How Clean Are Hotel Rooms? Part I: Visual Observations vs. Microbiological Contamination

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Abstract **Current evidence of hotel room cleanliness is based on observation rather than empirically based microbial assessment. The purpose of the study described here was to determine if observation provides an accurate indicator of cleanliness. Results demonstrated that visual assessment did not accurately predict microbial contamination. Although testing standards have not yet been established for hotel rooms and will be evaluated in Part II of the authors' study, potential microbial hazards included the sponge and mop (housekeeping cart), toilet, bathroom floor, bathroom sink, and light switch. Hotel managers should increase cleaning in key areas to reduce guest exposure to harmful bacteria.**

Introduction

It is ironic that no universal standards currently exist for cleaning hotel rooms, a procedure that is repeated thousands of times every day in the hotel industry. Typically, cleanliness is based on observation. Although this provides for an aesthetic evaluation, it does not address issues related to microbial contamination and the possibility of acquiring an illness from contaminated surfaces. Studies have shown that contact with contaminated surfaces in hotels may be a likely source of transmission of infectious disease during some outbreaks (Kimura et al., 2011; Love, Jiang, Barrett, Farkas, & Kelly, 2002).

Several issues would suggest that observational standards for cleanliness in the hotel industry may no longer be adequate. Global travel has expanded so that the spread of infectious disease may occur on an international scale. For example, global business travel accounted for $1 trillion in 2011 in spite of the influence of a poor global economy (Jonas, 2011). In addition, greater awareness exists of the modes of infectious disease transmission including transfer of microorganisms by touching fomites. The common cold, athletes' foot, influenza, herpes, *Staphylococcus* infections, *Streptococcus* infections, hepatitis, salmonellosis, acute gingivitis, intestinal flu, mononucleosis, tuberculosis, and Legionnaires' disease are just some of the common diseases that travelers can be exposed to while in a hotel (Dykstra, 1990).

Several types of equipment have been used to assess of cleanliness in research studies (Aycicek, Oguz, & Karci, 2006; Cunningham, Rajagopal, Lauer, & Allwood, 2011; Griffith, Cooper, Gilmore, Davies, & Lewis, 2000; Lueck, 2010; Moore & Griffith, 2002; Worsfold & Griffith, 1996). The efficacy of both aerobic plate/colony counts (APC) and adenosine triphosphate (ATP) has been evaluated and both are thought to offer important applications in cleanliness assessment. Research studies often use APC as the first test to compare surfaces to determine areas of greatest contamination, focusing on particular areas that are considered high touch or wet sites that may be overlooked in typical cleaning (Mulvey et al., 2011; Scott, Duty, & McCue, 2009). Assessment using ATP meters is also common in research studies suggesting that they are also well accepted although they lack specificity in that they also assess organic residues (Worsfold & Griffith, 1996). Their advantages are that they offer more rapid results, are easier to use, and do not require a laboratory for analysis.

The purpose of our study was to determine if observational standards provide an accurate indicator of hotel room cleanliness. More specifically, APC is used to determine the levels of microbial contamination in hotel rooms and evaluate whether observational standards provide an accurate indicator of hotel room cleanliness. Recommendations for further research are also suggested including the need for testing standards in hotel rooms.

Methods

Hotel Sampling

Microbial sampling of 19 hotel guest room surfaces was conducted by independent trained

TABLE **1**

Surfaces Sampled Within Hotel Guest Rooms

Room door handle (internal)	Bathroom door handle	Mug (when used in room)
Main light switch	Bathroom floor	Glove from maid cart
Entry carpet	Bathroom faucet	Mop from maid cart
Headboard	Bathroom sink	Sponge from maid cart
Bedside lamp switch	Shower floor	Curtain rod
Telephone keypad	Toilet paper holder	
TV remote keypad	Toilet basin	

TABLE **2**

Mean Total Aerobic Bacteria Counts (CFU/cm²)

