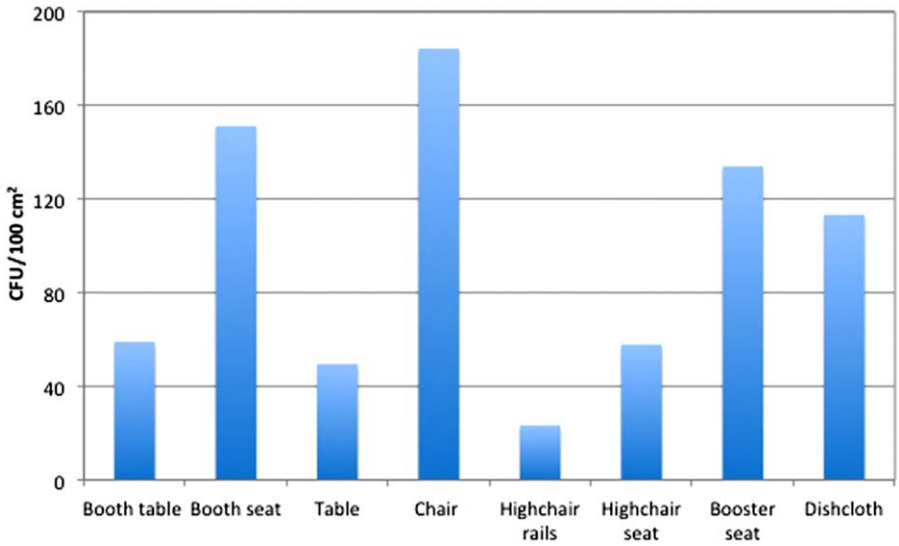

FIG. 1. TOTAL MICROBIAL BURDEN ON NONFOOD-CONTACT SURFACES IN A RESTAURANT. SURFACES WERE SAMPLED USING AN ASEPTIC SWABBING TECHNIQUE DESCRIBED IN THE METHODS. THE SAMPLES WERE THEN PLATED ONTO TSA WITH 5% SHEEP'S BLOOD. TOTAL CFU PER 100 cm^2 ARE GIVEN. DATA SHOWN ARE THE MEAN OF ALL SAMPLES TAKEN FROM EACH SURFACE TYPE. ($n = 4$ FOR BOOTH TABLE, BOOTH SEAT, TABLE AND CHAIR; $n = 2$ FOR HIGHCHAIR RAILS, HIGHCHAIR SEAT AND BOOSTER SEAT; $n = 1$ FOR DISHCLOTH)

the horizontal and vertical swabs. Each wipe was placed back into the conical vial it was removed from and taken to the lab. The dishcloth used to clean restaurant surfaces was removed from the cleaning solution it was stored in in the restaurant and immediately placed in a sterile glass beaker for transport to the lab.

Sample Processing

To assess for microbial contamination, 5 mL of sterile PBS was added to each of the conical tubes containing the wipes. The dishcloth was incubated in 200 mL of sterile PBS in the beaker where it was placed. The samples were vortexed for 1 min to allow the bacteria on the wipe to be transferred to the PBS. The samples were then allowed to settle for 20 min before 100 µL was plated onto prepared media. The samples were plated onto BBL Tripticase Soy Agar with 5% Sheep's Blood (TSA II), which allows for an assessment of all bacteria present in the samples. Selective and differential media were also used to examine the microbes present in the samples. BBL MacConkey II Agar was used for the enumeration of gram-negative bacteria, primarily coliforms and enteric pathogens. BBL Mannitol Salt Agar was used for the enumeration of staphylococci bacteria (TSA II, MacConkey II Agar, and Mannitol Salt Agar plates were purchased from VWR). All plates were incubated at 37°C and colonies were counted after 24 h. Samples suspected of having growth of gram-negative bacteria were subsequently plated on CHROMagar O157 and CHROMagar Salmonella plates (Fisher Scientific). These selective and differential medium plates were used to detect the presence of the foodborne pathogens *E. coli* serogroup O157 and *Salmonella*. No bacteria appearing to be *E. coli* O157 grew and bacteria colonies that were suspected of being *Salmonella* were sent to the microbiology laboratory at Greenville Health System for identification using conventional microbiological techniques.

RESULTS

Various nonfood-contact restaurant surfaces were assayed for microbial burden. Total microbial counts are provided in Figure 1. The average CFU/100 cm^2 is provided for each sample type. Surfaces with the highest levels of microbial growth were the booth seats and chair seats with 151 and 184 CFU/100 cm^2, respectively. The booth seats and chair seats sampled ranged from 9 to 614 CFU/100 cm^2. Other surfaces containing over 100 CFU/100 cm^2 were the child's booster seat and cleaning dishcloth with microbial counts of 134 and 113 CFU/100 cm^2, respectively.

