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Evaluating Accuracy of Sampling Strategies for Fluorescent Gel Monitoring of Patient Room Cleaning

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Narrative abstract:

We compared fluorescent gel removal rate from fewer high touch surfaces (HTS) and rooms, with a “gold standard” rate from 2942 HTS, 228 rooms, 13 units. Randomly selecting three HTS in two rooms predicted gold standard removal rate.

Keywords

Fluorescent gel; fluorescent gel monitoring; environmental hygiene; evaluation of environmental cleaning; infection control; cleaning and disinfection; sampling strategy

Introduction

A contaminated healthcare environment contributes to pathogen transmission. [1,2] Environmental Evaluation with Fluorescent Gel (EFG) is recommended to improve patient room cleaning. [3,4] FG, only visible with UV light, is placed on high touch surfaces (HTS) in patient rooms and bathrooms. After an interval, removal is checked using UV light.[5] Removed FG (not visible using UV light) indicates cleaned, and remaining FG uncleaned HTS. But, number of 1) HTS and 2) rooms to check balancing data accuracy with resource

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use is unknown. This study aims to elucidate least number of HTS and rooms required to predict FG removal rate of room and hospital unit.

Methods

The Johns Hopkins Hospital (JHH) is a 1,020 bed tertiary acute care teaching facility, in Maryland. Between December 2016 and August 2017 we assessed FG (DAZO©) removal for largest number of available HTS (min 7, max 21), in 228 rooms from 13 varied- specialty hospital units i.e. the “gold standard”. Standardized protocol and random number generators selected unit and room. Assessment occurred 36 hours post placement. We noted if room required contact precautions and if cleaning was daily or discharge. Daily if same patient room occupant at FG placement & checking, discharge if different room occupant.

During the study, the routine hospital infection prevention EFG program with feedback continued. No changes in environmental care associate (ECA) education occurred. ECAs were unaware of the extra FG markings. Johns Hopkins Medicine institutional review board approved the study.

We examined six different sampling strategies to see the least number of HTS needed per room. We chose strategies we considered feasible: one, two, three, four, or five random HTS per room, or one random HTS in main room plus one in bathroom. We calculated each room’s actual FG removal rate by dividing number of HTS with removed FG by total number of HTS checked. We generated 100 bootstrap samples for each strategy to ensure results would not depend on a single sample. We calculated sampling error, distance between each sample removal rate and actual FG removal rate. We report percent of samples with sampling error of ≤ 10% and ≤ 5%, for each strategy. Optimal sampling strategy was the least number of HTS where all samples had tolerable sampling error frequency (≤ 10%). This “tipping point” is where more HTS would not significantly increase accuracy, but rather increase labor effort and cost. We stratified rooms into high (>=80%) and low (<80%) FG removal rate, discharge and daily clean, and explored how the prediction might vary.

We applied the same approach for sampling rooms on a unit. If rooms were randomly selected more than once, we include only the first observation. We used Stata version 15 (Stata Corp., College Station, TX, USA).

Results

We placed and checked FG on 2942 high touch surfaces, in 228 rooms, on 13 units, at JHH. The average number of FG HTS placements per room was 17. Overall FG removal rate was 75%; discharge 88% (SD 27%) and daily 71% (SD 27%). Table 1 shows frequency each HTS was checked and its FG removal rate. Contact precautions were in place at room cleaning for 22/228 (10%). Table 2 compares actual FG removal rates with the sampling strategies and frequency of sampling errors.

Three randomly selected HTS from two randomly selected rooms, was the optimal number of HTS and rooms predicted FG removal on the unit. Analysis of combined sampling strategies for number of HTS and rooms found average sampling error of 0.02 (standard

error = 0.01). One of the 13 units has a sampling error larger than 0.05. Three randomly selected HTS remained optimal for rooms with low FG removal rates (n=62), and daily cleaning assessment (n=166). For rooms with higher overall FG removal rates (n=128) and discharge cleaning (n=62) two randomly selected HTS was optimal.

Discussion

We evaluated 2942 HTS, in 228 rooms on 13 hospital units; consistent FG assessment of three HTS in two rooms reflects entire room and unit removal rate. Inclusion of more HTS or rooms did not significantly enhance accuracy. We found near patient higher risk HTS (patient area; bedrails, IV keypad, vitals monitor) were cleaned less often. Evaluating at least one near patient high risk HTS for each room would ensure data from these critical areas for monitoring and feedback. Our FG removal rate (overall 75%, discharge 88%, daily 77%) is higher than published literature, which report discharge rates of 49% to 61%.[6,7,8] Optimal HTS number could depend on FG removal rate. To enhance generalizability, we stratified into low and high FG removal rates, and discharge and daily clean. When less variability in FG removal rate, e.g. rate >80%, or discharge cleans only, one fewer HTS assessment per room provided similar accuracy. Overall, for hospitals who do not know FG removal rates, or where rate <80%, three HTS from two rooms (all randomly selected) should represent that unit.