Item Rank (Clean to Least Clean)	Mean (Samples 1–9)	*SD*
Curtain rod	0.5	0.6
Headboard	0.5	1.0
Bathroom door handle	3.9	9.8
Shower floor	4.0	6.4
Room door handle	5.7	7.6
Bathroom faucet	6.5	13.9
Mug	9.1	14.2
Toilet paper holder	10.6	15.1
Entry carpet	11.2	8.3
Glove FMC*	18.2	15.9
Telephone keypad	20.2	25.0
Bedside lamp switch	21.7	39.4
TV remote keypad	67.6	109.2
Main light switch	112.7	332.7
Bathroom sink	117.8	331.0
Bathroom floor	119.0	330.6
Toilet basin	225.1	439.4
Mop FMC*	270.1	451.5
Sponge FMC*	505.1	529.2

Note. For the purpose of these calculations, counts of too numerous to count were replaced with 1,000 CFU/cm².
*FMC indicates that the item is from the maid cart used to clean the room.

researchers using three rooms and housekeeping carts in three hotels in Texas, Indiana, and South Carolina (one hotel per state) for a total of nine rooms. Because some hotel rooms did not have all of the sampling surfaces (e.g., mugs) a total of 162 samples were collected.

Hotel properties represented typical guest rooms that can be found in midscale hotels throughout the U.S. Properties ranged from approximately 100 to 200 rooms and included one full-service hotel with a restaurant and conference meeting space. Properties catered primarily to business travelers and some leisure travelers. Because of the controlled conditions used for sampling and the careful selection of hotel properties, the small number of rooms used in this study was deemed to be adequate to explore the possibility of microbial contamination in typical hotel rooms.

The hotel rooms in each hotel were also expected to represent typical rooms for that property. They were randomly selected by the general managers of the hotels based on guest departures and were cleaned by three different housekeepers in each of the hotels. The rooms were sampled after the rooms were cleaned and classified as vacant and ready to rent.

Surfaces that were selected for sampling in the hotel rooms included both bathroom areas as well as areas that would be considered "high touch" or "hand touch" in the bedroom area as these are considered in other locations such as hospitals to be habitually contaminated with pathogens (Dancer, 2009). Sites included floors, handles, switches, keypads, sinks, faucets, and toilets in the guest rooms, and three sites from the housekeeping cart including a used glove, mop, and sponge. The sites are listed in detail in Table 1.

Sampling Protocol

To avoid cross contamination during the data collection process prior to each sampling, the researchers washed their hands thoroughly and used a new set of sterile gloves prior to collecting data in each room. Using standard microbial techniques (Davidson, Griffith, Peters, & Fielding, 1999), each surface was swabbed aseptically in a 5-cm² area with sterile cotton swabs moistened in phosphate buffered saline (PBS) solution using sterile aluminum foil templates to define the area to be swabbed. After sampling, the wood handle of each swab was snapped off to ensure aseptic practices and to keep the cotton portion in the PBS-filled 15-mL centrifuge tubes after they were capped. This procedure was done to allow sampled microorganisms to remain viable until microbial testing was performed. The samples were then placed into insulated boxes with refrigerant and shipped overnight to the Food Microbiology Laboratory at the University of Houston for testing.

Bacterial Quantification

APC was used to assess levels of (general) bacterial contamination using standard techniques. APC is one of the most commonly used methods of microbial testing and has, been used in studies related to cleaning, as described previously (Cunningham et al., 2011; Yoon et al., 2008). APC was conducted using Petrifilm aerobic count plates to determine the aerobic bacteria population. The microbial samples were vortexed in 15-mL centrifuge tubes for 10 seconds using a fixed speed vortex mixer to release any bacteria from the swab. One mL of the PBS solution from the vortexed tubes was then pipetted

onto the APC Petrifilm. A plastic spreader disc was placed on top of the film to disperse solution (as per the manufacturer's instructions) and the film was incubated for 24 hours at 37°C and the colonies were quantified.