Figure 2 represents the numbers of staphylococci grown on Mannitol Salt Agar plates. The booth seat and chair seat again represent the highest levels of microbial burden with 18 and 21 CFU/100 cm^2, respectively. The tables and dishcloth had the lowest levels of staphylococcal growth. Figure 3 represents the numbers of gram-negative, enteric bacteria grown on MacConkey II Agar plates. Interestingly, the dishcloth was the only sample to grow bacteria on this media with 59 CFU/100 cm^2.

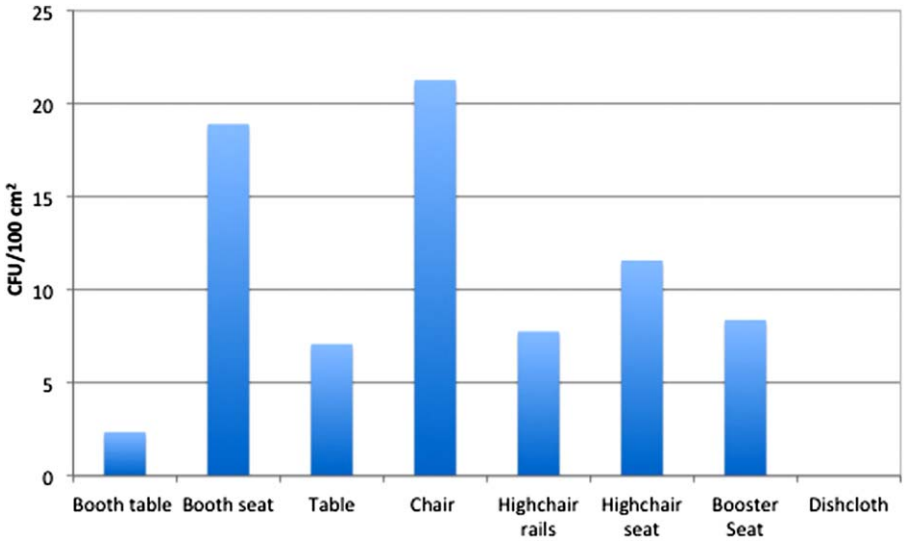

FIG. 2. TOTAL NUMBER OF STAPHYLOCOCCI GROWN ON MANNITOL SALT AGAR. SURFACES WERE SAMPLED USING AN ASEPTIC SWABBING TECHNIQUE DESCRIBED IN THE METHODS. THE SAMPLES WERE THEN PLATED ONTO MANNITOL SALT AGAR TO SELECTIVELY GROW STAPHYLOCOCCI. DATA SHOWN ARE THE MEAN OF ALL SAMPLES TAKEN FROM EACH SURFACE TYPE. ($n = 4$ FOR BOOTH TABLE, BOOTH SEAT, TABLE AND CHAIR; $n = 2$ FOR HIGHCHAIR RAILS, HIGHCHAIR SEAT AND BOOSTER SEAT; $n = 1$ FOR DISHCLOTH)

DISCUSSION

Foodborne illnesses are a significant public health threat and studying ways of preventing these diseases is crucial for lowering their incidence. In this study, we investigated the levels of microbial contamination on nonfood-contact surfaces (e.g., furniture, tables, chairs, handles, menus, highchairs). The cleaning of these surfaces is not as strictly regulated by health agencies as food-contact surfaces are; however, they may present a potential reservoir for foodborne pathogens.

The surfaces contaminated with the most bacteria in this study were seats, which also harbored the highest levels of staphylococci. This finding is not surprising, as seats are less likely to be regularly cleaned in restaurants. Restaurant