These findings provide guidance to infection prevention or environmental services teams starting EFG program. Hospitals yet to start a program may perceive significant extra human resource need. However, choosing every two weeks as a reasonable interval, we estimate EFG for three HTS, two rooms, on five units, takes five hours per month. Random selection of rooms and HTS ensures representation of contact precaution rooms, and rooms where patients are present. This may enhance validity and efficiency of existing EFG programs. Some existing programs selectively target FG assessment of discharge cleaning only. Identifying those patients planned for discharge, or FG placement after patient has left but before cleaning starts, is challenging due to postponement of discharges, and need for timely turnover of rooms. These study data may simplify that process and importantly, expand EFG programs to include daily cleaning.

This study has some limitations. A gold standard of FG assessment of every HTS in every room every day was not feasible. Our gold standard was 228 randomly selected rooms to represent the hospital. This study was in one academic hospital, and cleaning practices may differ in other settings. However, our stratification of FG removal rate into high and low may help hospitals adapt these findings to their cleaning program.

Our results suggest that sampling a small number of HTS in a small number of rooms is enough to check environmental cleaning on a unit. Hospitals should focus resources here given importance of improving room cleanliness and relatively low human resource need. Studies using systems engineering initiatives to improve patient room cleaning are underway.[9]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Frequency of FG placement and removal on high touch surfaces in the Observed Rooms (n = 228 rooms)

High touch surface	# FG placed	% FG removed
Main room		
Side bed rail	199	59.3%
Vital signs monitor	137	25.5%
Call bell	109	78%
Bedside tray table	213	73.2%
Supply cart	87	69%
IV pole (grab area)	138	57.2%
IV pump (touch area)	134	53.7%
Side table	150	70.7%
Telephone	96	80.2%
Chair	158	75.3%
Main room sink rim	175	74.3%
Main room sink faucet	174	84.5%
Bathroom outside door handle	227	78.9%
Bathroom		
Bathroom grab bar	214	79.9%
Flush handle	215	87.9%
Toilet seat	213	79.3%
Bathroom inside door handle	223	79.8%
Bathroom light switch	220	75.5%
Bathroom sink rim	216	84.7%
Bathroom sink faucet	216	87%
Bathroom soap dispenser	218	78.4%
Towel bar	201	81.6%

Table 2.

Summary statistics of actual FG removal rates, sampling errors, and percentage of rooms with sampling error ≤ 10% and 5%

	Actual FG removal rate, mean (SD)	Sample error		% with sampling error ≤ 10%	% with sampling error ≤ 5%
		Mean	SD		
Number of FG HTS assessments required to represent a room					
All rooms (n rooms = 228)					
1 HTS per room	75.4% (25.5%)	0.023	0.024	98.2	86.8
2 HTS per room		0.018	0.019	99.6	94.3
3 HTS per room		0.015	0.016	100	95.2
4 HTS per room		0.013	0.012	100	99.6
5 HTS per room		0.011	0.011	100	100
1 HTS in the main room and 1 HTS in the bathroom		0.018	0.022	99.6	94.3
Number of FG HTS assessments required to represent a room based on high or low overall FG removal rate					
Removal rate <80% (n rooms = 100)					
1 HTS per room	53.0% (23.3%)	0.034	0.027	97.0	74.0
2 HTS per room		0.026	0.022	99.0	87.0
3 HTS per room		0.021	0.019	100	89.0
4 HTS per room		0.017	0.013	100	99.0
5 HTS per room		0.014	0.011	100	100
1 HTS in the main room and 1 HTS in the bathroom		0.025	0.027	99.0	90.0
Removal rate >=80% (n rooms = 128)					
1 HTS per room	92.8% (6.3%)	0.015	0.017	99.2	96.9
2 HTS per room		0.011	0.012	100	100
3 HTS per room		0.010	0.011	100	100
4 HTS per room		0.009	0.010	100	100
5 HTS per room		0.008	0.009	100	100
1 HTS in the main room and 1 HTS in the bathroom		0.013	0.015	100	97.7
Number of FG HTS needed to accurately represent daily cleaning and discharge cleaning processes					
Daily cleaning (n rooms = 166)					
1 HTS per room	70.7% (27.2%)	0.026	0.022	98.2	86.1
2 HTS per room		0.019	0.019	99.4	92.8
3 HTS per room		0.015	0.015	100	95.2
4 HTS per room		0.013	0.012	100	99.4
5 HTS per room		0.012	0.011	100	100
1 HTS in the main room and 1 HTS in the bathroom		0.020	0.024	99.4	92.2
Discharge cleaning (n rooms = 62)					
1 HTS per room	87.8% (14.4%)	0.017	0.025	98.4	88.7
2 HTS per room		0.013	0.015	100	98.4

	Actual FG removal rate, mean (SD)	Sample error		% with sampling error ≤ 10%	% with sampling error ≤ 5%
		Mean	SD		
3 HTS per room		0.013	0.017	100	95.2
4 HTS per room		0.012	0.013	100	100
5 HTS per room		0.008	0.010	100	100
1 HTS in the main room and 1 HTS in the bathroom		0.013	0.013	100	100
Number of FG room assessments required to represent a unit (n unit = 13)					
1 room		0.012	0.015	100	84.6
2 rooms		0.019	0.016	100	100
3 rooms	79.8% (10.8%)	0.011	0.014	100	100
4 rooms		0.008	0.010	100	100
5 rooms		0.008	0.007	100	100

FG: fluorescent gel markers; HTS: high touch surface.