E. coli/coliform counts were also conducted as additional indicators of contamination. Coliform bacteria live in the intestines of warm blooded animals and are therefore often used as an indicator of sewage or fecal contamination. For this test, prepared samples as previously described were plated on Petrifilm *E. coli*/coliform count plates, incubated at 35°C for 24 hours, and quantified.

Results

APC

A total of 160 useable samples from surfaces from the nine hotel rooms and housekeeping carts were obtained and tested for aerobic bacteria using the APC method. Two samples were returned with an inadequate volume of PBS to complete this test and were deemed unusable. The mean and standard deviation of the bacteria counts for samples 1–9 are given in Table 2.

Highest levels of contamination were found with two items from the housekeeping cart, three areas in the bathroom, and one high-touch area in the main room. In terms of the mean aerobic bacterial count, highest levels were found for the sponge, mop, toilet basin, bathroom floor, bathroom sink, and main light switch. In support of this, sporadic very high levels ("too numerous to count" or TNTC) were found four times for the sponge, twice for the mop and toilet basin, and once each for the main light switch, the bathroom floor, and the bathroom sink. As found with other research studies discussed in the literature review, results varied widely.

Coliform Counts

A total of 159 useable samples from surfaces within nine different hotel rooms were obtained and tested for total coliform bacteria counts. After conducting the APC, one additional sample had an inadequate volume of PBS to complete this test and was deemed unusable. The mean and standard deviation of the coliform bacteria counts for samples 1–9 are given in Table 3.

Coliform count results identified some of the same sites as the APC as being heavily contaminated, although lower overall counts were found in coliform testing as compared to the APC testing. This would be expected due to the more specific nature of microbial contamination associated with the coliform count. Highest mean coliform counts were found for the sponge, mop, bathroom sink, and main light switch. Again, sporadic very high levels (TNTC) were found four times for the sponge, and once each for the main light switch, bathroom sink, and mop. In addition, as reported with other research studies, results varied considerably.

Because industry standards are not yet developed for the hotel industry, an exploratory approach was employed similar to the Scott and co-authors (2009) cleaning study, which drew comparisons at the 25th and 75th percentiles based on median levels of contamination. In our study, the exploratory approach was used to assess how many samples would meet the aerobic plate count standards of 5 CFU/cm^2, 10 CFU/cm^2, and 50 CFU/cm^2 (Table 4). In addition, a comparison was also made to how many samples would meet the coliform count standards of 1 CFU/cm^2, 2 CFU/cm^2, and 10 CFU/cm^2 (Table 5). As can be observed from these tables, numerous surface samples were still above these levels of contamination.

TABLE **3**

Mean Total Coliform Bacteria Counts (CFU/cm^2)

Item Rank (Clean to Least Clean)	Mean (Samples 1–9)	*SD*
Room door handle	0.0	0.0
Bathroom faucet	0.0	0.0
Bathroom door handle	0.1	0.2
Toilet basin	0.1	0.2
Toilet paper holder	0.1	0.2
Curtain rod	0.1	0.2
Headboard	0.1	0.4
Bedside lamp switch	0.1	0.3
TV remote keypad	0.1	0.4
Shower floor	0.1	0.4
Bathroom floor	0.2	0.6
Entry carpet	0.3	0.5
Mug	0.6	1.0
Glove FMC*	1.2	2.5
Telephone keypad	1.3	3.8
Main light switch	111.1	333.3
Bathroom sink	111.2	333.3
Mop FMC*	125.2	353.5
Sponge FMC*	500.1	534.4

Note: For the purpose of these calculations, counts of too numerous to count were replaced with 1,000 CFU/cm^2.
*FMC indicates that the item is from the maid cart used to clean the room.