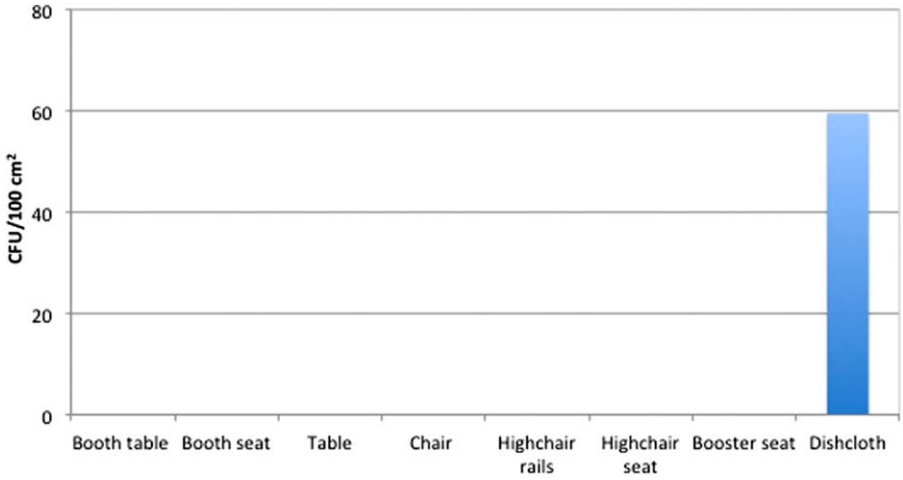

FIG. 3. TOTAL NUMBER OF ENTERIC GRAM-NEGATIVE BACTERIA GROWN ON MACCONKEY II AGAR. SURFACES WERE SAMPLED USING AN ASEPTIC SWABBING TECHNIQUE DESCRIBED IN THE METHODS. THE SAMPLES WERE THEN PLATED ONTO MACCONKEY II AGAR TO SELECTIVELY AND DIFFERENTIALLY GROW GRAM-NEGATIVE ENTERIC BACTERIA. DATA SHOWN ARE THE MEAN OF ALL SAMPLES TAKEN FROM EACH SURFACE TYPE. ($n = 4$ FOR BOOTH TABLE, BOOTH SEAT, TABLE AND CHAIR; $n = 2$ FOR HIGHCHAIR RAILS, HIGHCHAIR SEAT AND BOOSTER SEAT; $n = 1$ FOR DISHCLOTH)

employees are more likely to be concerned with cleaning tables than chairs or booth seats. However, seats often come in contact with hands, shoes, and dropped food and would benefit from being disinfected more often. The finding of staphylococci on these surfaces is also not surprising. Staphylococci are commensal organisms on human skin and are easily transferred to surfaces. One interesting finding in this study was the number of gram-negative, enteric bacteria found on the dishcloth used to clean restaurant surfaces. These cloths are maintained in an open-bucket sanitizing system between uses and then used to wipe down various locations within the restaurant, including tables, buffet lines and counters. The sanitizing solution in the buckets storing the cloths was a quaternary ammonium compound (QAC). QACs are commonly used disinfectants that kill a broad spectrum of bacteria by disrupting the plasma membrane and denaturing proteins (CDC, 2008). Studies have shown that using an open-bucket system with cotton cloths results in a decrease in the concentration of quaternary compounds released in the solution. Gram-positive bacteria are more susceptible to QACs than gram-negative and some gram-negative bacteria have been found to contaminate and grow in the disinfectant. These previous studies align with the results we obtained here, showing the growth of gram-negative bacteria on the cotton cloths stored in sanitizing solution in an open-bucket storage system (CDC, 2008). The level of microbes found on this dishcloth after it was soaking in disinfectant would suggest the need for reevaluation of the cleaning method used for these cleaning cloths. Studies are needed to determine how often the cloths should be changed, what cleaning solution should be used, and how often the cleaning solution needs to be changed. Using a cloth that is contaminated with bacteria, in particular enteric bacteria, to clean restaurant tables and surfaces could allow the spread of bacteria on the surfaces it contacts.

A total of eight samples suspected of having gram-negative bacteria were cultured on CHROMagar O157 and CHROMagar Salmonella Agar. Out of the samples cultured on these differential media, two samples produced colonies appearing to be *Salmonella*, while no samples grew colonies of O157. The bacteria suspected of being *Salmonella* were found on a chair seat and the dishcloth. Colonies suspected of being *Salmonella* were sent to Greenville Health Systems microbiology laboratory for identification. All bacteria sent for identification were *Pseudomonas* species. *Pseudomonas stutzeri*, *putida* and *fluorescens* were definitively identified.

This study was conducted during the summer. We suspect higher microbial loads may be found during winter months, and more importantly more pathogenic microbes that are often circulating during winter months may be isolated during the winter. Additional studies could be done to compare microbial loads on these surfaces during different seasons. All samples were collected from surfaces that had been cleaned using the restaurant's typical procedures and were considered ready for customers. These samples therefore represent the microbial loads that would be expected on surfaces that restaurant goers would encounter. Depending on the regulating body, the acceptable microbial load on food-processing equipment is <250 or 500 CFU/100 cm^2 (Dancer, 2004). While these guidelines exist for these food-contact surfaces, there are no guidelines that provide acceptable microbial loads on nonfood-contact surfaces due to the lack of strict regulations on these surfaces. There are indicator organisms, such as *S. aureus*, that have much lower acceptable levels of <100 CFU/100 cm^2 (Dancer, 2004). Our study suggests the need for more research examining the levels of microbial contamination on nonfood-contact surfaces in an effort to provide acceptable microbial loads for these surfaces and suggest the best cleaning practices and procedures. Future studies should also be done to examine different types of restaurants, as some restaurants are cleaned less often and may have even higher microbial loads on nonfood-contact surfaces. This may include restaurants ranging from high customer volume (i.e., fast food restaurants) to low customer volume (i.e. fine dining restaurants). These different types of restaurants vary in the volume of customers using these nonfood-contact surfaces as well as the frequency and thoroughness of the cleaning of these surfaces.

Therefore, a potential mode of transmission of foodborne pathogens is nonfood-contact surfaces. Food that accidently comes in contact with the surfaces may become contaminated. In addition, the hands of restaurant employees and patrons may become contaminated after contact with these surfaces. It is important to explore nonfood-contact surfaces and evaluate cleaning practices in restaurants. We believe this study demonstrates the need for more studies evaluating the microbial burden and cleaning practices of nonfood-contact surfaces in restaurants.

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