Discussion

Although this research suggests a potential starting point for further research in industry standards, industry applications may already be drawn. First of all, results of our study suggest that potential microbial hazards may exist in some hotel rooms. Secondly, surface sampling results may be used as a starting point to determine levels of bacterial contamination in hotel rooms and point to specific areas of the hotel room that may require greater attention for cleaning. Rooms division managers or executive housekeepers might consider these areas more closely in their cleaning protocols. Room attendants should focus their limited time in the guest room to cleaning those surfaces that are more likely to be contaminated. In addition, if supervisors are monitoring or evaluating hotel room cleaning done by room

TABLE **4**

Number of Samples Passed Based on Proposed Critical Limits for Aerobic Plate Counts

Surface Type	# Items Pass/Total # Samples		
	5 CFU/cm²	10 CFU/cm²	50 CFU/cm²
Room door handle	6/9	6/9	9/9
Main light switch	6/9	8/9	8/9
Entry carpet	3/9	4/9	9/9
Headboard	9/9	9/9	9/9
Bedside lamp switch	5/9	5/9	7/9
Telephone keypad	2/9	3/9	8/9
TV remote keypad	4/9	4/9	7/9
Bathroom door handle	8/9	8/9	9/9
Bathroom floor	5/9	6/9	8/9
Bathroom faucet	7/9	8/9	9/9
Bathroom sink	4/9	6/9	8/9
Shower floor	7/9	7/9	9/9
Toilet paper holder	4/9	7/9	9/9
Toilet basin	5/9	6/9	7/9
Mug	2/3	2/3	3/3
Glove FMC*	2/9	4/9	9/9
Mop FMC*	3/8	3/8	4/8
Sponge FMC*	2/8	2/8	4/8
Curtain rod	6/6	6/6	6/6

Note: For the purpose of these calculations, counts of too numerous to count were replaced with 1,000 CFU/cm².
*FMC indicates that the item is from the maid cart used to clean the room.

attendants, they may wish to focus their attention on these more critical areas.

As research progresses in hotel cleaning, the areas identified in our study should be further evaluated. As to the room surfaces tested in our study, many areas presented relatively low or infrequent bacterial contamination. Other areas presented very high levels, particularly from the housekeeping cart. This evaluation is beneficial in identifying areas of consistently high levels of bacterial contamination and routes of possible transmission. It is important to note that the risk of contracting illness or disease from an environmental surface is dependent on what type of bacteria are present and the levels of contamination. While APC does not indicate whether the microorganisms are pathogenic or not, it can be used as an indicator of the overall level of cleanliness of a surface by enumerating the total aerobic microbial load. In addition, coliform bacteria (indicating fecal contamination) were isolated from at least one sample of each item sampled except for the internal room door handle and bathroom faucet. Relatively high levels of contamination were found at some point on nearly all surface areas sampled.

Based on the mean aerobic bacteria counts, the high-risk items were the sponge and mop from the housekeeping cart, the toilet basin, the bathroom floor, the bathroom sink, and the main light switch. It is interesting to note that high-touch areas such as the door handles and the telephone keypad were not classified as high risk according to this analysis, as frequently touched surfaces have been cited as likely reservoirs of bacteria (Lueck, 2010). Based on the mean aerobic bacteria counts, the low risk items were the curtain rod, the headboard, the bathroom door handle, the shower floor, the room door handle, the bathroom faucet, and the mug.

Based on mean coliform bacteria counts, the high-risk areas were the sponge and mop from the housekeeping cart, the bathroom sink, the main light switch, the telephone keypad, the glove from the housekeeping cart, and the mug. Based on mean coliform bacteria counts, the surfaces presenting the lowest risk of contamination included the internal room door handle, the bathroom faucet, the bathroom door handle, the toilet basin, the toilet paper holder, the curtain rod, and the headboard. It is interesting to note that the majority of the lowest risk contaminated items were located in the bathroom. This could be attributed to the use of more stringent cleaning chemicals and the smooth nonporous nature of such surfaces.

The mop and sponge from the housekeeping carts demonstrated consistently high levels of both aerobic and coliform bacteria counts. These findings support previous studies indicating that sponges and cloths used for cleaning purposes are capable of sustaining the growth and survival of bacteria (Hilton & Austin, 2000; Mattick et al., 2003; Sun-Young, 2010). One of these studies also observed that rinsing the cloth between usages resulted in a significantly lower rate of transfer, while rinsing the sponge between usages did not (Hilton & Austin, 2000). The ability to transfer bacteria from sponges during cleaning to surfaces has been shown (Hilton & Austin, 2000; Kusumaningrum, Riboldi, Hazeleger, & Beumer, 2003; Mattick et al., 2003). Also, the transfer of bacteria from surface to hand and hand to mouth has been demonstrated (Rusin, Maxwell, & Gerba, 2002). Contact with contaminated surfaces has been cited as a possible mode of disease acquisition (Barbut & Petit, 2001; Jones, Kramer, Gaither, & Gerba, 2007).

While the mops and sponges from housekeeping carts had high levels of aerobic and coliform bacteria, the gloves sampled from housekeeping carts had significantly lower counts. This difference could be attributed to the use of a new pair of gloves for each room cleaned, as opposed to the continued use of the mop and sponge in different rooms. Proper use of disposable gloves has been shown to be an effective means of reducing the cross transmission of microorganisms (Berthelot et al., 2006; Larson, 1995). Hotel managers may wish to consider the use of more disposable items (including cleaning supplies) to help lower microbial counts. Further research is recommended on the effectiveness of cleaning or disinfecting the cleaning supplies for repeated use.

Conclusion

Even though all of the rooms in this sample appeared visually clean, APC tests confirmed that some areas of the guest rooms, as well as the maid carts, had high levels of contamination. Visual inspection does not appear to be a reliable indicator of cleanliness.

Although our study provides an assessment of the potential for microbial contamination in hotel rooms, one limitation of the study is the sample size of only nine rooms. A greater sample size would perhaps have provided a more accurate depiction of the hotel room cleaning. In addition, it is important to note that a high level of standard deviation occurred in the results for the tested items. Because actual hotel rooms were tested after having been cleaned, however, the large standard deviation might also suggest the need for more standardization of cleaning practices. One additional limitation of our study is that no testing standards exist for interpretation of our data. The concept of hotel room cleanliness will be discussed in part II of this study.

Protecting the health and safety of hotel guests is clearly important for hotel managers and for travelers who stay in their hotels. Research can help hotel managers more objectively evaluate cleaning rather than relying on visual assessment. Plainly, the time has come for more information about to how effectively clean hotel rooms, a routine practice done hundreds of thousands of times a day, but still needing improvement.

TABLE **5**

Number of Samples Passed Based on Proposed Critical Limits for Coliform Bacteria

Type of Surface	# Samples Pass/Total # Samples		
	1 CFU/cm²	2 CFU/cm²	10 CFU/cm²
Room door handle	9/9	9/9	9/9
Main light switch	8/9	8/9	8/9
Entry carpet	7/9	9/9	9/9
Headboard	8/9	9/9	9/9
Bedside lamp switch	9/9	9/9	9/9
Telephone keypad	8/9	8/9	8/9
TV Remote keypad	8/9	9/9	9/9
Bathroom door handle	9/9	9/9	9/9
Bathroom floor	8/9	9/9	9/9
Bathroom faucet	9/9	9/9	9/9
Bathroom sink	8/9	8/9	8/9
Shower floor	8/9	9/9	9/9
Toilet paper holder	8/8	8/8	8/8
Toilet basin	9/9	9/9	9/9
Mug	2/3	3/3	3/3
Glove FMC*	7/9	7/9	9/9
Mop FMC*	7/8	7/8	7/8
Sponge FMC*	4/8	4/8	4/8
Curtain rod	6/6	6/6	6/6

Note: For the purpose of these calculations, counts of TNTC were replaced with 1,000 CFU/cm².
*FMC indicates that the item is from the maid cart used to clean the room.

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